New insights into the rates of soil formation and their contribution to our understanding of soil lifespans

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Declaration

Except where references are made to other sources, I declare that the contents of this thesis are my own work and have not been previously submitted, in part or full, for the award of a higher degree elsewhere. Collaborations with other researchers are properly acknowledged.

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April 2020

Statement of Authorship

This thesis has been prepared as a set of papers intended for submission to peer-reviewed journals. The papers are presented in the format intended for submission, with the exception that each paper's list of references can be found in a consolidated bibliography at the end of this thesis. All papers have multiple authors, and their contributions are detailed below. Chapters 1, 2 and 7 are introductory, review, and discussion chapters, respectively, and are not intended for submission.

Chapter 1 outlines the main research challenges and structure of this thesis, and is not intended for publication.

Chapter 2 comprises a review of the literature and is not intended for publication.

Chapter 3 is in review for *European Journal of Soil Science*

Evans, D. L., Rodés, Á. and Tye, A. M. (2020) The Sensitivity of Cosmogenic Radionuclide Analysis to Soil Bulk Density: Implications for Soil Formation Rates.

D.E. designed the research, acquired the data and conducted data analysis. Á.R. designed the CoSOILcal model with contributions from D.E. D.E. wrote the manuscript, with contributions and revisions from Á.R. and A.T.

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D.L.E., J.N.Q. and J.A.C.D. designed research; D.L.E. performed research; D.L.E., J.N.Q and J.A.C.D. analysed data and D.L.E wrote the paper with contributions from all co-authors.

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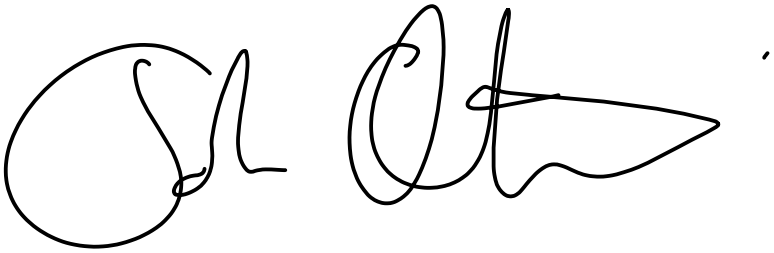
Chapter 7 comprises a general discussion and conclusion, and is not intended for publication.

I hereby agree with the above statements:



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‘There is one moment at sunset in the country when the whole visible world seems to gather itself in prayer and it seems to you strange that men should move on unconscious of this with spades over their shoulders, instead of falling on their knees in the grass; for in that hush, in the benediction of seconds before the first star shines, the universe seems waiting for a revelation.’

H. V. Morton (1927)

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I must make one final remark. Submitting my thesis represents the closing chapter in my four-year pursuit for a Doctor of Philosophy. Upon reflection, I realize I have always had *Philosophia* – a 'love for wisdom' – and it is this unremitting passion for knowledge that has partly fuelled me throughout this degree. But a love for wisdom only carries you so far, though. In times of self-doubt or rejection, when the hurdles feel too high, or when the path ahead seems unclear, one may need more than a love for a subject. Thankfully, I had more – *much* more. I had unwavering companionship and loyal support from all those in the 'Sustainable Soils' group: Pedro, Emma, Aimee, Rosanne, Bea, Hollie, Rose, Tori, Cristina, Jonathan, Roisin, Helena, Marx, Jacky, Stacia, Lael, Gabriel, and Dmitry. Likewise, I could always rely upon friends in STARS to get me laughing again at the end of a busy week: Mihai, Hannah, Emily, Lucy, Chris, Lewis, and Alex, to name only some. Often, I would need some projects away from research to recharge, and thanks to Benjamin Vis, TruLife, and the British Society of Soil Science, I always had plenty of options! Sometimes, I needed to unload on my closest friends: thank you for listening Sophie Paddock, Beckie Grimmer, Rachael Seaman, Lucinda Webb, Ben Church, Lewis Martins, 'Odd Pastonians', Emma Cooper, and Georgie Wood. And finally my greatest thanks must go to the most loyal,

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Abstract

Sustaining the provision of services by soils for future generations has become a critical goal for soil scientists. Preventing soil thinning and the exposure of the underlying parent material is paramount for achieving this goal. Soil thinning occurs when rates of soil erosion exceed those of soil formation. Although measuring soil erosion has received widespread attention, there has not been a commensurate effort to obtain rates of soil formation, and this undermines our capacity to determine the long-term sustainability of our soils. This thesis responds to that sizeable knowledge gap in two ways: measuring soil formation rates at sites previously subject to soil erosion monitoring, and demonstrating how rates of soil formation and erosion can be used to estimate soil lifespans.

Cosmogenic radionuclide analysis was used to measure the rates of soil formation across four UK hillslopes. These included the first measurements of their kind for arable soils, under some of the thickest soil profiles that have been subject to this technique. For the first time, the CoSOILcal model was used to account for the effect of variable soil bulk density on the attenuation of cosmic rays. A sensitivity analysis showed that accounting for these bulk density data for profiles thicker than 0.25 m brings about a significant difference in the calculated rates of soil formation. The rates obtained for the four hillslopes studied here fell within the range of those previously published for similar climates and lithologies. However, it was also found that rates were faster for lithologies with a greater porosity and a reduced matrix.

At one of the sites, rates of soil formation and erosion were used to calculate the lifespans for both the A horizon and the profile to bedrock. The shortest lifespans were found on the backslope, with the loss of the A horizon and bedrock exposure occurring in 138 and 212 years, respectively, in a worst-case scenario. Longer lifespans were observed for less erosive zones such as the toeslope where the time until bedrock exposure was more than triple that of the backslope. Similar analyses of soil lifespans were undertaken at the global scale. Combining over 10,030 plot years of erosion data from 255 sites with rates of soil formation, 93% of conventionally managed soils were found to be thinning, and 16% reported lifespans of less than 100 years. However, adopting conservation land-use and management practices were found to extend these lifespans, with over a third exceeding 10,000 years.

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Abbreviations used

ALD	Active Layer Development
AMS	Accelerator Mass Spectrometry
ASL	Above Sea Level
FAO	Food and Agriculture Organization of the United Nations
IPCC	Intergovernmental Panel on Climate Change
ISRIC	International Soil Reference and Information Centre
LOI	Loss On Ignition
NIST	National Institute of Standards and Technology
SEM	Scanning Electron Microscope
SLT	Soil Loss Tolerance
USDA	United States Department of Agriculture
WCED	World Commission on Environment and Development
WRB	World Reference Base

Chapter 1: Introduction

1.1 Threats to soils and soil functioning

Soil science enters the third decade of the 21st century enjoying a disciplinary renaissance (Hartemink and McBratney, 2008). There has been increasing recognition about the unique roles that soil plays in the Earth system as a critical nexus between the lithosphere, hydrosphere, biosphere, atmosphere and anthroposphere. The inextricable dependence that humankind places on soil resources means that they are not only the venue of geomorphological processes, but responsible for addressing societal demands too, including water purification, carbon storage, nutrient cycling, gene reserve, waste bioremediation, and habitat provision (Blum, 1993; Lal, 2009; Verheijen *et al*., 2009; Larkin, 2015; Vereecken *et al*., 2016). Since a third of global soil resources are moderately or highly degraded, ensuring that soils meet these present-day demands has become an intensified challenge for soil scientists (Bot *et al*., 2000). In addition, the United Nations' projection that the global population will rise to 9.7 billion by 2050 (FAO, 2015a) further exacerbates the pressures placed on soils. Ensuring that soils will continue to deliver ecosystem services for future generations against a contextual backdrop of increasing demand and uncertain environmental change has become one of the most critical items on the soil science agenda.

Resistance and adaptation to a suite of environmental and human-induced pressures are important for a soil to remain sustainable. However, there are two principal challenges that threaten soils and their functionality which are, arguably, of greater hierarchical importance: soil thinning and soil removal.

1.1.1 Soil thinning

The thickness of soil is one of the critical factors that promotes or constrains soil functionality (Patton *et al*., 2018). Over decadal to centennial timescales, soil thickness plays an important role in the geomorphology of landscapes. For instance, previous work has shown that soil thickness is a fundamental variable in influencing the stability and drainage of hillslopes (Dietrich *et al*., 1995). Over shorter time periods, soil thickness has been shown to affect the runoff and residence of water (Botter *et al*., 2011). This has important implications on the storage of plant-available water, and therefore, primary productivity (Evaristo *et al*., 2015). In addition, soil thickness significantly determines the size and the stability of the soil organic carbon reservoir. For example, the mean residence time of soil organic carbon has been shown to increase down the soil profile, with values between 2,000 and 10,000 years in soils that are deeper than 0.2 m (Fontaine *et al*., 2007).

Such is the importance of soil thickness on a variety of ecosystem functions and geomorphological processes that soil thinning can represent a serious threat. The extent of that threat is dictated by the rate of soil thinning (the rate of net soil loss) and the original soil thickness. For example, a soil profile of 5 m thickness thinning at a rate of 2 mm y^{-1} does not pose as much of a threat than a soil of 1 m thickness thinning at a rate of 0.5 mm y^{-1}, even though the rate is four times greater.

1.1.2 Soil removal

Without amelioration, the trajectory of any thinning soil is one that ultimately leads to the exposure of the underlying parent material. In the absence of soil,

it is palpably clear that soil ecosystem services cannot be delivered. Often the complete removal of the soil cover takes place on the most erosive convexities of hillslopes. Zhang *et al*. (2008) demonstrate that the extent of bedrock exposure on an arable hillslope in the Sichuan Basin (southwestern China) is influenced, in part, by the frequency of tillage. After five tillage events, the length of bedrock exposure was 1.05 m, representing 4.8% of the total experimental area. After a further ten tillage events, the length of bedrock exposure had more than doubled to 2.2 m. Similarly, the area of exposure had increased by more than 5%.

For some soil profiles it may be difficult to ascertain the point at which the soil has been removed, and the parent material has become exposed. This may largely depend on one's definition of soil. The most recently published definition is: "the layer(s) of generally loose mineral and/or organic material that are affected by physical, chemical, and/or biological processes at or near the planetary surface and usually hold liquids, gases, and biota and support plants" (van Es, 2017, p. 21). Furthermore, it could be the case that some parent materials have the physical, chemical and biological properties necessary for basic ecosystem functions, or the capacity to be developed relatively quickly into a proto-soil. For example, a mudstone or similar soft-rock may be able to be crushed by tillage equipment in order to preserve a shallow, but otherwise cultivable regolith. However, this regolith is likely to lack the organic carbon, nutrients, and aggregate stability to sustain a crop over multiple seasons.

1.2 Soil sustainability: two research challenges

In the previous section, two principal threats to soil sustainability were presented: soil thinning and soil removal. Both of these threats manifest when soil erosion rates exceed those of soil formation.

Soil erosion has received widespread scholarly attention (Kirkby and Morgan, 1980; Hooke, 2000; Boardman and Poesen, 2006; Montgomery, 2007; Quinton *et al*., 2010; Poesen, 2017). Many authors have attributed erosion as one of the most significant aspects of global soil degradation (Bot *et al*., 2000; Quinton *et al*., 2010). The anthropogenic acceleration of soil erosion, and the need for its effective attenuation on agricultural landscapes, is increasingly being discussed by governments and policy makers (IPCC, 2019). Over the last century, a range of soil conservation strategies aimed at reducing the rates of soil erosion have been deployed. These efforts have included changes to land use, such as afforestation and grassland restoration, and adaptations to agricultural practices, such as adopting conservation tillage or cover cropping (Panagos *et al*., 2016). However, active investment around the world in quantifying and evaluating the severity of soil erosion for this objective is overshadowed because we do not know, with equivalent accuracy, the rates of soil formation.

There are arguably two research challenges associated with the study of soil formation that need to be addressed for the effective combatting of soil thinning and soil removal.

1. The first research challenge is the impoverished state of the soil formation rate inventory. The meagre dataset of soil formation rates has been noted

by soil scientists, previously. Many authors comment on how “field measurements are impossible” (Li *et al*., 2009, p. 97), “limited data are available” (Schertz, 1983, p. 11) and how “current scientific knowledge on soil formation processes is insufficient” (Duan *et al*., 2017a, p. 8). To some extent, this challenge has been partly tackled by the conception of new field- and laboratory-based methods to measure rates of soil formation. Despite these methodological developments, there is still a dearth of soil formation data, which contrasts with the frequent and widespread measurement of soil erosion. This compromises our ability to determine the balance between soil formation and soil erosion, and therefore whether soils are thinning or not.

2. Second, the existing soil formation rate inventory has been mostly collated by those outside soil science (Portenga and Bierman, 2011; Heimsath *et al*., 2012) and so expectedly it has hitherto paid little contribution to the soil sustainability discourse. Instead, rates of soil formation have been obtained from uncultivated (often mountainous or ‘pristine’) sites in order to determine rates of landform and landscape evolution. One of the implications of this is that there have been few, if any, studies where rates of soil formation and soil erosion have been measured in parallel. Addressing this challenge is essential to better understand the sustainability of our global soil resources.

1.3 Thesis Structure

This thesis will respond to the research challenges presented above in the following sequence:

1. **Chapter 2:** To establish our current knowledge and understanding of soil formation, an extensive review of the literature will be conducted. It will first engage with the existing methodological approaches that soil scientists use to measure the rates of soil formation (Section 2.1.1 and 2.1.2). Next, a comprehensive global inventory of previously reported soil formation data will be presented (Section 2.1.3), followed by a discussion into the limiting factors that control the process of soil formation (Section 2.1.4). After this, the review will explore two applications of soil formation data: soil productive lifespans (Section 2.2) and soil loss tolerance (Section 2.3).

2. **Chapter 3:**

   Gap: In cosmogenic radionuclide analysis, bedrock lowering rates are inferred by measuring concentrations of Beryllium-10, and using a cosmogenic depth-profile model to calculate the attenuation of cosmic rays to the bedrock. To date, this model has assumed that the bulk density of the soil overlying the bedrock is either equal to that of the bedrock or constant with depth. The failure to acknowledge variations in soil bulk density in cosmogenic radionuclide analysis means that we do not know the sensitivity of soil formation rates to this important parameter.

   Research question: To what extent are cosmogenically-derived soil formation rates, measured at the soil-saprolite interface, sensitive to the overlying soil bulk density profile?

   Objectives: (1) Develop a model that calculates isotopically-derived soil formation rates, considering the bulk density profile of the soil overlying the

bedrock surface; (2) Use the model developed in Objective 1 to re-calculate cosmogenically-derived rates of soil formation.

Deliverables: (1) CoSOILcal model: a calculator that accounts for soil bulk density when deriving soil formation rates; (2) Sensitivity analysis of the effect of soil bulk density on cosmogenically-derived soil formation rates; (3) A revised global inventory of soil formation rates, recalculated using the CoSOILcal model.

3. **Chapter 4:**

   Gap: Although rates of soil formation and soil erosion have been measured separately, there has been no attempt to bring these datasets together to assess global soil lifespans.

   Research question: What is the distribution of soil lifespans globally and to what extent can changes in land-use or management practices extend them?

   Objectives: (1) Compile a global inventory of soil erosion rates from the published literature; (2) Quantify soil lifespans for each study compiled in Objective 1; (3) Assess the extent to which land-use or management change extends soil lifespans.

   Deliverables: (1) A global soil erosion dataset: 10,030 plot years of annual water erosion rates, derived from 1,103 erosion plot-based records from 240 studies, that comprise 255 unique locations across 38 countries; (2) Estimated soil lifespans for bare, conventionally-managed and conservation-managed soil.

4. **Chapter 5:**

   Gap: For soils currently supporting arable agriculture, cosmogenically-derived soil formation rates and rates of soil erosion have never been empirically measured in parallel. Therefore, we are unable to accurately assess the balance between soil formation and soil erosion, and thus unable to calculate soil lifespans.

   Research question: To what extent do rates of soil erosion exceed the rates of soil formation at two sites in the United Kingdom, and what are the estimated soil lifespans?

   Objectives: (1) Using cosmogenic radionuclide analysis, derive rates of soil formation for two sites in the United Kingdom (one arable and one woodland); (2) Quantify soil lifespans at the arable site.

   Deliverables: (1) Twelve ^{10}Be-derived soil formation rates for two catena sequences in an arable and coniferous woodland setting; (2) Estimated soil lifespans at the arable site.

5. **Chapter 6:**

   Gap: Although there has been a growing awareness about the role of major bedrock types on governing rates of soil formation, there has been no cosmogenic study into the effects of the lithological variabilities of a single rock type.

   Research question: To what extent does sandstone porosity govern rates of soil formation?

   Objectives: (1) Using cosmogenic radionuclide analysis, derive rates of soil formation for two arable hillslopes in the United Kingdom (one fluvially-

derived sandstone and one marine-based sandstone); (2) Statistically test the difference between rates of soil formation measured from fluvially-derived sandstone and those procured from marine-based sandstone; (3) Statistically test the difference between rates of soil formation measured in this study and those from other groups of sandstone using the global soil formation rate inventory.

Deliverables: (1) Sixteen ^{10}Be-derived soil formation rates for two catena sequences in arable settings.

6. **Chapter 7:** Finally, a general discussion of this thesis' findings will be presented, including an evaluation of the work, areas for further research, and an impact statement detailing how these findings may influence society.

Chapter 2: Literature Review

2.1 Soil Formation

2.1.1 Definitions

The study of soil formation – pedogenesis – is one of the oldest scholarly pursuits within soil science (Dokuchaev, 1879). The intellectual jurisdiction for a soil formation scholar is also very wide. In consequence, multiple definitions of pedogenesis exist (Table 2.1), ranging from the accumulation and transformation of parent material, the horizonisation of soil profiles, and the factors that influence the evolution of soil properties. Not only are there multiple foci, but there is a similarly inconsistent use of terminology within the discourse. A Web of Science search (1950 – 2017) found that scholars are just as likely to use 'Soil Formation' (*n* = 2,292) and 'Soil Development' (*n* = 1,947) in their publications as 'Pedogenesis' (*n* = 2,600). Furthermore, 'Soil Evolution' (*n* = 298), 'Soil Production' (*n* = 315) and 'Soil Genesis' (*n* = 466) are also commonly used terms.

Despite the multifarious strands of soil formation work, it could be argued that there are two categories by which to organise the research. The first grouping concerns itself with the accumulation of soil mass. Examples of this work include the research into the development of residual soils from bedrock weathering (Stockmann *et al*., 2014), or the generation of soils from parent material of allochthonous provenance, such as loess or alluvium (Catt, 2001). The second grouping focuses on the ways by which a soil profile matures from undifferentiated regolith into one with a series of distinctive horizons with distinguishing physical, chemical, and biological properties, from which

particular processes operate. Examples of this include the work carried out by Phillips (1993) who studied the “degree of pedogenic alteration and profile organisation”. A similar categorisation is observed between soil erosion and soil degradation. Whilst soil erosion is concerned with the absolute loss of soil mass from the system (often quantified in units of mass over area), soil degradation is concerned with the regressive changes to soil properties that lead to the decline of soil health and soil productivity (Lal, 2001).

The *mass* of a soil must first be present before soil profile development can take hold. At what stage does weathered rock or deposited parent material become soil is a contested question. There is also an argument that certain horizon-building and soil structure transformations are required before regolith can be recognized as soil. Nevertheless, understanding the mass losses from a soil system warrants a similar effort in quantifying the mass inputs into it. In consequence, the remainder of this section within the review will focus on soil formation as the accumulation of soil mass.

Table 2.1: Definitions of soil formation

Source	Definition
Shaw (1930)	Modification and partial destruction of the parent material by the action of water, air, temperature changes, and organic life.
Jenny (1941)	Transformation of rock into soil is designated as soil formation.
Simonson (1959)	Accumulation of parent materials and the differentiation of horizons in the profile. Of these two steps, the second is of more immediate concern to soil scientists.
Hurni (1983)	A mixture of processes which involve gains, losses, and transformations of different components, occurring at different rates in different horizons.
Catt (1991)	Changes to uppermost layers of the Earth's crust occurring beneath stable land surfaces.
Wakatsuki and Rasyidin (1992)	Rate of formation of soil materials that have the same mean composition as the mean composition of the A, B and C horizons of the soils in the area.
Phillips (1993)	Soil Development is defined here as the degree of pedogenic alteration and profile organization (where) … development is characterized by increases in thickness and by increasing degrees of alteration of parent material.
McAuliffe (1994)	Soil horizon development.
Huggett (1998)	Product of essentially downwards acting processes that lead to two sets of interrelated layers – the A Horizons and the B Horizons, which constitute the solum.
Minasny and McBratney (1999)	Breakdown or weathering of the underlying parent materials under physical, chemical, and biological processes, which will result in the lowering of the soil-bedrock interface.
Bockheim and Gennadiyev (2000)	Soil horizons, properties, and materials.
van Breemen and Burrman (2002)	Processes responsible for the formation of major genetic horizons.
Wilkinson and Humphreys (2005)	Rate at which saprolite is altered to soil.

Wilkinson and Humphreys (2005)	Development of horizons…a continuation of mineral alteration that began during the development of saprolite.
Ewing *et al*. (2006)	A mass balance between inputs and losses over integrated timescales.
Richter *et al*. (2007a)	Transformations over time, as energy chemical elements, and water are processed.
Targulian and Krasilnikov (2007)	The result of synergetic processes of self-organization of an in situ soil system during its functioning in time and space.
Targulian and Krasilnikov (2007)	Transformation of the solid-phase lithomatrix (parent material) of the soil system into the pedomatrix (soil body, soil mantle).
Yoo and Mudd (2008)	Chemical weathering of primary materials.
Verheijen *et al*. (2009)	Natural process of soil accumulation at any location.
Duchaufour (2012)	Initially thin surface soil gradually increases in thickness and successive layers, become differentiated in terms of colour, texture and structure to form a profile.
Egli *et al*. (2014)	A net change in the mass balance of the soil compartment.
Egli *et al*. (2014)	Transformation of the parent material into soil due to chemical and physical weathering, mineral transformation, and the lowering of the bedrock (or parent materials)–soil boundary.
Stockmann *et al*. (2014)	Conversion of parent material to soil combining physical and chemical processes.
Schaetzl and Thompson (2015)	All the natural processes involved in the formation of soils, including progressive and regressive processes.
Vereecken *et al*. (2016)	The combination of physical, chemical, biological and anthropogenic processes acting on a soil parent material over periods from years to millennia.
Yu *et al*. (2017)	Biogeochemical weathering, as a combination of physical, chemical, thermal, and biological processes together causing the disintegration of rocks, an evolutionary process that does not stop with the initial formation of soil.

2.1.2 Measuring rates of soil formation

The question “how fast does soil grow?” posed by Stockmann *et al*. (2014) represents one of the many examples when soil science scholars have enquired into the rates of soil formation. Whilst Li *et al*. (2009, p. 97) suggest that “field measurements are impossible”, there are many empirical methods to quantify rates of soil formation. Three of the most practiced include chronosequences, radioisotopic dating, and cosmogenic radionuclide analysis.

2.1.2.1 Chronosequences

Chronosequences are “a group of related soils that differ from one another, primarily as a result of differences in time or soil age, as a soil-forming factor” (Schaetzl and Thompson, 2015, p. 740). This adopts the ergodic principle where soils across space have the ability to also represent soils across different time periods (Huggett, 1998). In the context of measuring the rates at which the bedrock is converted to soil, the depth and age of soil can be used to estimate rates of soil formation. There are three critical presuppositions when employing this method. The first is that *time* is the only state factor of soil formation allowed to change, whilst all other state factors – climate, organisms, relief, and parent material – remain constant. In reality, and particularly for long (decadal to centennial) periods, this is not the case because these latter factors are variable. The second issue is that the chronosequence concept assumes that the rates of soil formation are constant. However, there is evidence to suggest that soil formation rates are self-limiting, with rates declining as soil mass increases (Wilkinson and

Humphreys, 2005). This will be further explored in Section 2.1.4.1.4. The third assumption is that the age of the soil is known. Accurately dating soils is a complex objective, as this review will now explore.

2.1.2.2 Radioisotopic dating

A number of radioisotopic dating techniques have been applied to estimate the age of distinct horizons within soil profiles, each with differing degrees of accuracy and precision, and each with their own inherent uncertainties. Radiocarbon dating is often utilized due to the fact that the radiocarbon cycle is relatively well understood (Ramsey, 2008). Radiocarbon, which is produced in the upper atmosphere, is converted to $^{14}CO_2$ and is then absorbed by plants during photosynthesis, such that it becomes incorporated as part of that plant's biomass. When the plant dies, this uptake of radiocarbon ceases, and the concentration of residual $^{14}CO_2$ in decaying leaves or seeds can be measured using Accelerator Mass Spectrometry (AMS) and used to determine the radiocarbon age (Taylor, 1987; Linick *et al*., 1989). This provides a minimum age of the soil.

Although the use of AMS dating is fast and requires a small sample size (2 – 30 mg), allowing one to select the most pristine portion of the carbon within a sample, there is an incongruity between the radiocarbon age and calendar age. This is because radiocarbon production in the atmosphere varies over time. Furthermore, soil horizons store a wide variety of organic matter representing many different stages of decomposition and thus ages potentially ranging over millennia (Tipping *et al*., 2010). To some extent, this can be addressed by calculating a 'mean residence time' which accounts for all humic

compounds that comprise the organic matter fraction within a sample (Paul *et al*., 1964). However, this does not resolve the fact that some carbon particles within the soil profile may be allochthonous, and introduced to the soil profile at a later date, thus leading to the erroneous over-estimation of the radiocarbon age.

2.1.2.3 Cosmogenic radionuclide analysis

Cosmogenic radionuclide analysis was first used to constrain the rates of various geomorphic processes by Lal (1991) but the technique was adapted for pedological studies by Heimsath *et al*. (1997). Terrestrial cosmogenic radionuclides (such as ^{10}Be, ^{26}Al, and ^{36}Cl) are produced when secondary cosmic rays interact with minerals in the uppermost metres of the Earth surface (in this case, the bedrock). The concentration of these radionuclides is dependent upon both the duration of bedrock exposure to cosmic rays, and the denudation of this bedrock into weathered regolith. If the bedrock is not directly exposed (i.e.: overlain by a mantle of soil) it is also important to determine the attenuation of these cosmic rays. This is often achieved using a model conceived by Lal (1991). Many other additional considerations are often applied in this process, including the need to normalize the radionuclide production rate in accordance with the site's elevation, longitude and latitude and, furthermore, any topographic shielding that may obstruct the cosmic ray flux (Dunne *et al.,* 1999; Stone *et al*., 2000; Balco *et al*., 2008; Stockmann *et al*., 2014).

The concentration of the radionuclide in a sample of soil-mantled bedrock (*a* in Figure 2.1; hereafter referred to as the 'current bedrock surface') can be

measured using Accelerator Mass Spectrometry. Given that secondary cosmic rays are attenuated as they travel through the soil profile (*b* in Figure 2.1), this means that less of the radionuclide is produced at depth than that which is produced at the soil surface. The soil surface in this instance represents the 'old bedrock surface' (*c* in Figure 2.1). In other words, this would have been the position of the bedrock surface before soil started to form. By quantifying the extent to which cosmic rays are attenuated, the measured concentration of the radionuclide at the current bedrock surface can be used to calculate that at the old bedrock surface. By knowing the annual production rate of the radionuclide, and this back-calculated concentration, the age of the soil can be estimated; that is to say, the time since the bedrock was at the Earth's surface. Finally, this age and the depth to the new bedrock surface (*d* in Figure 2.1, which is equal to the thickness of the soil) can be used to calculate the rate of bedrock lowering.

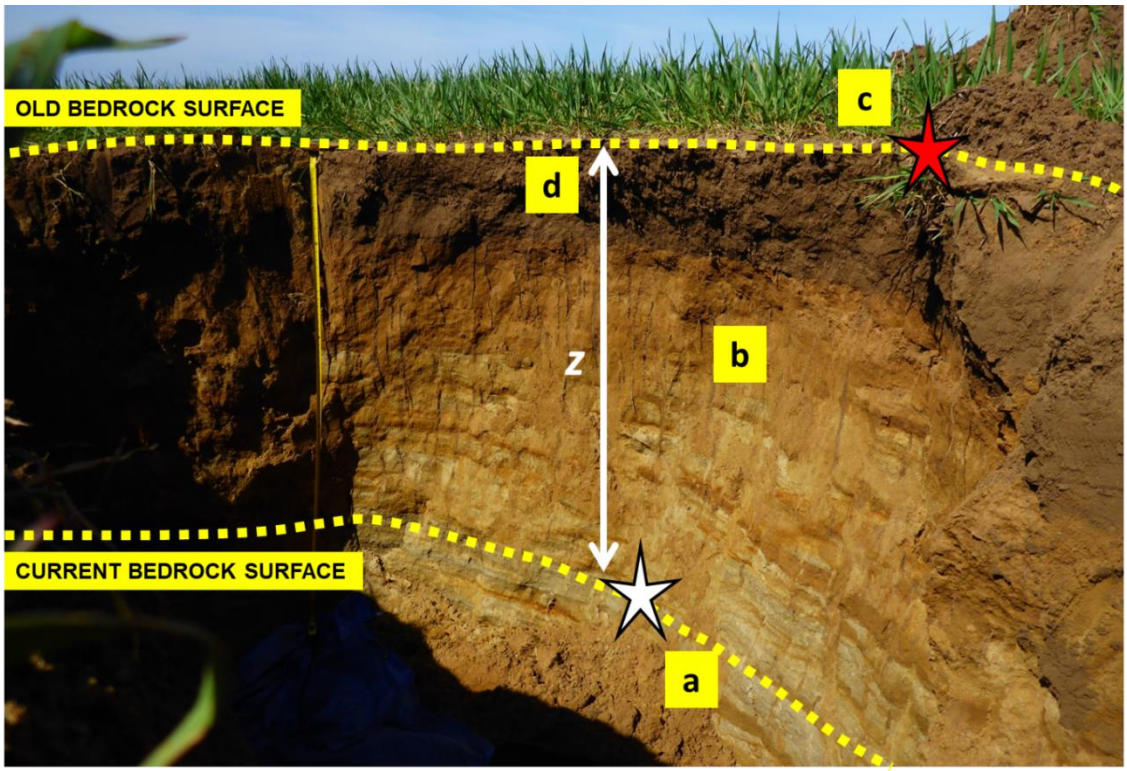

Figure 2.1: Schematic outlining the main steps of calculating soil formation rates from cosmogenically-derived concentrations of a radionuclide. Measured concentrations of a radionuclide in a sample from the current bedrock surface (*a*) and the attenuation of cosmic rays through the soil profile (*b*) are used to calculate the radionuclide concentration at the current soil surface (the old bedrock surface, *c*). In a final step (*d*), this surface concentration can be used to calculate an approximate age since the start of bedrock lowering. By dividing the age by the depth to the current bedrock surface (*z*), the rate of bedrock lowering (or soil formation) can be calculated. Photograph was taken by the author.

2.1.3 Rates of soil formation

Although there are multiple methods to measure the rates of soil formation, cosmogenic radionuclide analysis has become one of the most utilized, and provides the best opportunity to cross-compare rates across a wide range of environments. As a result, this review will focus on cosmogenically-derived soil formation rates.

^{10}Be-derived rates of soil formation (*n* = 243) were amassed by combining a range of previously published studies (Dixon *et al*., 2009; Heimsath, 2006; Heimsath *et al*., 1997; 2000; 2001a; 2001b; 2005; 2009; 2012; Owen *et al*., 2009; 2011; Riggins *et al*., 2011; Small *et al*., 1999; Wilkinson *et al*., 2005). This inventory represents fifteen sites across four countries (Australia, USA, Chile, and the UK). As such, six different Köppen climates are represented (Aw, Bsk, Bwk, Cfa, Cfb, and Csb) as well as all three major rock types (igneous, sedimentary and metamorphic). Although Portenga and Bierman (2011) present more ^{10}Be-derived rates of soil formation, these stem from samples extracted from bare rock terrain (outcrops, tors) and catchment deposits (stream sediments). Moreover, rates of weathering for bare bedrock surfaces have been shown not to be equal to rates of bedrock weathering at the soil-saprolite interface (Wilkinson and Humphreys, 2005).

Rates of soil formation span four orders of magnitude, ranging from 6×10^{-5} to 6×10^{-1} mm y^{-1} with a median of 0.021 mm y^{-1}. The fastest rates (0.010 – 0.594 mm y^{-1}; median = 0.069 mm y^{-1}) are associated with Warm Summer Mediterranean (Csb) climates (*n* = 103) whilst the slowest rates (0 – 0.005 mm y^{-1}; median = 0.001 mm y^{-1}) are found for Arid Cold (Bwk) climates (*n* = 38) (Figure 2.2). This is most likely due to the fact that bedrock weathering, and thus soil formation, is less effective in environments where water is limited which reduces the potential for frost shattering (Portenga and Bierman, 2011; Stockmann *et al*. 2014). Moreover, the fastest rates (0.009 – 0.359 mm y^{-1}; median = 0.038 mm y^{-1}) are associated with sedimentary lithologies such as sandstones and siltstones (*n* = 55). These contrast with the slowest rates (0 – 0.594 mm y^{-1}; median = 0.014 mm y^{-1}) measured from soils developing on

metamorphic lithologies, such as metasediments and gneiss (*n* = 120) (Figure 2.3). This may be explained by the fact that sedimentary rocks are inherently more porous which increases the residence time between water and rock grains, and enhances their susceptibility to weathering (Morel *et al*., 2003; Palumbo *et al*., 2009).

It is possible that the rates of soil formation presented here are overestimates. Given that these soil formation rates all stem from cosmogenic radionuclide analysis, this inventory is biased towards relatively shallow soils where access to the soil-bedrock interface makes for easier sample acquisition. The median depth for the inventory presented here is 0.35 m (range: 0.025 – 3.2 m) whilst only 6% of the inventory (five studies) report formation rates for soils deeper than a meter (*n* = 15). It is widely acknowledged that rates of soil formation exponentially decrease as soil thickens (Wilkinson and Humphreys, 2005). In this inventory, soils deeper than 1.5 m have a median formation rate of 0.013 mm y^{-1} (*n* = 7), nearly half that of the overall median reported for the total inventory.

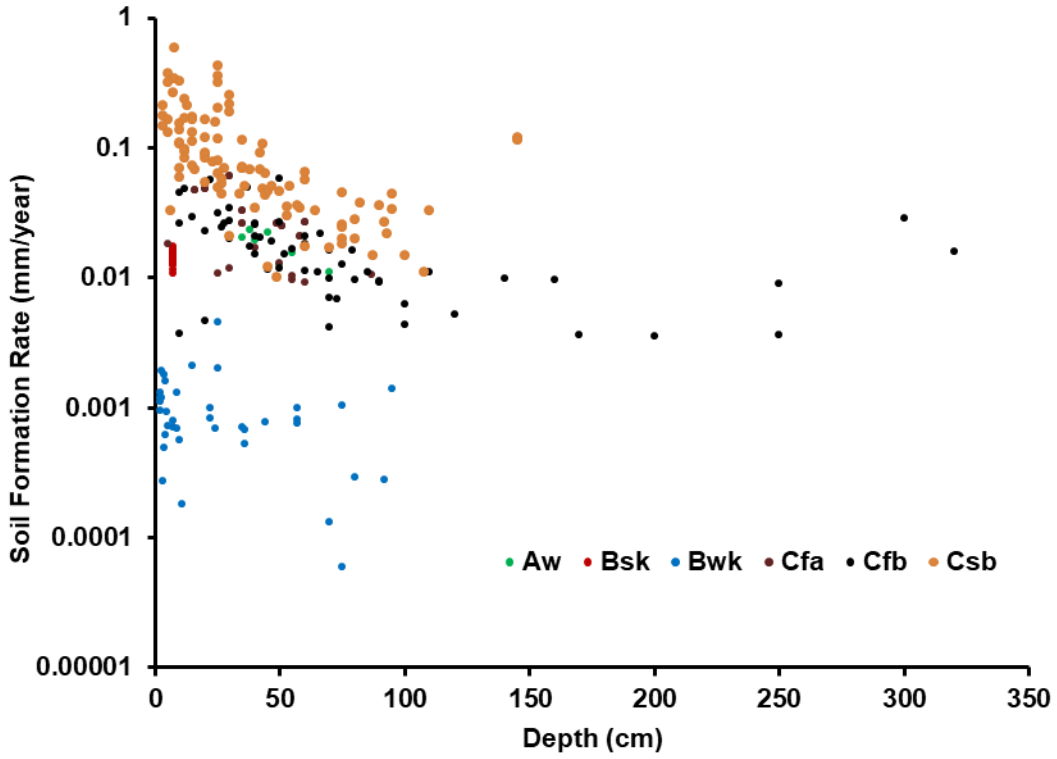

Figure 2.2: Global inventory of soil formation rates against soil depth, grouped by Köppen climate type (*n* = 243). Aw = tropical wet-dry; Bsk = cold semi-arid; Bwk = cold desert; Cfa = humid subtropical; Cfb = temperate oceanic; Csb = warm summer Mediterranean. For full dataset, see Appendix 2.1.

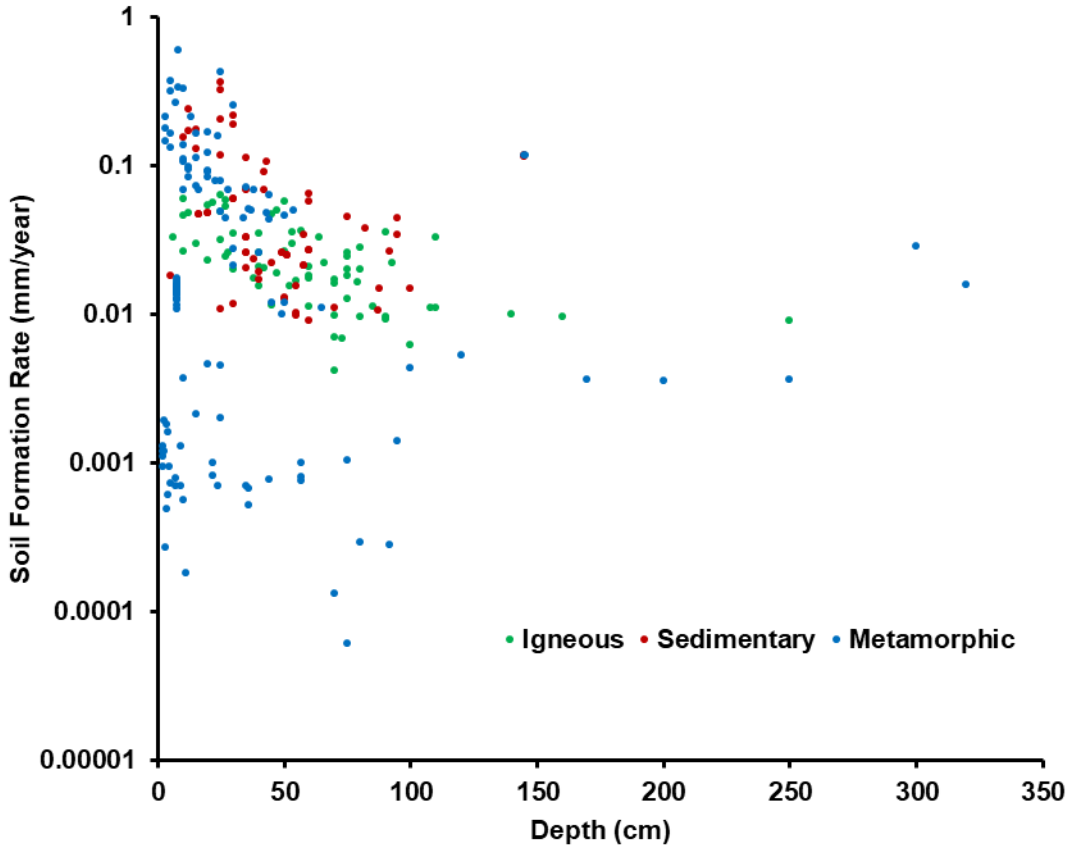

Figure 2.3: Global inventory of soil formation rates against soil depth, grouped by lithology (*n* = 243). For full dataset, see Appendix 2.1.

2.1.4 Factors that affect the rate of soil formation

As previously shown in Table 2.1, there are a range of definitions that have been applied to describe 'soil formation'. Many of these refer to the breakdown and transformation of the underlying bedrock, and the subsequent weathering processes that convert saprolite into soil (Shaw, 1930; Jenny, 1941; Minasny and McBratney, 1999; Wilkinson and Humphreys, 2005; Egli *et al*., 2014; Yu *et al*., 2017). The residual soils which form in this way will be referred to as autochthonous soils, and discussed in Section 2.1.4.1. However, in some instances, soils either partially or solely form from the deposition of parent

material transported from another location. These are hereafter referred to as allochthonous soils, and discussed in Section 2.1.4.2.

2.1.4.1 Autochthonous soil formation

2.1.4.1.1 Five factors of autochthonous soil formation

At the bedrock, soil formation occurs at the nexus of geochemical and physical weathering (Brunsden, 1979; Gabet *et al*., 2003). Much of the scholarship in this area has been delivered by the Critical Zone community (Brantley *et al*., 2017) interested in the processes and mechanisms that occur over relatively long timescales (millennia) and at depth below the soil profile. Recent work has elucidated our knowledge and understanding of the incipient stages of soil formation. It has been demonstrated that fractures in bedrock, even micro-fractures <1 μm wide (Graham *et al*., 2010), enable the transmission of meteoric water, enriched with dissolved oxygen and organic acids, which promotes mineral dissolution and weathering-induced fracturing (Navarre-Sitchler *et al*., 2015; Banwart *et al*., 2019). Further work by the Critical Zone community has been called for to further explore the evolution of pore-scale changes which occur in rock during incipient weathering since these represent the very beginning of the soil formation process (Navarre-Sitchler *et al*., 2015). The Critical Zone community has also invested a large research effort to studying the biotic mechanisms that contribute towards the weathering of parent material, following the creation of this initial porosity. For example, Brantley *et al*. (2017) show that trees both ‘build’ the critical zone, by micromechanically fracturing the rock mass, thereby promoting further weathering, and ‘plumb it’, by influencing the fluxes, pathways, and chemistry

of water (see also Zwieniecki and Newton, 1994; Pate *et al*., 1998). In addition, the roles played by microbiota (e.g., fungi and bacteria) have also been examined. Taylor *et al*. (2009) present a sequence of plant- and fungi-induced weathering mechanisms, demonstrating that mycorrhizal fungi in particular have the propensity to colonise mineral grains between roots, affect the solution pH (Bago *et al*., 1996), and secrete low molecular organic compounds that can accelerate mineral dissolution (Ochs, 1996; Schmalenberger *et al*., 2015).

Critical Zone examinations of incipient weathering in the parent material underlying soils have demonstrated that, much like the horizons observable in soil, the weathering profile can be similarly delineated in terms of the extent to which the parent material has been weathered. Figure 2.4 presents a conceptual diagram to illustrate this. Fresh, unweathered bedrock at the base is overlain by a layer of isovolumetrically weathered bedrock referred to as *saprolite* (Stolt and Baker, 1994) or *saprock* (Anand and Paine, 2002). Saprolite is chemically altered bedrock which maintains the fabric of the underlying fresh bedrock. This layer may exhibit fractures and support biotic weathering processes such as root expansion, mineral acquisition, or the release of organic acids (Brantley *et al*., 2017). One of the more challenging delineations to make is that of the transition between saprolite and soil, and workers in this area have often used the term ‘transition zone’ to underscore the diffuse nature of this boundary (Stolt *et al*., 1991). Lebedeva and Brantley (2017) expand on this idea by dividing a column of weathered bedrock into a series of blocks to explore the contribution of joint fractures in the weathering process.

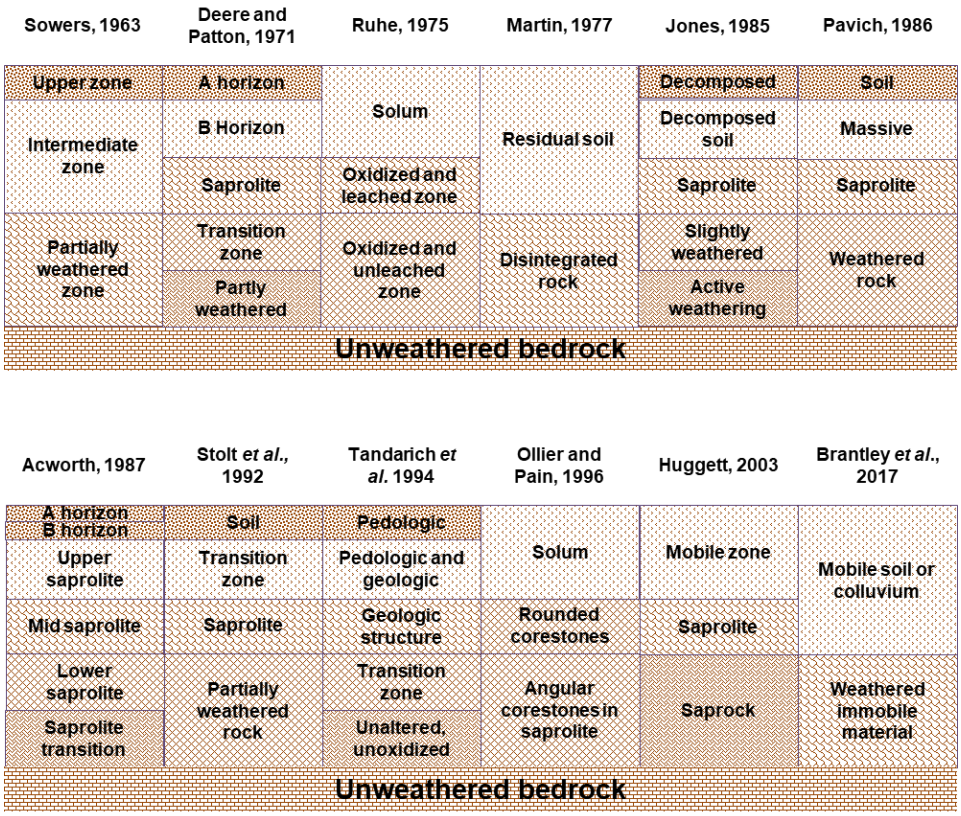

Figure 2.4: A summary of the weathering zones within a soil profile

Whilst Critical Zone scientists continue to explore the incipient fracturing and weathering mechanisms occurring in bedrock, soil scientists have focused on the extrinsic and intrinsic factors that may perpetuate that weathering. Early work (Dokuchaev, 1879; Glinka, 1914; Jenny, 1941) identified an array of independent extrinsic factors: climate, organisms, parent material, relief, and time. What was not manifestly explored at this time was the dynamic hierarchy of these factors. For instance, climate and organisms represent external factors that actively promote or retard soil development (Hasenmueller *et al*., 2017; Anderson *et al*., 2018). In contrast, relief is a passive variable that can indirectly influence soil formation through affecting these external factors, such as controlling the thermal and water regime of the developing soil, and thus its biota (Yair, 1990). Likewise, the parent material can be considered as a

passive state factor: a substrate from which the developing soil inherits many significant genetic properties, such as texture and mineralogy (Kirkby, 2018). Time, itself, is not an independent state factor (Mudd and Yoo, 2010). Time is a unit of measurement over which soils form. Soils do not form directly because of time.

2.1.4.1.2 Water: the nexus between the five soil formation factors

Fundamental for chemical weathering, and somewhat significant for mechanical weathering, is the presence of water (Pelletier and Baker, 2011). Work has been conducted to examine how the state factors listed above encourage or otherwise impede the contact time between water and the bedrock-soil interface (Heimsath and Burke, 2013). For example, Pope *et al*. (1995) suggests that climate influences soil formation rates, citing a linear relationship between precipitation and the magnitude of weathering. However, an increase in precipitation is not always analogous to an increase in subsurface water contact and water residence time at the bedrock. It is possible that increased precipitation results in greater rainsplash and surface crusting, thus progressively impeding the infiltration of water to the bedrock (Assouline, 2004). In addition, increased precipitation may stimulate greater biomass production, although this will also depend on other environmental factors (such as temperature) that govern vegetation development (Nearing *et al*., 2004). If greater biomass is stimulated, the proportion of the precipitation that can infiltrate through the soil to the bedrock may be species-dependent. Plants with a high leaf area index – one of the major determinants of water flux from plants (Wang *et al*., 2017a) – may increase transpiration and reduce

the transmission of water to the bedrock. However, some plants may have specific root traits (such as wider diameters) that create macropores and promote preferential flow (Gould *et al*., 2016). The relief of the site also determines the flow and residence time of water at the bedrock with steeper slopes promoting overland flow and consequently reducing water contact time in subsurface horizons (Burke *et al*., 2007).

Other workers have focussed on the biochemistry of water and how that contributes or retards the lowering of the bedrock weathering front (Wright, 1988). For example, Huang *et al*. (2013) demonstrate a positive relationship between acid precipitation and local bedrock weathering rates. However, the relative hierarchical importance of water chemistry to other limiting factors (water quantity and water residence time) has not been established. Since many of the state factors of soil formation are considered in isolation (Drever, 1994; Dixon *et al*., 2009), more research is needed to consider the roles and feedback mechanisms that exist between multiple state factors. In addition, another major gap in our understanding is the effect of human activity on rates of soil formation.

2.1.4.1.3 Human activity: a sixth soil formation factor?

Anthropic influence on pedogenesis is not entirely a fresh idea given that early work (Jenny, 1941) considered the organism state factor to encompass the role of humans. Despite this, some workers have recently concluded that “soil formation (is) affected little by human activities” (Verheijen *et al*., 2009, p. 33). Ultimately, the degree to which humankind influences the rates of soil formation is likely to be context specific. Some scholars have concluded that,

in some contexts, the role of humans represents more than that originally conceived for the state factor of organisms (Richter, 2007a).

One of the ways that humans may bear an influence on soil formation is through crop cultivation. In shallow soils, roots have the capacity to bio-mechanically induce bedrock weathering (Dietrich *et al*., 1995). This represents a direct influence of crop cultivation on pedogenesis. For deeper soils, root growth may assume a more indirect role in influencing bedrock weathering (Dixon *et al*., 2009; Rautaray, 2011; Jin *et al*., 2013). Deep-rooted crops, such as the forage radish (*Raphanus sativus* L. 'Diachon'), have roots that can alleviate compaction, and have been used to condition soils prior to the cultivation of high value crops. For example, Williams and Weil (2004) observed soybean roots (*Glycine Max* (L.) Merr.) growing through plough pans using channels created by decomposing forage radish.

One of the key characteristics of 'primer' or 'bio-tillage' crops, like the forage radish, is the large rooting diameter. Roots with larger diameters have been shown to increase hydraulic conductivity (Gould *et al*., 2016). This would theoretically permit more water to reach deeper zones of the profile, potentially augmenting the contact time between the water and the bedrock (Gabet *et al*., 2003). It is also likely that root-developing processes (such as root diameter expansion) contribute to an increase in hydraulic conductivity. As root diameter enlarges, the radial pressures exerted on to the soil increase (Mizra *et al*., 1986). In the rhizosphere, and in proximal bulk soil, these pressures can induce macroporosity and micro-fissure formation within the soil, reducing bulk densities in this zone (Yanusa and Newton, 2003; Bodner *et al*., 2014).

Crop cultivation also changes the biochemistry of the soil, which in turn, influences the chemical weathering potential in the bedrock (Drever, 1994; Riebe *et al*., 2004). For example, White and Blum (1995) find that root exudates accelerate silicate hydrolysis. As explained above, the ratio between soil depth and rooting depth will determine the potential significance of root exudates to bedrock weathering. On a shallow soil, where roots may grow into the bedrock horizon, these exudates may significantly enhance chemical weathering processes (Puente *et al*., 2004). For a soil of a thickness greater than root length, the mobilisation of these exudates to the bedrock zone will rely on the water flux of the soil. This re-engages the earlier discussion about how plant roots may induce macroporosity and assist with eluviation and percolation processes.

In addition to crop cultivation, land preparation methods may also affect soil formation. One study on a regosol in southwest China suggests that soil formation rates on conventionally tilled cropland are greater than that within forestland and grassland with rates of 3005, 2457 and 2036 t km^{-2} y^{-1} respectively (He *et al*., 2009 *citing* Liu *et al*., 2009). However, these rates were determined in a controlled experimental set-up whereby soils from each land use were first removed from the bedrock, and replaced on top of a nylon fabric with a pore diameter of 0.15 mm. The soil was later removed again to expose the bedrock, and the weathered bedrock was collected, dried, and measured (Liu *et al*., 2009). Critically, this study was not able to qualify whether the accelerated soil formation rates in tilled soils were due to the tillage operations *per se*, or the roots of the crops involved (especially the tuberous roots of *Ipomoea batatus* Lam.). Alternatively, the authors suggest that accelerated

pedogenesis could have been induced by acidification from fertilizer application.

2.1.4.1.4 Self-limiting behaviour in pedogenesis

A noteworthy development in pedogenesis studies is the awareness of the self-limiting behaviour demonstrated in the soil formation process (Muhs, 1984). This discussion is less focussed on the external factors that govern bedrock weathering and, instead, more concerned with the ways by which soil formation stimulates a negative feedback loop (Schaetzl and Thompson, 2005). Moreover, as the soil thickens, the soil formation rate decreases. Whilst this relationship has been widely accepted (Wilkinson and Humphreys, 2005) there is debate about the specific nature of the decline in soil formation. Many workers (Wilkinson *et al*., 2005; Gabet and Mudd, 2010) have advocated an 'exponential decay function' (Figure 2.5; curve *a*) by suggesting that an increasing soil thickness insulates the bedrock from the external influences of climate, organisms and relief. Moreover, Minasny and McBratney (1999) observe that a thickening soil insulates the bedrock from the diurnal temperature variations which are ultimately responsible for freeze-thaw weathering. Similarly, thicker soils are more likely to buffer the underlying bedrock from water contact and chemical weathering processes such as hydrolysis (Wilkinson and Humphreys, 2005).

Disputing this hypothesis are advocates for an alternative, humped production function (Figure 2.5; curve *b*) which suggests there is a threshold mantle thickness under which water residence times are not conducive for maximum weathering rates. Heimsath *et al*. (2009) find that a shallow mantle of 0.35 m

brings about peak soil formation rates. Above this threshold thickness, the soils increasingly act as insulating buffers, as discussed above. Indeed, the humped production function should be considered as a development of the original exponential decay function, although they are often treated as juxtaposing theories in the literature (Norton *et al*., 2014).

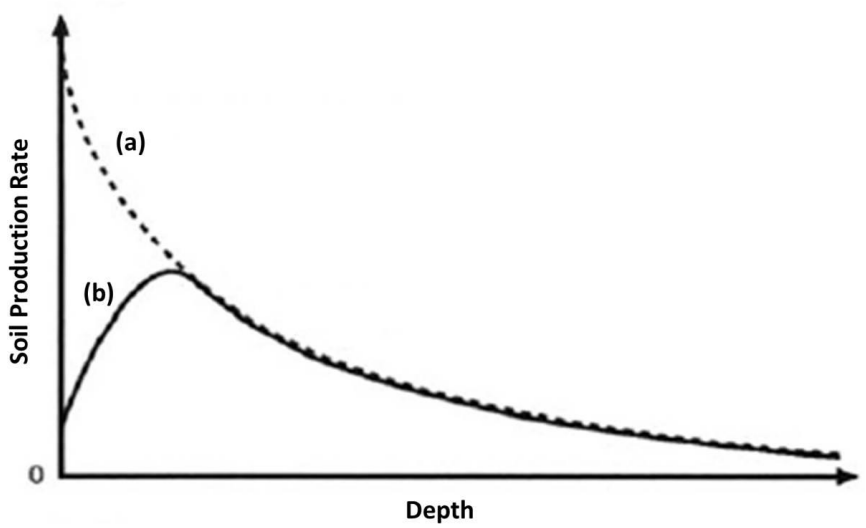

Figure 2.5: Schematic showing both proposed exponential (a) and humped (b) relationships between soil production and mantle thickness (Adapted from Wilkinson and Humphreys, 2005).

It has been demonstrated that soil thickness is a paramount variable in the soil formation process (Heimsath and Burke, 2013). Burke *et al.* (2007, p. 859) suggest that bedrock weathering "may depend simply on the vertical distance from the ground surface to the soil base". However, the thickness of soil does not fully explain the roles that soils play in regulating pedogenesis. This is clearly demonstrated in Figures 2.2 and 2.3 where, for a given soil thickness, there is a wide range of soil formation rates.

2.1.4.2 Allochthonous soil formation

Hitherto, we have considered autochthonous soil formation: processes acting on a pre-existing body of parent material (Simonson, 1959). This neglects the soils that form in aggrading landscapes. In this context, soils are in part, or sometimes wholly, constituted from the accumulation of allochthonous parent material, transported from another location (Hunt, 1972). There are multiple examples of these; the major types are itemized in Table 2.2.

Understanding the fundamental controls on the up-building of these soils requires a different approach than the traditional five factors of soil formation, previously outlined. Here, the accumulation of parent material is influenced by an array of geomorphological – rather than pedological – phenomena. For instance, the deposition of alluvium may be controlled by river discharge, just as the deposition of loess may be governed by wind speed. Nevertheless, there are some commonalities among different types of transport sediment. First, the sediment must become entrained, which is often a function of its texture and the velocity of the transporting medium (Schaetzl and Thompson, 2015). Second, the transported sediment must at some point be deposited, and this often relies on the force of gravity overcoming the capacity of the transporting medium to sustain material transport.

Table 2.2: Major types of allochthonous parent materials and their soil properties

Environment	Parent material	Characteristic soil properties
Channelized water	Alluvium	Finer soil textures at the top of soil profiles indicate larger particles were deposited first, followed by progressively finer materials (Baker *et al*., 1991).
Lacustrine	Proglacial lakes	Well preserved stratification of clay- and silt-rich sediments (James, 1988).
	Glacial varves	Annual couplets of fine dark clay (comminuted organic matter) with lighter silt horizons (Schaetzl *et al*., 2000).
	Marls	Carbonate-rich forms of organic-limnic sediment (Chambers, 1999).
	Playas	Soils are often saline (Peterson, 1980).
Coastal	Barrier islands, beaches and bars	Sandy soils, sometimes rich in sulphur and pyrite, developing into acid sulphate soils (Fanning and Fanning, 1989).
	Deltas	Sandy and clayey soils, finer-textured further away from delta head (Wang *et al*., 2017b).
Aeolian	Dunes	Yellow, thin coatings of oxidised iron and clay; well-sorted medium and fine, quartz rich sands; often negligible clay fraction (Muhs and Wolfe, 1999).
	Loess	Silt-loam and silty clay loams; porous; highly erodible; often high pH, weathering is not advanced (Lu and An, 1998).
Volcanic	Tephra	Minimal weathering; dominated by amorphous materials; low bulk densities; high macroporosity; high available water (McDaniel *et al*., 2011).

Glacial	Till	Unsorted; very clay-rich to coarse sandy textures; basal till is dense, superglacial till is porous (Applegarth and Dahms, 2011).
	Outwash sediment	Sandy and gravelly; small volume of clay; formation of E horizons and clay lamellae (Cooper and Crellin, 1996).
Gravity	Colluvium	Range in texture, depending on the source; some pre-existing weathered material; breakdown of aggregates (Goswami *et al*., 1996).

One of the anthropic contributions to allochthonous soil formation is the addition of mineral and organic material to the surface of the soil profile (Pape, 1970; Conry, 1971, 1972; Davidson and Simpson, 1984; Kosse, 1990; Bockheim and Gennadiyev, 2000; Dudal, 2004; Davidson *et al*., 2006). There is a long history to this, often evidenced in Plaggen Anthrosols where the uppermost part of the soil profile is characterized by a dark, and often anthropogenic, horizon formed after long-term manuring (Denevan and Turner, 1974; Blume and Leinweber, 2004; Giani *et al*., 2014; Schaetzl and Thompson, 2015). In northeast Scotland, the addition of turves, dung, midden material, calcareous sand, and seaweed, or a combination thereof, contributed towards a gradual increase in the depth of the solum (Davidson and Simpson, 1984) with accumulation rates believed to reach 1.9 cm y^{-1} giving rise to farm mounds of up to 4.3 m in thickness (Davidson *et al*., 1986). In the St. Kilda archipelago in Scotland, high rates of historic manure addition over-deepened soils to depths of 1.5 m (Hornung, 1974). In the Netherlands, a lower accretion rate of 1.3 mm y^{-1} is cited by de Bakker (1979) but it is

important to note that this is still two orders of magnitude greater than the natural rates of soil formation from bedrock weathering.

Inspired by the plaggen agriculture are a number of strategies in operation today that return waste streams to soils (Read *et al*., 1997). For instance, in Vietnam, a programme of toilet building in the 1950s led to the construction of thousands of concrete chambers in which to dry-process excrement for use as an agricultural fertiliser (Richardson, 2012). Similarly, in China, approximately 90% of agricultural produce is fertilised through human effluent (Black and Fawcett, 2008).

As well as these examples of untreated effluent, other techniques involve ecological sanitation, which removes the pathogens from by-products through dry-composting or the use of biogas, before agricultural application. One of these is vermicomposting, which has proven to be an effective treatment of faecal matter (Buzie, 2010). This refers to the decomposition of organic materials using the combined action of earthworms and micro-organisms (Shalabi, 2006; Buzie, 2010; Factura *et al*., 2010). Whilst micro-organisms are responsible for the biochemical breakdown of organic matter, earthworms are able to physically bioturbate the material into finer-particles (casts and fibres) than would otherwise occur in their absence (Aira *et al*., 2002).

This review has discussed a range of methodologies employed to measure rates of soil formation and has presented a global inventory of the data that currently exist. Furthermore, it has also explored the multifarious environmental and internal factors that influence the process of both autochthonous and allochthonous soil formation. In accordance with those

that argue that theoretical concepts within soil science should contribute towards issues of soil security and soil sustainability, this review will now turn to explore how our knowledge and understanding of soil formation can contribute towards two areas of soil conservation research: the soil lifespan and soil loss tolerance.

2.2 Soil lifespans

2.2.1 Approaches to date

If soil erosion rates exceed those of soil formation (Figure 2.6), soil profiles thin. The trajectory of any thinning soil is one that, left uninterrupted, will lead to the removal of the soil cover and the exposure of the underlying bedrock, thus threatening the long term sustainability of the soil resource (Amundson, 2015). The soil lifespan is “the length of time, under a given management regime, that a soil can be expected to fulfil the ecosystem services”.

Expressing the sustainability of soil in units of time has been attempted in the past (see Table 2.3). For instance, Stocking and Pain (1983) calculate the lifespan of a soil based on the length of time it can remain productive at a given erosion rate. Although this fails to account for any mass input to the soil system (such as that from bedrock weathering), this is later addressed by Elwell and Stocking (1984). The soil life in this revised model is constrained by the minimum depth required for a particular crop to grow. However, this ignores the possibility that soils under such depths may still be able to contribute towards other ecosystem services, such as the filtering of water or the sequestration of carbon. To avoid prioritizing one function over another, some authors have quantified soil lifespans by simplifying the model. For

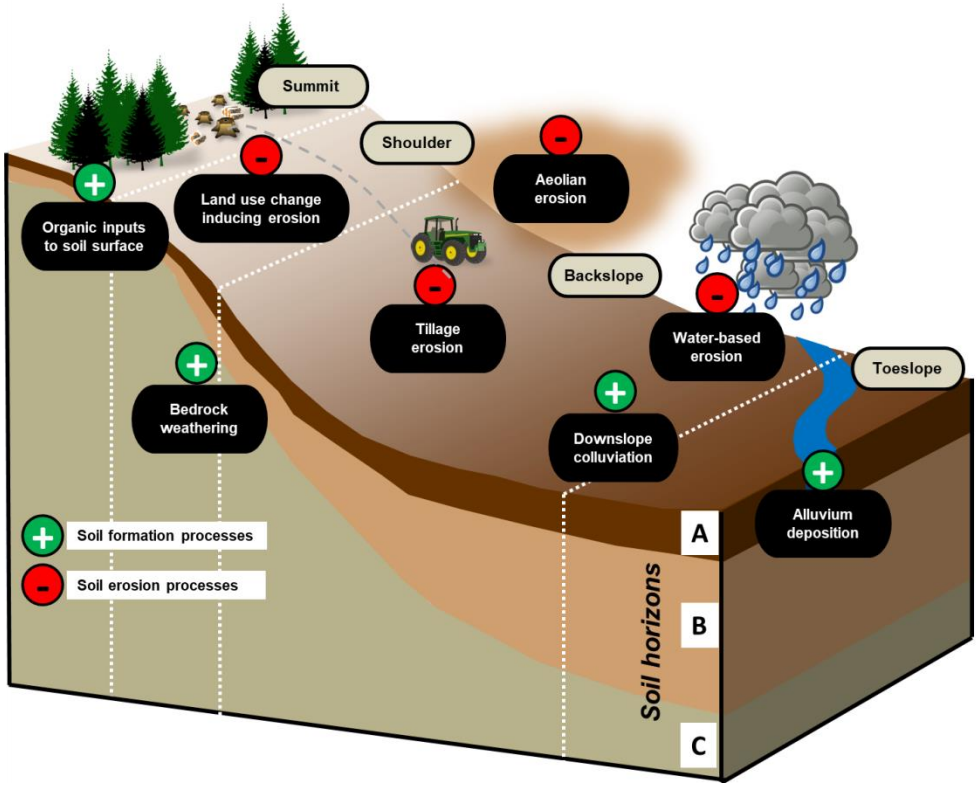

Figure 2.6: Soil formation and erosion processes down a hillslope

Table 2.3: Previous approaches to define the soil lifespan.

Source	Equation Name	Equation	Definition of Terms
Stocking and Pain (1983)	Soil Lifespan	$L = \frac{(D_Z - D_O)M}{(Z - Z_f)}$	D_z is initial depth (m), D_o is minimum depth required to support production (m), M is bulk density, Z is mean annual rate of soil erosion (t/ha) and Z_f is soil loss tolerance (t/ha)
Elwell and Stocking (1984)	Soil Life	$L_f = \frac{(D_e - D_O)M}{(Z - Z_f)}$	D_e is depth of available productive soil (m), D_o is minimum depth required for particular crop (m), M is bulk density, Z is predicted rate of soil loss (t/ha/yr) and Z_f is estimated rate of soil formation (t ha^{-1} y^{-1})
Montgomery (2007)	Critical Time	$T_c = \frac{S}{(E - P)}$	S is initial soil thickness (m), E is soil erosion rate (mm y^{-1}) and P is soil production rate (mm y^{-1})
Sparovek and Schnug (2001)	Lifetime	$LT = \frac{SD - SD_{min}}{\frac{SL}{D_s} + SF}$	SD is present soil depth (m), SD_{min} is minimum soil depth (0.2 m), SL is soil erosion (+soil loss – soil deposition, kg m^{-2} y^{-1}), D_s is bulk density (1200 kg m^{-3}), SF is soil formation (0.0002 m y^{-1}; -0.24kg m^{-2} y^{-1})
Medeiros et al. (2016)	Soil Lifetime Index	$SLti = \frac{P_{net}}{h_L}$	P_{net} is net solum depth (mm) and h_L is net soil loss rate (mm y^{-1})

example, Medeiros et al. (2016) simply divide the solum thickness by the net soil loss rate, applying the model to assess the sustainability of soil in the São Paulo state of Brazil. However, the soil renewal rate used to determine net soil loss was assumed to be 0.2 mm y^{-1} across the state, citing Friend (1992) who did not directly measure soil formation.

Although the literature base developing the concept of the soil lifespan is meagre, it is clear from Table 2.3 that two types of lifespan may be considered. First, a 'lifespan to bedrock' can be calculated to forecast the duration until the bedrock, or parent material, is exposed (Montgomery, 2007; Medeiros *et al*., 2016; Figure 2.7). However, Bakker *et al.* (2004, p. 58) assert "the point of zero yield may often be reached before the soil is completely removed". Therefore, a second 'truncated lifespan' can be calculated to forecast the length of time before a soil thins beyond a defined threshold depth, under which the soil is believed to be of inadequate quality to deliver one or more of the ecosystem services. This is arguably a more complex calculation than the 'lifespan to bedrock' since the degree to which a soil may provide ecosystem services is dependent both upon a range of spatially and temporally variable soil properties, and the ecosystem service under study.

Setting a threshold depth for the 'truncated lifespan' may be assisted by identifying any regressors or limiting factors down the soil profile (Bakker *et al.,* 2004). This often involves the need to undertake test soil pit inspections or, for some structural properties, the use of dynamic cone penetrometers or ground penetrating radar (Raper *et al*., 1990). For example, some root growth hindrances may be incurred by the presence of a plough pan but there could also be other, or indeed more, restrictions such as the deterioration of soil

structure, water holding capacity, or the presence of a pebble/gravel bed (Passioura, 1991). Equally, a threshold depth of nutrient deficiency may exist within the profile, potentially by the upward transport and progressive accumulation of clay particles into the A horizon which nutrients absorb to, rendering them inaccessible (Rhoton and Lindbo, 1997). Another limiting factor that occurs at depth is soil acidity. Soil acidity can hinder plant production because of the low content of base cations that affects root growth and the absorption of water (Tang *et al*., 1999). Whilst surface liming has been shown to improve topsoil acidity, it is generally less effective in improving subsoils (Caires *et al*., 2008). Therefore, it is likely that a threshold between lime-improved soil at the surface and less-improved and/or untreated subsoil may truncate primary production, and therefore, the soil lifespan.

There has been some attempt in the past to experimentally ascertain how and where in the soil profile these restrictions may occur. Desurfacing investigations, where the soil is removed at incremental depths to emulate high magnitude erosion processes has been conducted (Malhi *et al*., 1994; Larney *et al*., 1995; Tanaka, 1995). For example, Gollany *et al*. (1992) performed a desurfacing investigation over a five year period on a Typic Arguistoll at three depths (0, 0.3 and 0.45 m). The thinner Ap horizons overlying substantially more clayey Bw and Bt horizons introduced clay into the Ap horizon, which deteriorated structure, and reduced water holding capacity. However, Gollany *et al*. (1992) suggest that these desurfacing experiments often exaggerate the reality of natural soil erosion which typically allow for the mixing and incorporation of subsurface horizons into the top horizon.

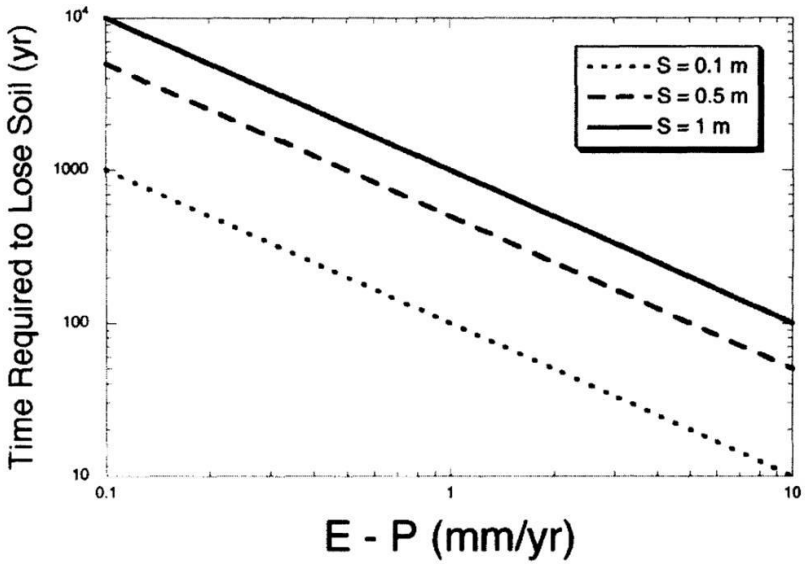

Figure 2.7: Critical time (T_c) required to erode a soil profile of differing initial thickness (S) for different net soil erosion rates (Adapted from: Montgomery, 2007).

2.2.2 Applications of the soil lifespan concept

To date, soil conservation management has been reported in terms of the units of soil protected ('erosion has been reduced by *x* tonnes per hectare') or enhancements to ecosystem services ('yields have increased by *x* %'). These do not explicitly address how soil conservation management enhances soil *sustainability*, a concept that demands a forward-looking perspective. After all, sustainability is defined as the "ability to meet the needs of the present without compromising the ability of *future* generations to meet their own needs" (WCED, 1987, my emphasis). The soil lifespan concept provides a direct forecast: an assessment as to the length of time, under a given land management regime, that a soil can be expected to deliver ecosystem services.

To directly evaluate the effectiveness of a range of erosion amelioration techniques to address the long-term sustainability of the soil, lifespans can be calculated (before and after their implementation). If the latter lifespan is greater, the conservation technique has extended the soil lifespan. The benefit of this method is the fact that a range of soil erosion amelioration techniques can be assessed using a standardized unit which is directly comparable. This can be shown with the use of an example.

Consider two soils (soil A and soil B), both of which have been subject to two different types of soil erosion amelioration; soil A has been subject to zero tillage whilst soil B has been subject to contour cultivation. If, for both soils, rates of erosion have been reduced from 12 mm y^{-1} to 1 mm y^{-1}, this would suggest that these strategies have had an equal effect. However, these results have not expressed how soil sustainability has been enhanced, neither have they considered rates of soil formation, nor the depth of the soil profile. It could be the case that soils A and B represent different positions down a hillslope where soil depths, and thus soil formation rates, may be spatially variable. Soil A forms at 0.9 mm y^{-1} and has a depth of 0.5 m, whilst soil B forms at 0.5 mm y^{-1} and has a depth of 2.0 m. The pre- and post-management lifespans to bedrock can then be calculated: 45 years and 5,000 years for soil A, and 174 years and 4,000 years for soil B, respectively. Although soil B has a greater post-management lifespan, this is due to the soil profile being four times as deep. Erosion amelioration on soil A has, in fact, achieved the greatest extension of the lifespan: 4,955 years, in comparison with 3,826 years for the amelioration on soil B.

The soil lifespan concept can be used to evaluate a range of different soil conservation practices. Some measures may reduce the net erosion rate and extend the soil lifespan. In these cases, erosion rates may still be finite; that is to say, net erosion rates remain positive, and soil profiles still thin, albeit at a retarded rate. Some measures may zero net erosion rates, extending lifespans indefinitely. This would bring about no long-term change in the thickness of the soil profile. The most effective soil conservation measures are those that yield negative net erosion rates (soil erosion rates fall below those of soil formation) leading to an aggrading soil profile.

2.3 Soil loss tolerance

2.3.1 Comparing soil formation rates with rates of soil loss tolerance

Soil formation rates are also used to derive rates of soil loss tolerance (SLT, hereafter). The premise of this concept is to curtail rates of erosion to those of soil formation so that the soil can sustain crop productivity, economically, and indefinitely (Di Stefano and Ferro, 2016).

This review conducted a Web of Science search using the phrase ‘soil loss tolerance’ (Appendix 2.2). Out of the 101 studies compiled, 58 reported SLT values, representing 18 countries (Figure 2.8). For 51 of these, the SLT values were presented as a range (for example, 0.5 – 1.5 t h^{-1} y^{-1}). In these instances, a median SLT value can be calculated. This dataset comprised 17 of the 26 World Reference Base soil orders (IUSS Working Group WRB, 2015) and included all soil textures apart from ‘sandy clay’, ‘sandy clay loam’ and ‘silty clay’.

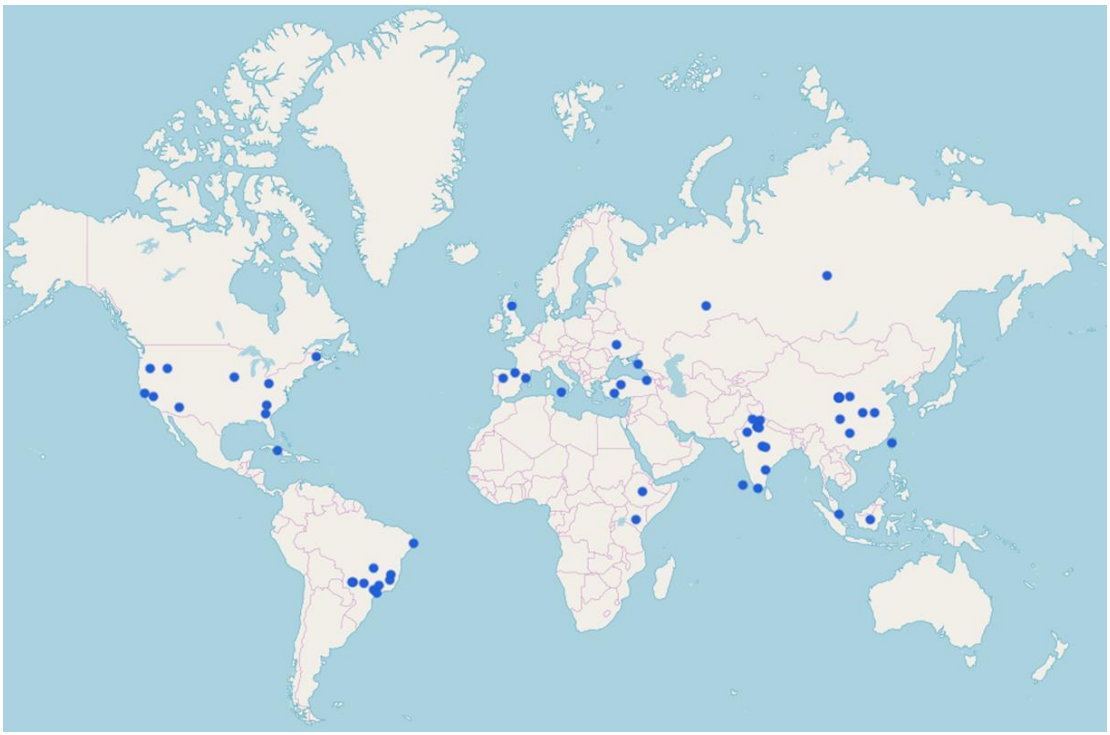

Figure 2.8: Distribution of SLT values from a global inventory (*n* = 58). For full dataset, see Appendix 2.2.

Early work to derive SLT values was limited by a lack of evidence and understanding of soil formation rates. Those that were calculated often led to claims that they represented “a scientific weakness” (Di Stefano and Ferro, 2016, p. 128), which were “rooted in erroneous beliefs” (Johnson, 1987, p. 160) and based on “a matter of guesswork” (Stocking, 1978, p. 307). In the inventory compiled by this review’s Web of Science search, 19 out of the 58 studies used soil formation data to calculate SLT. However, it is also the case that the soil formation rates used were based on a small number of historic studies, comprising non-isotopic data. Although cosmogenic radionuclide methods represent a relatively recent advancement in soil science, these SLT values made use of soil formation data derived more than a century ago. For example, more than 40% of the SLT values made use of soil formation rates that can be traced back to a 1909 White House address by the geologist T. S.

Chamberlin (Chamberlin, 1909). Many also used the methodology from Barth (1961) measuring the volume of mobile geochemical elements in runoff as a proxy for bedrock weathering, but fail to account for any atmospheric inputs, thus reducing the validity of the data (Alexander, 1988a; Velbel, 1989). Others have cited rates of building disintegration, such as the weathering of the Great Pyramid of Egypt, to represent the rates of soil formation (Barton, 1916 *cited in* Lal, 1998).

2.3.2 Revisiting SLT and the use of soil formation rates

Given that cosmogenic radionuclide analysis now allows the long-term rates of soil formation to be constrained with greater accuracy (Heimsath *et al*., 1997; Wilkinson *et al*., 2005), it is possible to bring these data together with our current estimates of SLT. This exercise is key to our understanding of the long-term sustainability of soils and whether our current metrics of tolerance are sufficient.

Analysing this review's inventory of SLT as outlined in the previous section, rates of soil loss tolerance range from 0.002 to 3.64 mm y^{-1} with the median being 0.49 mm y^{-1} (Figure 2.9). Whilst more than two thirds of these data fall within the range of soil formation, 97% of the data are greater than the median soil formation rate with 95% being more than twice this. Only two of the 66 inventoried SLT values fall below the median rate of soil formation.

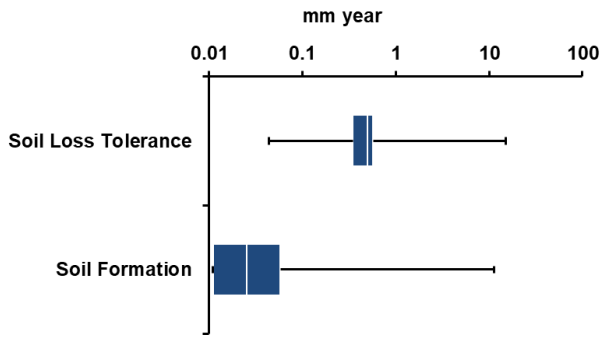

Figure 2.9: Distribution of soil loss tolerance values (*n* = 58) and soil formation rates (*n* = 243). Full data for soil formation can be seen in Appendix 2.1; for SLT, see Appendix 2.2. White lines within bars represent the median; boxplots represent interquartile ranges; error bars represent the 5th and 95th percentiles.

The incongruence between rates of SLT and soil formation has also led to erosion being inaccurately described on many erosion forecast maps. For instance, labels such as “tiny” and “minimal” erosion are used to represent rates of erosion that are an order of magnitude greater than soil formation (Hua *et al*., 2012; Zhu, 2015). Similarly, Weltz *et al*. (2014) indicate that a rate of 0.15 mm y^{-1} is “sustainable” despite it being six times faster than the median rate of soil renewal.

As demand on global soil resources grows, it is vital that soil loss tolerance is founded on a reliable and valid evidence base. To this end, more isotopic measurements to quantify the rates of soil formation are needed, particularly for soils of depths >1 m and for climates and lithologies hitherto unvisited. As part of this effort, rates of soil formation must also account for both the long-term rates of bedrock surface lowering, but also the short-term rates of soil up-building at the surface from colluvial, aeolian, alluvial, and glacial deposition. This requires greater synergy between soil scientists and other Earth Science disciplines.

Chapter 3: The Sensitivity of Cosmogenic Radionuclide Analysis to Soil Bulk Density: Implications for Soil Formation Rates

D. L. Evans, Á. Rodés, and A. M. Tye

This chapter has been submitted as a paper, and is in review in the *European Journal of Soil Science.*

Abstract

Improving our knowledge of soil formation is critical so that we can better understand the first-order controls on soil thickness and more effectively inform land management decisions. Cosmogenic radionuclide analysis has afforded soil scientists the opportunity to more accurately constrain the rates at which soils form from bedrock. In such analysis, the concentration of an isotope, such as Beryllium-10, is measured from a sample of bedrock. Since this concentration is partly governed by the lowering of the bedrock-soil interface, a cosmogenic depth-profile model can be fitted to infer the bedrock and surface lowering rates compatible with the measured concentrations. Given that the bedrock-soil interface is shielded by soil, the cosmic rays responsible for the in-situ production of the radionuclide are attenuated, with attenuation rates dependent on the density profile of this soil. Many studies have assumed that soil bulk density is either equal to that of the bedrock or constant with depth. The failure to acknowledge the variations in soil bulk density means that cosmogenically-derived soil formation rates previously published may be under- or over-estimates. Here, we deploy a new model

called ‘CoSOILcal’ to a global compilation of cosmogenic analyses of soil formation and, by making use of estimated bulk density profiles, re-calculate rates of soil formation to assess the sensitivity to this important parameter. We found that where a soil mantle > 0.25 m overlies the soil-bedrock interface, accounting for the soil bulk density profile brings about a significantly slower rate of soil formation than that previously published. Moreover, the impact of using bulk density profiles on cosmogenically-derived soil formation rates increases as soil thickens. These findings call into question the accuracy of our existing soil formation knowledge, and we suggest that future cosmogenic radionuclide analysis must consider the bulk density profile of the overlying soil.

3.1 Introduction

How, where and why do soils form? These questions represent some of the oldest scholarly enquiries within soil science (Dokuchaev, 1879). Being able to identify the processes of, and the factors that influence, soil formation can help to inform our understanding of the soil system: its processes and functions, and the delivery of multiple ecosystem services. Given the diverse range of environments in which soils form, the sub-discipline of pedogenesis has a wide focus. An inexhaustive list of the types of enquiries undertaken by soil formation scholars includes: the study of the accumulation and transformation of parent material (Jenny, 1941; Simonson, 1959; Hurni, 1983; Minasny and McBratney, 1999), the horizonisation of soil profiles (McAuliffe, 1994; Bockheim and Gennadiyev, 2000; Wilkinson and Humphreys, 2005), and the factors that influence the evolution of soil properties (Richter *et al*., 2007a; Schaetzl and Thompson, 2015; Vereecken *et al*., 2016). For the

purposes of this chapter, we define ‘soil formation’ here and hereafter as the process by which bedrock material converts into soil (Targulian and Krasilnikov, 2007; Egli *et al*., 2014).

One of the most important questions asked by soil scientists is: how fast does soil form? (Stockmann *et al*., 2014). Knowledge of the first-order balance between rates of soil formation and erosion is integral if we are to ensure the long-term sustainability of global soil resources (Montgomery, 2007). Whilst measuring soil erosion is a long-established practice within soil science (Quinton *et al*., 2010; Poesen, 2017), quantifying the rates that soils form from bedrock has received less widespread attention (Schertz, 1983; Duan *et al*., 2017a). Only within the past twenty to thirty years have technological advancements and interdisciplinary liaisons allowed soil scientists to more precisely constrain the rates at which soils form from bedrock (Heimsath *et al*., 1997; Román-Sánchez *et al*., 2019a,b). By conducting analyses across a range of climatological and lithological contexts, it has also become possible to assess the extent to which the state factors of soil formation – climate, organisms, relief, parent material, and time (Jenny, 1941) – influence these soil formation rates (Stockmann *et al*., 2014).

The development of cosmogenic radionuclide analysis has demonstrated that soil thickness exerts a significant internal control on these state factors, and by extension, soil formation rates (Larsen *et al*., 2014). Many authors have observed that soil thickening leads to an exponential decline in soil formation rates (Wilkinson and Humphreys, 2005). Thicker soil more effectively insulates the parent material against temperature and precipitation variations that drive weathering processes (Minasny and McBratney, 1999; Heimsath *et al*., 2009).

However, soil formation rates are not solely determined by this relationship with soil thickness. Moreover, Yu *et al*. (2017) show that rates of bedrock weathering are instead constrained by the transmission of water and solutes down the soil profile. A major determinant in the dynamics of this process is the bulk density of the soil, with greater bulk densities limiting the volume of water and solutes, and slowing their infiltration to the bedrock (Gabet *et al*., 2006).

Despite the fact that soil bulk density influences soil formation (Price and Velbel, 2003; Neely *et al*., 2019), precise density profiles are usually not integrated in the cosmogenic nuclide's production models. The cosmogenic nuclide concentrations in bedrock samples under the soil are fundamentally dependent upon two factors. One of these is the duration that the bedrock has been exposed to cosmic rays, as the cosmic bombardment of the minerals in the uppermost metres of bedrock produce these nuclides. Therefore, longer exposure times give rise to greater cosmogenic nuclide concentrations. The second factor is the evolution of the effective depth (lithostatic pressure) to the bedrock with time, which can be numerically related to the rate at which the bedrock weathers into soil (Lal, 1991; Stockmann *et al*., 2014). Given that the bedrock weathering rate is the desired dependent variable, concentrations of the radionuclide – *N* in Eq. (1) – can be measured using Accelerator Mass Spectrometry and interpolated to solve for bedrock weathering rates (ε).

$$N = \sum_{i=sp,\mu_f,\mu^-} \frac{P_i(\theta) \cdot e^{-z\rho/\Lambda_i}}{\lambda + \epsilon\rho/\Lambda_i} \quad (1)$$

where: P_i are the annual production rates of the radionuclide by spallation, fast muons and stopping muons (*sp, μ_f and μ^-*) at a surface with slope *Θ*; *z* is the

sample depth; ρ is the mean density of material overlying the sample; λ is the decay constant of the radionuclide and Λ_i are the mean attenuation lengths of the cosmic radiations (Lal, 1991).

Cosmic rays are attenuated when they pass through the soil to reach the underlying bedrock. Accounting for the factors that drive this attenuation is critical so that accurate bedrock weathering rates can be determined. Two terms in Eq. (1) directly address this attenuation: the depth of the sample and the density of the overburden material (in this case, the soil) (Balco *et al*., 2008). Many studies (Heimsath *et al*., 1997; Owen *et al*., 2011; Riggins *et al*., 2011) have assumed that the density of the soil is either equal to the bedrock density, or is constant with depth (but see Larsen *et al*., 2014). This fails to acknowledge the heterogeneities of the soil profile and, in particular, the spatial variation in bulk density (Evans *et al.,* 2019). As a result, all previous cosmogenic radionuclide analyses estimating soil formation rates for bedrock overlain by soil that have not measured and/or accounted for the variation in the soil density, may have yielded data which are under- or over-estimates.

Here, we amass an inventory of cosmogenically-derived soil formation rates previously reported for bedrock overlain by soil, where spatial changes in soil bulk density have hitherto not been employed. Employing the CoSOILcal programme, the first of its kind that considers overburden density (Rodés and Evans, 2019), our aim is to assess the sensitivity of these soil formation rates when bulk density data are accounted for.

3.2 Materials and methods

^{10}Be-derived rates of soil formation (*n* = 264) were amassed by compiling studies where *in-situ* ^{10}Be has been measured under soil profiles (Heimsath, 2006; Heimsath *et al*., 1997; 1999; 2000; 2001a; 2001b; 2005; 2009; 2012; Wilkinson *et al*., 2005; Dixon *et al*., 2009; Owen *et al*., 2011; Riggins *et al*., 2011). More studies exist (e.g.: Portenga and Bierman, 2011) but these measure soil formation from samples extracted from bare rock (outcrops, tors) and catchment deposits (stream sediments), and as such were not appropriate for the aims here.

From each of the shortlisted studies, raw data were extracted including sample latitude, longitude, and elevation, ^{10}Be concentration, the concentration uncertainty, and the soil formation rate. The density assumed by the authors (which was generally either bedrock density or average soil density) was also recorded. Although the production rate of ^{10}Be is influenced by topographic obstructions, this can be addressed by calculating a shielding factor. This represents the ratio of the ^{10}Be production rate at the obstructed site to that at a site where the surface is flat and the horizon is clear (Balco *et al*., 2008). These shielding factors were recorded from each study. Some studies did not report data for all of the above criteria. As a result, the inventory was truncated so as to only analyse entries with a complete dataset. This resulted in the removal of 101 entries, permitting 163 for analysis.

The resulting inventory of soil formation rates used in this analysis were collated from twelve studies, representing ten unique locations across Australia, USA, Chile, and the UK, five different climates (according to the

Köppen classification system) and all three major rock types (*n* = 163; see Appendix 3.1 for the full dataset). The median depth for the inventory was 0.35 m, with 72% between 0 – 0.5 m, 25% between 0.5 – 1.0 m, and 12% > 1.0 m.

The variations in the bulk density of the soil above the bedrock were not provided in any of the inventoried studies or their accompanying supplementary information files. Therefore, in the absence of these bulk density data, fine earth bulk densities were estimated for five depths (0, 50, 100, 150, and 200 cm) down the soil profile at each site using the International Soil Reference Information Centre (ISRIC) Global Soil Information System '*SoilGrids*' (250 m resolution; June 2016 update; see Hengl *et al*., 2017). We acknowledge the fact that the ISRIC 250 m raster was not intended for this type of site-specific analysis; a better approach would be to measure the bulk densities down the soil profiles at each site studied in the inventory. However, in the absence of bulk densities measured at the site-scale, we use the ISRIC data here solely as a means by which to demonstrate the sensitivity of soil formation rates to bulk density.

For this sensitivity analysis, we employed the CoSOILcal model (Rodés and Evans, 2019; see Appendix 3.2) first applied in Evans *et al*. (2019). The main objective of the CoSOILcal model is to calculate a 'best fit' bedrock lowering rate and its associated uncertainty at a site with known latitude, longitude, elevation, and shielding using measured concentrations of *in-situ* cosmogenic radionuclides (and their uncertainties) at or below the bedrock-soil interface of known depth, taking into account the overlying soil bulk density (Eq. 2).

First, an array of modelled bulk densities are generated and logarithmically distributed between 1 cm and 100 m, including those which are measured 'in the field' (*z,x*). Densities shallower and deeper than those measured are extrapolated using the shallowest and deepest measurement, respectively. The remaining densities to be calculated are those that lie in between each measured density; these are linearly interpolated from the nearest neighbours. Second, an array of erosion rates (ε) are generated and logarithmically distributed between 1 cm y^{-1} and 100 m My^{-1}.

Next, the surface production rates (*P*) of the radionuclide are calculated, based on the inputted latitude, longitude, and elevation data, as well as the apparent attenuation lengths of fast ($\Lambda_{\mu f}$) and stopping muons (Λ_{μ}-) under the soil surface. The model then uses these surface production rate and attenuation data, as well as the generated bulk density profile (*z,x*) and the array of erosion rates (ε), to calculate the concentrations of the cosmogenic isotope at several depths (*zs*) down the soil profile for a given landscape age. The landscape age here refers to the known age of the landscape and is inputted by the user. Time (*t*) is discretized in an array of 100 values logarithmically distributed between 100 years and the landscape age. For each of these 100 time steps, the model calculates an effective depth (*x*) by an interpolation of $zs + \varepsilon \cdot t$ down the profile. The concentration of the cosmogenic isotope that accumulates during each time step is then calculated using the following equation:

$$N = \sum_{i=sp,\mu_f,\mu^-} \frac{P_i(\theta) \cdot e^{-\frac{x}{\Lambda_i}}}{\lambda + \frac{\epsilon\rho}{\Lambda_i}} \left(1 - e^{-t\left(\lambda + \frac{\epsilon\rho}{\Lambda_i}\right)}\right) \quad (2)$$

where N is the cosmogenic isotope concentration accumulated during Δt time step at the effective depth x; ε is the bedrock weathering rate, P are the annual production rates of the radionuclide by spallation, fast muons and stopping muons (sp, μ_f and μ^-) at a surface with slope Θ; λ is the decay constant of the radionuclide; Λ are the mean attenuation lengths of the cosmic radiations and ρ is the density of overburden material for the time frame $t - \Delta t$ to t.

All of the modelled concentrations for the 100 time steps are then summed:

$$C = \sum_{t=0}^{T} N \cdot e^{-\lambda \cdot t} \quad (3)$$

where T is the landscape age.

Since isotope concentrations are measured using Accelerator Mass Spectrometry, bedrock weathering rates (ε) can be found by the simple interpolation of N. 'Best fit' bedrock weathering rates can be computed by first calculating the deviation(s) of these modelled isotope concentrations (C) from those which were measured using Accelerator Mass Spectroscopy:

$$s = \sum \frac{C - M}{\sigma_M} \quad (4)$$

where C is the modelled isotope concentration, M is the measured isotope concentration, and σ_M is the uncertainty of the measured concentrations.

Chi-square values are then computed as the sum of the squared deviations. Where chi-squared values are smaller than the minimum chi-squared value plus the number of samples, the modelled bedrock weathering rates are

considered to fit the data within a one-sigma confidence level. Further details about the model can be found in Rodés and Evans (2019; see Appendix 3.2).

This model was run for each entry within the soil formation rate inventory (*n* = 163). Soil formation rates from both the original inventory and those re-calculated using the CoSOILcal model were not normally distributed (the Anderson Darling Test statistics were -5.1 and -12.2, respectively; $p > 0.05$ for both tests), so the Mann Whitney U Test (a non-parametric statistical test for difference) was run. All statistical analyses were completed at 95% significance on a standard Excel workbook.

3.3 Results

Before the CoSOILcal model was applied, rates of soil formation as previously published spanned five orders of magnitude, ranging from 6×10^{-5} to 6×10^{-1} mm y^{-1} with a median of 0.03 mm y^{-1}. Climatologically, the fastest rates (0.01 – 0.59 mm y^{-1}; median = 0.07 mm y^{-1}) were associated with Warm Summer Mediterranean (Csb) climates (*n* = 80) whilst the slowest rates (0 – 0.01 mm y^{-1}; median = 0.001 mm y^{-1}) were found for Arid Cold (Bwk) climates (*n* = 25). With regards to the effects of lithology, the fastest rates (0 – 0.59 mm y^{-1}; median = 0.05 mm y^{-1}) were associated with metamorphic lithologies such as metasediments and gneiss (*n* = 70). These contrast with the slowest rates (0.01 – 0.06 mm y^{-1}; median = 0.03 mm y^{-1}) measured from soils developing on igneous lithologies, such as granites and granodiorites (*n* = 49).

Employing the CoSOILcal model, the median rate of soil formation for the total inventory increased by 16% to 0.034 mm y^{-1} (range: 0.001 – 0.47 mm y^{-1}) (Figure 3.1). However, this was not found to be statistically significant ($p >$

0.05). Moreover, 68% of the inventory reported instances where soil formation rates decreased after the adoption of the CoSOILcal model. Within this subset, the mean reduction in soil formation rates was 0.02 mm y^{-1} (range: 0 – 0.21 mm y^{-1}). In just under a third of instances, soil formation rates increased after applying CoSOILcal, with the mean increase for this subset being 0.03 mm y^{-1} (range: 0.001 – 0.22 mm y^{-1}). With respect to the effect of climate, the fastest rates were still associated with Warm Summer Mediterranean (Csb) contexts and, although the median had decreased by 0.02 mm y^{-1} in comparison to the original data, this was not found to be statistically significant ($p > 0.05$). On the contrary, the CoSOILcal output showed that the slowest rates were not associated with Arid Cold (Bwk) conditions, as was the case previously, but with Humid Subtropical (Cfa) climates ($n = 26$) (Figure 3.2; top panel). The median soil formation rate for the Humid Subtropical subset was 0.02 mm y^{-1}, representing a decrease of 0.006 mm y^{-1} in comparison to the original data, which was not statistically significant ($p > 0.05$). For Arid Cold climates, the CoSOILcal output reported an increase of 0.04 mm y^{-1} in the median soil formation rate, which was statistically significant ($p < 0.05$).

The CoSOILcal output had less of an impact on the lithological influence on soil formation (Figure 3.2; bottom panel). The fastest rates were again associated with metamorphic lithologies. For this subset, the median soil formation rate had increased by 0.01 mm y^{-1} but this was not found to be significant ($p > 0.05$). Likewise, the slowest rates were associated with igneous lithologies. For this subset, the CoSOILcal output reported a small decrease of 0.002 mm y^{-1} in the median soil formation rate, which again was not found to be significant ($p > 0.05$).

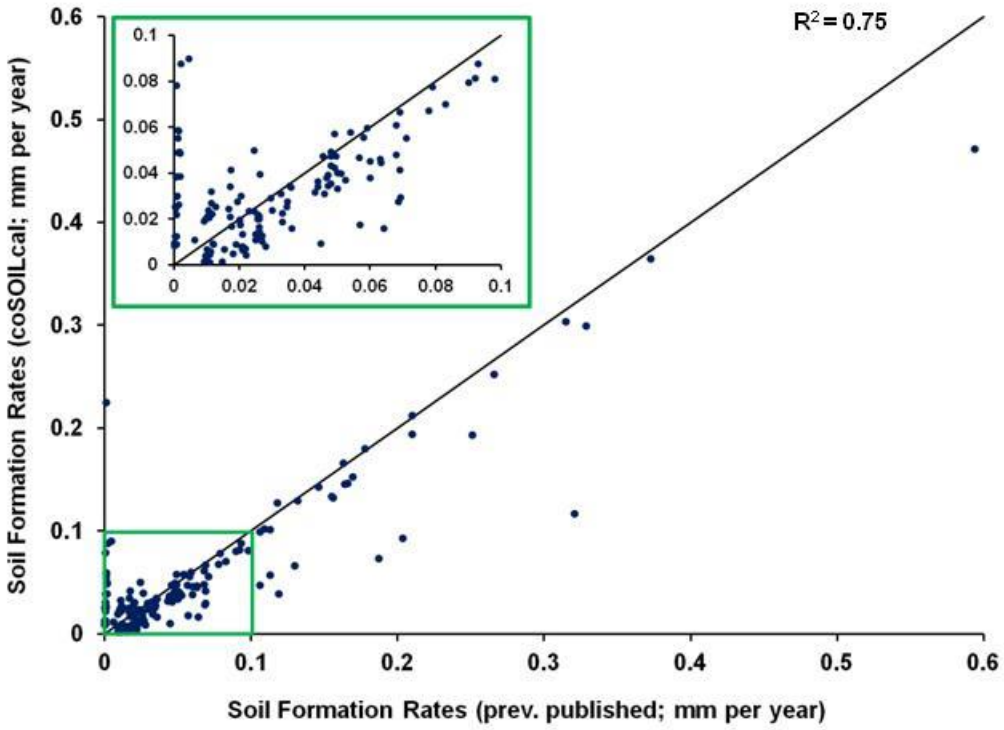

Figure 3.1: Soil formation rates from the global inventory previously published (*x* axis) and those calculated using the CoSOILcal model (*y* axis). The diagonal line represents $y = x$. The inset shows a zoomed projection of rates between 0 and 0.1 mm y^{-1}. Full dataset can be found in Appendix 3.3.

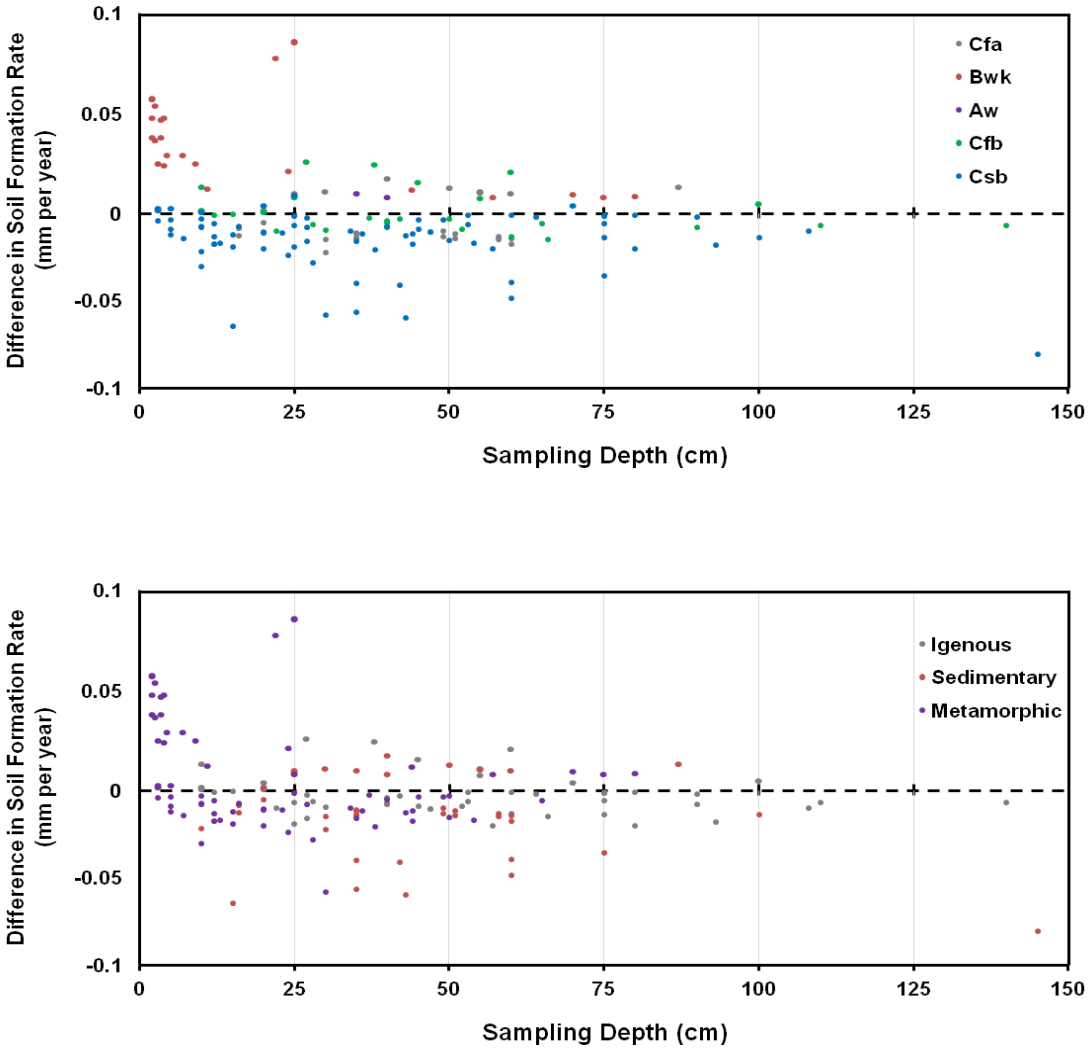

Figure 3.2: Difference in the soil formation rate when the CoSOILcal was employed in comparison to the original dataset (*n* = 163) for different climatic regions (*top panel*) and lithologies (*bottom panel*). Full dataset can be found in Appendix 3.3.

3.4 Discussion

The lack of a significant difference between soil formation rates prior to the application of CoSOILcal and those after the model was run may be explained by soil thickness. Moreover, the basis of the CoSOILcal model is that more of the heterogeneity in the density of the soil overlying the bedrock is accounted for. It is therefore reasonable to hypothesise that there is a threshold soil thickness under which the employment of these density data do not bring about a significant difference to soil formation rates. This was tested using the global inventory collated for this chapter. It was found that the CoSOILcal model brought about a statistically significant difference in soil formation rates for soils > 0.25 m ($p < 0.05$). For those soils within the inventory > 0.25 m (n = 95), the median soil formation rate derived using the CoSOILcal model was 1.2 times slower than the median of the rates previously published. Furthermore, as soil thickness increased, the difference between the CoSOILcal median and that of the original inventory also increased. For instance, for soils > 0.4 m (n = 64) and > 0.5 m (n = 46) in thickness, the medians calculated using CoSOILcal were 1.3 and 1.7 times slower than those previously published, respectively.

Given that over half of the soil formation rates in this study's inventory are attributed to soils which are > 0.25 m (n = 95), of which 48% of these are > 0.5 m (n = 46), it calls into question the accuracy of these data. Moreover, it suggests that for these deeper soils, cosmogenically-derived soil formation rates may be slower than we have previously estimated. This may have wider implications on some of the land management decisions that have been based around these rates. For example, soil formation rates have been

previously used to derive rates of soil loss tolerance. Although there are multiple methods of calculating soil loss tolerance values, one of those that has been popularly used is based on the premise that rates of soil erosion should be curtailed to those of soil formation (Di Stefano and Ferro, 2016). A review of the soil formation rates used hitherto to calculate soil loss tolerance values is beyond the scope of this study. However, our findings suggest that if the soil formation rates used stem from studies where the soil depth exceeded 0.25 m, the soil loss tolerance values may have been over estimated.

To address the potential inaccuracies of the existing soil formation rate data, the CoSOILcal model can be applied *post hoc* so that the measurement of radionuclide concentrations does not have to be repeated. However, this would require bulk density values being measured from the positions where sampling for cosmogenic radionuclide analysis took place. To ensure that these re-calculated rates are as accurate as possible, we argue that the approach taken here (that is, the use of the ISRIC 250 m raster for soil bulk density) should not be used to make these corrections. The use of the ISRIC data here was solely to demonstrate the sensitivity of soil formation rates to bulk density. Nevertheless, following the preliminary analyses presented here, a global effort is now required to revisit our network of soil formation studies, and recalculate rates using soil bulk density data measured at the site-scale.

Furthermore, we argue that future attempts to derive soil formation rates using cosmogenic radionuclide analysis should encompass the measurement of bulk density down the soil profile and the use of these data in the CoSOILcal model when calculating bedrock lowering rates. Accurately quantifying soil formation rates is essential given that these are often used to guide policy

decisions on soil conservation and erosion mitigation (Montgomery, 2007; Verheijen *et al*., 2009).

Although we have focused this work on the implications of bulk density on soil formation rates, it is also important to acknowledge that these findings are equally impactful beyond soil science. Cosmogenic radionuclide analysis has been used to derive rates of bedrock weathering for a range of geomorphological discourses and Earth System models (Cockburn and Summerfield, 2004). These include calculating the long-term rates of landscape evolution (Heimsath *et al*., 1997) and quantifying the mobilisation of bedrock-derived petrogenic carbon (Hemingway *et al*., 2018). The bulk density profiles of the unconsolidated material overlying the bedrock in these studies will have a similar effect on attenuating cosmic rays and should be accounted for. As a result, we argue that both our findings and the CoSOILcal model represent a significant contribution to multiple communities across Earth Sciences.

3.5 Conclusions

We have demonstrated that applying higher resolution estimates of soil bulk density when using cosmogenic radionuclide analysis to calculate rates of soil formation is essential. Applying the CoSOILcal model to a global inventory of previously published analyses, we found that soil formation rates, modelled from measured concentrations of Beryllium-10 in the bedrock, were significantly different when high resolution bulk density data for soils > 0.25 m in thickness were applied. Furthermore, the impact of soil bulk density on cosmogenically derived rates increases with soil thickness. These findings

highlight important implications for the community using cosmogenic radionuclide analysis both within and beyond soil science. Not only does our existing soil formation rate inventory require re-visiting, future work that uses cosmogenic radionuclide analysis to derive soil formation rates should account for the bulk densities down the soil profile, and employ the CoSOILcal model to calculate the rates of bedrock lowering. This is especially important given that soil formation rates have been, and continue to be, employed when constructing land management policies and decisions.

Further papers arising from the work presented in this chapter:

Rodés, A. and Evans, D. L. (2019) 'Cosmogenic soil production rate calculator', *MethodsX*, 7, pp. 1-5.

This can be found in Appendix 3.2.

Chapter 4: Soil lifespans and how they can be extended by land management change

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This chapter is intended for publication in *Environmental Research Letters*.

Abstract

Human-induced soil erosion is a serious threat to global sustainability, endangering global food security, driving land use change and biodiversity loss, and degrading other vital ecosystem services. We amassed a global inventory of soil erosion rates consisting of 10,030 plot years of data from 255 sites under conventional agriculture and soil conservation management. Utilising existing soil formation data to estimate soil sustainability expressed as a lifespan, here defined as the time taken for a topsoil of 30 cm to be eroded, we show that over a quarter of conventionally managed soils in the dataset exhibit lifespans of <200 years, with 16% <100 years. Conservation measures substantially extend lifespan estimates, and in many cases promote soil thickening, with 39% of soils under conservation measures exhibiting lifespans exceeding 10,000 years. However, the efficacy of conservation measures is influenced by site- and region-specific variables such as climate, slope, and soil texture. Finally, we show that short soil lifespans of <100 years are widespread globally, including in some of the wealthiest nations. These findings highlight the pervasiveness, magnitude, and in some cases the immediacy of the threat posed by soil erosion to near-term soil sustainability. Yet, this work also demonstrates that we have a toolbox of conservation methods that have potential to ameliorate this issue, and their implementation

can help ensure that the world's soils continue to provide for us for generations to come.

4.1 Introduction

Soils have underpinned the health and longevity of every society. They are a critical global resource, providing the basis of food production, a store and filter for our water resources, the largest organic carbon store, and a platform for development (Blum, 2005). Pressures on the soil resource grow as food demands rise and land degradation increases. To date, 36% of the world's cultivable land has been farmed (FAO, 2015) and in many areas of the world conventional plough-based agriculture is accelerating local soil degradation (Montgomery, 2007). The United Nations' Food and Agriculture Organisation (FAO) estimates that 66% of the world's soils suffer from some form of degradation (Bot *et al*., 2000), with soil erosion estimated at between 25 and 40 Pg y^{-1} globally (Quinton *et al*., 2010).

Rates of human-induced soil erosion are estimated to outpace soil formation rates by more than an order of magnitude (Montgomery, 2007). The consequential trajectory of soil thinning is one that, left uninterrupted, leads to the removal of the soil cover and the exposure of the underlying parent material. Given that the thickness of the pedosphere is a first-order control on soil functioning, with thicker soils having a greater capacity for water, carbon, and nutrient storage (Power *et al*., 1980), the continued thinning of near non-renewable soil profiles, and the associated consequences on their productivity and health, is one of the most significant threats to soil sustainability (FAO, 2015; UNCCD, 2017). Understanding the timeline for soil ecosystem services

to be severely degraded by complete loss of topsoil is of considerable importance for policy makers, land managers, and society as a whole.

Yet, we have not quantified the longevity of our remaining soil resource. Media reports (e.g. Arsenault, 2014; Wong, 2019) have repeatedly stated that there are as little as 60 years of topsoil left, but there appears to be no scientific basis for these claims. Here, we provide the first scientifically robust, globally relevant estimate of soil lifespans and the degree to which changes in land use or management can extend them. We define a first-order upper physical limit on the productive lifespan of soils as the time it would take for the uppermost 0.3 m of soil to erode, assuming current rates of soil erosion and soil formation remain constant. We then employ this definition with a global dataset (10,030 plot years of annual water erosion rates, derived from 1,103 erosion plot-based records from 240 studies, that comprise 255 unique locations across 38 countries; Fig. 4.1) to quantify typical soil productive lifespans and examine the extent to which land use change and management practices can extend the timescales over which soils remain productive. This is a critical step in motivating and informing land management decisions that secure and sustain food, water, and climate services from soils.

Figure 4.1: Number and spatial distribution of plot years for the 255 unique locations in this study. Full dataset can be found in Appendix 4.1.

4.2 Materials and methods

4.2.1 Data collation

A compilation of 4,285 plot-based gross erosion rates representing 10,030 plot years, were amassed from 240 studies, comprising 255 unique locations across 38 countries (Fig. 4.1; sources are listed in Appendix 4.1). These data were initially obtained from a Web of Science search, using the search term “Soil Erosion”. Compiled studies were then scanned, with modelling-based studies and those that did not measure erosion rates empirically being discarded. In addition, studies which reported singular erosion events or those failing to report a year’s worth of erosion data (or a mean annual erosion rate) were discarded. To avoid biasing the analysis towards studies with long timeseries or many replicates, we averaged plot replicates and multi-year studies such that all data points represent one erosion rate for each treatment at a single location. Throughout this chapter, we use *n* to denote the number of these gross erosion rates, and *PY* to denote the number of plot years.

The data were assigned into three categories with respect to land management: bare, non-bare conventional agriculture, and conservation-based agriculture. The bare soils dataset was from soils that are kept free of vegetation on experimental plots (*n* = 62; *PY* = 470). These are often used to gauge erosion in a worst-case scenario. Whilst instances of constantly bare soil are only likely to occur periodically (e.g. prior to crop emergence), the use of bare soil data provides a worst-case baseline against which conventional agriculture and soil conservation practices can be assessed. The non-bare conventional agriculture dataset includes observations from plots undergoing non-conservation agricultural practices including downslope cultivation, non-

terraced cropland, and conventional tillage (*n* = 320; *PY* = 4,816). The conservation-based agriculture dataset comprises an array of plots that have been subject to soil conservation techniques, such as land-use change and modifications to agricultural practices (*n* = 721; *PY* = 4,744).

Gross erosion rates in the study's native units were compiled along with details of the respective management or soil conservation practice. Additional information about the study site was noted, including: soil type (FAO), textural data, mean annual precipitation, slope, and location co-ordinates. Bulk density was recorded if such information was provided; otherwise, the lower and upper values from bulk density ranges were calculated utilising accepted standards for each soil texture (US Department of Agriculture, 2018). Cultivation notes, including ploughing depth, mulching technique, and crop species were recorded wherever applicable. The dataset includes soils from 14 of the 26 soil orders as recognized by the World Reference Base. All soil textures apart from 'Silt' and 'Sandy Clay' soils are represented within this inventory, with the modal texture being 'Silt Loam' (*n* = 182; *PY* = 1,865); a comprehensive breakdown of textural data can be found in Appendix 4.1.

4.2.2 Lifespan model

To permit a valid comparison between the rates of gross erosion and those of soil formation, all erosion data were converted from their native units to mm y^{-1}. This involved a two-step approach whereby data in native units were first converted into t ha^{-1} y^{-1} and then, with the bulk density estimate, into mm y^{-1}, following previous approaches (Montgomery, 2007). Bulk densities were either taken directly from original papers or, in the case of these data being absent,

a lower and upper bulk density were estimated based on accepted standards (US Department of Agriculture, 2018). A lower and an upper gross erosion rate were thus calculated.

A previously compiled global dataset (*n* = 264) of soil formation rates were used in this study (Evans *et al*., 2019; see Appendix 2.1). This dataset comprises ^{10}Be-derived rates of soil formation measured at ten unique locations across Australia, USA, Chile, and the UK, representing five different climates (according to the Köppen classification system) and all three major rock types (igneous, sedimentary, and metamorphic) (Heimsath, 2006; Heimsath *et al*., 1997; 1999; 2000; 2001a; 2001b; 2005; 2012; Wilkinson *et al*., 2005; Dixon *et al*., 2009; Owen *et al*., 2011; Riggins *et al*., 2011; Evans *et al*., 2019). The mean soil formation rate was 0.053 ± 0.005 mm y^{-1}. The 25th and 75th percentiles of this dataset (0.011 and 0.059 mm y^{-1}, respectively) were employed into the lifespan model (Appendix 4.2).

Where gross erosion rates exceed those of soil formation, soil profiles thin and over time, assuming these rates remain constant, the soil profile will eventually erode beyond a critical depth required for the delivery of ecosystem services. The length of time until such a threshold thickness is crossed is referred to as the soil lifespan. Various iterations of the soil lifespan model exist within the literature (Stocking and Pain, 1983; Elwell and Stocking, 1984; Sparovek and Schnug, 2001; Montgomery, 2007; Medeiros *et al*., 2016). In principle, the three inputs of these lifespan models consistently include: gross annual soil formation rate, gross annual soil erosion rate, and soil thickness or soil depth. Often gross formation and gross erosion rates are used to produce a net annual erosion or net annual loss rate (*E*).

Soil thickness invariably refers to the whole solum but has been truncated in previous models to calculate lifespans at the horizon scale, rather than for the whole profile. In this study, we employed a truncated soil thickness (*D*) of 0.3 m and used this consistently throughout. We argue that the surface horizons of the soil are critical for ecosystem service delivery as they are enriched with nutrients and organic matter, and critical for plant growth. In line with the FAO Harmonised World Soil Database, the World Reference Base Soil Classification and by the IPCC (IPCC, 2006; Nachtergaele *et al*., 2008; FAO, 2014) we set the critical functional topsoil depth as 0.3 m. We chose a single topsoil depth as few of the plots where the erosion rates were measured had detailed soil descriptions. Global spatially explicit estimates of soil depth exist, such as the International Soil Reference Information Centre (ISRIC) Global Soil Information System 'SoilGrids', however, the representativeness of these data products for the individual sites is unknown (Hengl *et al*., 2017; Shangguan *et al*., 2017).

Lifespans (*L*) were calculated for bare, non-bare conventional, and conservation-based land use regimes using Eq. 1 (Appendix 4.2):

$$L = \frac{D}{E-F} \quad (1)$$

where *D* is depth (mm) (set at 3000 mm); *E* is the gross annual soil erosion rate (mm y^{-1}), and *F* is the gross annual soil formation rate (mm y^{-1}).

For each form of land use, calculated lifespans were pooled, and an Anderson Darling test for normality was conducted. Each sub-dataset was found to be non-parametric so the median was employed as a measure of central tendency, rather than the mean. To demonstrate the scatter of the lifespan

data for each category, both the interquartile range and the 5th and 95th percentiles were calculated.

Where gross erosion rates fall below those of soil formation, the lifespan calculated in the way expressed thus far becomes defunct. As such, the soil profile has crossed a lifespan threshold, from being a once-thinning soil to a now-thickening soil. In these instances, the net annual soil gain was calculated using the gross soil erosion and formation rates.

4.3 Baseline lifespans for bare and conventional agricultural soils

Here we consider soils that are devoid of vegetation (bare) and under conventional cropping (e.g.: inversion tillage, seedbed preparation followed by cereal or vegetable cropping), representing the worst-case and business-as-usual scenarios, respectively. The cumulative distribution of the estimated soil lifespans is illustrated in Figure 4.2. For plots kept bare, 34% of the dataset reported lifespans of <100 years (n = 60; PY = 447), and the median lifespan was 333 years. For bare thickening soils (n = 2; PY = 23), the mean annual estimated soil gain was 0.03 ± 0.003 mm y^{-1}. For soils from non-bare, conventionally managed plots, 16% of the dataset (n = 298; PY = 4,737) reported lifespans of <100 years, with a median of 491 years for thinning soils, and the mean annual estimated soil gain was 0.03 ± 0.001 mm y^{-1} for thickening soils (n = 22; PY = 79).

Our analysis forms the first quantitative estimate of the baseline lifespans of soils. It demonstrates the magnitude of the threat that soil thinning can place on relatively near-term soil sustainability, and identifies the urgent need to ameliorate soil erosion. Whilst these conclusions are alarming, it should be

noted that these baseline lifespans were spread across five orders of magnitude, and were heavily dependent on the management in operation and the local environmental conditions at the site-scale. This suggests that the popular quote that there are 60 years of global topsoil left (e.g. Arsenault, 2014; Wong, 2019), and particularly the citation of a single figure, does not effectively acknowledge the range of baseline lifespans that exist under a number of different land management practices.

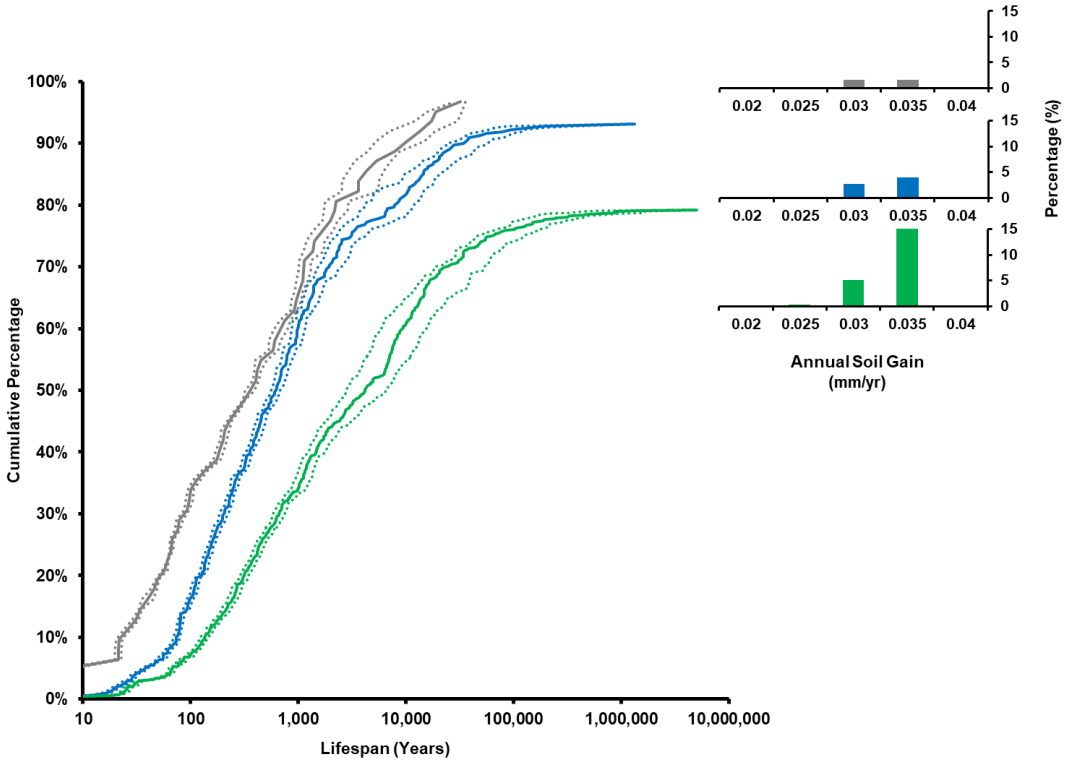

Figure 4.2: Cumulative distribution of soil lifespans (*n* = 929; *PY* = 9,168 for thinning and *n* = 174; *PY* = 862 for thickening soils) and annual soil gain for bare soils (grey), non-bare conventionally managed soils (blue), and conservation management (green). Percentages are normalized based on the total sample (finite and indefinite lifespans). Bold lines on the cumulative distribution chart represent median lifespans; dotted lines represent upper and lower bounds of lifespans when uncertainties in soil formation and soil erosion data are taken into account (see *Materials and Methods*). Full dataset can be found in Appendix 4.2.

4.4 Extending soil lifespans by changing land use and agricultural practice

The lifespans of soils under conservation management, including changes to both land use and agricultural practice, were estimated using measured erosion rates (*n* = 721; *PY* = 4,744) drawn from 201 plot-based studies. Gross soil erosion rates were lower than soil formation in 21% of cases (*n* = 150; *PY* = 760), leading to a net annual soil gain (Figure 4.2). Compared with the bare and conventionally managed plots, the conservation management plots were more than twice as likely to be thickening rather than thinning.

Pooling all data for plots managed with conservation practices, 7% of lifespans were <100 years. This represents a reduction of more than half in the proportion of lifespans <100 years compared with the conventionally managed plots in the dataset (Figure 4.2). The distribution of lifespans for the plots under conservation management was shifted towards longer lifespans when compared to conventionally managed soils. For conservation managed soils, 48% of the estimated lifespans exceeded 5,000 years compared to 23% for conventional agriculture, and 39% exceeded 10,000 years compared to 18% for conventionally managed soils.

4.4.1 Land use change

Afforesting both bare soil and cropland soil was one of the most effective land use changes for extending the soil lifespan (Figure 4.3). The shortest lifespan in the afforestation dataset was 420 years, compared to 16 years for cropland soils. In 50% of cases, gross erosion rates in forests fell below those of soil formation, promoting soil thickening (0.032 ± 0.001 mm y^{-1}). This proportion of

thickening soils was fifteen times that for bare plots, and six times that for cropland plots.

These findings concur with similar work that has concluded that croplands erode, on average, more than an order of magnitude faster than forest soils (Zhao *et al*., 2016). One of the principal ways that forests ameliorate soil erosion is to intercept rainfall and reduce the volume of concentrated flow on the forest floor (Jirasuktaveekul *et al*., 1998; Reubens *et al*., 2007; Shinohara *et al*., 2019). As forests mature, and their above-ground biomass increases, the potential for this interception and consequent erosion reduction increases. However, the management of the understorey to promote ground cover is important since where it has been removed the size and kinetic energy of raindrops can result in soil detachment (Shinohara *et al*., 2019).

Similarly effective in lengthening soil lifespans was the shift from bare soil and cropland to grassland. For plots with bare soils converted to grassland, we found that 2% of lifespans were <100 years, a 17-fold reduction in the proportion <100 year lifespans found for plots kept bare. Converting cropland to grassland led to a seven-fold reduction in lifespans of <100 years. In 37% of cases, gross soil erosion rates fell below those of soil formation, promoting soil thickening (0.032 ± 0.001 mm y^{-1}). This represents an 11-fold increase in the occurrence of thickening soils compared to bare soils, and a four-fold increase compared to cropland soils.

The effectiveness of grassland systems for ameliorating soil erosion is widely established. Many authors have cited dense above-ground biomass and fine root architecture as two particular traits that can contribute to dissipating the

energy of drop impact and overland flow (De Baets *et al*., 2006; Reubens *et al*., 2007). It has been suggested that grasslands subject to grazing pressures may be less able to reduce erosion, either because of stock-induced compaction, which reduces the soil's hydraulic conductivity, or the removal of above-ground biomass, which increases vulnerability to soil detachment and promotes overland flow generation (Evans *et al*., 2017). To overcome grazing pressures, rangeland scientists have focused their restoration efforts on defining sustainable stocking rates, improving shepherding, resting pastures, and excluding grazing from the worst affected areas.

4.4.2 Changing agricultural practices

Conversion of cropland to forest and grassland may be effective in extending the soil lifespan but it requires a change in land use. Without reducing the area of land designated for agriculture, we found that cover cropping previously bare soils was an effective method of extending lifespans. No plot in the cover-crop dataset had lifespans of <100 years, in contrast with the 34% of bare plots and the 16% of non-bare, conventionally managed plots which did. In a quarter of cases, gross soil erosion rates fell below those of soil formation, promoting an estimated net annual soil gain of 0.031 ± 0.001 mm y^{-1}. These results accord with previous work showing the importance of cover cropping in reducing erosion (Nyakatawa *et al*., 2001; Verstraeten *et al*., 2002; Gyssels *et al*., 2005). Not only does the above-ground biomass act as a buffer against potential rainsplash detachment, but cover cropping is also likely to improve soil structure, increase infiltration rates, and slow overland flow, further reducing water erosion (Smith *et al*., 1987).

Whilst cover cropping is one of the most effective agricultural practices for lengthening soil lifespans, a suite of additional practices both prior to and during the cropping season can extend these further. The shift towards conservation-based tillage practices has previously been found to reduce soil loss (Sharratt *et al*., 2006). In our dataset the shift from conventional tillage to conservation tillage led to a two-fold reduction in the proportion of cases with critically short lifespans (<100 years). Similarly, we found the shift from conventional tillage to zero tillage also lengthened soil lifespans.

In terms of cultivation direction, we found that the shift from downslope to contour cultivation brought about an extension of the soil lifespan, with 7% of these having lifespans of <100 years compared to 37% for up-and-downslope cultivation. For 6% of the contour cultivation dataset, soil thickening led to an estimated net annual soil gain of 0.032 ± 0.001 mm y^{-1}; a two-fold increase in the cases of soil thickening compared to soils cultivated downslope. On particularly steep gradients, contour cultivation may not be practical, and the most effective conservation-based management strategy may be terracing. For terraced soils, 2% of the dataset reported lifespans of <100 years, which compared to downslope cultivation represents a 23-fold reduction in critical lifespans. However, terraces can lead to a reduction in the crop production area (Herweg and Ludi, 1999), although some have argued that the risers are potentially cultivable (Sahoo *et al*., 2015). The ultimate performance of terrace systems as a soil conservation strategy is fundamentally dependent on the maintenance of the terraces. A review of over 60 studies into terrace abandonment showed that even though terrace abandonment can give rise to an increase in scrub cover, it is often not expansive enough to protect soils

from extensive surface and sub-surface erosional processes, and ultimately terrace collapse (Arnáez *et al*., 2015).

4.4.3 Decision making at the site-scale

The decision about which conservation practice is most likely to be more effective in sustaining soils at a given location is dependent on an array of social, economic and site-specific factors. For example, land use change to either forest or grassland may not be appropriate if agricultural activity is displaced to more erosive locations. The selection of specific agricultural practices is also likely to be partly determined by the social context, as well as the financial and resource capability of the land manager in question. Issues such as the duration of land tenancies and the existing polices, incentives, and advisory services provided at a regional and national level will influence the adoption of soil conservation approaches. Furthermore, the land use changes and agricultural practices presented in this chapter vary in their 'establishment time': the time for a selected conservation management regime to be set up, launched, and become effective. For soils with critical lifespans, and especially the 25 instances in our dataset where lifespans are shorter than 25 years, it could be argued that the most effective management decision is to adopt a strategy with a short establishment time. In this context, conversion to grass, cover cropping, and/or contour cultivation may be most appropriate, as the establishment time for these strategies is in the order of months to a year. By contrast, the planting of trees to convert cropland to forest may require less preparatory time, but there is a lag time for forests to mature. Previous studies have found that effective soil conservation in forests is only ensured when vegetation cover reaches a minimum coverage of 50%,

and the litter layer achieves a thickness of 0.8 cm (Wu *et al*., 1994; Béliveau *et al*., 2017). An immature forest is therefore unlikely to be as effective in extending soil lifespans as one where the canopy and litter are more established.

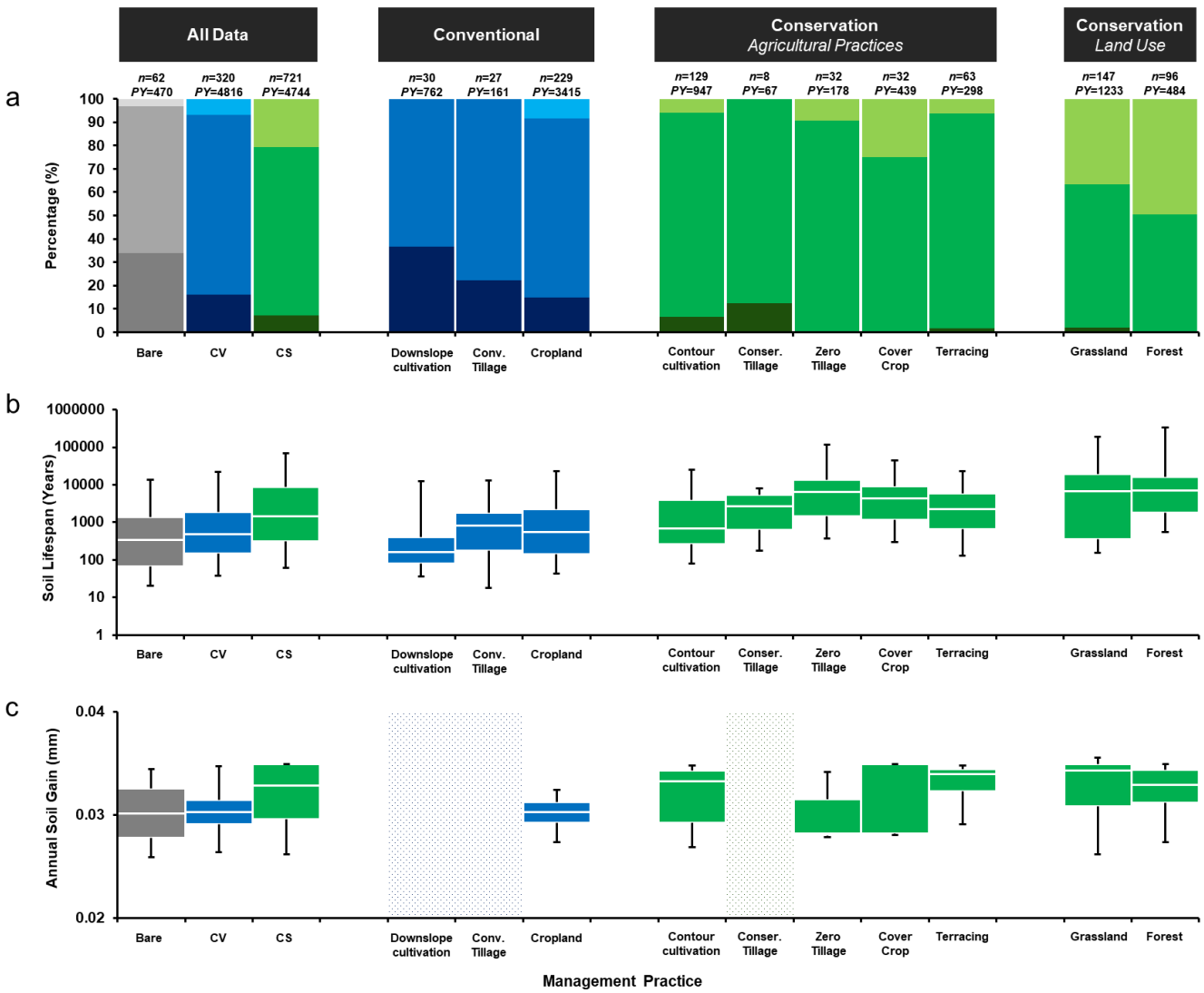

Figure 4.3: (a) Distribution of critical (<100 years; lowermost bars), finite (>100 years; middle bars), and infinite (thickening; uppermost bars) lifespans for bare, conventional, and conservation-based management (*n* = 1,103; *PY* = 10,030). **(b)** Soil lifespans for conventional (blue) and soil conservation (green) management practices (*n* = 929; *PY* = 9,168), excluding those soils that are thickening. **(c)** Net annual soil gain for conventional (blue) and conservation-based (green) management practices (*n* = 174; *PY* = 862). Dotted bars denote incidences where either annual soil gain did not occur or there were not enough data. Boxplots represent the interquartile range; error bars refer to the 5th and 95th percentiles, within each management shift category. A description of management practices can be found in Appendix 4.3. Full dataset can be found in Appendix 4.2.

4.5 Global and regional distribution of soil lifespans

The effects of soil conservation management, either through implementing shifts in land use or changes in agricultural practices, are also influenced by factors operating at local and regional scales. The 261 unique locations in this study were grouped into five regions: North America (*n* = 217; *PY* = 2,487); South America (*n* = 201; *PY* = 3,221); sub-Saharan Africa (*n* = 105; *PY* = 1,219), Europe and the Middle East (*n* = 107; *PY* = 963); and Asia and Australia (*n* = 473; *PY* = 2,140).

Pooling conventional and conservation-based data, sub-Saharan Africa, Asia and Australia and North America had the greatest proportions of data reporting thinning soils (95%, 88% and 83%, respectively), with North America having the greatest proportion of critical lifespans (18%) (Table 4.1). These contrast with South America where 73% of the dataset reported thinning soils, with 12% of lifespans being critical. Although 78% of the Europe and the Middle East dataset reported thinning soils, only 5% of these were critical.

Comparing conventionally managed soils with those under conservation management for each region, we found that the shift towards conservation practices nearly always reduced the proportion of cases with critical lifespans. The largest reduction was found in the sub-Saharan Africa region, where there was a 14-fold reduction in cases with lifespans of <100 years. We found that shifting from conventional to conservation management in this region led to an increase in the occurrence of thickening soils.

Our regional analysis indicates three important findings. First, whilst previous authors have identified hotspots of soil erosion, we show that every region has

soils that have critical lifespans. Many of the wealthiest countries, as defined by gross domestic product (World Bank, 2019), report some lifespans shorter than 100 years. Second, soil lifespans can be significantly extended even in regions prone to some of the shortest lifespans, such as sub-Saharan Africa. The soil conservation practices attributed to reducing gross soil erosion rates, and thereby extending lifespans in this region, included the conversion of cropland to grassland and forest (15% of the data), contouring (16%) and terracing (21%). The same practices in Asia and Australia had a similar effect of reducing the proportion of lifespans shorter than 100 years from 13% to 2%. The third main finding is that there are some conservation measures that are less effective in reducing gross erosion, emphasising the importance of additional region- and site-specific factors. Contour cultivation in Lacrosse, USA, implementing contour ridges in Tanzania, and practising conservation tillage in Hailun Heilongjiang, China are three examples where the implementation of conservation management did not enhance the soils' sustainability, with lifespans shorter than 100 years in all three cases.

Table 4.1 | Global distribution of finite, critical, and infinite lifespans for the five regions studied in this chapter.

	All Data		Finite Lifespans				Critical Lifespans			Infinite Lifespans			
	n	*PY*	n	*PY*	% of region	Median lifespan (years)	*n*	*PY*	% of region	*N*	*PY*	% of region	Mean soil gain ($mm\ y^{-1}$)
North America	217	2,487	181	2,346	83	583	39	755	18	36	141	17	0.033
South America	201	3,221	147	3,019	73	7,101	24	134	12	54	203	27	0.031
sub-Saharan Africa	105	1,219	100	1,198	95	671	17	212	16	5	21	5	0.035
Europe and Middle East	107	963	83	689	78	6,270	5	24	5	24	274	22	0.032
Asia and Australia	473	2,140	418	1,917	88	1,397	40	162	9	55	223	11	0.031

[a] Comprises bare, non-bare conventional, and conservation land use management.

[b] Full data can be found in Appendix 4.2.

4.6 Site-specific variables that influence lifespans

Underpinning the variability in the efficacy of soil conservation management across different regions are local, site-specific variables including climatic, topographic and pedological factors. Our data suggest that precipitation has a substantial influence on governing soil lifespans (Figure 4.4). The data were grouped into four classes of mean annual precipitation (MAP, hereafter): 0 to 500 mm y^{-1} (*n* = 70; *PY* = 400); 501 to 1,000 mm y^{-1} (*n* = 335; *PY* = 2,549); 1,001 to 1,500 mm y^{-1} (*n* = 255; *PY* = 3,576); and 1,501 to 2,000 mm y^{-1} (*n* = 110; *PY* = 708). For conventionally managed soils subject to MAP between 0 and 500 mm y^{-1}, 92% of observations reported thinning soils whilst the remaining 8% reported soil thickening. This increased to 96% and 4%, respectively, for soils subject to MAP of between 500 and 1,000 mm y^{-1}. One explanation for this is that the erosion associated with those soils subject to MAP less than 500 mm y^{-1} is water-limited. As MAP increases to between 500 and 1,000 mm y^{-1}, the potential for erosion intensifies and, in consequence, the proportion of thinning soils also swells. However, soils subject to MAP greater than 1,500 mm y^{-1} reported a reduction in observations of thinning soils and a commensurate increase in the occurrence of soil thickening. For instance, comparing the 500 to 1,000 mm y^{-1} class with the 1,500 to 2,000 mm y^{-1} class, the proportion of instances of thinning soils decreased by 30% and there was a eight-fold increase in the proportion of cases of thickening soils. A similar pattern is observed for critical lifespans. Soils subject to MAP of between 500 and 1,000 mm y^{-1} reported the greatest proportion (17%) of critical lifespans whilst this proportion more than halved for the 1,500 to 2,000 mm y^{-1} class. The reduction in soil thinning for soils subject to MAP less than

1,000 mm y^{-1} can potentially be explained by the fact that the increase in precipitation gives rise to increased biomass production, leading to the protection of the soil surface from rain drops, slowing of overland flow, and in some cases, the enhancement of infiltration (Nearing *et al*., 2004).

For soils subject to conservation management, the patterns described above are similar, albeit less pronounced. Between the 0 to 500 mm y^{-1} and 500 to 1,000 mm y^{-1} classes, there was a 2% increase in the proportion of thinning soils. Although this proportion then decreased for conventionally managed soils subject to MAP greater than 1,000 mm y^{-1}, this was not observed for soils managed with conservation practices. Instead, the instances of soil thinning increased by a further 1% for soils subject to MAP of between 1,000 and 1,500 mm y^{-1}. However, between the 1,000 to 1,500 mm y^{-1} and the 1,500 to 2,000 mm y^{-1} classes, observations of soil thinning decreased by 2%. With regards to critical lifespans, there was a steady increase in the proportion of soils reporting critical lifespans for each successive MAP class, from 2% for the 0 to 500 mm y^{-1} class, to 10% for the 1,500 to 2,000 mm y^{-1} class. Whilst MAP may explain some of the variation in soil lifespans, it is also important to acknowledge that it is one of the many measures of precipitation that influence soil loss (Doetterl *et al*., 2012; Ballabio *et al*., 2017).

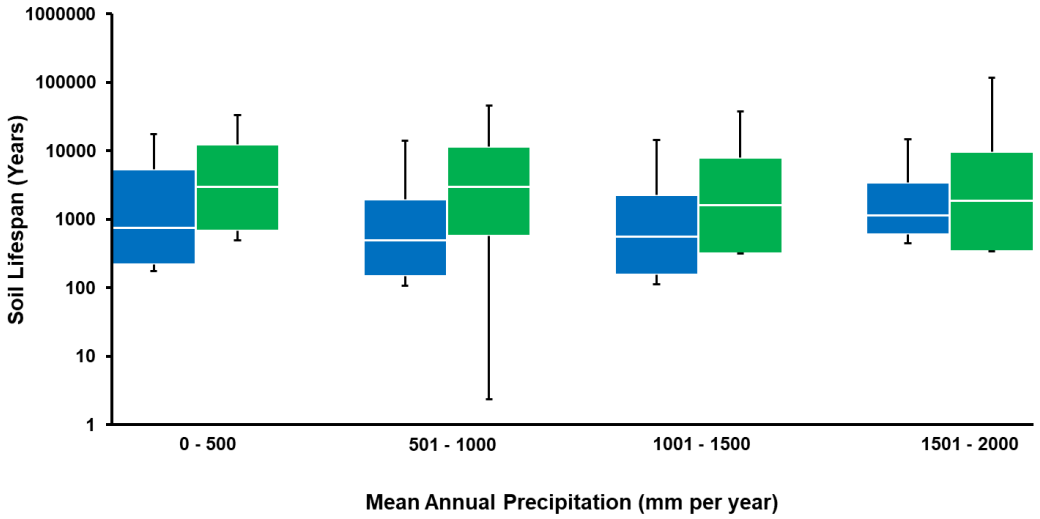

Figure 4.4: Soil lifespans for conventional (blue) and soil conservation (green) management practices under different mean annual precipitations. Boxplots represent the interquartile range of soil lifespans. Error bars refer to the 5th and 95th percentile soil lifespans.

The slope or gradient of a soil surface is another factor controlling soil loss, and driving the variability in the efficacy of soil conservation strategies (Figure 4.5). The data were grouped into three slope classes with a similar number of data points: 0 to 5% (*n* = 264; *PY* = 4,099); 6 to 10% (*n* = 103; *PY* = 1,581) and 11 to 20% (*n* = 144; *PY* = 1,539). For soils subject to conventional management, the proportion of instances of soil thinning was higher in the 6 to 10% class (100%) compared to the 0 to 5% class (92%). Between the 0 to 5% and 6 to 10% class, there is also a corresponding increase in the proportion of cases with critical lifespans from 4 to 43%, respectively. Counterintuitively, a reduction in the instances of soil thinning and the proportion of cases with critical lifespans was observed for slopes between 11 and 20%. Between the 6 to 10% and 11 to 20% slope classes, there was a 8% decrease in the instances of soil thinning, and a 14% reduction in the proportion of cases with critical lifespans. This could be explained by the fact that nearly two-thirds of the soils within the 11 to 20% class were in crop, compared to just over a third

for the 6 to 10% class. In this instance, the crops may have diminished the potential for soil erosion that would otherwise have been expected for a steep slope class. For soils subject to conservation management, the proportion of instances of soil thinning increased by 3% between the 0 to 5% and 6 to 10% slope classes. In contrast, the proportion of critical lifespans decreased between these two bins. Furthermore, the efficacy of conservation management increased as slope increased. Shifting from conventional to conservation management brought about a 20% increase in the proportion of cases with thickening soils on slopes of 0 to 5%, and a 26% increase for slopes of 6 to 10%.

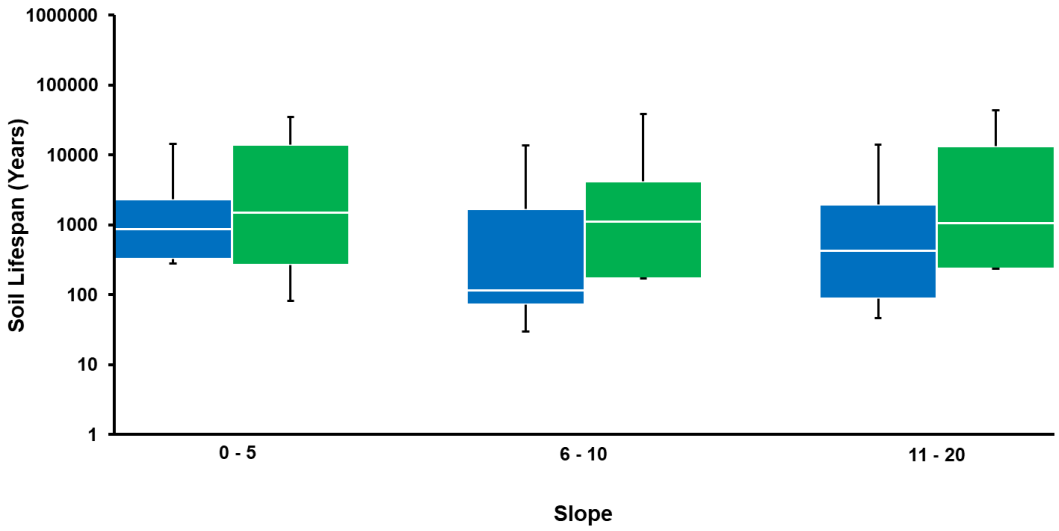

Figure 4.5: Soil lifespans for conventional (blue) and soil conservation (green) management practices under different slopes. Boxplots represent the interquartile range of soil lifespans. Error bars refer to the 5th and 95th percentile soil lifespans.

Soil texture forms a third driving variable that influences soil lifespans and the extent to which management strategies may extend them (Figure 4.6). This study's dataset of conventional- and conservation-based management comprised all soil textures apart from silt and sandy clay textured soils, with the modal texture being silty loam (*n* = 182; *PY* = 1,865). For all of the observed soil textures apart from silty clay and loamy sand, conservation-based practices reduced the proportion of the dataset reporting thinning soils, with the greatest reduction observed for silty clay loam soils. Furthermore, conservation management increased the proportion of thickening soils and reduced the proportion of critical lifespans. Compared to conventional management, conservation management was most effective at increasing the instances of soil thickening on silty loam soils (an 11-fold increase) followed by loam soils (a three-fold increase). With regards to reducing the proportion of critical lifespans, we found no instances of critical lifespans for silty clay and silty clay loam soils when subject to conventional management. Loamy sand soils reported the largest proportion of critical lifespans under conventional management, but also the greatest reduction of the proportion of critical lifespans when conservation-based practices were employed.

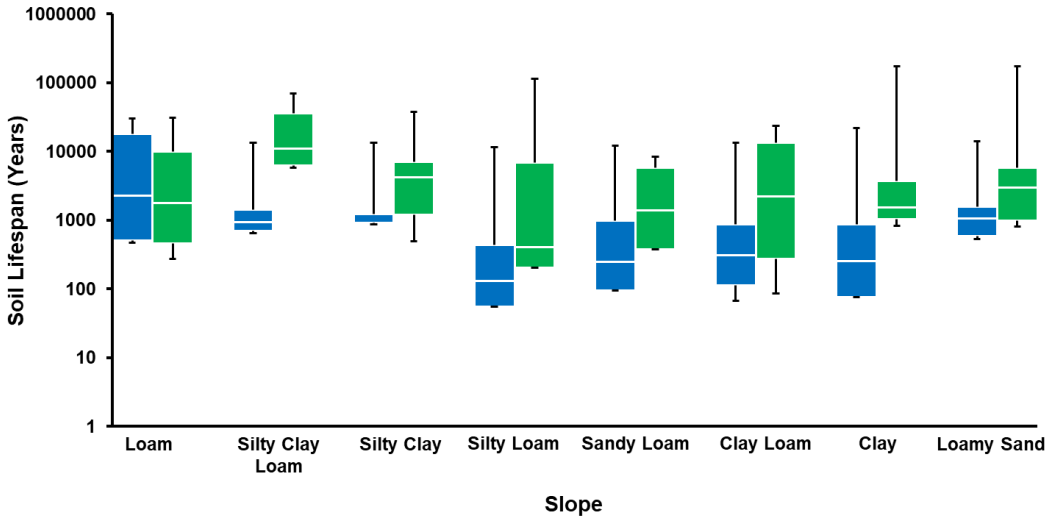

Figure 4.6: Soil lifespans for conventional (blue) and soil conservation (green) management practices under different soil textures. Boxplots represent the interquartile range of soil lifespans. Error bars refer to the 5th and 95th percentile soil lifespans.

4.7 Limitations and knowledge gaps

In setting out these first-order soil lifespans, and discussing the controlling variables, we acknowledge a range of assumptions. The lifespans calculated here are based on a single proxy (net erosion), which is just one form of degradation that threatens the sustainability of soils around the world. There are a range of retrogressive processes that can degrade soils in shorter time frames (Heimsath *et al*., 2009). For example, soil compaction can bring about adverse effects on the physical, chemical and biological properties of soils, without a loss of soil thickness (Batey, 2009). However, the balance between soil formation and soil erosion provides a good first-order estimate of the lifespan: it is the maximum estimate of the lifespan assuming that if any soil is present, it is functioning. The soil formation and erosion rate (and, therefore, the net annual soil loss and gain) were assumed to remain constant over time. This does not account for the year-to-year fluctuations observed in long-term

soil erosion studies (Martínez-Casasnovas *et al*., 2002), nor the potential increase in bedrock weathering rates as the overlying soil mantle progressively thins (Heimsath *et al*., 1997). In addition, the bedrock-derived soil formation rates neither account for allochthonous additions (aeolian and alluvial deposits) nor the thickening of an organic layer on the mineral soil surface, observed as a product of some management practices, such as conservation tillage (Sharratt *et al*., 2006). In addition, we selected a critical soil depth of 0.3 m, but in reality, depending on the soil and the environment, the critical soil depth threshold may be lower or higher than this. Furthermore, we do not account for any adaption of the subsoil: if surface erosion rates are sufficiently low, the underlying subsoil (if it exists) could be transformed, chemically and biologically, into topsoil (Bakker *et al*., 2004). Such a transformation of subsoil into topsoil would constitute a form of soil formation which our calculation does not account for. In these instances, the lifespans calculated here would represent underestimates.

Assumptions were also made in the collation of input data used in the lifespan calculation. First, the lifespans presented here have been calculated from erosion rates measured at the plot scale, which are not wholly representative of the erosional processes observed at the landscape scale, such as gully erosion (Takken *et al*., 1999; Cerdan *et al*., 2010). Depending on how different plot-scale and landscape-scale erosional processes operate, the lifespans may be either overestimates or underestimates. Although the compiled data were processed through a series of quality checks often employed in similar inventory studies (Cerdan *et al*., 2010), it should be acknowledged that the data collated here were derived from erosion plot experiments which can be

biased towards sites of high erodibility, and therefore it could be argued that the lifespans calculated here are also biased. To establish whether this bias is substantial requires a greater number of erosion investigations conducted on soils under a representative range of agricultural conditions. We also acknowledge that the erosion rates included in this analysis are solely those of water-based soil redistribution. Whilst the influence of tillage regime on water-based erosion rates has been included in our analysis, quantifying the redistribution of soil by tillage has not, although soil redistribution by tillage represents a significant mechanism for translocating soil in agricultural landscapes (St. Gerontidis *et al*., 2001). Therefore, it is likely that estimates of lifespans are overestimated for soils on slope convexities where tillage reduces soil depth, and underestimated on slope concavities where tillage leads to soil accumulation (Van Oost, 2006).

Finally, one of the greatest limitations is the imbalance between the number of observations in the soil erosion dataset and those within the inventory of soil formation. There has been very little investment within Soil Science in the derivation of soil formation rates globally (Portenga and Bierman, 2011; Stockmann *et al*., 2014). A Web of Science search shows that the percentage increase in publications for the search term “soil erosion and degradation” between 1950 and 2016 is more than two orders of magnitude compared to that for the search term “soil formation”. We therefore encourage a fresh movement of cross-community collaboration whereby critical zone scientists, geologists, and soil conservationists work together to expand the knowledge on the rates of the soil formation process.

4.8 Conclusions

In this chapter, we have presented the first broad quantitative estimates of the lifespans of soils and the degree to which these may be extended by land management change. By compiling globally distributed soil erosion and soil formation rate data and applying the soil lifespan concept, we can contribute the following conclusions.

First, an assessment of baseline (current) soil lifespans using soil loss rates measured from non-bare soils under conventional management systems suggest that, under a worst-case scenario, 93% are thinning with 16% having exceptionally short (0-100 years) lifespans. At these sites, soil erosion is a significant threat to the soil's capacity to grow food, support ecosystems, store and regulate water, cycle carbon and nutrients and thus the overall functioning of the soil system. It has been acknowledged that there are factors that govern the sustainability of soil resources, other than the net soil loss rate. However, given that the presence and thickness of soils are first order controls on soil functioning, the topsoil depth change calculations presented here are potentially representative of the maximum soil lifespans expected.

Second, we have shown that shifts both in land use and land management practices can meaningfully extend the soil lifespan and, in many cases, promote the onset of soil thickening. Only 7% of the conservation plot dataset had critical lifespans, with 48% of the estimated lifespans exceeding 5,000 years and 39% exceeding 10,000 years. The conversion of bare cropland to forest or grassland is most effective in achieving both of these outcomes, closely followed by cover cropping. However, given the need to meet the

growing demand for food, arguably cover cropping is the more attractive option for extending lifespans. A suite of additional strategies to extend soil lifespans and promote annual soil gain include shifts towards contour cultivation and terracing. In all of these extensions, the primary result is to lengthen the duration of time before soil profiles reach critical thickness, below which they cannot fulfil valuable ecosystem services. However, both the extension of soil lifespans and the promotion of soil thickening has secondary implications, namely to increase the potential for water, carbon, and nutrient storage, and thereby rendering conditions which could enhance yields.

Third, we have shown that there is a wide distribution of soil lifespans globally, encompassing five orders of magnitude, and partly reflective of an extensive variation in the underlying driving variables such as climate, slope, and soil texture which can influence the efficacy of soil management changes. However, soils with human-scale lifespans shorter than 100 years are present in all of the observed regions, including many of the wealthiest nations. This clearly demonstrates that the thinning of soil is one of the most critical threats to soil sustainability globally, and that urgent action worldwide by policy makers, land managers and society is imperative to prevent the collapse of soil ecosystem service provision.

Acknowledgements:

We wish to thank all those who assisted us in our efforts to compile the dataset, particularly Khasijah Binti Muhamad, Calvin Rose, Bofu Yu, and Mark Nearing. The statistical advice of Professor Murray Lark and Dr. Victoria Janes-Bassett is also gratefully acknowledged.

Chapter 5: Arable soil formation and erosion: a hillslope-based cosmogenic-nuclide study in the United Kingdom

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Abstract

Arable soils are critical resources that support multiple ecosystem services. They are frequently threatened, however, by accelerated erosion. Subsequently, policy to ensure their long-term security is an urgent societal priority. Although their long-term security relies upon a balance between the rates of soil loss and formation, there have been few investigations of the formation rates of soils supporting arable agriculture. This chapter addresses this knowledge gap by presenting the first isotopically constrained soil formation rates for an arable (Nottinghamshire, UK) and coniferous woodland hillslope (Shropshire, UK). Rates ranged from 0.026 to 0.096 mm y^{-1} across the two sites. These rates fell within the range of previously published rates for soils in temperate climates and on sandstone lithologies, but significantly differed from those measured in the only other UK-based study. We suggest this is due to the parent material at our sites being more susceptible to weathering. Furthermore, soil formation rates were found to be greatest for aeolian-derived sandstone when compared with fluvially derived lithology, raising questions about the extent to which the petrographic composition of the parent material governs rates of soil formation. On the hillslope currently supporting arable agriculture, we utilized cosmogenically derived rates of soil

formation and erosion in a first-order lifespan model and found, in a worst-case scenario, that the backslope A horizon could be eroded in 138 years, with bedrock exposure occurring in 212 years under the current management regime. These findings represent the first quantitative estimate of cultivated soil lifespans in the UK.

5.1 Introduction

Soil erosion is a significant threat to society (Pimentel *et al*., 1995; UNCCD, 2017). Whilst uncultivated soils may develop steady-state thicknesses, where erosion and formation are in dynamic equilibrium (Phillips, 2010), human-induced erosion has led to soil thinning across many landscapes (Montgomery, 2007). Soil erosion, left unchecked, can ultimately lead to the removal of the soil cover and the exposure of the underlying parent material (Amundson *et al*., 2015). The development of soil conservation strategies has long been an active field for research and practice (Panagos *et al*., 2016; Govers *et al*., 2017). Given any long-term strategy to preserve soil resources relies upon a balance between the rates of soil loss and soil renewal (Hancock *et al*., 2015), the measurement of soil formation is a fundamental component in these conservation efforts.

The mechanisms associated with soil formation have been studied for over a century, with a focus on the development of soil horizons and the evolution of soil properties (Dokuchaev, 1879; Jenny, 1941; Bryan and Teakle, 1949; Tugel *et al*., 2005). Efforts to quantify the rates at which soils form from parent materials have included studying how soil properties change across chronosequences (Turner *et al*., 2018), developing chemical weathering

models (Burke *et al*., 2007) and, in particular, employing terrestrial cosmogenic radionuclide analyses (Heimsath *et al*., 1997). In the latter, the concentrations of radioactive isotopes in the bedrock, which are partly dependent upon the rate at which bedrock transforms into soil, are measured and assumed to equal the rates of soil formation.

Despite the recent advancements in cosmogenic radionuclide analysis, their application in soil science has, arguably, not been fully realized. Moreover, there are three research challenges that may explain this. First, there is a dearth of soil formation rate data. Whilst there have been many attempts at calculating a global average soil formation rate from collating multiple inventories (Alexander, 1988a; Montgomery, 2007; Stockmann *et al*., 2014; Minasny *et al*., 2015), these datasets often omit more than 100 countries, particularly in Africa and Europe, presenting a clear rationale for more studies to take place in these areas of the world. Second, over 80 % of the soil formation rate inventory, comprising data from Montgomery (2007), Portenga and Bierman (2011) and Stockmann *et al*. (2014), is attributed to samples taken from outcrops and stream sediments procured from drainage basins. Moreover, only 252 ^{10}Be-derived rates from this inventory of 1850 stem from samples extracted from underneath the soil mantle. In addition, the majority of these stem from mountain regions and deserts (Heimsath *et al*., 1997; Wilkinson *et al*., 2005; Zhao *et al*., 2018; Struck *et al*., 2018). This is partly because the observation and estimation of bedrock weathering rates is most commonly carried out by the geomorphological community, principally to identify the mechanisms behind long-term landscape evolution (Heimsath, 2006; Heimsath and Burke, 2013; Ackerer *et al*., 2016; Zhao *et al*., 2018). As

a result, there has been no investment in deriving rates of soil formation for soils that support arable agriculture (Heimsath, 2014), despite these soils being identified as a societal priority (FAO, 2015). Such soils are critical to the delivery of multiple ecosystem services and, for many countries, are one of the most critical resources in ensuring the health of the society and sustained economic growth. They are also often intensely managed, and thus the loci for accelerated erosion (Quinton *et al*., 2010; Borrelli *et al*., 2017). However, in the absence of soil formation rate data, the magnitude of the threat erosion places on the sustainability of soils and arable production is unknown, amounting to a critical knowledge gap. Third, although the distributions of inventoried soil erosion and formation rates are often presented together to demonstrate the severity of soil erosion (Montgomery, 2007; Minasny *et al*., 2015), the spread of globally compiled data is such that it cannot offer a useful forecast of the sustainability of soil at a site scale. Both distributions are platykurtic, and there is substantial overlap in these rates: 0–28.8 mm y^{-1} for soil formation (Minasny *et al*., 2015) and 0–52.9 mm y^{-1} for soil erosion (Montgomery, 2007). For a greater understanding into the sustainability of soil resources at the local scale, we argue that soil scientists should undertake empirical measurements of both soil formation and erosion in parallel.

In this UK-based study, we present ^{10}Be-derived soil formation rates for two catena sequences in an arable and coniferous woodland setting. The former are the first of their kind globally, and the latter are the first of their kind in Europe. We place our results in the context of the rates previously derived in similar climatic and petrographic settings around the world. Finally, using

previously measured soil erosion rates at the arable site, we calculate first-order soil lifespans to infer the long-term sustainability of the soil resource.

5.2 Materials and methods

5.2.1 Site description

This study measures soil formation down two catena sequences (Figure 5.1). The first is an arable hillslope at Rufford Forest Farm (RFF), east of Mansfield in Nottinghamshire, UK (53°7′13.43″ N, 1°4′39.61″ W). The second is a woodland hillslope in Comer Wood (CW), north of Quatford in Shropshire, UK (52°30′30.43″ N, 2°22′45.68″ W). RFF was selected as it is the site of previous tillage and water-based erosion studies (Quine and Walling, 1991; Walling and Quine, 1991; Govers *et al*., 1996). Electing CW as a sister site is justified based on its similarities in parent geology, macroclimate, and soil physical properties with RFF as detailed below. A Trimble S6 Total Station was used to measure the relative elevation and slope of the catenas at both sites (Fig. 5.1b).

A reconnaissance study of the parent materials and their feasibility for cosmogenic radionuclide analysis was undertaken in spring 2017. Both sites are underlain by Triassic sandstone. At RFF, the Sherwood Sandstone (Chester formation; Olenekian, 247–251 Ma) is described as pinkish to red, medium to coarse grained, pebbly, cross-bedded, and friable. In CW, the New Red Sandstone (Bridgnorth formation; Cisuralian, 273–299 Ma) is described as brick-red, medium grained, cross-bedded, and aeolian based. Both RFF and CW are south-facing slopes, and sit in a temperate oceanic climate (Cfb), between 96–99 and 50–71 m a.s.l., respectively. The mean annual

precipitation and temperature is 709 mm and 9.8 °C at RFF, and 668 mm and 9.9 °C at CW, respectively (Met Office, 2018).

Both sites are positioned beyond the areal limits of the Late Devensian ice sheet, but studies conducted on similar formations of Triassic Sherwood Sandstone nearby suggest that the weathering of the parent material was partly induced by freeze–thaw processes associated with periglacial active layer development possibly during this period (Tye *et al*., 2012). Although proglacial glaciogenic deposits have been found in the vicinity of CW, the prevalence of similar deposits on the study hillslope has not been studied. However, unpublished work conducted by the authors suggests that the upper (3–5 m) of the lithosphere at both sites was subject to high-magnitude sediment transport at least 200,000 BP or before, potentially during the Anglian glaciation (~450,000 BP). The complex land use and vegetation change in the Sherwood Sandstone outcrop, within which RFF is based, has been extensively studied and mapped by Tye *et al*. (2013). Following the onset of the Holocene, the area has been dominated by a complex sequence of land use change including broadleaf woodland (6000–2000 BCE), heathland (43–409 CE) and landscaped heathland for hunting (1600 CE). From at least 1855 CE, RFF has been under an arable regime, and in the last 12 years, the dominant crops have been winter wheat and rye. CW is understood to have been an open field until 1903–1926, and then heathland until 1954. Between 1954 and the present day, however, the site has been continuously occupied by a coniferous forest (Mike Annis, personal communication, 8 October 2018).

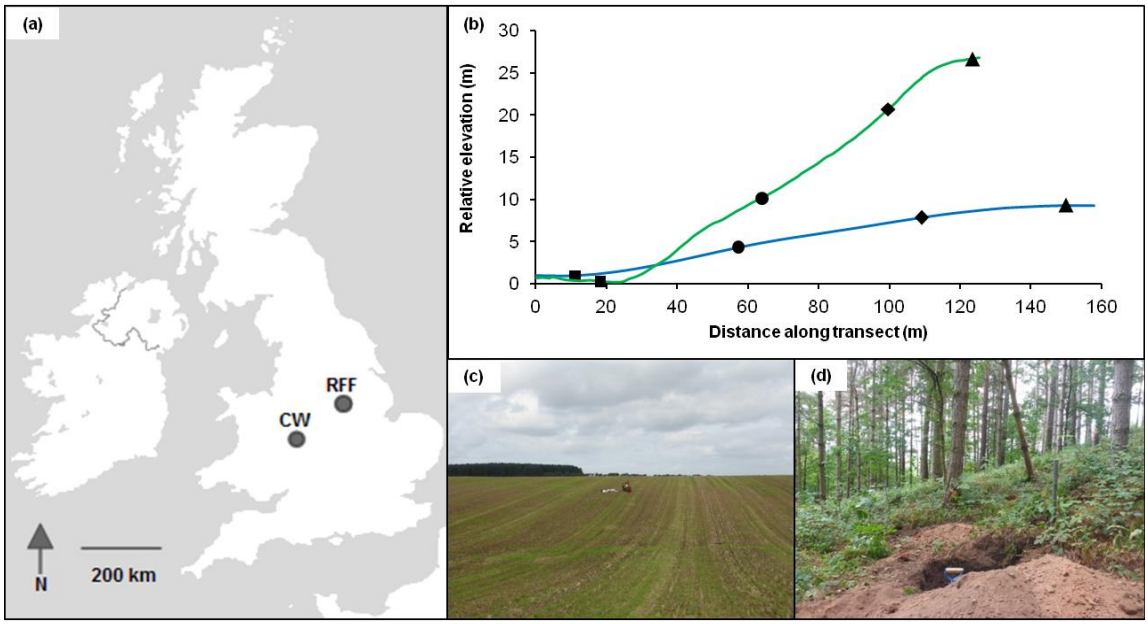

Figure 5.1: Locations of the study sites in this chapter **(a)** with elevation profiles **(b)** for both Comer Wood (CW; green) and Rufford Forest Farm (RFF; blue). The position of summit (triangles), shoulder (diamonds), backslope (circles) and toeslope (squares) sampling positions are indicated on each profile. Photographs of RFF **(c)** and CW **(d)** were taken by the author at the time of sampling.

5.2.2 Saprolite extraction and soil sampling

Four positions (summit, shoulder, backslope and toeslope) along a catena transect were selected for depth-to-bedrock surveys and saprolite extraction. First, a dynamic cone penetrometer was used to estimate the depth of the soil–saprolite interface. At RFF, a percussion drilling rig then proceeded to extract a series of vertical undisturbed core samples of the soil and saprolite. Cores were later halved lengthways, and by observing the changes in the consolidation and physical integrity of the extracted material (i.e. whether it remained intact when removed from the core), together with the penetration resistance data acquired in the field, the soil–saprolite interface was

demarcated. Two samples of saprolite (5 cm thickness) were then subsampled for cosmogenic radionuclide analysis: one at this interface and one from 50 cm below. In CW, following the use of the dynamic cone penetrometer to locate suitable sites, a soil pit was manually dug vertically at each of the four sampling locations. Observing the changes in the consolidation and physical integrity of the material down the profile wall, together with the penetration resistance data, the soil–saprolite interface was ascertained. A sample of saprolite (5 cm thickness) was then extracted from this interface for cosmogenic isotope analysis.

The bombardment of quartz minerals in the uppermost metres of bedrock with cosmic rays leads to the production of ^{10}Be. Assuming the intensity of these cosmic rays and the in situ weathering of bedrock (ε) is constant, the concentration of ^{10}Be (N) in a sample of bedrock, as shown in Eq. (1), is dependent upon the balance of two factors: the time that the bedrock has been exposed to cosmic rays with longer durations leading to greater concentrations, and the weathering of this bedrock into mobile regolith (soil) with greater rates of bedrock weathering leading to smaller concentrations (Lal, 1991; Stockmann *et al*., 2014). We assume here that the production of ^{10}Be and the erosion of the bedrock is at an equilibrium:

$$N = \sum_{i=sp,\mu_f,\mu^-} \frac{P_i(\theta) \cdot e^{-\frac{x}{\Lambda_i}}}{\lambda + \frac{\epsilon\rho}{\Lambda_i}} \left(1 - e^{-t\left(\lambda + \frac{\epsilon\rho}{\Lambda_i}\right)}\right) \quad (1)$$

where: P are the annual production rates of ^{10}Be by spallation, fast muons and stopping muons (*sp*, *μf* and *μ*-) at a surface with slope Θ; x is the mass sample depth ($\rho \cdot z$); ρ is the density of overburden material; z is the depth of

the sample; *t* is the age of the bedrock surface (the age when the original surface was generated); λ is the decay constant of ^{10}Be with λ equalling In2/^{10}Be half-life; and Λ are the mean attenuation of cosmic radiations (Lal, 1991). *t* is usually considered infinite. At RFF, we took two samples from the same depth profile at each catena position to test if the data support these assumptions. RFF data are compatible with landscape ages >200 ka. Production rates, decay constants, and attenuation lengths were calculated using field data and the CRONUS-Earth online calculator v2.3 Matlab code for the St scheme (Balco, 2008). As *N* can be measured using Accelerator Mass Spectrometry (AMS), Eq. (1) can be solved for ε by simple interpolation of *N*.

A total of twelve samples of saprolite (eight from RFF and four from CW) were prepared for AMS at the Cosmogenic Isotope Analysis Facility, East Kilbride, Scotland. This comprised of mineral separation, quartz cleaning, and procedures leading to the preparation of BeO sample cathodes (Kohl and Nishiizumi, 1992; Fifield, 2010; Corbett *et al*., 2016). The AMS measurements were carried out at the SUERC AMS laboratory (Xu *et al*., 2010). ^{10}Be concentrations are based on 2.79 x10^{-11} ^{10}Be/^{9}Be ratio for the NIST Standard Reference Material 4325. The processed blank ratio ranged between 6 and 13% of the sample ^{10}Be/^{9}Be ratios. The uncertainty of this correction is included in the stated standard uncertainties. Concentrations of ^{10}Be were subsequently determined, following Balco (2006) (see Appendix 5.1).

Previous work (e.g. Heimsath *et al*., 1997) has assumed that the bulk density of the soil above the bedrock surface is either equal to that of the bedrock, or constant with depth. For this chapter, we developed a model called 'CoSOILcal' to calculate soil formation rates using empirically measured bulk

density data from each catena position at both RFF and CW (Rodés and Evans, 2019). The local annual production rate of ^{10}Be at each study site must also account for any obstructions that reduce the cosmic ray flux to the parent material (Phillips *et al*., 2016). For an obstruction to cause this reduction, it is required to be several metres thick which equates, in practice, to topographic features at the scale of tens of meters or greater. The shielding factor, therefore, is a ratio of the ^{10}Be production rate at the obstructed site to that at an identical site but with a flat surface and a clear horizon (Balco *et al*., 2008). To calculate both shielding factors and subsequently normalize local ^{10}Be production rates, site elevation, latitude, and longitude were inputted into the CRONUS-Earth Matlab code v2.3 using Lal/Stone (St) scaling (Balco *et al*., 2008).

Soil samples were sub-sampled every 5 cm from each core at RFF and on each profile wall at CW. All samples were then oven dried overnight (105°C for 12 hours), grounded with a pestle and mortar, and sieved to discard the >2 mm fraction before being subject to particle size analysis and loss on ignition (LOI). Particle size analysis was conducted using a Beckman Coulter Laser Diffraction Particle Sizing Analyser LS 13 320 (pump speed: 70 %; sonication: 10 seconds; run-length: 30 seconds). For LOI, 5 g of each sample was placed in a Carbolite furnace CWF 1300 (550°C for 12 hours). Full data from these analyses can be found in Appendix 5.2.

The soils at RFF are classified as Arenosols (IUSS Working Group WRB, 2015) with weak horizonisation. An Ap loamy-sand horizon (82% sand, 16% silt, 2% clay) thickens from 30 to 75 cm and increases in LOI content from 3.65 to 3.91% from summit to toeslope, respectively. Despite being subject to

arable practices for over 150 years, the presence of a 30 cm Ap horizon may be explained in part by the incorporation of mineral matter with the remaining organic material after harvest, although further isotopic work is required to verify this for RFF. This Ap horizon is underlain by a 5 cm fluvial pebble-bed, typical of the Bunter pebble-beds found in the vicinity (Ambrose *et al*., 2014). An undifferentiated, weakly-consolidated subsoil steadily grades into saprolitic, moderately-consolidated sandstone.

The soils at CW are classified as Arenosols (IUSS Working Group WRB, 2015). Similar to RFF, there is little evidence for horizonisation down the profile at CW. A thin (<5 cm) litter-fermentation-humus layer overlays an undifferentiated, weakly-consolidated, sandy subsoil (94% sand, 5% silt, 1% clay) and grades into moderately-consolidated saprolitic sandstone. The sandy composition of these soils suggests that proglacial outwash deposits have not contributed to the soils of the study sites and that, instead, the soils are largely residual.

5.2.3 Lifespan analysis at Rufford Forest Farm

To provide an insight into the sustainability of the soil profiles at RFF under arable agriculture, in terms of the balance of erosion and formation, a first-order lifespan model was employed. Calculating the sustainability of a net-eroding soil in first-order terms has been attempted in the past (Elwell and Stocking, 1984; Sparovek and Schnug, 2001; Montgomery, 2007; Medeiros *et al*. 2016). Early models (Stocking and Pain, 1983), however, did not account for mass inputs into the soil system, such as that derived from bedrock weathering. In this study, this omission was addressed by using soil formation

rates empirically measured at RFF. Furthermore, in previous models, the solum thickness used to calculate the soil lifespan is not universally consistent. Some authors constrain the lifespan by the minimum depth required for primary production (Stocking and Pain, 1983; Elwell and Stocking, 1984).

Notwithstanding the fact that this soil threshold depth will, in part, be crop-dependent, soils that fall below this threshold may still be able to fulfil some of the ecosystem services, such as the sequestration of carbon. To address this here, two lifespan (*L*) scenarios were calculated, both of which are based on the continuation of contemporary arable agriculture. The first referred to the expected lifespan of the current A horizon (*D* = 30 cm across the catena). At the toeslope, an additional lifespan was calculated to account for the greater depth (75 cm) of the A horizon. Here, we did not account for any transformation of subsoil into topsoil, which could occur if erosion rates are sufficiently low, nor did we account for any allochthonous inputs to the profile such as aeolian additions and organic amendments. The second estimated the time until the underlying parent material is exposed. Here, the observed depth to the soil-saprolite interface at each catena position was employed.

Both lifespan scenarios were calculated for summit, shoulder, backslope, and toeslope catena positions. Three different erosion rates (*E*) were applied. First, a mean annual erosion rate of 1.19 mm y^{-1} was used based on ^{137}Cs-based data (*n* = 103) measured by Quine and Walling (1991) at RFF. This mean value represents all erosion processes, including water-based and tillage-based erosion. Two additional lifespans were calculated using rates from the 5th and 95th percentiles of this dataset (0.19 mm y^{-1} and 2.2 mm y^{-1},

respectively). It should be acknowledged here that the rates of soil formation represent timescales four orders of magnitude greater than those of soil erosion. However, if lifespans are to provide an insight into the sustainability of the soil profiles at RFF, the soil erosion rates must represent those from contemporary arable agriculture.

The soil formation rates, as empirically measured in this chapter, were then plotted to derive the soil production function *P*; Eq. (2):

$$P = W\, e^{\left(\frac{-h}{\gamma}\right)} \quad (2)$$

where *W* is the production rate at zero soil thickness (*h*) and *γ* is a parameter that determines the thickness of soil when soil formation decreases by 1/e. The data for both the production rate (*P*) and the thickness of the soil (*h*) were used to calculate *W* and gamma using least squares regression. In this study, *γ* was calculated as being 2.26 m, which is substantially greater than that previously reported (e.g. Heimsath *et al*., 1997). It was therefore concluded that soil formation rates at RFF are relatively insensitive to changes in soil thickness. As a result, constant soil formation rates (*F*) for each catena position, together with two additional rates representing upper and lower standard deviations, were used to calculate soil lifespans. Furthermore, the expected increase in soil formation rates as a result of soil thinning were captured within these upper and lower uncertainties. Soil lifespans were thus calculated using Eq. (3):

$$L = \frac{D}{E-F} \quad (3)$$

where *D* is depth in mm, *E* is gross annual soil erosion rate in mm y^{-1} and *F* is gross annual soil formation rate in mm y^{-1}.

5.3 Results and discussion

5.3.1 Soil formation rates

Soil formation rates calculated from measured ^{10}Be concentrations at RFF range from 0.026 mm y^{-1} to 0.084 mm y^{-1}, with the mean soil formation rate being 0.048 ± 0.008 mm y^{-1} (Table 5.1). At CW, soil formation rates range from 0.053 mm y^{-1} to 0.096 mm y^{-1}, with the mean soil formation rate being 0.070 ± 0.010 mm y^{-1}, which is 0.022 mm y^{-1} greater than that at RFF. These rates indicate declining soil formation rates with increasing soil thickness (Figures 5.2 and 5.3). In accordance with geomorphological theory (Conacher and Dalrymple, 1977; King *et al*., 1983; Pennock, 2003; Schaetzl, 2013), soils are thinner on the slope convexities and the steepest gradients where surface erosion is considered most prevalent. In contrast, soil thicknesses are greater at the summit where surface erosion has been less extensive, and the toeslope zone where sediment has been deposited. In RFF, the fastest soil formation rates were found on the backslope where soils are thinnest. These results are consistent with many theorized mechanisms that demonstrate how parent material overlain by shallower soils is more affected by diurnal thermal stresses, contact with water, and physical disturbance, which can together proliferate physical and chemical weathering processes, and thus the conversion of saprolite into soil. Conversely, it was found the slowest formation rates were associated with the deepest soils at the summit where the increasing thickness of the soil mantle buffers the parent material from any subaerial factors that may otherwise proliferate weathering (Carson and Kirby,

1972; Cox *et al*., 1980; Dietrich *et al*., 1995; Minasny and McBratney, 1999; Wilkinson and Humphreys, 2005). At CW, the difference in soil thickness between eroding and non-eroding zones is less pronounced. On the shoulder and backslope positions, where soils are thinnest, the soil formation rates were 0.03 mm y^{-1} faster than summit and toeslope positions.

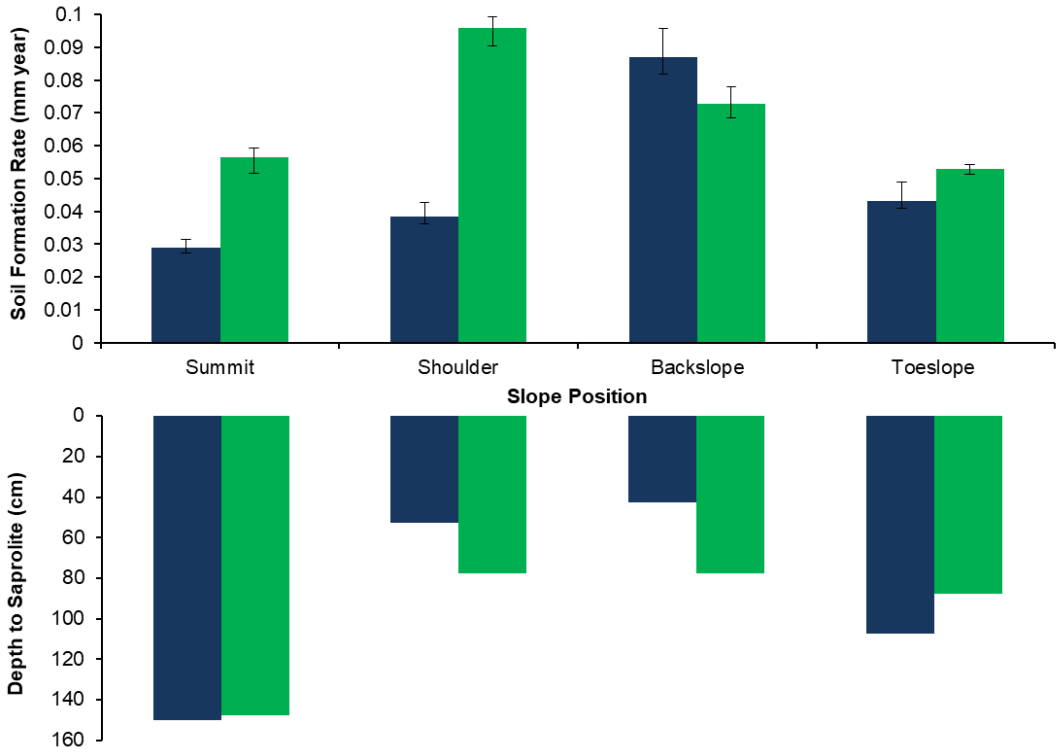

Figure 5.2: Soil formation rates and the depths to saprolite for the four sampling positions along the catena transects at Rufford Forest Farm (blue; *n* = 4) and Comer Woodland (green; *n* = 4). The error bars represent one sigma uncertainties. At RFF, two ^{10}Be concentrations down the same depth profile have been used in the CoSOILcal model to derive a 'best fit' soil formation rate. Depth here refers to that for the midpoint (between the top and bottom) of the sample.

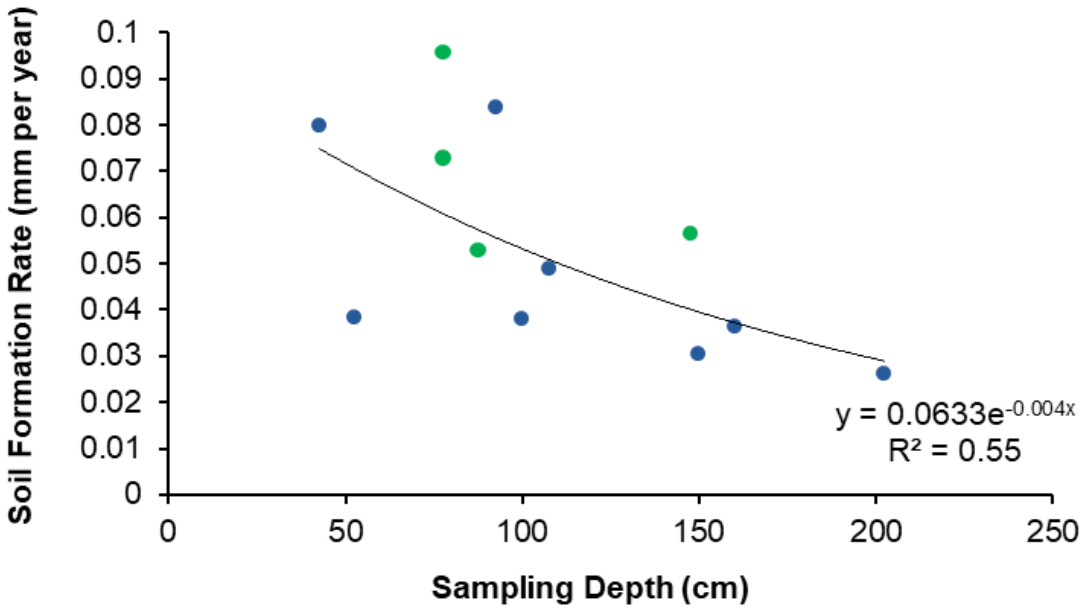

Figure 5.3: Soil formation rates against sampling depth for Rufford Forest Farm (blue; *n* = 8) and Comer Woodland (green; *n* = 4). Depth here refers to that for the midpoint (between the top and bottom) of the sample.

Table 5.1: ^{10}Be concentrations and calculated maximum soil formation rates for Rufford Forest Farm (RFF) and Comer Wood (CW)

Site	Catena Position	Elevation (m)	Horizon Position	Depth (cm)	^{10}Be atoms (atoms/g) (x 10^4)	Uncertainty of ^{10}Be atoms (atoms/g) (x 10^4)	^{10}Be production rate at surface (g^{-1} $year^{-1}$)	Soil Formation Rates, (Best Fit) (mm ka^{-1})	Uncertainty (mm ka^{-1})
RFF	Summit	98.7	A	150	3.5	0.2	4.63	30	29 - 33
RFF	Summit	98.7	B	203	2.3	0.2	4.63	26	24 - 28
RFF	Shoulder	99.3	A	53	5.4	0.2	4.63	38	36 - 41
RFF	Shoulder	99.3	B	100	3.0	0.2	4.63	38	36 - 40
RFF	Backslope	97.9	A	43	4.6	0.2	4.63	80	77 - 83
RFF	Backslope	97.9	B	93	2.9	0.2	4.63	84	77 - 88
RFF	Toeslope	95.7	A	108	3.3	0.2	4.62	49	46 - 53
RFF	Toeslope	95.7	B	160	2.5	0.2	4.62	36	34 - 39
CW	Summit	70.6	A	148	2.5	0.2	4.49	57	52 - 59
CW	Shoulder	65.3	A	78	2.5	0.1	4.46	96	90 - 99
CW	Backslope	58.9	A	78	3.1	0.2	4.42	73	69 - 78
CW	Toeslope	50.1	A	88	4.1	0.2	4.39	53	51 - 54

Horizon Position ‘A’ denotes the sample was taken at the soil-saprolite interface. Horizon Position ‘B’ denotes an additional sample was taken ~50cm below the interface from the same depth profile. The depth here refers to that for the midpoint (between the top and bottom) of the sample. The shielding correction was calculated as 1.0 (to 1 d.p) for all samples and ^{10}Be production rates are corrected for elevation and location (see Appendix 5.1). ^{10}Be concentrations are in the form of ^{10}Be atoms per gram of quartz, following convention. All uncertainties are one standard deviation, based on uncertainties in the measurement of ^{10}Be concentrations (Rodés et al., 2011).

Comparing data between RFF and CW demonstrates that there are other factors besides soil thickness that govern soil formation rates. For example, at the shoulder the soil thickness at CW is greater by 25 cm than that at RFF which would suggest slower formation rates. Instead soil formation rates are faster by 0.038 mm y^{-1} at CW. One possible explanation is the petrographic composition of the parent material, and the susceptibility of that parent material to weathering. Whilst both RFF and CW are underlain by sandstone, the bedrock at RFF is fluvially-derived whereas that at CW is aeolian-derived. Petrological studies on fluvially-derived sandstone report a greater concentration of cementing clays in the matrix material which ultimately reduces the porosity and decreases its susceptibility to particle detachment, leading to slower soil formation rates (Wakatsuki *et al*., 2005; Mareschal *et al*., 2015).

In studies where cosmogenic methodologies have not been applied, it has been found that land use regime can promote or retard rates of bedrock weathering. Humphreys (1994) found that root channels and mesofaunal pedotubles in both the topsoil and subsoil can enhance the surface to bedrock hydrological connectivity. Similarly, Dong *et al*. (2019) demonstrated how an interconnected network of ecohydrologic interactions controls the supply and transport of acid to the bedrock. When a greater proportion of root mass was distributed in the uppermost horizons of the soil profile, CO_2 was predominantly emitted as gas whereas when roots were distributed in the subsoil, more CO_2 moved downwards to increase acid production, and enhance chemical weathering. Other work has sought to identify the mechanisms that affect the thermal regime of soil profiles, and the

consequential impacts on the weathering susceptibility of the parent material (Ahnert, 1967; Minasny and McBratney, 1999). At CW, the roots are deeper than those found observed at RFF and this is likely to proliferate weathering processes. However, given the fact that the ^{10}Be derived soil formation rates are millennial scale averages, it is unlikely that relatively recent (decadal-centennial) variances in the site's land use regime would be captured in the isotopic data (Darvill, 2013).

5.3.2 Derived soil formation rates in reference to the global inventory

Figure 5.4 compares soil formation rates for the study sites to an inventory of soil formation rates extracted from the published literature (*n* = 252; Figure 5.4a; Appendix 2.1). The median soil formation rate in this study (0.051 mm y^{-1}) is 0.028 mm y^{-1} faster than that of the mantled inventory, a statistically significant difference (U test; $P < 0.05$). However, this global inventory comprises studies conducted on a range of geologies and climates, which are both influences on bedrock weathering rates.

Isolating the data from temperate climates (*n* = 187; Figure 5.4b) presents a median soil formation rate of 0.035 mm y^{-1}, which is 0.016 mm y^{-1} slower than that measured for RFF and CW, although there is no statistically significant difference between those data and those we have measured at the UK study sites presented in this chapter (U test; $P > 0.05$). It is likely that the inventory's median soil formation rate for temperate climates is slower as 44% of the temperate-based data has been collected from regions that have lower mean annual precipitation than RFF and CW, which can lead to less weathering

activity in the parent material (Heimsath *et al*., 2001a; Heimsath *et al*., 2005; Dixon *et al*., 2009; Heimsath *et al*., 2012).

Isolating the sandstone-derived data from the inventory (*n* = 57; Figure 5.4c) presents a median soil formation rate of 0.045 mm y^{-1}, which is 0.006 mm y^{-1} slower than that measured for RFF and CW, although there is no statistically significant difference (U test; $P > 0.05$). Although the sandstone-derived data were derived from the global soil-mantled database, all data stem from sites in temperate climates, which reduces the influence that climate may have otherwise had in this analysis on lithology. We suggest that faster formation rates at RFF and CW may be explained by the fact that the specific varieties of sandstone at these study sites are generally more susceptible to weathering than those within the sandstone-based inventory, of which the dominant form is the greywacke, characterised by a hard, fine-grained, argillaceous matrix, with greater resistance to weathering (Cummins *et al*., 1962). Although there has been substantial work on the susceptibilities of major geological rock types to weathering (Stockmann *et al*., 2014; Wilson *et al*., 2017), we do not know of any study which seeks to identify whether the susceptibility of specific varieties of sandstone has an influence on soil formation rates.

The only other study to measure soil formation rates in the UK is that of Riggins *et al*. (2011) where rates were derived for Bodmin Moor, Cornwall (*n* = 5; Figure 5.4d). In that study, the median soil formation rate was 0.015 mm y^{-1}, which is 0.036 mm y^{-1} slower than that for RFF and CW, and statistically significant (U test; $P < 0.05$), despite the fact that Bodmin Moor receives about 300 mm more precipitation per year than the sites in this study, which should

increase soil formation rates (Riggins *et al*., 2011). This is explained by the parent material at Bodmin Moor (coarse-grained granite) being generally less prone to weathering than the varieties of sandstone evident at RFF and CW (Portenga and Bierman, 2011).

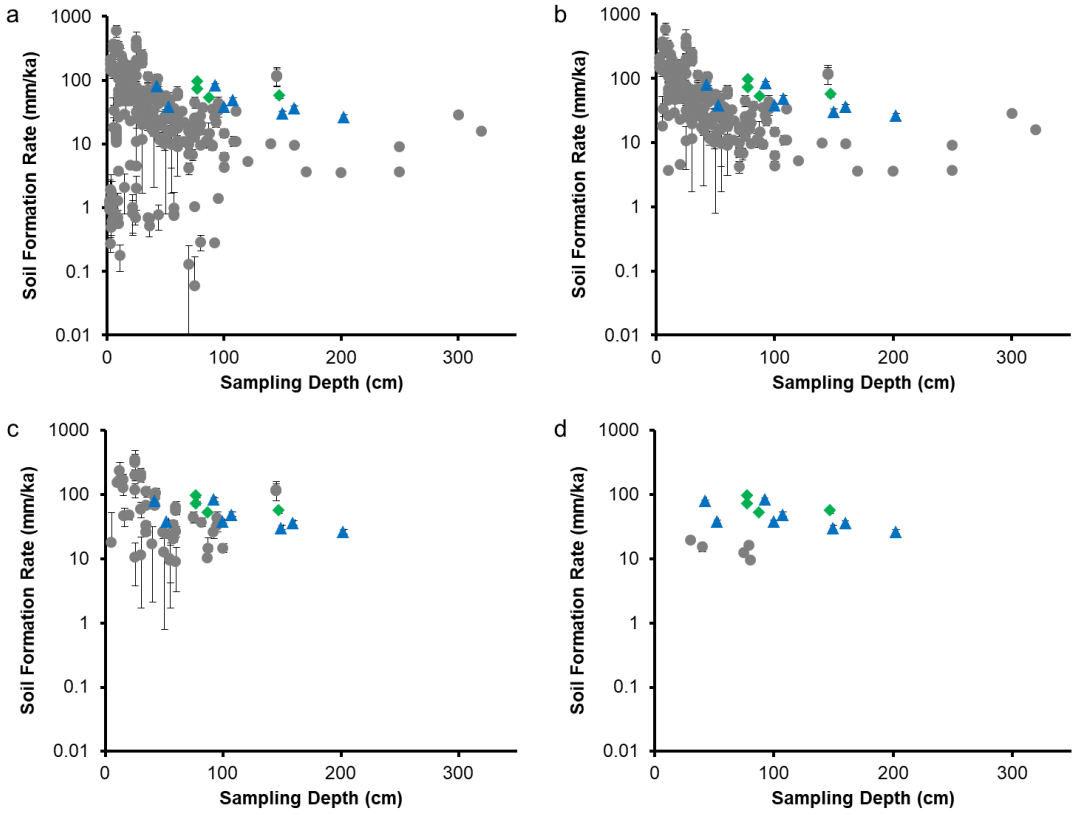

Figure 5.4: Soil formation rates from a globally compiled inventory (grey circles) and from this study at Rufford Forest Farm (blue triangles) and Comer Woodland (green diamonds) plotted against sampling depth. The depth here refers to that for the midpoint (between the top and bottom) of the sample. Rates in grey are from (a) the total mantled inventory (*n* = 252); (b) studies from temperate climates (*n* = 187); (c) studies on sandstone geology (*n* = 57); and (d) the UK, exclusively from Riggins *et al*. (2011) (*n* = 5). Error bars indicate the standard error.

5.3.3 Lifespan analysis at Rufford Forest Farm

Based on a mean annual erosion rate of 1.19 mm y^{-1} under arable agriculture, the lifespans of the A horizon across the catena at RFF range between 258 – 272 years (Figure 5.5). This range expands to 138 – 3,000 years when the 5th and 95th percentile soil erosion rates are applied. However, further examination of the A horizon from cores extracted down the catena suggest that the toeslope is in a phase of aggradation rather than thinning. This is supported by the fact that the depth of the Ap horizon at the toeslope is 75 cm, whereas it is 30 cm on all other observed landscape positions. Moreover, comprised within the upper stratigraphy of the soil profile down the catena is the Bunter Pebble Bed which can be found at approximately 30 cm on summit, shoulder, and backslope positions, but 70 cm at the toeslope. The depth to which this pebble bed occurs at the toeslope suggests that either colluviation has occurred, or is still occurring. In a scenario where colluviation is no longer active, the lifespan of this 75 cm A horizon is finite, and ranges from 347 – 5,245 years, but lifespans here could be longer or indefinite if colluviation continues. This demonstrates the difficulty of calculating lifespans using soil formation rates derived from bedrock alone, and not from other system inflows of soil mass such as that from colluviation and soil carbon additions.

Soil lifespans indicating the time until the exposure of the parent material span between 407 – 1,334 years. The range of these lifespans can be explained by the fact that unlike scenario one, where a constant A horizon thickness of 30 cm was applied across the catena, the soil thickness applied here is the depth to the soil-saprolite interface measured at each catena position (see Table

5.1). Applying upper and lower confidence intervals in the soil formation term, and the 5th and 95th percentiles in the soil erosion term further widens the breadth of lifespans to 212 – 9,688 years. The shortest lifespans are found on the backslope where bedrock exposure is expected to occur between 212 – 4,500 years. In contrast, the greatest lifespans are found at the summit where soil thickness is 155 cm (713 – 9,688 years). Although soil formation rates are greater at the toeslope, the depth to bedrock is 40 cm greater at the summit and, as a result, longer durations are required for bedrock to become exposed at this position. The soil detached and transported from the backslope is expected, in part, to continue to be a contributory source of the colluvium observed at the toeslope. Although the growth of soil profiles due to colluvium is not considered in the lifespan equation, it suggests that lifespans at the toeslope may either be longer than the calculated maximum of 8,042 years or indefinite.

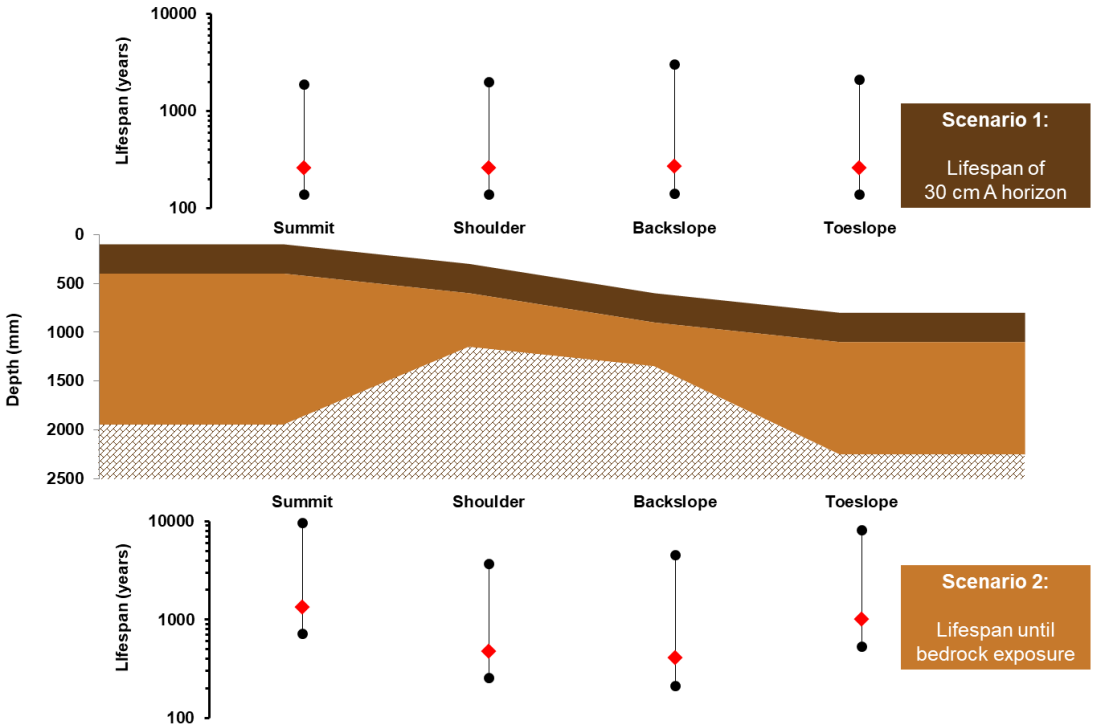

Figure 5.5: First-order soil lifespans calculated at four catena positions at Rufford Forest Farm for Scenario 1 (the time until the erosion of a 30 cm A horizon) and Scenario 2 (the time until bedrock exposure). The centre diagram indicates the thickness of the A horizon (dark brown), the subsoil (light brown) and the depth to the soil-saprolite interface (bricks). Red diamonds denote lifespans calculated using a mean annual soil erosion rate of 1.19 mm y^{-1} from Quine and Walling (1991) and soil formation rates from this study. Black dots denote the minimum and maximum lifespans calculated using the 5th and 95th percentile of the soil erosion dataset and the one sigma uncertainties in the soil formation dataset.

The first-order lifespans presented here are based on a number of assumptions. Notwithstanding the fact that the land management regime may change within the cited time spans altering the protection the soils receive from wind and water, the erosion rates employed neither reflect the increase in the erodibility of subsoil horizons, characterised by a relatively weaker soil structure (Tanner *et al.*, 2018), nor the potential role that the Bunter Pebble Bed may play in armouring the soil surface in the future. Moreover, they do not reflect the expected shift in erosivity, commensurate with more intense

precipitation events (Burt *et al*., 2015). Acknowledging these factors, the lifespans presented here are likely to be overestimated. However, the fate of eroded soil upslope may contribute to the up-building of soil profiles in downslope concavities, extending the lifespans in the colluvial zone. In this respect the lifespans presented here, particularly those for the toeslope, are likely to be underestimated.

5.4 Conclusions

We have presented the first isotopically-derived rates of soil formation for soils currently supporting arable agriculture. Rates derived for two UK catena sequences using cosmogenic radionuclide analysis range from 0.026 mm y^{-1} to 0.084 mm y^{-1}, with mean rates being 0.048 ± 0.008 mm y^{-1} and 0.070 ± 0.010 mm y^{-1} for Rufford Forest Farm and Comer Wood, respectively. By combining soil formation rates from Rufford Forest Farm with soil erosion rates derived from a prior isotopic study in a first-order lifespan model, we estimate that in a worst-case scenario the soil that currently comprises the A horizon on the backslope may be eroded in 138 years, and bedrock exposure may occur in 212 years. Assessing gross soil erosion with measured rates of soil formation is important because soils that support arable agriculture are under threat from accelerated soil erosion. We have therefore shown that both the derivation and application of soil formation rates must become a fundamental component in future discussions of soil sustainability.

This work also represents the second of all isotopic studies of soil formation in the UK, and therefore a significant contribution to our knowledge of pedogenesis. Soil formation rates were found to fall within the range of those

previously published for soils in temperate climates and on sandstone lithologies, but were found to be significantly greater than those measured previously at Bodmin Moor. This is explained by the fact that the parent material at Bodmin Moor is a coarse-grained granite, and therefore less susceptible to weathering than the sandstone materials underlying Rufford Forest Farm and Comer Wood. Such petrographic controls may also explain the greater rates of soil formation at Comer Wood where the sandstone matrix is largely devoid of the cementing agents present at Rufford Forest Farm and, therefore, more susceptible to particle detachment during physical and chemical weathering. Given that petrographic variability has not been thoroughly investigated in pedogenesis work, greater investment is warranted to better understand how the geochemical composition of the parent material governs the rates of soil formation.

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Chapter 6: The matrix effect: how the composition and petrographic structure of sandstone affects rates of soil formation

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Abstract

Soils deliver multiple ecosystem services and their long-term sustainability is fundamentally controlled by the rates at which they form and erode. Our knowledge and understanding of soil formation is not commensurate with that of soil erosion, in part due to the difficulty of measuring the former. However, developments in cosmogenic radionuclide accumulation models have enabled soil scientists to more accurately constrain the rates at which soils form from bedrock. To date, all three major rock types – igneous, sedimentary and metamorphic lithologies – have been examined in such work. Soil formation rates have been measured and compared between these rock types, but the impact of rock characteristics, such as rock matrix mineralogy and porosity on soil formation rates, have seldom been explored. In this UK-based study, we addressed this knowledge gap by using cosmogenic radionuclide analysis to investigate whether the lithological variability of sandstone governs pedogenesis. Soil formation rates were measured down two arable hillslopes at Woburn and Hilton, which are underlain by different types of arenite sandstone. These rates ranged from 0.031 to 0.193 mm y^{-1}. Rates were faster

at Woburn, and we suggest that this is due to the fact that the Woburn sandstone formation is relatively porous and less cemented that that at Hilton. Similarly, rates at Woburn and Hilton were found to be faster than those measured at two other sandstone-based sites in the UK, and with those compiled in a global inventory of cosmogenic studies on sandstone-based soils. We suggest that the matrix-abundant, less porous wackes that have been studied previously may slow the transmission and storage of water in the sandstone, and reduce the rates of bedrock weathering.

6.1 Introduction

Soils are critical global resources. They are key to our food, water and energy security, mitigating and adapting to climate change, the safeguarding of biodiversity, and the protection of human health (Blum, 2005; McBratney *et al*., 2014; Adhikari and Hartemink, 2016). Conserving soils so that that we meet present-day demands, and those of future generations, is therefore a societal priority (Pimentel *et al*., 1995). This is especially important in the context of the rising demands from a growing population and widespread soil degradation (Quinton *et al*., 2010; FAO, 2015; Baude *et al*., 2019).

A fundamental component of our efforts to ensure the long-term sustainability of the soil resource is a better understanding of the controls on soil thickness. The thickness of a soil is fundamentally determined by the balance between the rates of soil erosion and those of soil formation. Where rates of soil erosion exceed those of soil formation, the soil profile thins and, as a result, the capacity of the soil to store water, carbon and nutrients is reduced. Efforts to ameliorate soil erosion have been, and continue to be, prominent in soil

science (Panagos *et al.,* 2015). However, significant knowledge gaps remain in our understanding of the rates of soil formation.

The factors that govern soil formation were conceived in the initial development of soil science (Dokuchaev, 1879; Jenny, 1941; Simonson, 1997). The five factors, namely *Climate, Organisms, Relief, Parent Material* and *Time* have since been employed as a framework upon which to base further enquiry into the controls of pedogenesis. Although much of this work is theoretical, there has been a greater effort to empirically measure the rates of soil formation in recent decades (Stockmann *et al*., 2014). In particular, the innovation and application of terrestrial cosmogenic radionuclide analysis in a range of landscapes (Heimsath *et al*., 1997; Minasny *et al*., 2015) has improved the precision of soil formation rates. Some authors have compiled global datasets inventorying cosmogenically-derived rates of soil formation in order to investigate the relationship between climate and pedogenesis (Montgomery, 2007; Portenga and Bierman, 2011). However, decadal to centennial fluctuations in regional and global climatic regimes are unlikely to be detected by cosmogenic radionuclide analysis which determine long-term soil formation rates over 1-100 kyr timescales (Cockburn and Summerfield, 2004).

A more apposite use of terrestrial radionuclide data is to study the control of lithology on soil formation rates, but such work to date has only focussed on comparisons between major rock types such as igneous, sedimentary and metamorphic (Stockmann *et al*., 2014). One of the largest global meta-data analyses of soil formation rates conducted by Portenga and Bierman (2011) specifically omits soil-mantled bedrock, and instead focuses on bedrock

outcrops and basin sediments. Nevertheless, the authors found that sedimentary lithologies weather faster than igneous and metamorphic lithologies. This finding is also supported by Morel *et al*. (2003) in a study comparing soil formation rates from sedimentary (sandstone river bedload) and igneous (granite river bedload) lithologies, and Palumbo *et al*. (2009) in a similar study between sedimentary (Cretaceous stream sediments) and metamorphic (low grade metamorphosed Palaeozoic rocks) lithologies. However, rocks have an array of physical and geochemical properties, all of which may play different roles in influencing soil formation rates. By studying soil formation across the three major rock types, which are lithologically dissimilar in multiple properties, it is difficult to identify whether there is one lithological property that has a more noteworthy role in pedogenesis. One of the solutions to this is to measure and compare soil formation rates on variations of one lithology, thus limiting the number of lithological properties that may potentially differ.

To the best of our knowledge, few studies have assessed the variability of soil formation rates across one lithology. Gontier *et al*. (2015) used U- and Th-series nuclides to demonstrate that differences in the grain size of granites do not significantly affect the rates of soil formation. This is contrary to the work of Wakatsuki *et al*. (2005) who showed that soil formation rates in coarser grained granites were significantly faster than those of finer grained granites. The authors proposed that coarser grained minerals in granite have a smaller specific surface area, meaning a smaller volume of water is necessary for weathering than that required by finer grained minerals.

However, rates of soil formation may be regulated by other lithological properties that control the supply and transfer of water through the rock. Porosity, defined as the ratio of the aggregate volume of pores to the total volume of the rock (Goudie *et al*., 1994), and the size and distribution of rock pores are, in turn, governed both by the composition and arrangement of rock grains, and the presence, volume and composition of the interstitial matrix are likely to be important. Furthermore, the properties of this matrix can change over time. For example, soluble cements, such as calcite, dolomite and gypsum, are dissolved (Burley and Kantorowicz, 1986) leaving a non-soluble, clay-rich matrix (Tye *et al*., 2012). No studies have explored the roles played by rock porosity and the interstitial matrix on influencing rates of soil formation, representing a significant knowledge gap.

In this study, we use cosmogenic radionuclide analysis for the first time to investigate the extent to which the lithological variability of sandstone governs rates of soil formation. We present ^{10}Be-derived soil formation rates for two arable hillslopes in the UK, underlain by a fluvial- and a marine-derived sandstone. Furthermore, we place these rates in the context of those previously measured at two other sandstone-based sites in the UK, and with those measured in similar climatic settings around the world.

6.2 Materials and methods:

6.2.1 Site description

Two catena sequences were selected in Autumn 2018 (Table 6.1; Figure 6.1). The first site is a south-west facing hillslope at the Hilton Experimental Site (hereafter, Hilton), situated west of Wolverhampton, in Shropshire

(52°33′16.34″ N, 2°19′43.17″ W). This is a long-term study site established in 1976, predominantly to facilitate empirical measurements of soil erosion, but it has been employed in a range of multidisciplinary studies (Reed, 1979; Fullen, 1985, 1992). The second site is a south-facing hillslope at Woburn Experimental Farm (hereafter, Woburn), situated east of Milton Keynes in Bedfordshire (52°0′50.73″ N, 0°35′5.63″ W). Woburn was established in 1876 partly as an expansion on to the nearby, long-term experimental farms at Rothamsted (Catt *et al*., 1975). Hilton and Woburn sit in a temperate oceanic climate (Cfb) between 58 – 64 m a.s.l and 97 – 109 m a.s.l., respectively. The mean annual precipitation and temperature is 751 mm and 9.8°C at Hilton, and 657.4 mm and 9.9°C at Woburn.

At Hilton, the Sherwood Sandstone Group (Helsby sandstone formation) has been described as reddish brown, well-cemented, sometimes pebbly, fine to medium grained, sub-angular to sub-rounded and locally micaceous (Bloomfield *et al*., 2006). The reddish brown colour has been previously described as that of hematite veneers coating the grains (Strong, 1993). Studies on the interstitial matrix of the Helsby sandstone formation have observed zones of calcite and non-ferroan dolomite cement in some closed or restricted pore spaces, as well as cementation by evaporitic cements such as gypsum, anhydrite, and halite (Strong, 1993; Bloomfield *et al*., 2006). This cementation most likely represents one of the first stages of the paragenetic sequence in the Helsby sandstone. Evaporitic cements would have been subsequently dissolved, leaving remnants of calcite and non-ferroan dolomites, which are observable today. Studies have also observed evidence of ferroan dolomite, detrital mica, and authigenic illite and kaolinite clay

cements in the matrix, representing later stages in the paragenetic sequence. These cements may account for between 30 – 50% of the rock's volume (Burley, 1984; Strong, 1993). This has the effect of reducing porosities to 15% in places.

The provenance of the Helsby Sandstone formation is debated in the literature. Bloomfield *et al*. (2006) suggest that the formation is predominately fluvial due to the presence of scoured channel bases and rounded mud-clasts. However, these rounded clasts may be the product of reworked aeolian deposits (Mountney and Thompson, 2002). Observations made by the authors suggest that the sandstone at Hilton is predominantly of fluvial origin based on the presence and abundance of sub-rounded to rounded pebbles within the sandstone matrix (Figure 6.2). What is more widely accepted is the fact that the Helsby sandstone formation developed during the Triassic period, when sediments were laid down in desert basins, in dry (~ <300 mm y^{-1} annual precipitation) and hot conditions (Benton *et al*., 2002). Moreover, previous research has demonstrated that the diagenetic features exhibited in the Sherwood Sandstone group are similar to those in sandstones that form today in the Sonoran Desert (Walker *et al*., 1978).

At Woburn, the Lower Greensand Group (Woburn sandstone formation) has been described as fine to coarse grained, friable rounded quartzose sand (94%) with subsidiary alkali feldspar (2%), glauconite (2%), and muscovite (< 1%) (Catt *et al*., 1975). In contrast to the Helsby sandstone formation, the sandstone at Woburn is nearly matrix-free and uncemented, and the interstices exhibit negligible (0.1%) clay content (Catt *et al.*, 1975; Palmer and Barton, 1987). The porosity has been previously reported as 35% with little

evidence found of porosity reduction based on the small proportion of ductile clasts and the moderate sorting (Palmer and Barton, 1987). A detailed mineralogical analysis of the Lower Greensand Group at Woburn is provided by Catt *et al*. (1975) and further assessments of the parent material at nearby sites can be found in Rastall (1919). Extensive analysis suggests that the provenance of the Lower Greensand at Woburn is marine-based (Stead and Eyers, 2017). Although there is much dispute in the literature about the mechanisms of its formation, many scholars believe that the Woburn sandstone developed from an offshore tidal sand wave deposit in shallow water conditions (Stride, 1982; Eyers, 1991; Owen, 1992). This marine-based sandstone cut into the Late Jurassic mudstones between the late Aptian and early Albian (126 – 100 Ma) during the Cretaceous period (Catt *et al*., 1975).

It is likely that the provenance of the sandstones at Hilton and Woburn partly explains some of the differences observed in the volume and composition of their matrix material. In a similar petrographic comparison on upper Palaeozoic sandstones, Obrist-Farner and Yang (2011) found that fluvially-derived sandstones were more enriched with calcite cements than deltaic sandstones. As a result, the fluvially-derived sandstones exhibited very low porosities (2.5%) compared with the deltaic sandstones (21%). The difference in these porosities (18.5%) is similar to that between Hilton and Woburn (Table 6.1). Similarly, Khalifa and Morad (2012) discuss the differences in cementation between fluvial and tidal Cretaceous sandstones. They suggest that the presence of interstitial detrital clays in fluvial sandstones (as is also observed at Hilton) is due to the infiltration of water rich in suspended mud, which is transferred into the interstices of alluvium; a process also observed

by Moraes and De Ros (1990) and Strong (1993). Although this may explain the presence of detrital clays in the sandstone at Hilton, this does not necessarily explain the *absence* of cementation in the sandstone at Woburn. Moreover, Palmer and Barton (1987) highlight that the lack of cementation at Woburn contrasts distinctively from other marine-based sandstone formations, which are comparatively more lithified, and exhibit a greater volume of authigenic clays (Milodowski and Wilmot, 1985). One possible explanation to account for the lack of lithification at Woburn is that the depth of burial was relatively shallow (approximately 300 m) when compared with other marine-based sandstones. The consequence of a shallow burial is that there was less diagenetic change (e.g.: porosity reduction) than would typically occur in more deeply buried sandstones.

Both sites are positioned within the Anglian glaciation (~450,000 BP). Although both sites are located beyond the areal extent of the Late Devensian ice sheet (~ 20,000 BP) (Eyles *et al*., 1994; Gibbard and Clark, 2011), evidence suggests that periglacial conditions are likely to have dominated at these latitudes during this period (Watson and Morgan, 1977; Tye *et al*., 2012). Hilton is positioned beyond the areal extent of the British-Irish ice sheet at the Last Glacial Maximum (LGM; ~21,000 BP) (Gibbard and Clark, 2011). However, there is some debate as to whether this area was covered, if only partly, during the earlier stages of the Devensian glaciation (Bowen *et al*., 2002; Evans *et al*., 2005). The site sits within the 'Wolverhampton Line' (Shotton, 1967) which represents the terminal position of the Irish Sea Glaciation and nearby the site are a number of drift and till deposits (Hollis and Reed, 1981). The area is likely to have been dominated by broadleaf

woodland between 6000 and 2000 BC, and heathland until the late 19th century. By 1883, Hilton was under agriculture, and this was most likely to have been pastoral (Fullen, 2020).

At Woburn, the study site and surrounding area was blanketed in boulder clay after the retreat of the Anglian glaciation. This was subsequently eroded, leaving a thin decalcified remnant of this clay incorporated into the Lower Greensand through processes of cryoturbation (Catt *et al*., 1975). Particle size analysis conducted by the authors suggests that this boulder clay has not been incorporated into the soils at the study site; a finding similarly observed by Catt *et al*. (1975). The site would have been dominated by periglacial conditions during the Late Devensian (Gibbard and Clark, 2011). Johnston (1977) suggest that forests were cleared in the Middle to Late Bronze Age (~ 3000 years ago), when the soils were first cultivated.

Table 6.1: Locational context of the Hilton and Woburn study sites.

		Hilton	Woburn
Locational context	**UK county**	Shropshire	Bedfordshire
	GPS co-ordinates	52°33′16.34″ N, 2°19′43.17″ W	52°0′50.73″ N, 0°35′5.63″ W
	Aspect	South-west	South
	Elevation (m a.s.l)	58-64	97-109
	MAP (mm)	751	657
	MAT (·C)	9.8	9.9
Lithology	**Parent material**	Helsby Formation, Sherwood Sandstone	Woburn Formation, Lower Greensand
	Provenance	Fluvial/aeolian	Marine
	Matrix composition	Detrital mica, precipitated illite-smectite, and authigenic clays.	Nearly matrix-free and uncemented. Negligible clay content (0.1%).
	Porosity (%)	~ 6 – 27	~ 35
Glacial history	**Anglian**	Glaciated	Glaciated
	Last Glacial Maximum	Periglacial conditions	Periglacial conditions
Land-use history	**Forest clearance**	2000 BC	1000 BC
	Cultivation	Pastoral farming from 1883	From approx. 1000 BC
	Current land-use	Grass/shrub cover	Winter cereals

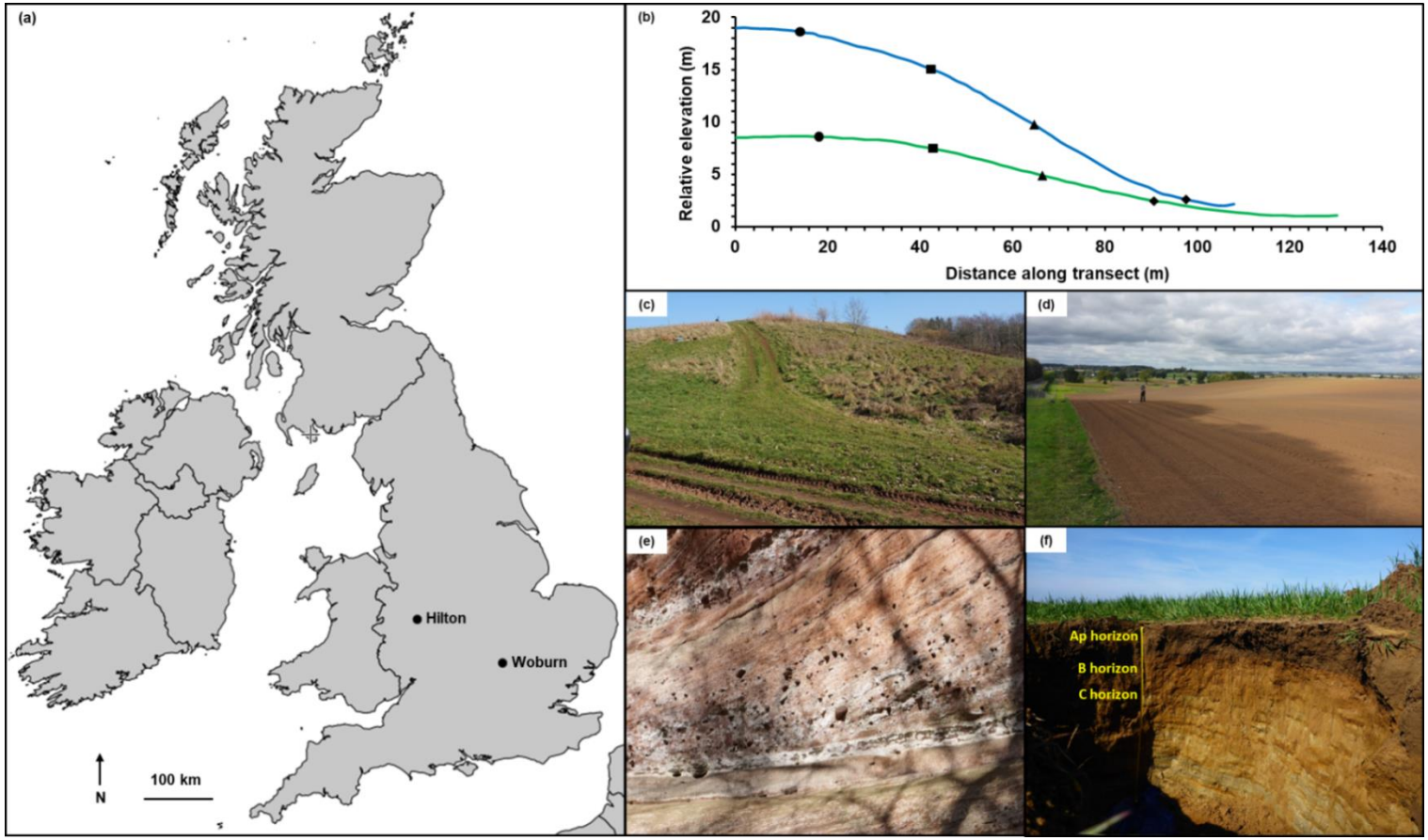

Figure 6.1: Location of the study sites (a) with elevation profiles (b) for Hilton (blue) and Woburn (green). Summit (circles), shoulder (squares), backslope (triangles), and toeslope (diamonds) are indicated on each profile. Photographs of the hillslope at Hilton (c) and Woburn (d) were taken from the toeslope during the reconnaissance survey. An exposure of the fluvially-derived sandstone (interbedded with sub-rounded pebbles) close to the study slope at Hilton is shown in (e) (photograph by Miroslav Bauer, 2019). The soil profile, soil-saprolite interface, and underlying bedrock at Woburn are shown in (f).

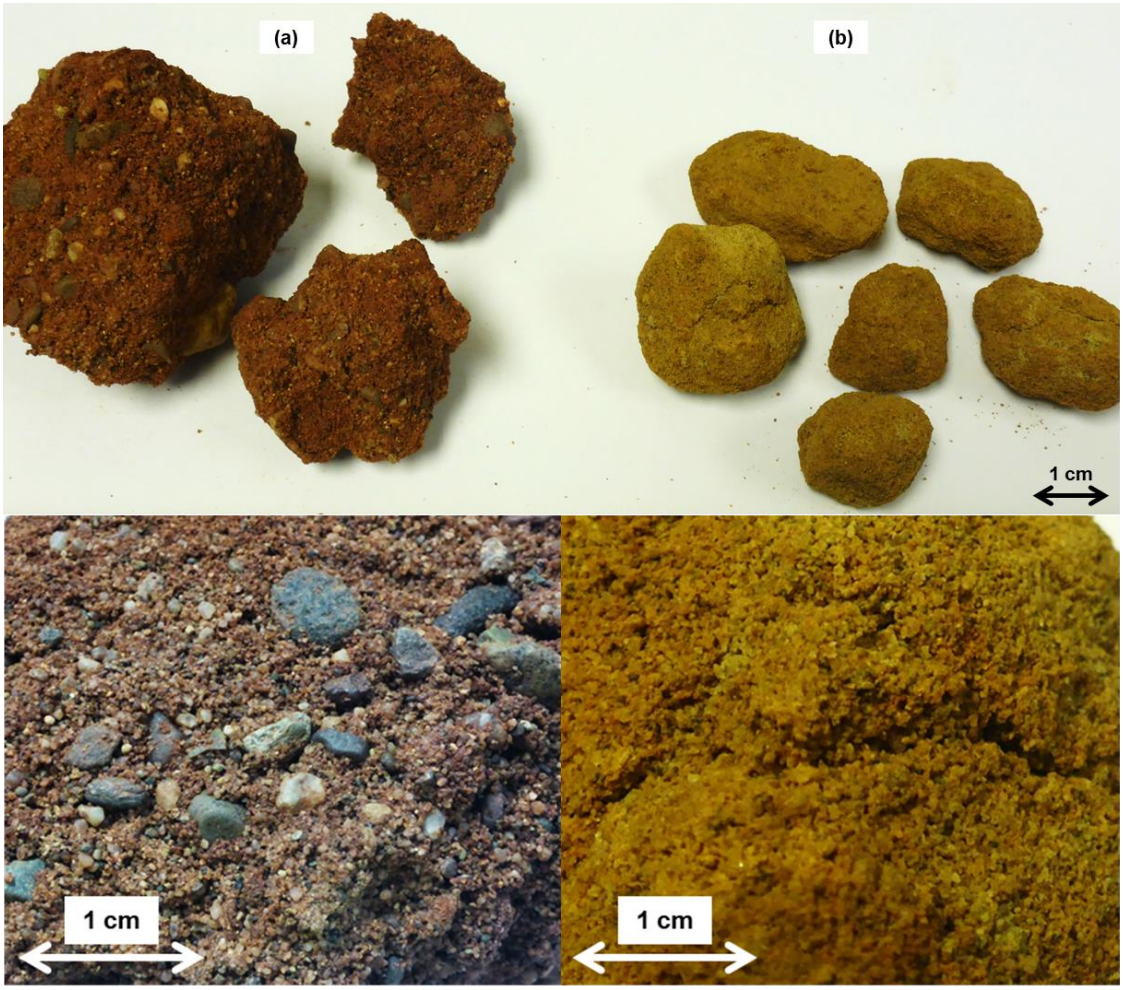

Figure 6.2: Photographs of the saprolite at Hilton (a) and Woburn (b).

6.2.2 Sampling and processing soil and saprolite

Summit, shoulder, backslope, and toeslope positions on both catenas were selected for depth to bedrock surveys, as well as soil and saprolite extraction. At each position, a dynamic cone penetrometer was employed to ascertain the approximate depth of the soil-saprolite interface before a soil pit was dug vertically to this zone. Variations in the consolidation of the profile wall were observed by extracting small cores down the profile and noting the extent to which the material remained intact. These observations were then compared with the penetration resistance data to confirm the depth of the soil-saprolite interface. Samples of saprolite of between 5 and 10 cm thickness were extracted from each interface for cosmogenic radionuclide analysis. A further sample was then extracted approximately 30 cm below this interface.

Beryllium-10 is produced when quartz grains within the uppermost metres of bedrock are bombarded with cosmic rays. In cosmogenic radionuclide analysis, the intensity of these cosmic rays and the weathering of the bedrock (ε) are assumed to be constant. Thus, the concentration of ^{10}Be (*N*) in a sample of bedrock is dependent upon the time that the bedrock has been exposed to cosmic rays, and the rate at which bedrock weathers into mobile regolith (soil). Short exposure times and fast rates of bedrock weathering both lead to lower concentrations of ^{10}Be, and vice versa (Lal, 1991; Stockmann *et al*., 2014). We assume here that ^{10}Be production and bedrock denudation is at equilibrium.

$$N = \sum_{i=sp,\mu_f,\mu^-} \frac{P_i(\theta) \cdot e^{-\frac{x}{\Lambda_i}}}{\lambda + \frac{\epsilon\rho}{\Lambda_i}} \left(1 - e^{-t\left(\lambda + \frac{\epsilon\rho}{\Lambda_i}\right)}\right) \quad (1)$$

where: P are the annual production rates of ^{10}Be by spallation, fast muons and stopping muons (denoted by subscripts sp, μf and μ-) at a surface with slope Θ; x is the mass sample depth ($\rho \bullet z$); p is the density of overburden material; z is the depth of the sample; t is the age of the bedrock surface (the age when the original surface was generated); λ is the decay constant of ^{10}Be with λ equalling In2/^{10}Be half-life; and Λ are the mean attenuation thicknesses of cosmic radiation for different production pathways (Lal, 1991). Here, we considered t as infinite to calculate the apparent weathering rate ε, assuming that the age of the landscape is old enough for the ^{10}Be depth-profile to be in equilibrium. By studying two samples down the same depth profile, we tested whether the data met this assumption. By measuring N using Accelerator Mass Spectrometry (AMS), Eq. (1) was solved for ε by simple interpolation of N.

A total of sixteen samples of saprolite (eight from Hilton and eight from Woburn) were prepared for AMS at the Cosmogenic Isotope Analysis Facility, East Kilbride, Scotland. After mineral separation, quartz cleaning, and procedures leading to the preparation of BeO sample cathodes (Kohl and Nishiizumi, 1992; Fifield, 1999; Corbett *et al*., 2016), AMS measurements were carried out at the SUERC AMS laboratory (Xu *et al*., 2010) (see Appendix 6.1). ^{10}Be concentrations were based on 2.79 x10^{-11} ^{10}Be/^{9}Be ratio for the NIST Standard Reference Material 4325. The processed blank ratio ranged between 5 and 24% of the sample ^{10}Be/^{9}Be ratios. The uncertainty of this correction is included in the stated standard uncertainties.

As first demonstrated in Evans *et al*. (2019), the interpolation of *N* to solve for ε must account for the variability in the density of the soil above the point of sampling because the overburden density exerts an influence on the attenuation of cosmic rays down the profile. The CoSOILcal model (Rodés and Evans, 2019) was applied in this study to calculate soil formation rates using empirically measured soil bulk densities from each catena position, at both sites. In addition, the annual production rate of ^{10}Be was calculated, accounting for obstructions that would reduce the cosmic ray flux to the parent material (Phillips *et al*., 2016; Evans *et al*., 2019). These local ^{10}Be production rates were normalized by inputting site elevation, latitude and longitude data into the CRONUS-Earth Matlab code v2.3 using Lal/Stone (St) scaling (Balco *et al*., 2008). Version 2.3 incorporates new reference production rates derived from Borchers *et al*. (2016).

The calculated soil formation rates were plotted to derive the soil production function (*P*):

$$P = W\, e^{\left(\frac{-h}{\gamma}\right)} \quad (2)$$

where *W* is the soil formation rate at zero soil thickness (*h*) and *γ* determines the soil thickness when soil formation is reduced by 1/*e*. Both *W* and *γ* were calculated using least-squares regression.

Soil samples were extracted every 10 cm from the profile wall of each catena position at both sites. These samples were then oven dried at 105°C for twelve hours, grounded with a pestle and mortar, and sieved to remove the > 2 mm fraction. Using these samples, stone-corrected bulk density measurements were calculated. A Beckman Coulter Laser Diffraction Particle

Sizing Analyser LS 13 320 was employed for particle size analysis (pump speed: 70%; sonication: 10 seconds; run length: 60 seconds). Soil carbon was determined from separate 5 g sub-samples using mass loss following heating at 550°C for twelve hours in a Carbolite furnace (CWF 1300) (see Appendix 6.2).

6.3 Results and discussion

6.3.1 Soil profiles at Hilton and Woburn

At Woburn, the soils are classified as Arenosols (IUSS Working Group WRB, 2015). Both the topsoil and subsoil at each hillslope position have a coarse sand texture, with the mean particle size distribution being 83% sand, 10% silt and 7% clay, which was consistent down the soil profile. At the summit, an Ap horizon of 30 cm thickness, with a mean bulk density of 1.2 g cm^3, overlies an iron pan between 30 and 70 cm. This was a hardpan horizon, principally cemented by iron oxides, which did not disaggregate when subject to manual pressure in the field. The consequential greater density of this iron pan (1.6 g cm^3), and the effect on the attenuation of cosmic rays, is accounted for. The CoSOILcal model, employed in this study to calculate soil formation rates from measured ^{10}Be concentrations, considers the density profile of the soil overlying the soil-saprolite interface (Rodés and Evans, 2019). At the bottom of this iron pan is the soil-saprolite interface, under which lies moderately consolidated, cross-bedded saprolitic sandstone with a mean bulk density of 1.5 g cm^3. The LOI content decreases from 2.49% in the Ap horizon to 1.53% in the underlying subsoil to a depth of 100 cm. The iron pan observed at the summit is not present down the soil profiles at the other hillslope positions surveyed. At the shoulder and backslope, the thickness and mean bulk

density of the Ap horizon is 27 cm (1.4 g cm^3) and 30 cm (1.5 g cm^3), respectively, and both are underlain by an undifferentiated subsoil, extending down to 40 cm at the shoulder (incidentally, the shallowest soil down the catena) and 66 cm at the backslope. The mean bulk density for both the shoulder and backslope B horizons is 1.5 g cm^3. The LOI content at the shoulder and backslope also demonstrates similar trends to the summit, with the Ap horizon having a LOI content between 2.06 and 2.21% which decreases to 0.8 and 1.04% in the B horizon. At the toeslope, there are two distinct A_1 and A_2 horizons; an A_1 mantle extending from the surface down to 35 cm (with a mean bulk density of 1.3 g cm^3) burying an A_2 horizon that extends down to 50 cm (with a mean bulk density of 1.6 g cm^3). The B horizon is similar to that observed at the shoulder and summit, with a density of 1.5 g cm^3, except for the fact that this horizon extends to 170 cm, making this profile the thickest. The toeslope also has the greatest LOI content, with 2.85% in the A_1 horizon, 2.05% in the A_2 horizon, and 1.21% in the B horizon. The presence of an A_p horizon at each catena position may be explained in part by the mixing of mineral and organic material through cultivation following the harvest, although isotopic work at Woburn is required to verify this.

At Hilton, the soils are also classified as Arenosols (IUSS Working Group WRB, 2015) and are of a coarse sand texture, with the mean particle size distribution being 80% sand, 15% silt and 5% clay. Overall, the soil profiles surveyed at Hilton show less evidence of horizonisation than those at Woburn. At the summit, the A horizon is 30 cm in thickness with a mean bulk density of 1.4 g cm^3, below which lies a 75 cm B horizon with a mean bulk density of 1.6 g cm^3. The soil-saprolite interface is observed at 105 cm, below which the

profile grades into saprolitic, moderately consolidated sandstone. The LOI content decreases from 4.98% in the A horizon to 0.94% in the underlying subsoil. At the shoulder, the A horizon is 10 cm thick and, in places, it is less distinct. The loose and friable nature of the soil at the surface explains its relatively low bulk density: 1 g cm^3. The B horizon extends to 80 cm, below which the material becomes more consolidated (mean bulk density is 1.4 g cm^3) and saprolitic. Here, the A horizon has a LOI content of 4.89 %. This contrasts with the B horizon where the mean LOI content is 0.96%. The thinnest soil is found at the backslope, with the soil-saprolite interface observed at 50 cm. The soil comprises a 10 cm A horizon, and like the shoulder, has a relatively low bulk density of 0.8 g cm^3. The B horizon is 40 cm and has a mean bulk density of 1.3 g cm^3. The LOI content of the A horizon is 4.16%. Below this, the mean LOI content falls to 2.15%. Finally, the soil at the toeslope is 100 cm thick. Although this is also the case for the summit, the toeslope profile exhibits a comparatively thicker A horizon (40 cm) suggesting that colluviation has, or is still, happening at this position. However, the presence of a grass and shrub cover at Hilton suggests that colluviation rates are currently slow, if not negligible. Despite the thicker A horizon, the mean LOI content (3.06%) is smaller than that observed for the summit, but the mean bulk density is similar (1.4 g cm^3). In the 60 cm B horizon, the mean LOI content falls to 1.49% and the mean bulk density is 1.5 g cm^3.

6.3.2 Soil formation rates

Soil formation rates were calculated from measured ^{10}Be concentrations at Hilton and Woburn. At Hilton, these range from 0.065 to 0.193 mm y^{-1}, with

the mean soil formation rate being 0.128 ±0.043 mm y^{-1} (Figure 6.3; see Appendix 6.1). At Woburn, soil formation rates range from 0.031 to 0.150 mm y^{-1}, with the mean being 0.100 ±0.051 mm y^{-1}, which is 0.029 mm y^{-1} slower than that at Hilton.

Down both catenas, the depths to saprolite are in accordance with geomorphological theory (Figure 6.4). At the shoulder and backslope, the soil is thinner as the steeper convexities are typically more susceptible to erosion than the shallower plateau found at the summit. At Woburn, the deposition of soil from upslope has contributed to a thickened Ap horizon at the toeslope, with the depth to saprolite being 0.7 m greater than that at the summit, and more than double that found at the shoulder and backslope. However, this extent of colluviation is not as readily observable at Hilton, with the depth to saprolite at the toeslope (1 m) approximately equal to that of the summit (1.05 m). This could be due to the fact that the hillslope has been almost constantly vegetated, thus limiting the potential for downslope soil redistribution.

Data from both sites suggest that soil formation rates are slower under thicker soil profiles (such as those observed at the summit and toeslope positions). This largely supports the conclusions previously observed for two other sites in the UK (Evans *et al*., 2019). Under a thicker soil, the bedrock is buffered more effectively from climate fluctuations, organism activity at the surface, and other subaerial factors that may promote bedrock weathering (Minasny and McBratney, 1999; Wilkinson and Humphreys, 2005).

Given the relationship between soil thickness and rates of soil formation, it is prudent to determine the soil formation rates for a given thickness at both

sites. This is achieved by calculating the soil production function, which can indicate the soil formation rate at a set soil thickness (Appendix 6.3). At zero soil thickness, the soil formation rates at Hilton and Woburn are 0.164 mm y^{-1} and 0.229 mm y^{-1}, respectively. The soil production function can also indicate the depth scale over which soil formation decreases by 1/*e* (see Eq. 2). At Hilton, this is 3 m, which is similar to that found in Evans *et al*. (2019) but still considerably greater than that calculated in previous studies (Heimsath *et al*., 1997; Heimsath *et al*., 1999; Wilkinson *et al*., 2005). At Woburn, this decay is more than half that, at 1.15 m. This demonstrates that soil formation rates are more sensitive to soil thickness at Woburn than they are at Hilton. Given this analysis, both raw measurements of soil formation, and those modelled using the soil production function, will be presented hereafter.

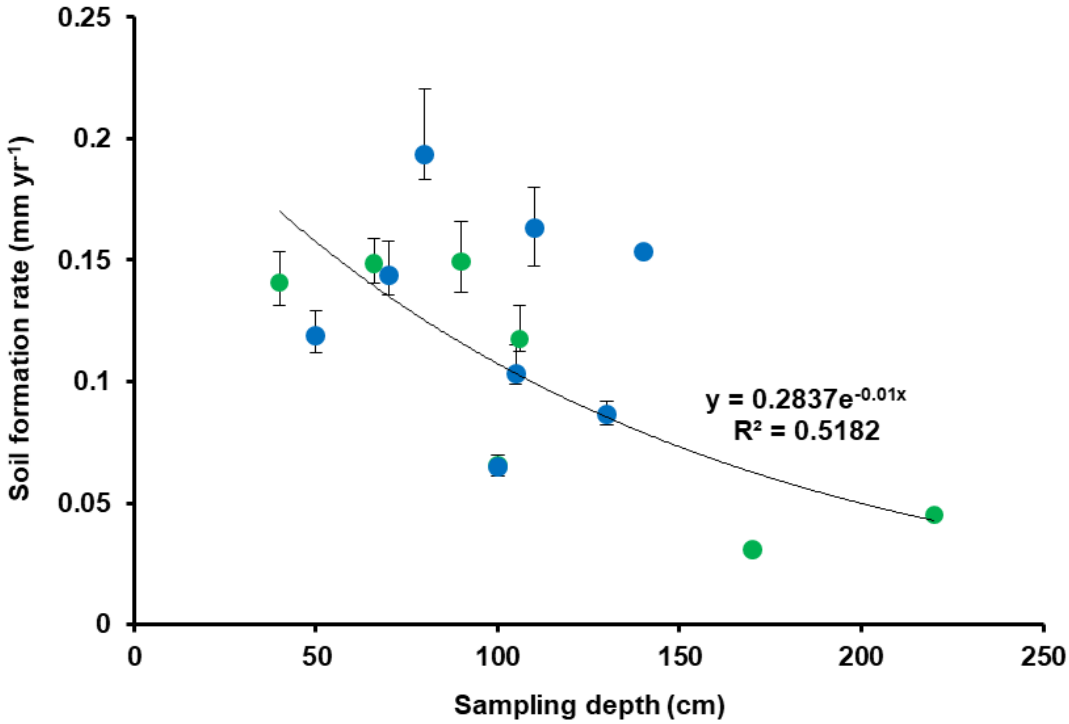

Figure 6.3: Soil formation rates against sampling depth for Hilton (blue; *n* = 8) and Woburn (green; *n* = 7). The error bars represent one standard deviation uncertainties.

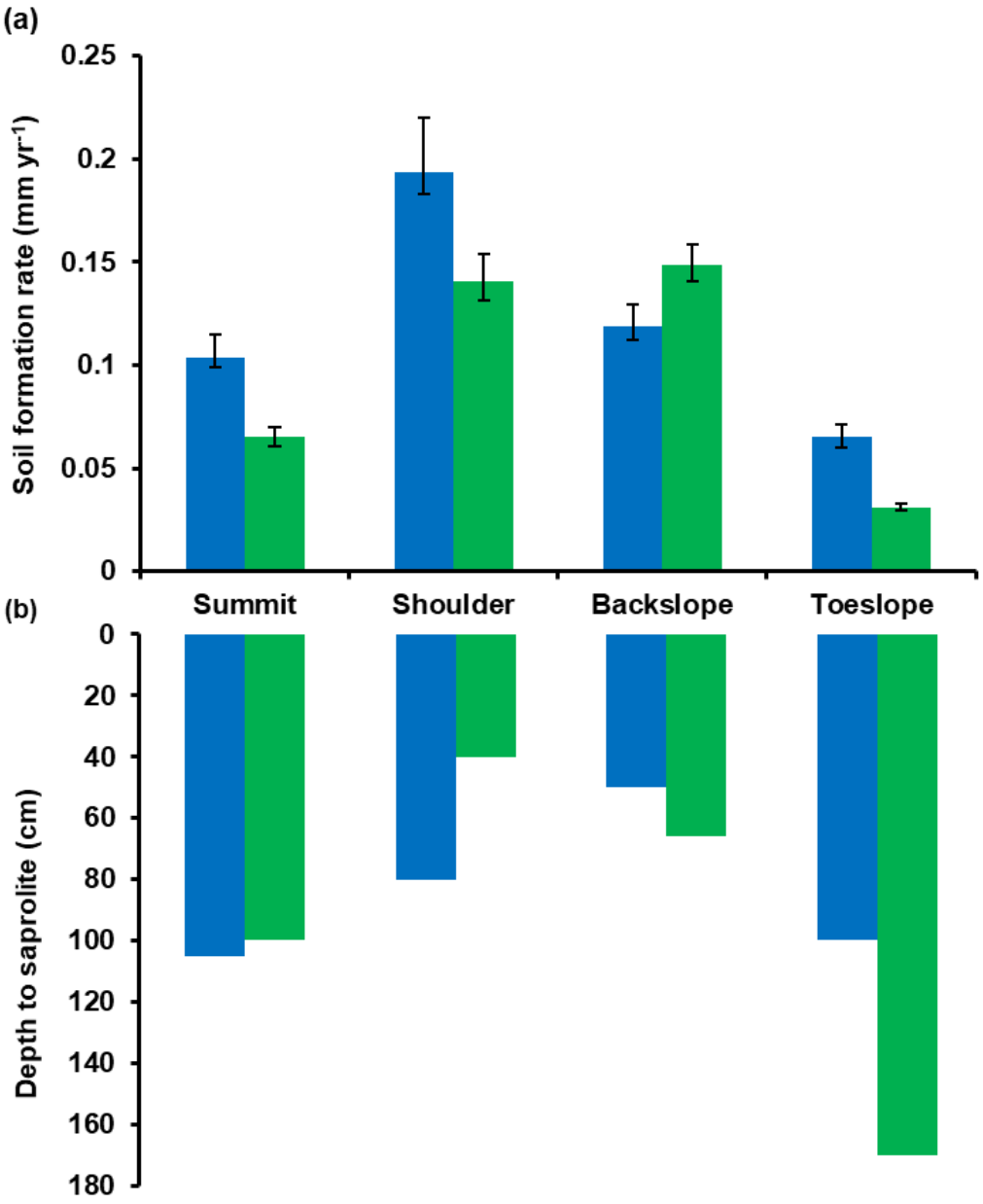

Figure 6.4: Soil formation rates and the depths to saprolite for the four landscape positions at Hilton (blue; *n* = 4) and Woburn (green; *n* = 4). The soil formation rates here represent a 'best fit' calculated using two ^{10}Be concentrations down the same depth profile. The error bars represent one standard deviation uncertainties.

6.3.3 Lithological variability: the role of the sandstone porosity and matrix

Figure 6.5 compares soil formation rates measured at Hilton and Woburn with those previously calculated for two other sandstone sites in the UK: Rufford Forest Farm, in Nottinghamshire, and Comer Woodland, in Shropshire (Evans *et al*., 2019). Like Hilton, the soil at Rufford Forest Farm (Rufford, hereafter) has formed from the Sherwood Sandstone (Chester formation, Olenekian, 247-251 Ma) which has been described as fluvially-derived, pinkish to red, medium to coarse grained, pebbly, cross-bedded and friable (see Radley and Coram, 2016). In contrast, the soils at Comer Wood (Comer, hereafter) stem from the New Red Sandstone (Bridgnorth formation, Cisuralian, 273-299 Ma). This sandstone is of aeolian origin, and has been described as brick-red, medium grained, and cross-bedded (British Geological Survey, 2020). Further contextual details about Rufford and Comer can be found in Evans *et al*. (2019).

Figure 6.5 suggests that there are upper limits to the soil formation that can be achieved for a given soil thickness. Soil formation rates are then reduced according to other factors. Given that the data here stemmed from one climate, we suggest that this reduction can be explained by the lithological composition of the parent material. Moreover, we suggest that sandstone porosity is one of the principle factors influencing the rates of soil formation across these sites. The porosity of the saprolite will determine the extent of subsurface storage space and flow pathways for meteoric water. Saprolite with a greater porosity will have an increased water storage capacity, allowing

more mineral surfaces to be in contact not only with water, but the oxidants and acids (e.g.: fulvic, humic, oxalic, and citric acids) that can induce chemical weathering reactions (Lazo *et al*., 2017). As chemical weathering progresses, increasing both the surface area of and overall access to these mineral surfaces, the secondary porosity of the saprolite will similarly increase (Schmidt and McDonald, 1979). This highlights a positive feedback relationship between chemical weathering (and, therefore, soil formation) and porosity (Hayes *et al*., 2019; Lebedeva and Brantley, 2020).

Table 6.2 demonstrates the role of porosity in governing rates of soil formation. Given that soil thickness also differs between sites, and could also influence rates of soil formation, here we will focus our analysis only on the rates of soil formation calculated for zero soil thickness, using the soil production function. Soil formation at Woburn at zero soil thickness was 1.4 times faster than that at Hilton, and nearly four times faster than that at Rufford. One explanation for this is that the sandstone at Woburn has a relatively high porosity (~ 35%) in contrast to the Helsby sandstone formation at Hilton (~ 6 – 27%) and the Chester formation at Rufford (~25%) (Burley, 1984; Bloomfield *et al*., 2006). By having a greater porosity, the sandstone at Woburn would store and transmit a greater proportion of precipitation that infiltrates down the soil profile. Greater storage of water within the Woburn sandstone would allow more mineral surfaces to be in contact with water and, in consequence, amplify chemical weathering processes. Conversely, the smaller porosities observed in the Sherwood Sandstones would imply a slower transmission of water through the rock, thus slowing down bedrock weathering.

There are multiple reasons to explain why the porosity of the saprolite at Woburn is greater than that at Hilton and Rufford. We suggest the predominant factor influencing porosity in this case is the depth of burial, and the temperatures and pressures that are associated with this. The depth of burial of the Woburn sandstone formation is relatively shallow (approximately 300 m) when compared with the Sherwood Sandstones at Hilton and Rufford (approximately 1000 m) (Burley, 1984; Palmer and Barton, 1987; Evans *et al*., 1993). Previous work has shown that overburden compaction increases linearly with depth (Ramm, 1991). This suggests that deeper burials, such as that at Hilton, are more effective at reducing porosity since a greater overburden compaction can induce more rotation, re-orientation, and plastic deformation of ductile particles (Palmer and Barton, 1987).

In addition, the consequence of a deeper burial in the Sherwood Sandstone group would have been to increase grain-to-grain contacts within the bedrock. This ratio expresses the difference between the length of contact a grain has with its neighbouring grains, and its own individual length (Dyke and Dobereiner, 1991). Previous work elsewhere has demonstrated a strong relationship between grain contact and the strength of sandstone (Dobereiner, 1984). At Hilton and Rufford, we suggest that the greater grain-to-grain contact induced by a deeper burial may explain why these sites exhibit relatively smaller porosities than those observed at Woburn and, by extension, why soil formation rates at Hilton and Rufford are comparatively slower.

In addition to enhancing grain-to-grain contact, greater burial depths have also been shown to amplify processes of cementation within sandstones. For example, Bloch *et al*. (2002) found that greater temperatures (> 100°C)

associated with deeper burials can lead to quartz dissolution, which subsequently results in the precipitation of quartz cements. These quartz cements can bind as overgrowths to the uncoated surfaces of mineral grains within the sandstone, and strengthen their physical integrity. The additional strength provided by these overgrowths would further reduce the susceptibility of the sandstone to weathering processes. Previous work that has been undertaken on the deeply buried Sherwood Sandstones has found a pervasive presence of quartz overgrowths which, in many cases, occlude porosity (Burley, 1984). Furthermore, an increase in the grain-to-grain contact ratio in the Sherwood Sandstones would have reduced the intergranular pore volumes. A consequence of this is that a relatively smaller volume of cementing agents would have been required to cause cohesion between these mineral grains. In Hilton, Comer, and Rufford, iron oxides (mostly in the form of hematite) have often been shown to cause this intergranular welding. The formation of hematite predominantly occurred as a result of the alkaline Triassic groundwaters oxidising iron into ferric oxide. The red pigmenting exhibited in Figure 6.2a demonstrates the presence of hematite in the saprolite underlying Hilton.

By contrast, the shallow burial of the sandstone at Woburn would have resulted in a different array of diagenetic conditions. The relatively lower temperatures and pressures would have reduced quartz dissolution reactions and the subsequent precipitation of quartz overgrowths. Moreover, Palmer and Barton (1987) found a relative absence of quartz overgrowths in the Woburn sandstone in a comparison with similar lithologies, such as the Wyoming Sands. The lack of iron oxides in the sandstone at Woburn may be

a legacy of the marine conditions in which the sandstone was laid. Seawater has a relatively low concentration of iron (Bloch *et al*., 2002) which may explain why the saprolite exhibits less evidence of hematite. Further analysis, such as the use of SEM imaging, is required to verify the relative abundance and absence of intergranular cements within the saprolite sampled at Hilton and Woburn.

During the initial formation of the Helsby and Woburn sandstone formations, the dominant environmental conditions suggest that evaporitic minerals may have composed part of the matrix material. In the case of the Helsby sandstone formation at Hilton, the climatic conditions of the Triassic period would have led to the extensive formation of evaporite minerals within the rock. In *confined* Sherwood Sandstone aquifers, to which meteoric waters have not gained access, evaporite minerals are still observable today (Burley, 1984). However, for unconfined aquifers, such as the Helsby sandstone at Hilton, isotope evidence suggests that these Triassic evaporites subsequently dissolved as a result of being flushed with cool, fresh, meteoric waters (Burley, 1984), potentially during the Pleistocene (Downing *et al*., 1987; Tellam, 1995). Similarly, the marine provenance of the sandstone at Woburn suggests that halite, in particular, would have been abundant in the initial depositional stages; indeed, it would have likely been more abundant than that which formed at Hilton. Despite the fact that halite would have initially filled the pores in the sandstone at Woburn, this mineral is highly soluble, and would have dissolved rapidly. Milodowski and Wilmot (1985) suggest that the dissolution of evaporitic minerals at Woburn is largely responsible for the great porosities observed in the sandstones underlying this site.

Another example of a matrix mineral previously shown to give structural integrity to saprolite is clay. Heimsath and Whipple (2019) present a conceptual model that builds on earlier work which suggests that as soils develop and thicken from the underlying saprolite, soil formation rates decrease. This induces a delay in the formation of soil from saprolite (Heimsath and Whipple, 2019) and consequently leads to some clays and secondary minerals forming within it that may act to retain some structural integrity for longer. In a similar way that soil shear strength increases with greater clay content (Stark and Eid, 1994), Heimsath and Whipple (2019) suggest that the clays which begin to accumulate within the saprolite can increase its resistance to further physical weathering or disruption by helping to retain its structural integrity, thus reducing rates of soil formation. Although the authors do not present measured clay contents, they do show that the shear strength of saprolite increases as the overlying soil thickens, and propose that original clay or re-precipitated clay formation plays a large role in maintaining some structural integrity within the saprolite.

Mean particle size distributions for the saprolite sampled from Hilton and Woburn are presented in Table 6.3 (see Appendix 6.4). It shows that the proportions of clay-sized material within both sandstone formations are similar. As a result, we suggest that the importance of clay for strengthening the structural integrity of the saprolite at Hilton and Woburn is secondary to that of the depth of burial. However, there is some evidence to suggest that clay may affect soil formation rates across the two sites. Figure 6.6 shows a moderately strong negative relationship between clay content and rates of soil formation (R^2 = 0.6). It should also be noted that the effect of clay in

maintaining the structural integrity of saprolite may be diminished at Hilton and Woburn because these sites were subjected to periglacial processes during the Last Glacial Maximum (LGM). Moreover, the Active Layer Development (ALD), and the seasonal freeze thaw processes associated with periglacial environments, would have broken some physical bonds between particles in the saprolite (Tye *et al*., 2012). Between the end of the LGM and the onset of deforestation, tree roots would have also played a similar role in degrading the structure of the regolith, through breaking the physical binding of the clays that act as forms of cohesive cements within the saprolite.

In some cases, analysing porosity *per se* may not be sufficient to explain the differences in rates of soil formation. For example, the rate of soil formation for zero soil thickness at Comer was about 1.3x faster than at Rufford, despite the fact that their respective sandstone porosities are similar (24 – 26%) (Allen *et al*., 1997). Similarly, the soil formation rate for zero soil thickness at Hilton is nearly three times as fast as that at Rufford, despite the fact that both sandstone formations underlying these sites stem from the same Permo-Triassic parent rock (the Sherwood Sandstone group) and their porosities are almost identical (~ 24 – 25%). Here, we should acknowledge other hydrogeological processes and, in particular, the role of permeability: a "measure of the capacity of a rock or soil to transmit fluids" (Goudie, 1994, p. 381). This necessitates a wider understanding of bedrock features, like fractures, that may promote fluid flow (Neuman, 2005). Recent work by Critical Zone scientists has elucidated the feedback processes that may occur between bedrock weathering and the formation of fractures. Worthington *et al*. (2016) found that weathering is often focussed in the vicinity of fractures,

since fluids are concentrated along them, and this weathering could subsequently be a major factor that induces further fracturing, promoting greater permeability. Although the primary measurement of permeability was beyond the scope of this study, previous work has been published that may explain the difference in soil formation rates across sites with similar porosities. For example, faults and fractures observed in the Helsby sandstone underlying Hilton have been shown to increase its hydraulic conductivity to > 10 m d^{-1}. This is in contrast to the hydraulic conductivities observed for the Chester Formation at Rufford (0.5 – 5 m d^{-1}) (Allen *et al*., 1997; Griffiths *et al*., 2003). Given that it has been shown that weathering is often enhanced around fractures, these greater hydraulic conductivities at Hilton may, in part, be responsible for the faster soil formation rates at this site when compared to Rufford. However, further empirical evidence is required to validate this hypothesis.

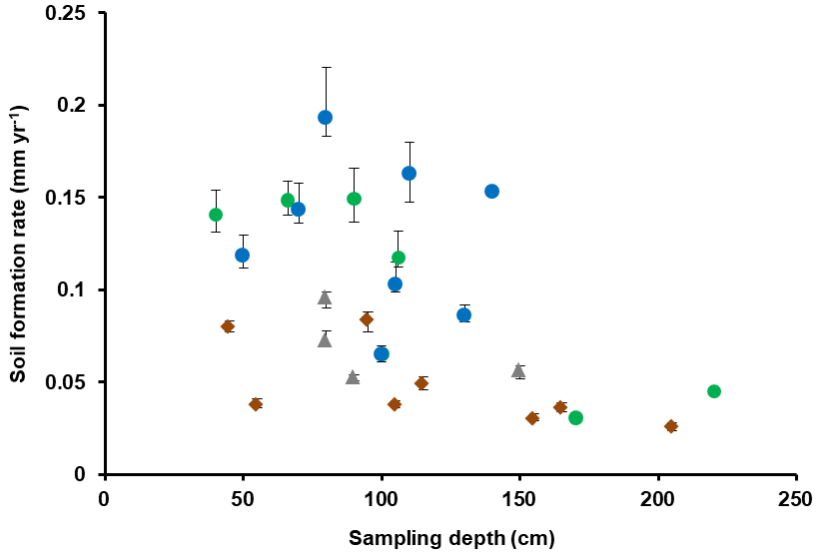

Figure 6.5: Soil formation rates against sampling depth for Hilton (blue; *n* = 8) and Woburn (green; *n* = 7) with those previously measured at Rufford Forest Farm (brown diamonds; *n* = 8) and Comer Wood (grey triangles; *n* = 4). The error bars represent one standard deviation uncertainties.

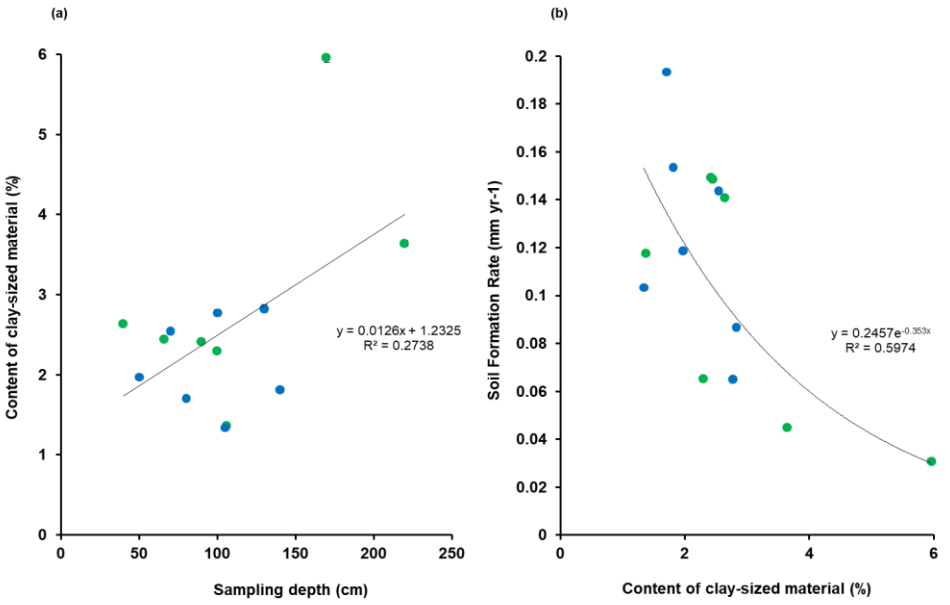

Figure 6.6: Analysis of the relationship between sampling depth and the content of clay-sized material in the saprolite (a) and that between the clay-sized material in the saprolite and the soil formation rate (b) for Hilton (blue; *n* = 7) and Woburn (green; *n* = 7).

Table 6.2: Properties of the sandstone and soil formation rates for each of the four sites in this chapter.

		Comer	Hilton	Rufford	Woburn
Sandstone formation		Bridgnorth	Helsby	Chester	Woburn
Provenance		Aeolian; Draas and linear dunes	Fluvial; channels; lateral dune and bar migration	Fluvial; Gravelly to sandy braid plains	Marine; Offshore tidal sand wave bar
Period and Age (Ma)		Cisuralian, Early Permian; 273 – 299	Anisian, Middle Triassic; 242 – 247	Olenekian, Early Triassic; 247 – 251	Aptian, Early Cretaceous; 101 – 125
Depth of Burial (m)		~ 1000	~ 1000	~ 1000	~ 300
Porosity (%)		24 - 26	6 – 27	~ 25	~ 35
Matrix composition		K-feldspars, authigenic clays, hematite, detrital rock fragments	Ferroan dolomite, hematite, detrital mica, authigenic clays	Micaceous, coarse to fine, silty matrix; pebbles/ cobbles	Alkali feldspar, glauconite, muscovite, calcite; negligible clays
Gamma value[a]		1.9	3.0	2.5	1.1
Soil Formation Rate (mm y^{-1})	*Mean*	0.046	0.128	0.037	0.100
	Zero soil thickness[b]	0.076	0.164	0.058	0.229

[a] Calculated soil thickness when soil formation is reduced by 1/*e* using the soil production function (see Eq. 2 in *Methods*).

[b] Soil formation rates calculated using the soil production function (see Eq. 2 in *Methods*).

Table 6.3: Particle size distributions for the saprolite sampled at Hilton and Woburn.

		Mean Particle Size Distribution (%)	
		Hilton (*n* = 7[a])	**Woburn (*n* = 7[a])**
Clay		2.1*	3.0*
Silt		5.4**	6.7**
	Very fine	4.2	3.7
	Fine	24.2***	39.9***
Sand	***Medium***	47.5	41.0
	Coarse	15.4****	5.1****
	Very coarse	1.0	0.6
Median grain size[a] (µm)		310	227
Mean variance (a.u[d])		4.16	4.64
Mean skewness (a.u)		2.31	2.60

[a] Mean of the sample for each site. Data for CRN2 and CRN12 are omitted from this analysis because of equipment failures during measurement.

[b] Starred values denote the presence of statistically significant different (*U* test; $P < 0.05$).

[c] Clay: < 8 µm; Silt: 8 – 63 µm; Very fine sand: 63 – 100 µm; Fine sand: 100 – 250 µm; Medium sand: 250 – 500 µm; Coarse sand: 500 – 1000 µm; Very coarse sand: 1000 – 2000 µm.

[d] a.u = arbitrary units.

[e] Full dataset can be found in Appendix 6.4.

6.3.4 Comparison with global inventory

Figure 6.7 compares soil formation rates from Hilton and Woburn with those from other sandstone-derived soils taken from the published literature (n = 60; Appendix 2.1). Scholars have previously shown that climate is one of the most influential factors in constraining rates of soil formation (Stockmann *et al*., 2014). Therefore, in order to reduce the influence that climate may have on this analysis, the data that comprise this global inventory stem from temperate climates only.

The data from the global inventory demonstrate a reduction in soil formation rates as soils thicken. In accordance with previously published analyses, soil formation rates fall by more than an order of magnitude between soil thicknesses of 0 and 50 cm. Between 50 and 100 cm, this decline is less pronounced with rates oscillating between ~ 0.01 and 0.06 mm y^{-1}. Comparing the data from both this study and Evans *et al*. (2019), with those from the published inventory, presents two important findings.

First, for soils between 40 and 100 cm in thickness, soil formation rates from Hilton and Woburn are similar to those from the global inventory. The pattern is one of quasi steady-state where rates do not significantly decline with increasing soil thickness and, instead, are enveloped within a range (~ 0.07 – 0.19 mm y^{-1}). However, in the majority of instances, the rates from Hilton and Woburn are towards the upper end of, if not greater than, those previously published.

Second, for soils thicker than 100 cm, the data from Hilton and Woburn show a linear negative relationship between soil formation rates and soil thickness.

Given that there is only one rate presented for soils thicker than 100 cm from the global inventory, the data from Hilton and Woburn, together with those from Rufford and Comer, represent an important contribution to our knowledge of soil formation for deeper soils.

The soil formation rates calculated using the soil production function also show that Hilton and Woburn are toward the upper end of, if not greater than, the range of those previously published. At Hilton and Woburn, the rates at zero soil thickness are 0.229 mm y^{-1} and 0.164 mm y^{-1}, respectively. These contrast by more than an order of magnitude with those from both Heimsath *et al*. (1997) and Wilkinson *et al*. (2005), where soil formation rates at zero soil thickness were 0.068 mm y^{-1} and 0.02 mm y^{-1}, respectively.

One explanation for why soil formation rates at Hilton and Woburn are towards the upper end of, if not greater than, those previously published could be because of the volume and composition of the sandstone matrix. Many of the sandstones previously studied are classified as ‘wackes’ (using the Pettijohn *et al*., 1987 scheme) due to the fact that 15% of their rock volume is matrix material. This contrasts with the arenite sandstones found at Hilton and Woburn, where the matrix material comprises less than 15% of the total rock volume. By supporting a denser matrix, the rock inherently has a lower porosity, which can reduce the rates of weathering and soil formation processes.

For example, Wilkinson *et al*. (2005) conducted work on the Blue Mountains in Australia, where the climate is described as mild temperate. The parent material was a moderately to strongly lithified Triassic sandstone, dominated

by cobbles of ferruginous sandstone that are resistant to weathering, which were neither observed at Hilton nor Woburn. At 50 cm, the soil formation rate on the Blue Mountains was nine times slower than that at Hilton for the same soil thickness. We believe that the bands of relatively resistant sandstone, cemented by an iron-enriched matrix, are in part responsible for the slower soil formation rates measured on the Blue Mountains. Similarly, Heimsath *et al*. (2001b) measured soil formation at Coos Bay, located along the Oregon coast range, in the USA. The soils are underlain by an Eocene arkosic wacke: a sandstone with a matrix comprising more than 15% by volume, and more than 25% feldspar. At 100 cm, the soil formation rate at Coos Bay was 0.014 mm y^{-1}, five times slower than that at Woburn, where the absence of this matrix promotes the transmission of water and weathering processes (Cummins, 1962).

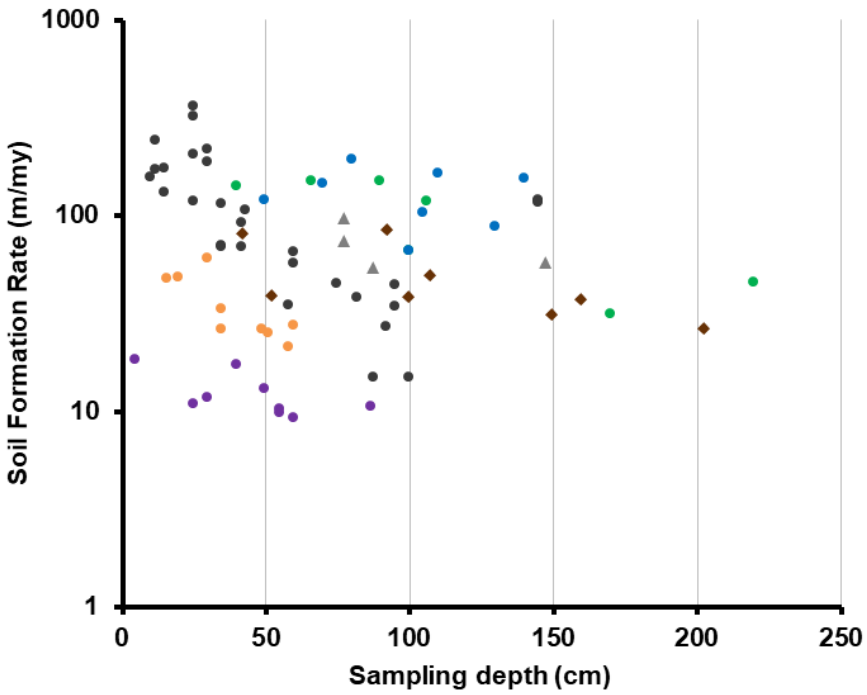

Figure 6.7: Soil formation rates from Hilton (blue; *n* = 8) and Woburn (green; *n* = 7), together with those from Rufford Forest Farm (brown diamonds; *n* = 8), Comer Wood (grey triangles; *n* = 4), and those from a globally compiled inventory of soil formation rates on sandstone geology from Heimsath *et al*., 1997 (orange circles; *n* = 9), Heimsath *et al*., 2001b (grey circles; *n* = 30), and Wilkinson *et al*., 2005 (purple circles; *n* = 9).

6.4 Conclusions

In this study, we have investigated the extent to which the lithological variability of sandstone governs rates of soil formation. Cosmogenically-derived rates of soil formation for two UK hillslopes range from 0.031 – 0.193 mm y^{-1}, with the means being 0.128 ±0.043 mm y^{-1} and 0.100 ±0.051 mm y^{-1} for Hilton and Woburn, respectively. In addition to being only the second study in the UK to measure soil formation for soils currently supporting arable agriculture, the sandstone-derived soils studied here represent some of the deepest profiles that have been subject to cosmogenic radionuclide analysis.

We found that soil formation rates at Woburn are faster than those measured at Hilton, and suggest here that this may be substantially governed by the lithological variabilities exhibited between the two sandstone formations. The sandstone at Woburn has a greater porosity than that at Hilton, enabling more mineral surfaces to be in contact with water, and this leads to faster rates of bedrock weathering. This smaller porosity at Hilton is partly brought about by increased grain-to-grain contact, as a direct result of a greater depth of burial. The greater temperatures and pressures associated with a deeper burial would have additionally led to the cohesion of mineral grains by intergranular cements. One of the effects of these cementing agents is to slow down the transmission of water through the bedrock and reduce rates of chemical weathering.

Similarly, the rates from the arenite sandstones of Hilton and Woburn are, in some cases, up to nine times faster than those previously obtained by scholars working on wackes. Here, we suggest that these matrix-abundant

wackes reduce the transmission of water and slow down the processes of bedrock weathering. These findings highlight the need for a more precise insight into the mineralogy and petrology of the parent material when interpreting rates of soil formation.

Our work has opened a new research gap for soil formation scholars. This community has hitherto measured soil formation rates and compared them across major rock types (igneous, sedimentary, and metamorphic). An area that has not enjoyed equal investment is an exploration into the role of the mineralogical and petrographic variations within a single rock group in governing rates of soil formation. Having shown here the breadth of soil formation rates across different types of sandstone, more work is required to study other sedimentary units and, indeed, different types of igneous and metamorphic lithologies, too.

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Chapter 7: Discussion and conclusions

7.1 Introduction

This thesis began by recognising the disciplinary renaissance occurring in soil science. Over recent decades, soil science has strengthened its liaisons with neighbouring disciplines, and forged new interdisciplinary alliances with emerging fields (Brevik *et al*., 2015). As a result of this cross-fertilization, soil resources are more regularly discussed across a wide range of terrestrial science. Moreover, soil is now acknowledged as an important nexus in environmental systems, bridging discourses which were hitherto discrete, and highlighting opportunities for wider interdisciplinarity.

It is exactly a century since the publication of *The World's Food Resources* (von Engeln, 1920) in which the author proposes solutions to expand the food supply for a climbing world population, but fails to acknowledge the role of soils. A century on, the services provided by soils are ubiquitous, and the need to conserve them is manifest. Soils have been identified as essential resources with which to combat global sustainability issues, including many of the United Nations' Sustainability Development Goals (e.g.: zero hunger, good health and wellbeing, clean water and sanitation, responsible consumption and production, and life on land).

However, addressing these challenges is more difficult when soils face a number of threats. Whilst soils have been enlisted to tackle climate change, they are also vulnerable to its impacts. Warming-induced changes in the temperature and moisture regimes of soils can increase their decomposition,

and accelerate processes such as erosion and desertification (FAO, 2015). Finding ways to improve a soil's resistance and resilience to global environmental change, and restoring degraded soils, is therefore paramount.

However, there is arguably a superior priority for soil scientists. The chapters comprising this treatise are hinged on one fundamental principle: the processes, functions, health, productivity, resistance, and recovery of any soil can neither exist nor endure without the presence of the soil material (Power *et al*., 1980). Thus, one of the chief duties for soil scientists must be to prevent the thinning and loss of soil profiles. In the broadest sense, this call for action heeds and advocates the large body of work already established around soil conservation, and the combatting of soil erosion (Poesen, 2017).

Yet, these efforts have ignored a sizeable knowledge gap. Whilst soil erosion has been measured, monitored, and modelled, we have not made a commensurate effort to obtain the rates of soil formation. In consequence, we have a very sparse knowledge base upon which to consider the future sustainability of global soil resources, and their long-term delivery of ecosystem services. Responding to these knowledge gaps, this thesis has made two contributions to the discourse on soil sustainability. First, it has responded to the impoverished state of the soil formation inventory by empirically measuring rates of soil formation, and furthering our understanding about the factors which govern this process. Second, it has compared soil formation rates with those of soil erosion to forecast soil lifespans. In so doing, it has demonstrated that soil formation rates can be used to help soil scientists quantify the sustainability of these resources. Both of these were set out as

‘research challenges’ in Chapter 1, and these will now be explored further in this general discussion.

7.2 Research challenge 1: state of the soil formation inventory

Cosmogenically-derived rates of soil formation were presented in Chapter 2. These data represent the soil formation that occurs at the soil-saprolite interface, rather than the weathering that takes place on bare bedrock surfaces, such as outcrops and tors. This inventory – thirteen studies conducted across four countries – represents a research effort spanning fifteen years (1997 to 2012). However, a Web of Science search found that over 1,217 studies were published on the topic of “soil formation” during that time-frame. This suggests that deriving rates of soil formation *per se* was not one of the major foci for this sub-discipline of soil science during this period.

There are still many contexts in which soil formation has not been measured. For example, polar regions have been the subject of relatively little pedogenesis work, despite the fact that these areas are increasingly experiencing large-scale environmental change, such as thawing permafrost and accelerated deglaciation (Liu *et al*., 2016). Similarly, very little work to derive rates of soil formation has been conducted in monsoonal climates, even though the heavy rainfall associated with summer monsoons may promote bedrock weathering (Shao and Yang, 2012).

This leads to an important question for discussion. Should future efforts to measure rates of soil formation be concentrated in locations that have been hitherto neglected in order to expand the geographical spread of our

knowledge, or focussed more on understanding the fundamental controls that govern soil formation?

In this thesis, both of these foci have arguably been demonstrated. With regards to expanding the geographical spread of our knowledge on soil formation, Chapter 5 presented 12 cosmogenically-derived rates measured across an arable and woodland site in the UK. The former represented the first of their kind globally, since previous work had instead focused on uncultivated 'pristine' soils. Likewise, the rates derived for the woodland site represented the first of their kind in Europe. The rates obtained were found to fall within the range of those previously published for temperate climates, and on sandstone lithologies. Furthermore, this study was only the second of its kind to take place in the UK after Riggins *et al*. (2011). The rates here were significantly greater than those previously obtained for the igneous lithologies on Bodmin Moor, representing an important contribution to our knowledge about soil formation in the UK. Similarly, Chapter 6 presented a further 15 rates for arable and grassland soils in the UK. One of the main findings to stem from this chapter was that rates of soil formation significantly differed from those previously presented in Chapter 5. The variability in soil formation rates demonstrated in these two chapters suggests that further work is necessary to ascertain the full range of soil formation across a wider range of environmental contexts in the UK.

The second proposition presented above was to focus less on the geographical spread of our pedogenesis knowledge, and to instead explore the fundamental mechanisms that govern the process of soil formation. It could be argued that these foci are not mutually exclusive. After all, some of

these controlling variables may be best investigated by measuring soil formation across a range of locations and environmental contexts. For example, a global transect could be established to assess how extreme temperatures and precipitation regimes affect bedrock weathering rates, and this may consequently focus research on new locations and environments. This was the case for the work presented in this thesis. As well as being novel in its selection of field sites, Chapters 5 and 6 made two additional contributions to our knowledge on the factors that govern soil formation.

First, Chapters 5 and 6 presented rates of soil formation for relatively thick (>1 m) soils. Before this work, the median thickness in the soil formation rate inventory was 0.35 m, with only 6% of the dataset reporting rates for soils deeper than a metre. For sandstone lithologies in temperate climates, there was only one rate presented for soils deeper than a metre. Therefore, the soils studied in this thesis represent some of the thickest profiles that have been subject to cosmogenic radionuclide analysis. To better understand the relationship between rates of soil formation and soil thickness, more work needs to be carried out on thick (>1 m) soils.

Second, Chapter 6 presented further insights into the extent to which the lithological variability of sandstone governs rates of soil formation. Moreover, the rates obtained for the arenite sandstones in this study were shown, in some cases, to be up to nine times faster than those previously measured by scholars working on wackes. These findings suggest that the abundance of matrix in wackes reduces the transmission of water into the rock, slowing the process of bedrock weathering. Meanwhile, comparatively matrix-free arenite sandstones promote the transmission and storage of water, and enable more

contact between water and mineral particles, thus speeding up weathering processes.

In summary, this thesis has widened the geographical spread of our knowledge on soil formation, whilst simultaneously investigating some of the intrinsic mechanisms that control the process of bedrock weathering. It could be suggested that more rates are still required, but this thesis has also argued that accuracy should not be substituted for quantity. For example, in Chapter 3, a new model called CoSOILcal was presented. The major contribution here was the opportunity, for the first time, to take into account the overlying soil bulk density when calculating a 'best fit' bedrock lowering rate using measured concentrations of *in-situ* radionuclides from samples taken at or below the bedrock-soil interface. The model was employed in a sensitivity analysis on previously published bedrock concentrations of Beryllium-10. This was to assess the extent to which high-resolution bulk density data for the overlying soil in each case (previously ignored in the original studies) would bring about significantly different rates of soil formation. It was found that for soils thicker than 0.25 m, these bulk density data brought about a significant difference in this way. Whilst measuring rates of soil formation using cosmogenic radionuclide analysis should continue to be a priority for soil scientists, care should be taken to ensure that the rates obtained are as accurate as possible. This thesis suggests that accounting for soil bulk density in future isotopic work should be an essential aspect of this quality assurance.

7.3 Research challenge 2: application of soil formation rates

The second research challenge outlined in Chapter 1 considered the application of soil formation rates. To date, soil formation rates have been most commonly measured by communities from outside soil science (e.g.: Heimsath *et al*., 1997). Thus, these data have been principally used to address research agenda with little, if any, relation to soil (e.g.: to identify long-term landscape evolution mechanisms). By contrast, soil formation data have provided comparatively little contribution to the discourse of soil sustainability. Although statements regarding the imbalance between soil formation and soil erosion continue to be made by soil scientists, seldom are these statements supported by empirical measurements. Instead, soil formation rates are often estimated by referring to other studies, some of which stem from contexts dissimilar in climate and lithology. Notwithstanding the need for more data, soil scientists should also explore and develop ways to apply the rates already obtained.

In Chapter 2, two potential applications for soil formation data were discussed: the estimation of soil lifespans, and the establishment of soil loss tolerance (SLT) values. Both of these have enjoyed varying degrees of engagement by soil scientists, particularly the latter (Di Stefano and Ferro, 2016). In the case of soil loss tolerance, the general principle that rates of soil erosion should fall below those of soil formation is widely accepted. However, the analysis presented in Chapter 2 shows that less than half of the studies that have calculated SLT values have employed soil formation data. In the case of soil lifespans, the development of these models has been iterative and mostly conceptual (i.e.: soil formation rates have seldom been measured for soil

lifespan calculations; rather, they have been estimated using data obtained by studies from dissimilar contexts).

Soil lifespans have been explored progressively throughout this thesis. In Chapter 4, the first scientifically robust, globally relevant, quantitative estimates of soil lifespans were presented. This work brought about two major findings. First, 93% of non-bare soils subject to conventional land management practices (e.g.: conventional ploughing, cultivation up-and-downslope, etc.) were shown to be thinning, with 16% of the dataset reporting lifespans of less than 100 years. Second, shifts in the way land is used and managed can extend these lifespans and, in many cases, promote soil thickening. For soils managed with conservation-based practices (e.g.: minimal tillage, contour cultivation, etc.), over a third of the lifespans in the dataset exceeded 10,000 years.

The work presented in Chapter 5 further developed the soil lifespan concept. At Rufford Forest Farm, soil lifespans were calculated for both the A horizon and the whole solum. Measuring rates of soil formation and erosion, and estimating soil lifespans at four different catena positions, enabled an assessment into the variability of soil lifespans at the field-scale. The shortest lifespans were found on the backslope (212 years, in a worst-case scenario), whereas the longest lifespans were found at the summit (713 years, in a worst-case scenario).

Together, the findings of Chapters 4 and 5 contest the popular claims that there are 60 years of global topsoil left (Arsenault, 2014; Wong, 2019). On the contrary, the global soil lifespans analysed in Chapter 4, and the localised

lifespans estimated for Rufford Forest Farm in Chapter 5, span five orders of magnitude. This thesis has demonstrated that land-use and management practices can influence the long-term sustainability of soil profiles, as indeed can soil depth. There is arguably much more work to be done to substantiate these findings, particularly in terms of addressing the many limitations of the soil lifespan model. Nonetheless, the analyses presented in this thesis represent the first evidence-based assessments of soil lifespans, and shows that claims citing 'single-figure' lifespan estimates do not realistically reflect the variability in the sustainability of our soil resources.

7.4 Evaluation

This section of the closing discussion will provide a general evaluation of the work completed for this thesis. It will focus, in turn, on three aspects: accuracy, reliability, and validity, and will largely discuss these with respect to Chapters 4, 5, and 6. For specific and more detailed evaluative comments, please refer to the discussions contained within each chapter.

7.4.1 Accuracy

Every attempt has been made to ensure that the findings of this thesis are as accurate as possible. However, some of the methodologies employed here are inherently limited in this regard. One of the often-cited advantages of cosmogenic radionuclide analysis is that it can be used to measure soil formation rates over long time scales, averaging out any short-term or high frequency perturbations (Cockburn and Summerfield, 2004). In Chapter 6, this was particularly advantageous; the aim here was to measure soil formation rates from multiple sites across the UK in order to better understand the

effects of lithology. Although each site is subject to a specific microclimate (e.g.: Hilton receives approximately 90 mm more precipitation annually than Woburn), these disparities would not have been detected by cosmogenic radionuclide analysis, and thus would not have impacted the examination of the lithological controls. However, if the research objective was to determine the effect of arable practices on soil formation rates, cosmogenic radionuclide analysis would no longer be a suitable method (i.e.: arable practices would not have been implemented over timescales long enough for their effects on soil formation to be detectable by this technique). Yet, other methods have demonstrated that arable practices can influence rates of soil formation over short-term (monthly to annual) timescales (Gabet *et al*., 2003). Therefore, it is likely that the rates presented for the arable sites studied in Chapters 5 and 6 are less accurate because they do not account for short-term changes in land management. By extension, this affects the lifespan analysis for the soils at Rufford Forest Farm. In the event that the land management practices in operation at this site have increased rates of soil formation (e.g.: seasonal ploughing has increased the infiltration of water to the soil-saprolite interface), the lifespans currently estimated in Chapter 5 may have been under-estimated. Conversely, if these practices have slowed the rates of soil formation (e.g.: reducing the transmission of water to the saprolite through compacting surface horizons), it is likely that the lifespans have been over-estimated. To address this, cosmogenic radionuclide analysis should be used in tandem with other methods, particularly those that are able to ascertain the effects of relatively short-term land management operations on the rates of bedrock weathering.

The lifespan analysis presented for Rufford Forest Farm is also affected, in turn, by the accuracy of the erosion data applied in the lifespan model. In this case, the data stemmed from a ^{137}Cs-based study conducted by Quine and Walling (1991) and represented all erosion processes in operation at the site since approximately 1956. If annual rates of soil erosion have increased or decreased since the early 1990s, it is possible that the lifespans outlined in this thesis have been either under- or over-estimated. This point can also be extended to the global lifespan analysis presented in Chapter 4. The erosion data used here stemmed from over 240 studies, each of which may have adopted different techniques to measure rates of erosion. To some extent this was mitigated by discarding modelling-based studies, those that did not empirically measure erosion, and those that failed to report a year's worth of data. However, to ensure greater accuracy in the estimated lifespans, a standard procedure to measure soil formation would need to have been applied universally and consistently.

7.4.2 Reliability

A second consideration in this evaluation is the reliability of the data obtained. One of the negative implications of employing cosmogenic radionuclide analysis to measure soil formation rates is that it is an expensive technique (approx. £1,580 per sample, compared with approx. £315 per sample for radiocarbon dating). It also necessitates a relatively lengthy period of sample preparation and processing time (approx. 8 months, compared with approx. 4 months for radiocarbon dating). As a result, it is more challenging within a concretized budget of time and money to achieve the degree of sample replication that may be possible for other analyses within soil science.

Justifying the way that cosmogenic radionuclide analysis was employed in this thesis required balancing the benefits of spatial coverage in measuring soil formation (i.e.: across different catena positions) with the need to perform replicates. In Chapters 5 and 6, replication was only partly achieved by measuring ^{10}Be concentrations from two samples down the same depth profile. For greater reliability, and to avoid pseudo-replication, multiple transects down multiple hillslopes should have been studied.

7.4.3 Validity

Whilst the measurement of soil formation at four sites across the UK represent an important contribution to our knowledge base, the sites studied in Chapters 5 and 6 are not representative of all environmental (e.g.: climatic and lithological) contexts that characterise the UK. In part, the sites were selected based on their suitability for cosmogenic radionuclide analysis and, in particular, the presence and abundance of quartz minerals >250 μm within the parent material. Given that sandstone often satisfies these criteria, this biases the work towards sandstone-derived soils. As a result, the findings presented in this thesis cannot validly represent the spread of soil formation rates expected across the UK. In order to determine the likely range of soil formation rates across the country, studies covering a wider array of climates and lithologies in the UK need to be undertaken. In addition, this may require alternative radionuclides (such as ^{36}Cl) being used instead of ^{10}Be. The use of ^{36}Cl to measure the rates of weathering on carbonate-based bedrock has been demonstrated previously (Moore and Granger, 2019).

Similarly, this also implies that the soil lifespans presented for Rufford Forest Farm cannot be used to represent the sustainability of all or other soils across the UK. Rufford Forest Farm was selected in part based on the fact that it is known to have a high erosion risk. As a result, the lifespans calculated for the soils at this site may be shorter than the UK mean. To achieve a more comprehensive insight into the lifespans of UK-based soils, it is essential that soils within a broader array of environmental and land management contexts are studied. By extension, this may also require more empirical work focused on measuring soil erosion across a representative range of environmental conditions in the UK. The findings of Benaud (2017) suggest that the UK has a rich history of soil erosion research, but that work to date has been biased towards localities with a known susceptibility for soil erosion. Going forwards, it is essential that empirical measurements of soil erosion adopt an unbiased sampling design. This is essential if the uncertainties in erosion models are to be suitably quantified (Batista *et al*., 2019).

7.5 Future work

In addition to improving the accuracy, reliability, and validity outlined in Section 7.4, there are three avenues of further research that could stem from the work presented in this thesis.

7.5.1 Rates of soil *function* formation

The rates of soil formation determined here represent the first stage of the soil formation process: the conversion from bedrock to saprolite. Critically, they cannot provide an insight into the rates at which this saprolite is converted into a functioning soil (i.e.: one that is able to maintain a host of soil ecosystem

services such as crop production, purifying water, and sequestering carbon). Further work is required to better understand the 'lag-time' – to borrow a term from hydrology – between the production of saprolite and the beginning of soil functioning, and the factors that may influence this. A useful starting point for such work may include isotopically dating low (near-bedrock) soil horizons and comparing these dates with the maximum ages derived from cosmogenic radionuclide analysis.

7.5.2 Lifespans after complete soil removal

In this thesis, maximum soil lifespans were determined based on an estimated period of time until bedrock exposure. However, this assumption disregards the possibility that the underlying saprolite may be able to perform some, if not all, of the ecosystem services provided by soils. The saprolite is one of the least studied zones of the soil profile, with the majority of the work to date feeding geomorphological and geological discourses, rather than the dialogues on soil sustainability and soil ecosystem services. Therefore, large gaps exist in our knowledge and understanding of the potential roles of saprolite for ecosystem functioning. Further work to address these gaps is essential if maximum soil lifespans are to be representative. This work may involve expanding our knowledge about the physical, chemical, and biological properties of saprolite underlying soils, and the extent to which these properties contribute towards the provision of ecosystem services. In addition, additional work may adopt the five factors of soil formation as a conceptual framework with which to study the factors that govern the functional capacity of the saprolite horizon.

7.5.3 Rates of soil formation for deep soils

A third package of work could further explore the factors that constrain the rates at which soils form at the bedrock. One of the major contributions of this thesis has been the focus on obtaining soil formation rates for relatively thick (>1 m) soils. Furthermore, the data presented here can help soil scientists better understand the relationship between soil thickness and rates of soil formation. Despite this, the relative dearth of soil formation data for soils thicker than 1 m still represents a sizeable knowledge gap, and one requiring more nuanced attention by soil scientists. However, considering cosmogenic radionuclides attenuate with depth (Gosse and Phillips, 2001), clearly this technique may need to be supported by other methods for significantly thick (>3 m) soils.

7.6 Research outputs and impact statement

The final task of this evaluation is to discuss the outputs and impact of this work, both those which have already been generated, and the potential for additional outputs and impacts going forwards.

At the time of submitting this thesis, the work contained herein has led to three major forms of research output. First, this thesis has led to the publication of two peer-reviewed articles in international, peer-reviewed journals (Evans *et al*. 2019; Rodés and Evans, 2019) and a number of conference papers. It has also facilitated the development of the CoSOILcal model (see Chapter 3) which has the potential to contribute towards cosmogenic radionuclide studies both within and beyond the discipline of soil science. The second major research output has been the publication of two outreach articles for *The*

Conversation and *Air Water Environment International* (Evans, 2020a,b). These have allowed for the distillation and communication of some of the broader messages emanating from this thesis to audiences beyond the academy. Accompanying these engagement articles is a third research output: the production of a six minute film, focussing on the soil lifespan (STARS, 2018).

The work presented in this thesis has the potential to generate additional impacts. One of these is on land policy. There have been many governmental and non-governmental reports published recently which assert claims about the lifespans of UK soils, without supporting these claims with appropriate evidence. For example, the Environmental Agency's 2019 'State of the Environment' report suggests that some parts of the country "could be only 30 to 60 years away from the fundamental eradication of soil fertility" (Environmental Agency, 2019, p. 5). Although this statement made reference to an academic paper, the paper in question focussed its analysis solely on the degradation of peat (Matysek *et al*., 2019). Similarly, Secretary of State Michael Gove has previously stated that "we may be 30, 50, 60 harvests away from the fundamental eradication of [soil] fertility in parts of the country" (Soil Association, 2017). Statements of this nature also continue to be made in both Houses of Parliament, yet are seldom evidenced (Sinclair, 2017; Featherstone, 2018; Whitty, 2019).

The lifespans presented in this thesis, particularly those from the global analysis conducted in Chapter 4, could be used, in part, to support future claims, but also to identify 'lifespan hotspots'. These hotspots would indicate areas with critical soil lifespans which are arguably most in need of urgent soil

conservation policy. Furthermore, the conclusions of Chapter 4 that discuss techniques to extend soil lifespans could be used to inform future policy, both within the UK and abroad. By implementing evidence-based measures for soil conservation, and thereby extending soil lifespans, soils will be better placed to sustain their provision of ecosystem services. Achieving this goal will bring wide-reaching impacts across present-day society, and for future generations.

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Appendices:

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Appendix 2.1: Global Inventory of Soil Formation Rates

Author	Year	Site	MAT (°C)	Climate	Köppen Code	Lithology	Vegetation	Depth (cm)	Native Units	SPR (mm/y)	± (mm/yr)
Heimsath et al	1997	Tennessee Valley, California	15.9	Humid Subtropical	Cfa	Greywacke, Sandstone (Sedimentary)	Coastal Grassland/Scrub	16	m/Ma	0.047	0.015
Heimsath et al	1997	Tennessee Valley, California	15.9	Humid Subtropical	Cfa	Greywacke, Sandstone (Sedimentary)	Coastal Grassland/Scrub	35	m/Ma	0.026	0.003
Heimsath et al	1997	Tennessee Valley, California	15.9	Humid Subtropical	Cfa	Greywacke, Sandstone (Sedimentary)	Coastal Grassland/Scrub	58	m/Ma	0.021	0.003
Heimsath et al	1997	Tennessee Valley, California	15.9	Humid Subtropical	Cfa	Greywacke, Sandstone (Sedimentary)	Coastal Grassland/Scrub	51	m/Ma	0.025	0.004
Heimsath et al	1997	Tennessee Valley, California	15.9	Humid Subtropical	Cfa	Greywacke, Sandstone (Sedimentary)	Coastal Grassland/Scrub	30	m/Ma	0.06	0.016
Heimsath et al	1997	Tennessee Valley, California	15.9	Humid Subtropical	Cfa	Greywacke, Sandstone (Sedimentary)	Coastal Grassland/Scrub	49	m/Ma	0.026	0.005
Heimsath et al	1997	Tennessee Valley, California	15.9	Humid Subtropical	Cfa	Greywacke, Sandstone (Sedimentary)	Coastal Grassland/Scrub	20	m/Ma	0.048	0.008
Heimsath et al	1997	Tennessee Valley, California	15.9	Humid Subtropical	Cfa	Greywacke, Sandstone (Sedimentary)	Coastal Grassland/Scrub	35	m/Ma	0.033	0.005
Heimsath et al	1997	Tennessee Valley, California	15.9	Humid Subtropical	Cfa	Greywacke, Sandstone (Sedimentary)	Coastal Grassland/Scrub	60	m/Ma	0.027	0.005
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0139	0.0015
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0144	0.0037
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0148	0.0016
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0133	0.0033
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0126	0.0013
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0125	0.0029
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0155	0.0043
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0159	0.0045
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0175	0.0054
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0145	0.0032
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0137	0.0015
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0139	0.0016
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0147	0.0016
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0126	0.0014
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0115	0.0012
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0107	0.0012
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0157	0.0018
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0147	0.0018
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0167	0.002
Small et al	1999	Wind River Range, Wyoming	1.91	Tropical/Subtropical Steppe	Bsk	Granite / Gneiss (Igneous and Metamorphic)	Bare	7.5	m/Ma	0.0138	0.0016
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	15	m/Ma	0.13009	0.03413
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	15	m/Ma	0.17415	0.03361
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	87.5	m/Ma	0.0147	0.00181
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	42	m/Ma	0.06856	0.00732
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	42	m/Ma	0.09107	0.01891
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	25	m/Ma	0.20351	0.04147
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	100	m/Ma	0.0148	0.00227
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	95	m/Ma	0.04406	0.00966
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	92	m/Ma	0.02659	0.00601
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	145	m/Ma	0.11873	0.03921
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	145	m/Ma	0.1148	0.03458
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	145	m/Ma	0.1168	0.01339
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	95	m/Ma	0.03382	0.00739
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	75	m/Ma	0.04475	0.00877
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	82	m/Ma	0.03761	0.00549
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	60	m/Ma	0.05688	0.00871
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	60	m/Ma	0.06413	0.01462
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	35	m/Ma	0.11323	0.02115
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	25	m/Ma	0.11792	0.029
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	58	m/Ma	0.03439	0.00473
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	43	m/Ma	0.10616	0.01922
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	10	m/Ma	0.15487	0.02248
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	12	m/Ma	0.1693	0.02042
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	12	m/Ma	0.2392	0.07539
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	25	m/Ma	0.32105	0.10208
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	25	m/Ma	0.35904	0.12271
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	30	m/Ma	0.18726	0.03134
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	30	m/Ma	0.21608	0.04391
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	35	m/Ma	0.06915	0.00787
Heimsath et al	2001b	Coos Bay, Oregon Coast Range, Oregon	9.5	Warm Summer Mediterranean	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	Fir Trees	35	m/Ma	0.06882	0.0084
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	90	m/Ma	0.00925	0.0011
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	10	m/Ma	0.0456	0.00443
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	12	m/Ma	0.04787	0.00412
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	60	m/Ma	0.02061	0.00208
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	42	m/Ma	0.02024	0.00267
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	30	m/Ma	0.03451	0.00395
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	28	m/Ma	0.02608	0.00227
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	40	m/Ma	0.02082	0.00227
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	47	m/Ma	0.01897	0.0018
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	22	m/Ma	0.05653	0.00578
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	52	m/Ma	0.01526	0.00145
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	15	m/Ma	0.02945	0.00239
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	66	m/Ma	0.02183	0.00238
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	40	m/Ma	0.02562	0.0029
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	110	m/Ma	0.01094	0.00089
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	160	m/Ma	0.00956	0.00071
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	20	m/Ma	0.02283	0.00212
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	140	m/Ma	0.00995	0.00088
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	250	m/Ma	0.00907	0.00071
Heimsath et al	2000	Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	10	m/Ma	0.02629	0.00235
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	10.55	Humid Subtropical	Cfa	Ferruginized Sandstone (Sedimentary)	Heath	5	m/Ma	0.0182	0.034
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	10.55	Humid Subtropical	Cfa	Saprolitic coarse sandstone (Sedimentary)	Heath	40	m/Ma	0.0171	0.015
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	10.55	Humid Subtropical	Cfa	Ferruginized Sandstone (Sedimentary)	Forest	25	m/Ma	0.0108	0.007
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	10.55	Humid Subtropical	Cfa	Soft Saprolitic Sandstone (Sedimentary)	Forest	55	m/Ma	0.0097	0.008
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	10.55	Humid Subtropical	Cfa	Soft Saprolitic Sandstone (Sedimentary)	Forest	50	m/Ma	0.0128	0.012
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	10.55	Humid Subtropical	Cfa	Saprolite (Sedimentary)	Forest	55	m/Ma	0.0102	0.006
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	10.55	Humid Subtropical	Cfa	Saprolite (Sedimentary)	Forest	60	m/Ma	0.0091	0.006
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	10.55	Humid Subtropical	Cfa	Soft Saprolitic Sandstone (Sedimentary)	Forest	87	m/Ma	0.0105	0.011
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	10.55	Humid Subtropical	Cfa	Ferruginized Sandstone (Sedimentary)	Forest	30	m/Ma	0.0117	0.01
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	25	m/Ma	0.04908	0.00439
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	37	m/Ma	0.04942	0.00463
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	40	m/Ma	0.02599	0.00226
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	50	m/Ma	0.01179	0.00104
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	65	m/Ma	0.01105	0.0011
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	120	m/Ma	0.00526	0.00037
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	300	m/Ma	0.02842	0.00207
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	30	m/Ma	0.02731	0.00212
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	320	m/Ma	0.01581	0.0012
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	20	m/Ma	0.00462	0.00032
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	250	m/Ma	0.00365	0.00026
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	170	m/Ma	0.0036	0.00025
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	100	m/Ma	0.00433	0.00033
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	10	m/Ma	0.00371	0.00029
Heimsath et al	2001a	Frogs Hollow, Canberra	13.25	Marine West Coast Climate	Cfb	Metasediments/Granites (Igneous/Metamorphic)	Dry schlerophyll forest/grassland	200	m/Ma	0.00357	0.00028
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		5	m/Ma	0.373	0.034
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		38	m/Ma	0.068	0.005
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		30	m/Ma	0.251	0.051
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		23	m/Ma	0.078	0.017
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		30	m/Ma	0.021	0.009
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		43	m/Ma	0.048	0.012
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		36	m/Ma	0.051	0.013
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		15	m/Ma	0.164	0.029
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		15	m/Ma	0.113	0.023
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		10	m/Ma	0.106	0.02
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		44	m/Ma	0.063	0.015
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		27	m/Ma	0.044	0.009
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		34	m/Ma	0.044	0.01
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		10	m/Ma	0.138	0.033
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		20	m/Ma	0.09	0.018
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		44	m/Ma	0.043	0.01
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		54	m/Ma	0.05	0.013
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		45	m/Ma	0.012	0.003
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		16	m/Ma	0.068	0.013
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		10	m/Ma	0.069	0.013
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		15	m/Ma	0.072	0.013
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		10	m/Ma	0.109	0.02
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		28	m/Ma	0.069	0.012
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		12	m/Ma	0.093	0.018
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		20	m/Ma	0.084	0.017
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		20	m/Ma	0.121	0.024
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		24	m/Ma	0.156	0.032
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		49	m/Ma	0.01	0.002
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		50	m/Ma	0.046	0.012
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		35	m/Ma	0.071	0.016
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		25	m/Ma	0.427	0.145
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		5	m/Ma	0.315	0.061
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		7	m/Ma	0.266	0.054
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		13	m/Ma	0.21	0.041
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		3	m/Ma	0.21	0.038
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		20	m/Ma	0.092	0.018
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		5	m/Ma	0.132	0.025
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		3	m/Ma	0.146	0.028
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		3	m/Ma	0.178	0.033
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		12	m/Ma	0.083	0.015
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		12	m/Ma	0.098	0.018
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		8	m/Ma	0.594	0.125
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		25	m/Ma	0.079	0.016
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		8	m/Ma	0.338	0.09
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		10	m/Ma	0.329	0.069
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		20	m/Ma	0.166	0.034
Heimsath et al	2012	San Gabriel Mountains, California	18.3	Warm Summer Mediterranean	Csb	Granitic and Metamorphic (Igneous/Metamorphic)		5	m/Ma	0.163	0.031
Riggins et al.	2011	Bodmin Moor, UK	10	Maritime temperate	Cfb	Granite (Igneous)	Grasses	75	m/Ma	0.01265	0.001139
Riggins et al.	2011	Bodmin Moor, UK	10	Maritime temperate	Cfb	Granite (Igneous)	Grasses	79	m/Ma	0.01622	0.001298
Riggins et al.	2011	Bodmin Moor, UK	10	Maritime temperate	Cfb	Granite (Igneous)	Grasses	40	m/Ma	0.01532	0.002298
Riggins et al.	2011	Bodmin Moor, UK	10	Maritime temperate	Cfb	Granite (Igneous)	Grasses	30	m/Ma	0.01992	0.001992
Riggins et al.	2011	Bodmin Moor, UK	10	Maritime temperate	Cfb	Granite (Igneous)	Grasses	80	m/Ma	0.00964	0.000771
Dixon et al.	2009	Sierra Nevada Range; Blasingame	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Sparsely Vegetated	6	t/km/yr	0.0331	0.0072
Dixon et al.	2009	Sierra Nevada Range; Blasingame	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Sparsely Vegetated	25	t/km/yr	0.0632	0.00495
Dixon et al.	2009	Sierra Nevada Range; Blasingame	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Sparsely Vegetated	27	t/km/yr	0.05245	0.00505
Dixon et al.	2009	Sierra Nevada Range; Blasingame	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Sparsely Vegetated	40	t/km/yr	0.0346	0.00275
Dixon et al.	2009	Sierra Nevada Range; Blasingame	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Sparsely Vegetated	45	t/km/yr	0.04665	0.0032
Dixon et al.	2009	Sierra Nevada Range; Blasingame	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Sparsely Vegetated	53	t/km/yr	0.0299	0.0022
Dixon et al.	2009	Sierra Nevada Range; Blasingame	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Sparsely Vegetated	75	t/km/yr	0.0256	0.0021
Dixon et al.	2009	Sierra Nevada Range; White Bark	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Grassland	53	t/km/yr	0.03525	0.003
Dixon et al.	2009	Sierra Nevada Range; White Bark	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Grassland	64	t/km/yr	0.03255	0.0038
Dixon et al.	2009	Sierra Nevada Range; White Bark	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Grassland	70	t/km/yr	0.0171	0.00155
Dixon et al.	2009	Sierra Nevada Range; White Bark	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Grassland	110	t/km/yr	0.03305	0.0029
Dixon et al.	2009	Sierra Nevada Range; White Bark	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Grassland	75	t/km/yr	0.0201	0.0017

Dixon et al.	2009	Sierra Nevada Range; White Bark	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Grassland	75	t/km/yr	0.02435	0.00205		
Dixon et al.	2009	Sierra Nevada Range; White Bark	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Grassland	60	t/km/yr	0.0175	0.0015		
Dixon et al.	2009	Sierra Nevada Range; White Bark	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Grassland	90	t/km/yr	0.0357	0.00305		
Dixon et al.	2009	Sierra Nevada Range; White Bark	3.9 - 16.6	Warm Summer Mediterranean	Csb	Grandiorite (Igneous)	Grassland	80	t/km/yr	0.02	0.0018		
Owen et al	2009	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	10	m/Ma	0.00056			
Owen et al	2009	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	36	m/Ma	0.00067			
Owen et al	2009	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	95	m/Ma	0.00139			
Owen et al	2009	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	35	m/Ma	0.0007			
Owen et al	2009	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	57	m/Ma	0.00099			
Owen et al	2009	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	9	m/Ma	0.00069			
Owen et al	2009	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	92	m/Ma	0.00028			
Owen et al	2009	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	7	m/Ma	0.0007			
Owen et al	2009	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	75	m/Ma	0.00104			
Owen et al	2009	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	57	m/Ma	0.00076			
Heimsath et al.	2005	Point Reyes, California	11.4	Warm Summer Mediterranean	Csb	Granitic , quartz diorite and granodiorite (Igneous)	Pine Trees, grassland and scrub	80	m/Ma	0.028	0.004		
Heimsath et al.	2005	Point Reyes, California	11.4	Warm Summer Mediterranean	Csb	Granitic , quartz diorite and granodiorite (Igneous)	Pine Trees, grassland and scrub	25	m/Ma	0.049	0.008		
Heimsath et al.	2005	Point Reyes, California	11.4	Warm Summer Mediterranean	Csb	Granitic , quartz diorite and granodiorite (Igneous)	Pine Trees, grassland and scrub	20	m/Ma	0.054	0.008		
Heimsath et al.	2005	Point Reyes, California	11.4	Warm Summer Mediterranean	Csb	Granitic , quartz diorite and granodiorite (Igneous)	Pine Trees, grassland and scrub	57	m/Ma	0.036	0.004		
Heimsath et al.	2005	Point Reyes, California	11.4	Warm Summer Mediterranean	Csb	Granitic , quartz diorite and granodiorite (Igneous)	Pine Trees, grassland and scrub	75	m/Ma	0.018	0.002		
Heimsath et al.	2005	Point Reyes, California	11.4	Warm Summer Mediterranean	Csb	Granitic , quartz diorite and granodiorite (Igneous)	Pine Trees, grassland and scrub	47	m/Ma	0.05	0.009		
Heimsath et al.	2005	Point Reyes, California	11.4	Warm Summer Mediterranean	Csb	Granitic , quartz diorite and granodiorite (Igneous)	Pine Trees, grassland and scrub	108	m/Ma	0.011	0.002		
Heimsath et al.	2005	Point Reyes, California	11.4	Warm Summer Mediterranean	Csb	Granitic , quartz diorite and granodiorite (Igneous)	Pine Trees, grassland and scrub	93	m/Ma	0.022	0.004		
Heimsath et al.	2005	Point Reyes, California	11.4	Warm Summer Mediterranean	Csb	Granitic , quartz diorite and granodiorite (Igneous)	Pine Trees, grassland and scrub	10	m/Ma	0.059	0.007		
Heimsath et al.	2005	Point Reyes, California	11.4	Warm Summer Mediterranean	Csb	Granitic , quartz diorite and granodiorite (Igneous)	Pine Trees, grassland and scrub	27	m/Ma	0.058	0.007		
Heimsath et al.	2009	Tin Camp Creek, Arnhem Land, Australia	20.6 - 32.1	Tropical Savannah	Aw	Sandstone (Sedimentary)	Dry schlerophyll forest/grassland	40	m/Ma	0.0193	0.003		
Heimsath et al.	2009	Tin Camp Creek, Arnhem Land, Australia	20.6 - 32.1	Tropical Savannah	Aw	Sandstone (Sedimentary)	Dry schlerophyll forest/grassland	45	m/Ma	0.0222	0.003		
Heimsath et al.	2009	Tin Camp Creek, Arnhem Land, Australia	20.6 - 32.1	Tropical Savannah	Aw	Sandstone (Sedimentary)	Dry schlerophyll forest/grassland	70	m/Ma	0.0111	0.0024		
Heimsath et al.	2009	Tin Camp Creek, Arnhem Land, Australia	20.6 - 32.1	Tropical Savannah	Aw	Sandstone (Sedimentary)	Dry schlerophyll forest/grassland	55	m/Ma	0.0155	0.0053		
Heimsath et al.	2009	Tin Camp Creek, Arnhem Land, Australia	20.6 - 32.1	Tropical Savannah	Aw	Sandstone (Sedimentary)	Dry schlerophyll forest/grassland	50	m/Ma	0.0127	0.0027		
Heimsath et al.	2009	Tin Camp Creek, Arnhem Land, Australia	20.6 - 32.1	Tropical Savannah	Aw	Sandstone (Sedimentary)	Dry schlerophyll forest/grassland	38	m/Ma	0.0234	0.0053		
Heimsath et al.	2009	Tin Camp Creek, Arnhem Land, Australia	20.6 - 32.1	Tropical Savannah	Aw	Sandstone (Sedimentary)	Dry schlerophyll forest/grassland	35	m/Ma	0.0204	0.0039		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	4.5	m/Ma	0.00093	0.00049		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	5	m/Ma	0.00072	0.00015		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	24	m/Ma	0.00069	0.00016		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	9	m/Ma	0.0013	0.0004		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	7	m/Ma	0.00079	0.00018		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	36	m/Ma	0.00052	0.00017		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	57	m/Ma	0.0008	0.00091		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	70	m/Ma	0.00013	0.00012		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	75	m/Ma	0.00006	0.00011		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	80	m/Ma	0.00029	0.00008		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	2.5	m/Ma	0.0012	0.0004		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	2	m/Ma	0.0012	0.0005		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	2	m/Ma	0.0013	0.0005		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	4	m/Ma	0.0016	0.001		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	2	m/Ma	0.0011	0.0004		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	3.5	m/Ma	0.0018	0.0015		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	2	m/Ma	0.00094	0.00032		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	3.5	m/Ma	0.00049	0.00012		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	2.5	m/Ma	0.0019	0.0008		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	3	m/Ma	0.00027	0.00007		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	4	m/Ma	0.00061	0.00016		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	11	m/Ma	0.00018	0.00008		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	44	m/Ma	0.00077	0.00033		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	15	m/Ma	0.0021	0.0013		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	22	m/Ma	0.001	0.0006		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	22	m/Ma	0.00082	0.00045		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	25	m/Ma	0.002	0.0011		
Owen et al	2011	Atacama Desert, Chile	13.5 - 17	Arid Cold	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	Sparsely Vegetated	25	m/Ma	0.0045	0.0181		
Heimsath et al.	2006	Brown Mountain, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	60	m/Ma	0.01808	0.00468		
Heimsath et al.	2006	Brown Mountain, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	25	m/Ma	0.03165	0.00677		
Heimsath et al.	2006	Brown Mountain, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	55	m/Ma	0.0167	0.00299		
Heimsath et al.	2006	Brown Mountain, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	50	m/Ma	0.02659	0.00587		
Heimsath et al.	2006	Brown Mountain, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	100	m/Ma	0.00623	0.00115		
Heimsath et al.	2006	Brown Mountain, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	70	m/Ma	0.01605	0.00358		
Heimsath et al.	2006	Brown Mountain, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	73	m/Ma	0.00679	0.00137		
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	85	m/Ma	0.01113	0.00266		
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	27	m/Ma	0.02451	0.0025		
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	70	m/Ma	0.00975	0.0013		
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	90	m/Ma	0.00948	0.00153		
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	70	m/Ma	0.00419	0.00088		
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	45	m/Ma	0.01143	0.00073		
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	38	m/Ma	0.01727	0.00147		
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	60	m/Ma	0.0113	0.00089		
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	50	m/Ma	0.05738	0.00692		
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	15.2	Oceanic	Cfb	Granite/Granodiorite (Igneous)	Schlerophyll forest	70	m/Ma	0.00701	0.00113		

Appendix 2.2: Global Inventory of Soil Loss Tolerance values

Author	Year	Location	Country	Type	Texture	T Value LOW mm/y	T Value HIGH mm/y	T Value MEDIAN mm/y	Use of Soil Formation Rates
Abu Hammad	2011	Palestinian Highlands	Palestine	Entisol	Silt Loam to Silty Clay Loam	0.3333333	0.7333333	0.5333333	Unknown
Alexander	1988a		Global				0.1646667	0.1646667	Yes
Alexander	1988b					0.6666667	0.7466667	0.7066667	Yes
Alexander	1989								
Andrews et al	2004								
Angima et al	2003	Kianjuki	Kenya	Humic Nitosols		0.1466667	0.6666667	0.4066667	Yes
Auerswald	1987								
Avanzi et al	2013		Brazil	Argisol, Plinthsol		0.3333333	0.7333333	0.5333333	No
Bagarello et al	2015	Sparacia, Sicily	Italy	Inceptisol	Clay	2.6066667	4.6733333	3.64	No
Baja et al	2002					0.0666667	0.7466667	0.4066667	Yes
Beach and Gersmehl	1993		USA				0.8233333	0.8233333	No
Bhattacharyya et al	2008	Shivalik-Himalaya	India		Sandy Loam to Loamy Sand	0.1666667	0.8333333	0.5	No
Bhattacharyya et al	2011	Punjab, Himachal Pradesh and Haryana	India			0.1666667	0.8333333	0.5	No
Biswas et al	2015	Andhra Pradesh and Telangana	India	Inceptisol, Vertisol, Entisol, Alfisol, Mollisol	Loam, Clay	0.1666667	0.8333333	0.5	No
Bryant et al	1993		USA						
Campos et al	2008	Pereira Barreto, SP	Brazil						
Casali et al	2009	Navarre	Spain		Loam, Silty Clay Loam, Sandy Loam	0.3333333	0.7333333	0.5333333	Yes
Castro et al	2002		Brazil						
Chaves	2010	Distrito Federal	Brazil						
da Silva et al	2011	Doce River Valley	Brazil			0.478	0.748	0.613	No
da Silva et al	2014	Rio Doce Basin, MG	Brazil	Inceptisol, Oxisol	Clay	0.4	0.6	0.5	Yes
Dai et al	2013	Jieliucun	China						
de Oliveira et al	2011a	Campo Grande	Brazil	Neosol, Latosol, Argisol, Gleisol	Clay, Sand, Loam	0.5	1	0.75	No
de Oliveira et al	2011b	Terenos, MS	Brazil						
Delgado and Lopez	1998		Venezuela						
Di Stefando and Ferro	2016								
Du et al	2013		China				0.7333333	0.7333333	Unknown
Duan et al	2012		China	Mollisols	Silt	0.0453333	0.2386667	0.142	No
Duan et al	2017	Red River Basin	China			0.0606667	0.6826667	0.3716667	No
Ghafari et al	2017	Haji-Ghushan	India		Silty	0.42	0.5	0.46	No
Gogichaishvili	2016	Georgia	USA	Leptosols, histosols, cambisols.		0.2666667	0.6666667	0.4666667	No
Grigor'ev	1998	Right Bank Steppe	Ukraine			0.3333333	0.4666667	0.4	Unknown
Guo et al	2013		China		Sandy to Clay	0.1465533	0.2502933	0.1984233	No
Hacisalihoglu et al	2010a	Aglasun	Turkey	Leptosol, regosol, cambisol		0.0666667	0.3333333	0.2	No
Hacisalihoglu et al	2010b	Camlihemsin	Turkey	Brown earth		0.0666667	0.3333333	0.2	No
Hua et al	2012	Daning Watershed	China		Clay Loam		0.3333333	0.3333333	No
Huang et al	2013	Fengxingzhuang	China	Lixisol, Cambisol		0.0173333	0.1093333	0.0633333	Yes
Igwe	1999		Nigeria			0.0773333	0.0866667	0.082	No
Il'ichev	1999								
Jha et al	2009	Delhi State	India		Loam	0.3333333	0.8333333	0.5833333	No
Johnson	1987								
Johnson	2005								
Karas and Oguz	2015	Ankara	Turkey		Clay	0.1466667	0.7466667	0.4466667	Yes
Kereselidze et al	2013	Georgia	USA			0.1666667	0.8333333	0.5	No
Kirkbride and Reeves	1993	Angus	Scotland		Sandy Loams/Sandy Clay Loams	0.0013333	0.0033333	0.0023333	No
Klimen'ev and Tikhonov	2001								
Kuznetsov and Abdulkhanova	2013	Central Chernozemic Region	Russia	Chernozems		0.02	0.6666667	0.3433333	No
Lakaria et al	2008		India	Inceptisols		0.1666667	0.8333333	0.5	No
Lakaria et al	2009	Madhya Pradesh	India			0.1666667	0.8333333	0.5	No
Lal	1998						0.8233333	0.8233333	Yes
Langdale et al	1992	Southern Piedmont	USA						
Le Roux et al	2008		South Africa			0.2	0.6666667	0.4333333	No
Lenka et al	2014	West Benghal	India			0.1666667	0.8333333	0.5	No
Lentz and Sojka	1994	Idaho	USA		Silt Loam to Silty Clay Loam		0.7333333	0.7333333	No
Li et al	2017a								
Li et al	2009		China			0.0133333	0.0666667	0.04	Yes
Li et al	2017b	Yujiang Catchment	China						
Li et al	2019	Guzhou watershed, Huanjiang	China			0.02	0.0453333	0.0326667	Yes
Li et al	2017c	Yuyao City	Singapore				1.7033333	1.7033333	Unknown
Liu et al	2009	Sichuan	China	Purple Soil		0.5333333	0.8	0.6666667	Yes
Liu et al	2010	Mashezihe Watershed	China	Chernozems					
Mandal and Sharda	2013	East Himalayas	India	Inceptisols, Alfisols, Ultisols, Entisols, Mollisols	Loam	0.1666667	0.8333333	0.5	No
Mandal and Sharda	2011		India			0.1666667	0.8333333	0.5	No
Mandal and Tripathi	2009	Lakshadweep Islands	India	Entisols	Loamy/Sandy	0.5	0.8333333	0.6666667	No
Mandal et al	2010	Doon Valley	India	Inceptisol	Silty Loam to Silty Clay Loam	0.44	0.96	0.7	No
Martin and Cassel	1992	Piedmont	USA				0.8233333	0.8233333	Unknown
Mbagwu	1991		Nigeria						
Medeiros et al	2016	Sao Paulo	Brazil	Latosols		0.3	1	0.65	No
Mellerowicz et al	1994	New Brunswick	Canada						
Mendes et al	2018	Alfenas, MG	Brazil	Oxisols	Sand	0.346	0.3933333	0.3696667	No
Mirtskhulava	2001								
Moges and Bhat	2017	Rib	Ethiopia	Alisols, cambisols, ferralsols, leptosols, luvisols, regosols, vertisols.		0	0.7333333	0.3666667	No
Montgomery	2008								
Newman et al	2010	Iowa	USA						
Olivetti et al	2015	Ribeirao Cacus	Brazil	Latosol		0.36	0.46	0.41	No
Pacheco et al	2014	Douro	Portugal	Fluvisols		0.2553333	0.9873333	0.6213333	Yes
Patsukevich et al	1997								
Peng and Wang	2012	Guizhou Province	China		Loam	0.0045	0.00472	0.00461	Yes
Phillips et al	1993		USA						
Pierce et al	1984								
Ramos and Martinez-Casasno	2009		Spain	Marls			0.7333333	0.7333333	Yes
Ramos and Porta	1997	Penedes/Anoia	Spain	Inceptisol		0.1333333	0.7333333	0.4333333	No
Rodrigues et al	2011	Terenos, MS	Brazil						
Rusanov	2006	Southern Urals, Orenburg State	Russia						
Sails et al	2018	California	USA			0.1646667	0.8233333	0.494	Yes
Schertz	1983					0.1466667	0.7466667	0.4466667	Yes
Schiettecatte et al.	2008	Cuyaguateje	Cuba			0	0.4666667	0.2333333	No
Sharda et al	2013		India						
Shi et al	2004	Wangjiaquiao	China	Purple Soil		0.3333333	0.6666667	0.5	No
Shipitalo and Edwards	1998	Coshocton, Ohio	USA	Ultisol, Alfisol	Loamy, Silty, Loamy	0	0.52	0.26	No
Shtompel et al	1998	Abinskii, Caucasus	Russia			0.2933333	0.44	0.3666667	No
Singh et al	2017	Rajasthan State	India	Entisols		0.1666667	0.8333333	0.5	No
Tavares et al	2019	Alfenas, MG	Brazil	Latosols	Clayey	0.346	0.3933333	0.3696667	No
Trigunasih et al	2018	Gunggung Watershed	Indonesia						
Velbel	1989								
Watters et al	1996	Arizona	USA		Clay Loam	0.1646667	0.8233333	0.494	Yes
Weill and Sparovek	2008	Piracicaba, SP	Brazil						
Weltz et al	2014		USA				0.1466667	0.1466667	Yes
Wight	1982								
Zhu	2015	Danjiangkou	China	Yellow Brown			0.3333333	0.3333333	No
Zuzel et al	1993	Oregon	USA						

Appendix 3.1: Global Inventory of Soil Formation Rates used in the CoSOILcal Sensitivity Analysis

Author	Year	Location	Köppen Code	Lithology	Depth (cm)	Bulk Density (g cm3)	10Be Conc.	10Be Conc. Error	Lat (°)	Long (°)	Elevation (m)	Shielding Factor	Original Soil Formation Rate (mm/y)	Original Uncertainty (mm/y)
Heimsath et al	1997	Tennessee Valley, California	Cfa	Greywacke, Sandstone (Sedimentary)	16	1.5	108000	7000	37.98	-122.68	104	0.87	0.047	0.015
Heimsath et al	1997	Tennessee Valley, California	Cfa	Greywacke, Sandstone (Sedimentary)	35	1.5	195000	8000	37.98	-122.68	70	0.69	0.026	0.003
Heimsath et al	1997	Tennessee Valley, California	Cfa	Greywacke, Sandstone (Sedimentary)	58	1.5	229000	16000	37.98	-122.68	42	0.52	0.021	0.003
Heimsath et al	1997	Tennessee Valley, California	Cfa	Greywacke, Sandstone (Sedimentary)	51	1.5	171000	11000	37.98	-122.68	64	0.59	0.025	0.004
Heimsath et al	1997	Tennessee Valley, California	Cfa	Greywacke, Sandstone (Sedimentary)	30	1.5	74000	6000	37.98	-122.68	86	0.72	0.06	0.016
Heimsath et al	1997	Tennessee Valley, California	Cfa	Greywacke, Sandstone (Sedimentary)	49	1.5	151000	13000	37.98	-122.68	91	0.61	0.026	0.005
Heimsath et al	1997	Tennessee Valley, California	Cfa	Greywacke, Sandstone (Sedimentary)	20	1.5	83000	6000	37.98	-122.68	115	0.85	0.048	0.008
Heimsath et al	1997	Tennessee Valley, California	Cfa	Greywacke, Sandstone (Sedimentary)	35	1.5	134000	7000	37.98	-122.68	98	0.68	0.033	0.005
Heimsath et al	1997	Tennessee Valley, California	Cfa	Greywacke, Sandstone (Sedimentary)	60	1.5	161000	15000	37.98	-122.68	73	0.54	0.027	0.005
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	15	1	68586	4243	42.47	-124.13	246	0.78	0.13009	0.03413
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	42	1	88910	6908	42.47	-124.13	242	0.465	0.06856	0.00732
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	25	1	52155	5196	42.47	-124.13	268	0.89	0.20351	0.04147
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	100	1	443385	28434	42.47	-124.13	290	0.275	0.0148	0.00227
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	145	1	55540	4972	42.47	-124.13	190	1	0.11873	0.03921
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	75	1	164825	12032	42.47	-124.13	291	0.35	0.04475	0.00877
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	60	1	114452	8290	42.47	-124.13	249	0.42	0.05688	0.00871
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	60	1	107241	8745	42.47	-124.13	254	0.34	0.06413	0.01462
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	35	1	60858	5189	42.47	-124.13	291	0.63	0.11323	0.02115
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	25	1	33990	3257	42.47	-124.13	285	0.76	0.11792	0.029
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	43	1	58070	5318	42.47	-124.13	261	0.52	0.10616	0.01922
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	10	1	41472	3054	42.47	-124.13	269	0.92	0.15487	0.02248
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	12	1	35445	3417	42.47	-124.13	263	0.915	0.1693	0.02042
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	25	1	42242	471	42.47	-124.13	263	0.915	0.32105	0.10208
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	30	1	56232	4172	42.47	-124.13	265	0.76	0.18726	0.03134
Heimsath et al	2001	Coos Bay, Oregon Coast Range, Oregon	Csb	Turbidite Sandstone/Siltstone (Sedimentary)	35	1	135025	5676	42.47	-124.13	301	0.76	0.06915	0.00787
Heimsath et al	1999	Tennessee Valley, California	Cfa	Greywacke, Sandstone, Chert (Sedimentary)	16	1.1	108000	7000	37.9	-122.6	120	0.87	0.047	0.015
Heimsath et al	1999	Tennessee Valley, California	Cfa	Greywacke, Sandstone, Chert (Sedimentary)	35	1.1	195000	8000	37.9	-122.6	105	0.69	0.026	0.003
Heimsath et al	1999	Tennessee Valley, California	Cfa	Greywacke, Sandstone, Chert (Sedimentary)	58	1.1	229000	16000	37.9	-122.6	100	0.52	0.021	0.003
Heimsath et al	1999	Tennessee Valley, California	Cfa	Greywacke, Sandstone, Chert (Sedimentary)	51	1.1	171000	11000	37.9	-122.6	115	0.59	0.025	0.004
Heimsath et al	1999	Tennessee Valley, California	Cfa	Greywacke, Sandstone, Chert (Sedimentary)	30	1.1	74000	6000	37.9	-122.6	116	0.72	0.06	0.016
Heimsath et al	1999	Tennessee Valley, California	Cfa	Greywacke, Sandstone, Chert (Sedimentary)	49	1.1	151000	13000	37.9	-122.6	140	0.61	0.026	0.005
Heimsath et al	1999	Tennessee Valley, California	Cfa	Greywacke, Sandstone, Chert (Sedimentary)	20	1.1	83000	6000	37.9	-122.6	135	0.85	0.048	0.008
Heimsath et al	1999	Tennessee Valley, California	Cfa	Greywacke, Sandstone, Chert (Sedimentary)	35	1.1	134000	7000	37.9	-122.6	133	0.68	0.033	0.005
Heimsath et al	1999	Tennessee Valley, California	Cfa	Greywacke, Sandstone, Chert (Sedimentary)	60	1.1	161000	15000	37.9	-122.6	133	0.54	0.027	0.005
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	90	1.2	513300	13560	-36.62	149.5	389	0.3	0.00925	0.0011
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	10	1.2	113700	3048	-36.62	149.5	395	0.87	0.0456	0.00443
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	12	1.2	107100	4036	-36.62	149.5	388	0.85	0.04787	0.00412
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	60	1.2	249100	6337	-36.62	149.5	386	0.45	0.02061	0.00208
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	42	1.2	168300	5067	-36.62	149.5	378	0.58	0.02024	0.00267
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	30	1.2	148000	4590	-36.62	149.5	404	0.68	0.03451	0.00395
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	28	1.2	195700	5981	-36.62	149.5	404	0.72	0.02608	0.00227
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	40	1.2	234600	6083	-36.62	149.5	385	0.64	0.02082	0.00227
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	47	1.2	262900	6572	-36.62	149.5	377	0.5	0.01897	0.0018
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	22	1.2	87590	2627	-36.62	149.5	383	0.71	0.05653	0.00578
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	52	1.2	319000	8122	-36.62	149.5	389	0.49	0.01526	0.00145
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	15	1.2	166500	3714	-36.62	149.5	399	0.82	0.02945	0.00239
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	66	1.2	229900	6233	-36.62	149.5	389	0.39	0.02183	0.00238
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	40	1.2	152800	8297	-36.62	149.5	420	0.64	0.02562	0.0029
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	110	1.2	332200	10560	-36.62	149.5	420	0.58	0.01094	0.00089
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	160	1.2	392000	12590	-36.62	149.5	420	1	0.00956	0.00071
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	20	1.2	161000	8213	-36.62	149.5	420	0.62	0.02283	0.00212
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	140	1.2	370900	14320	-36.62	149.5	420	0.62	0.00995	0.00088
Heimsath et al	2000	Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	10	1.2	153100	4063	-36.62	149.5	394	1	0.02629	0.00235
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	Cfa	Saprolitic coarse sandstone (Sedimentary)	40	1.2	191000	15000	-33.25	150.1	1080	0.96	0.0171	0.015
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	Cfa	Ferruginized Sandstone (Sedimentary)	25	1.2	381000	23000	-33.25	150.1	1130	1	0.0108	0.007
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	Cfa	Soft Saprolitic Sandstone (Sedimentary)	55	1.2	305000	22000	-33.25	150.1	1130	1	0.0097	0.008
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	Cfa	Soft Saprolitic Sandstone (Sedimentary)	50	1.2	246000	21000	-33.25	150.1	1130	1	0.0128	0.012
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	Cfa	Saprolite (Sedimentary)	55	1.2	290000	17000	-33.25	150.1	1130	1	0.0102	0.006
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	Cfa	Saprolite (Sedimentary)	60	1.2	308000	19000	-33.25	150.1	1130	1	0.0091	0.006
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	Cfa	Soft Saprolitic Sandstone (Sedimentary)	87	1.2	200000	18000	-33.25	150.1	1130	1	0.0105	0.011
Wilkinson et al	2005	Marrangaroo Creek, Blue Mtns, Australia	Cfa	Ferruginized Sandstone (Sedimentary)	30	1.2	336000	27000	-33.25	150.1	1130	1	0.0117	0.01
Heimsath et al	2001a	Frogs Hollow, Canberra	Cfb	Metasediments/Granites (Igneous/Metamorphic)	25	1.2	103217	4175	-35.96	149.42	940	0.72	0.04908	0.00439
Heimsath et al	2001a	Frogs Hollow, Canberra	Cfb	Metasediments/Granites (Igneous/Metamorphic)	37	1.2	99159	4637	-35.96	149.42	934	0.61	0.04942	0.00463
Heimsath et al	2001a	Frogs Hollow, Canberra	Cfb	Metasediments/Granites (Igneous/Metamorphic)	40	1.2	202519	6759	-35.96	149.42	916	0.6	0.02599	0.00226
Heimsath et al	2001a	Frogs Hollow, Canberra	Cfb	Metasediments/Granites (Igneous/Metamorphic)	50	1.2	392381	22043	-35.96	149.42	930	0.56	0.01179	0.00104
Heimsath et al	2001a	Frogs Hollow, Canberra	Cfb	Metasediments/Granites (Igneous/Metamorphic)	65	1.2	422049	32354	-35.96	149.42	939	0.43	0.01105	0.0011
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	5	1.3	19234	1200	34.186	-117.77	950	0.87	0.373	0.034
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	38	1.3	96379	2945	34.207	-117.76	855	0.75	0.068	0.005
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	30	1.3	42231	1518	34.285	-118.15	1673	0.75	0.251	0.051
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	23	1.3	169007	8781	34.372	-118.07	2015	0.78	0.078	0.017
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	43	1.3	215144	10047	34.371	-118.07	2005	0.62	0.048	0.012
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	36	1.3	209929	13146	34.371	-118.07	1990	0.64	0.051	0.013
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	15	1.3	87295	2481	34.357	-118.06	1804	0.95	0.164	0.029
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	15	1.3	112041	7431	34.354	-118.06	1625	0.94	0.113	0.023
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	10	1.3	124135	4809	34.293	-118.02	1725	0.92	0.106	0.02
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	44	1.3	130184	4427	34.293	-118.02	1721	0.58	0.063	0.015
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	27	1.3	238056	11651	34.293	-118.02	1729	0.74	0.044	0.009
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	34	1.3	207673	9994	34.291	-118.02	1650	0.67	0.044	0.01
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	20	1.3	173488	7192	34.327	-117.8	2194	0.83	0.09	0.018
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	44	1.3	212347	8250	34.346	-118.01	1800	0.62	0.043	0.01
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	54	1.3	171194	8059	34.347	-118.01	1790	0.58	0.05	0.013
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	45	1.3	679503	15236	34.348	-118.01	1780	0.6	0.012	0.003
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	16	1.3	195283	6867	34.359	-117.99	1710	0.95	0.068	0.013
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	10	1.3	190834	6398	34.359	-117.99	1710	0.95	0.069	0.013
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	10	1.3	123053	3774	34.359	-117.99	1702	0.95	0.109	0.02
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	28	1.3	144389	4764	34.322	-118.09	1132	0.76	0.069	0.012
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	12	1.3	167501	4979	34.332	-117.95	2137	0.86	0.093	0.018
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	24	1.3	91160	3372	34.332	-117.95	2115	0.79	0.156	0.032
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	49	1.3	875243	20851	34.348	-118	1773	0.64	0.01	0.002
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	50	1.3	194067	10544	34.348	-118	1785	0.6	0.046	0.012
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	35	1.3	142209	7458	34.347	-118	1802	0.68	0.071	0.016
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	5	1.3	44831	1899	34.362	-117.91	1912	0.87	0.315	0.061
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	7	1.3	52156	2518	34.361	-117.91	1889	0.87	0.266	0.054
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	13	1.3	69810	2692	34.335	-117.97	1973	0.88	0.21	0.041
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	3	1.3	79523	2678	34.335	-117.97	1973	1	0.21	0.038
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	20	1.3	143406	4663	34.335	-117.97	1973	0.8	0.092	0.018
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	5	1.3	124486	5886	34.335	-117.97	1973	0.99	0.132	0.025
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	3	1.3	94629	4582	34.326	-117.97	1703	0.97	0.146	0.028
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	3	1.3	84063	3061	34.331	-117.97	1847	0.97	0.178	0.033
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	12	1.3	183575	6055	34.331	-117.97	1840	0.9	0.083	0.015
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	12	1.3	155283	5968	34.331	-117.97	1835	0.9	0.098	0.018
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	8	1.3	29193	2350	34.352	-117.88	2058	0.83	0.594	0.125
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	25	1.3	168775	6861	34.364	-117.84	1934	0.98	0.079	0.016
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	10	1.3	43445	2879	34.365	-117.84	1880	0.9	0.329	0.069
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	20	1.3	105570	3844	34.372	-117.86	2442	0.8	0.166	0.034
Heimsath et al	2012	San Gabriel Mountains, California	Csb	Granitic and Metamorphic (Igneous/Metamorphic)	5	1.3	127553	6192	34.372	-117.86	2398	0.98	0.163	0.031
Dixon et al.	2009	Sierra Nevada Range; Blasingame	Csb	Grandiorite (Igneous)	25	1.2	90282	3745	37.468	-118.95	220	0.99	0.0632	0.00495
Dixon et al.	2009	Sierra Nevada Range; Blasingame	Csb	Grandiorite (Igneous)	27	1.2	107038	7076	37.468	-118.95	220	0.99	0.05245	0.00505
Dixon et al.	2009	Sierra Nevada Range; Blasingame	Csb	Grandiorite (Igneous)	40	1.2	132701	5745	37.468	-118.95	220	1	0.0346	0.00275
Dixon et al.	2009	Sierra Nevada Range; Blasingame	Csb	Grandiorite (Igneous)	45	1.2	93307	2265	37.468	-118.95	220	1	0.04665	0.0032
Dixon et al.	2009	Sierra Nevada Range; Blasingame	Csb	Grandiorite (Igneous)	53	1.2	136789	4587	37.468	-118.95	220	1	0.0299	0.0022
Dixon et al.	2009	Sierra Nevada Range; Blasingame	Csb	Grandiorite (Igneous)	75	1.2	131622	5941	37.468	-118.95	220	0.99	0.0256	0.0021
Dixon et al.	2009	Sierra Nevada Range; White Bark	Csb	Grandiorite (Igneous)	53	1.2	581657	17376	37.468	-118.95	2990	1	0.03525	0.003
Dixon et al.	2009	Sierra Nevada Range; White Bark	Csb	Grandiorite (Igneous)	64	1.2	578575	48527	37.468	-118.95	2990	1	0.03255	0.0038
Dixon et al.	2009	Sierra Nevada Range; White Bark	Csb	Grandiorite (Igneous)	70	1.2	801896	32260	37.468	-118.95	2990	1	0.0171	0.00155
Dixon et al.	2009	Sierra Nevada Range; White Bark	Csb	Grandiorite (Igneous)	75	1.2	824462	19688	37.468	-118.95	2990	1	0.0201	0.0017
Dixon et al.	2009	Sierra Nevada Range; White Bark	Csb	Grandiorite (Igneous)	75	1.2	688245	18081	37.468	-118.95	2990	1	0.02435	0.00205
Dixon et al.	2009	Sierra Nevada Range; White Bark	Csb	Grandiorite (Igneous)	60	1.2	1E+06	25628	37.468	-118.95	2990	0.99	0.0175	0.0015
Dixon et al.	2009	Sierra Nevada Range; White Bark	Csb	Grandiorite (Igneous)	90	1.2	406837	13257	37.468	-118.95	2990	0.98	0.0357	0.00305
Dixon et al.	2009	Sierra Nevada Range; White Bark	Csb	Grandiorite (Igneous)	80	1.2	789064	30516	37.468	-118.95	2990	1	0.02	0.0018
Heimsath et al	2005	Point Reyes, California	Csb	Granitic , quartz diorite and granodiorite (Igneous)	80	1.2	172900	13900	38.08	-122.88	165	0.41	0.028	0.004
Heimsath et al	2005	Point Reyes, California	Csb	Granitic , quartz diorite and granodiorite (Igneous)	25	1.2	77400	5400	38.08	-122.88	144	0.66	0.049	0.008
Heimsath et al	2005	Point Reyes, California	Csb	Granitic , quartz diorite and granodiorite (Igneous)	20	1.2	63900	5000	38.08	-122.88	148	0.73	0.054	0.008
Heimsath et al	2005	Point Reyes, California	Csb	Granitic , quartz diorite and granodiorite (Igneous)	57	1.2	133100	8300	38.08	-122.88	191	0.51	0.036	0.004
Heimsath et al	2005	Point Reyes, California	Csb	Granitic , quartz diorite and granodiorite (Igneous)	75	1.2	247300	13300	38.08	-122.88	159	0.36	0.018	0.002
Heimsath et al	2005	Point Reyes, California	Csb	Granitic , quartz diorite and granodiorite (Igneous)	47	1.2	56500	5300	38.08	-122.88	140	0.48	0.05	0.009
Heimsath et al	2005	Point Reyes, California	Csb	Granitic , quartz diorite and granodiorite (Igneous)	108	1.2	388500	18600	38.08	-122.88	128	0.24	0.011	0.002
Heimsath et al	2005	Point Reyes, California	Csb	Granitic , quartz diorite and granodiorite (Igneous)	93	1.2	193000	11300	38.08	-122.88	137	0.25	0.022	0.004
Heimsath et al	2005	Point Reyes, California	Csb	Granitic , quartz diorite and granodiorite (Igneous)	10	1.2	76100	4000	38.08	-122.88	151	0.86	0.059	0.007
Heimsath et al	2005	Point Reyes, California	Csb	Granitic , quartz diorite and granodiorite (Igneous)	27	1.2	62600	4500	38.08	-122.88	159	0.71	0.058	0.007
Heimsath et al.	2009	Tin Camp Creek, Arnhem Land, Australia	Aw	Sandstone (Sedimentary)	40	1.5	56000	4000	-12.45	133.27	93	0.404	0.0193	0.003
Heimsath et al.	2009	Tin Camp Creek, Arnhem Land, Australia	Aw	Sandstone (Sedimentary)	35	1.5	59000	3000	-12.45	133.27	123	0.477	0.0204	0.0039
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	4.5	1.5	261000	11900	-24.13	-69.99	1170	N/A	0.00093	0.00049
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	24	1.5	270000	4640	-24.13	-69.99	1170	N/A	0.00069	0.00016
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	9	1.5	261000	3270	-24.13	-69.99	1170	N/A	0.0013	0.0004
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	7	1.5	232000	3900	-24.13	-69.99	1170	N/A	0.00079	0.00018
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	57	1.5	567000	24000	-24.38	-69.94	1450	N/A	0.0008	0.00091
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	70	1.5	461000	18900	-24.38	-69.94	1450	N/A	0.00013	0.00012
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	75	1.5	500000	17500	-24.38	-69.94	1450	N/A	0.00006	0.00011
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	80	1.5	460000	12800	-24.38	-69.94	1450	N/A	0.00029	0.00008
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	2.5	1.5	110000	2610	-26.28	-70.49	687	N/A	0.0012	0.0004
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	2	1.5	106000	2500	-26.28	-70.49	687	N/A	0.0012	0.0005
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	2	1.5	106000	2530	-26.28	-70.49	687	N/A	0.0013	0.0005
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	4	1.5	121000	3480	-26.28	-70.49	687	N/A	0.0016	0.001
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	2	1.5	127000	3580	-26.28	-70.49	687	N/A	0.0011	0.0004
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	3.5	1.5	123000	5650	-26.28	-70.49	687	N/A	0.0018	0.0015
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	2	1.5	155000	3510	-26.28	-70.49	670	N/A	0.00094	0.00032
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	3.5	1.5	154000	3580	-26.28	-70.49	670	N/A	0.00049	0.00012
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	2.5	1.5	156000	3810	-26.28	-70.49	670	N/A	0.0019	0.0008

Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	3	1.5	233000	4540	-26.28	-70.49	670	N/A	0.00027	0.00007
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	4	1.5	238000	6670	-26.28	-70.49	670	N/A	0.00061	0.00016
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	11	1.5	389000	6610	-26.28	-70.49	670	N/A	0.00018	0.00008
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	44	1.5	294000	8800	-26.28	-70.49	670	N/A	0.00077	0.00033
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	22	1.3	22600	1150	-29.77	-71.08	377	N/A	0.001	0.0006
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	22	1.3	65400	2390	-29.78	-71.08	400	N/A	0.00082	0.00045
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	25	1.3	57100	1530	-29.78	-71.08	400	N/A	0.002	0.0011
Owen et al.	2011	Atacama Desert, Chile	Bwk	Volcanic, Plutonic and Metasedimentary (Igneous and Metamorphic)	25	1.3	55500	1390	-29.78	-71.08	400	N/A	0.0045	0.0181
Heimsath et al.	2006	Brown Mountain, Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	55	1.3	250000	20000	-36.62	149.5	970	1	0.0167	0.00299
Heimsath et al.	2006	Brown Mountain, Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	100	1.3	192000	16000	-36.62	149.5	1033	0.4	0.00623	0.00115
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	27	1.3	100000	10000	-36.62	149.5	214	1.1	0.02451	0.0025
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	45	1.3	160000	10000	-36.62	149.5	220	1.1	0.01143	0.00073
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	38	1.3	120000	10000	-36.62	149.5	221	1.2	0.01727	0.00147
Heimsath et al.	2006	Snug, Bega Basin, SE Australia	Cfb	Granite/Granodiorite (Igneous)	60	1.3	130000	10000	-36.62	149.5	222	1.2	0.0113	0.00089

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Method Article

Cosmogenic soil production rate calculator

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A B S T R A C T

To understand the rates at which soils form from bedrock, it is important to know the rates at which the bedrock surface lowers (the apparent erosion rate, which is assumed to be constant). Previous models that calculate apparent erosion rates using measured concentrations of cosmogenic radionuclides rely on the assumption that the bulk density of the soil which forms as a product of bedrock erosion either equals that of the bedrock itself or is constant with depth down the soil profile. This assumption fails to recognise that soils have significantly lower densities that might not be constant with depth. The model presented here allows for the calculation of isotopically-derived soil production rates, considering the bulk density profile of the soil overlying the bedrock surface. This calculator, which can be run both in MATLAB® and GNU Octave©, represents a novel and significant contribution to the derivation of soil production rates.

A R T I C L E I N F O

Method name: Cosmogenic soil production rate calculator (CoSOILcal)
Keywords: Cosmogenic nuclides, ^{10}Be, ^{26}Al, ^{21}Ne, ^{3}He, ^{36}Cl, ^{14}C, MATLAB, Octave, Soil production, Erosion rate
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Specification Table

Subject Area:	Earth and Planetary Sciences
More specific subject area:	geochemistry; geochronology; cosmogenic nuclides; ^{10}Be; ^{26}Al; ^{21}Ne; ^{3}He; ^{36}Cl; ^{14}C
Method name:	Cosmogenic soil production rate calculator (CoSOILcal)
Name and reference of original method:	Evans, D. L., Quinton, J. N., Tye, A. M., Rodés, Á., Davies, J. A. C., Mudd, S. M., and Quine, T. A (2019) Arable soil formation and erosion: a hillslope-based cosmogenic-nuclide study in the United Kingdom, *SOIL, 5, 253-263.* https://doi.org/10.5194/soil-5-253-2019
Resource availability:	set of scripts submitted with this paper

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1 Method details

Herewith we present a set of MATLAB® / GNU Octave© scripts and their mathematical description. These are designed to calculate the surface erosion rates using one or more measured cosmogenic concentrations at or below the surface when the bulk density profile is known. An example of this model's application is described in [4].

1.1 Input data

Site data has to be inputted in individual comma separated files (.csv) for each site. An example of input file is attached (see "input_data.csv"). The input file contains the following headers (first line) that we recommend are not changed:

1 **Depth**: List of depths where density was measured or where samples were collected for cosmogenic radionuclide analysis. In cm.
2 **Density**: Measured densities in g/cm^3
3 **Concentration**: Measured concentrations of *in-situ* cosmogenic ^{10}Be, ^{26}Al, ^{21}Ne, ^{3}He, ^{36}Cl or ^{14}C in atoms/g.
4 **Concentration Uncertainty**: Uncertainty of the cosmogenic isotope concentration in atoms/g.
5 **Isotope mass**: Atomic mass of the measured isotope: 10, 26, 21, 3, 36 or 14.
6 **Lat. (Degrees)**: Latitude of the sampled site, to be inputted only in the second line of the csv file.
7 **Lon. (degrees)**: Longitude of the sampled site, to be inputted only in the second line of the csv file.
8 **Elv. (m)**: Elevation of the sampled site, to be inputted only in the second line of the csv file.
9 **Shielding**: Shielding factor at the surface of the sampled site, to be inputted only in the second line of the csv file.
10 **Landscape age (a)**: Known age of the landscape in years. Input a large number (e.g. the age of the Earth: 4.54E+09) to consider steady state conditions. Only in the second line of the csv file.

Please leave the cells without data empty (i.e. do not put zeros) and place the desired csv files in the same folder as the scripts (by default in the CoSOILcal folder).

1.2 Model fit

To model the apparent erosion rates, associated uncertainty and the graphical output shown in Fig. 1, just run the script `start.m` and select the desired csv file(s) in the pop-up dialog.

2 Under the hood

The mathematical details of the calculations made in each script are described here:

2.1 `start.m`

This script generates the dialog that allows selecting the input file(s) and calls `soil_solver.m` for each dataset.

2.2 `soil_solver.m`

This is the main function. Depth (z), density (ρ) and effective mass depth (x) arrays are generated and are logarithmically distributed between 1 cm and 100 m, including all the depths that contain input data (density measurements or cosmogenic concentrations). Densities outside the measured range are extrapolated using the shallowest and deepest measurements. The rest of the densities is interpolated from the nearesr neighbours, as shown in Fig. 1a. The effective mass depth (x) is

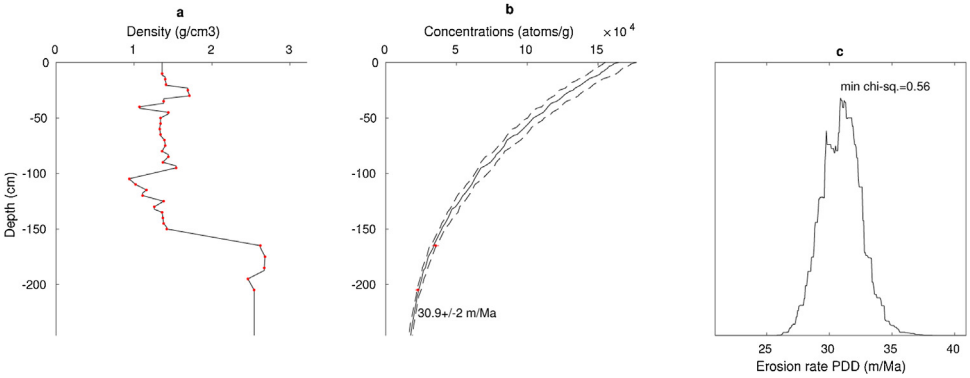

Fig. 1. Graphical abstract. The graphical output of CoSOILcal includes (a) the considered density profile (measured densities as red dots), (b) the measured cosmogenic concentrations (red) and the depth profile of modelled concentrations in black (dashed lines reflect the results within one-sigma), and (c) the probability density distribution (PDD) of the modelled erosion rates.

calculated as

$$x(z) = \sum_{z_i=0}^{z} \Delta z_i \cdot \rho \tag{1}$$

The surface production rates for cosmogenic isotopes are calculated using the `Production_rate.m` function, described below. Modelled cosmogenic concentrations and deviation from the data are calculated with the `model.m` and `desvmodel.m` functions, also described below.

Erosion rates (ε) are fitted iteratively by the interpolation of a variable erosion rate array, starting with erosion rates logarithmically distributed between 1 cm/a and 100 m/Ma. Best fit and one sigma upper and lower bounds are plotted in Fig. 1b.

Chi-square values (χ^2) are calculated as the sum of the squared deviations. Models with chi-squared values smaller than the minimum chi-square value plus the number of samples are considered to fit the data within one-sigma confidence level. Relative probabilities associated to the chi-squared values are calculated as $e^{(-\chi^2/2)}$. These probabilities are plotted in Fig. 1c.

2.3 `Production_rate.m`

This function calculates these surface production rates, the apparent attenuation lengths of fast and stopping muons under the surface, and the corresponding pressure for a given latitude, longitude and elevation. It uses the following code from the CRONUS calculators v.2.3 [2]: `NCEPat_2.m` and `NCEP2.mat` to calculate pressure, `antatm.m` to calculate pressure in Antarctica (if latitude <−55), `al_be_consts_v23.mat` for constants, `stone2000.m` and `PMag_Mar07.mat` for spallation production rates, and `P_mu_total.m` for muon production rates at the surface.

The inputs of this function are *site_lat*,*site_lon*, *site_elv*, *shielding* and *nuclide*, as defined in section 1.1.

Calculated ^{10}Be production rates in quartz are scaled for other isotopes based on published ratios:

- ^{26}Al/^{10}Be production rate ratios in quartz are taken from [2]
- ^{21}Ne/^{10}Be production rate ratios in quartz are taken from [1]
- ^{3}He/^{10}Be production rate ratios in pyroxenes and quartz are taken from [3]
- ^{36}Cl/^{10}Be production rate ratios in calcite and quartz are taken from [5]
- ^{14}C/^{10}Be production rate ratios in quartz are taken from [5]

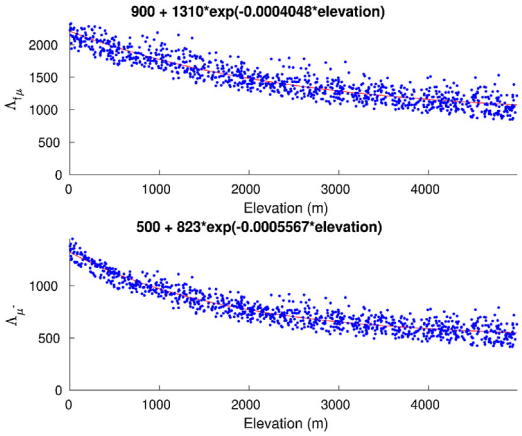

Fig. 2. Apparent muon attenuation lengths. A thousand muon-production depth profiles between 2 and 10 m around the globe were generated using `P_mu_total.m`. 100 muon production rates were calculated for each profile. Apparent muon attenuation lengths (blue dots) were calculated by fitting production rates to exponentials. The calculated relations between apparent attenuation lengths and elevation (red lines) fit the synthetic data within a 7%. This 7% uncertainty is mostly due to the variability in the depth of the randomly generated profiles.

Apparent muon attenuation lengths can be calculated by fitting muon production rates at different depths (from `P_mu_total.m`) to simple exponentials. A thousand depth profiles were randomly generated for maximum depths between 2 and 10 m around the globe. Resulting values of the apparent attenuation lengths were they fitted to altitude exponentials as shown in Fig. 2. The following approximations fit the apparent attenuation lengths within a standard deviation of 7%:

$$\Lambda_{f\mu} = 900 + 1310 * e^{-0.0004048 \cdot h} \tag{2}$$

$$\Lambda_{\mu^-} = 500 + 823 * e^{-0.0005567 \cdot h} \tag{3}$$

where $\Lambda_{f\mu}$ and Λ_{μ^-} are the attenuation lengths of fast and stopping muons in g/cm^2 respectively and h is the elevation of the site.

The outputs of this function are: Production rates, attenuation lengths and atmospheric pressure.

2.4 `model.m`

This function calculates the cosmogenic isotope concentration at several depths (zs) considering the surface production rate data and decay rate (P, Λ, λ), a variable-density profile (z, x) for a landscape age and several erosion rates (ε). The time (t) is discretized in an array of 100 values logarithmically distributed between 100 years and the landform age. For each t, zs and ε combination, a corresponding effective depth x is calculated by interpolation of $zs + \varepsilon \cdot t$ in the variable-density profile. Then the accumulated cosmogenic concentration is calculated following:

$$C_i = \sum_{Sp.f\mu,\mu^-} \frac{P}{\lambda + \frac{\varepsilon \cdot \rho}{\Lambda}} \cdot e^{-x/\lambda} \cdot \left(1 - e^{-\Delta t \cdot \left(\lambda + \frac{\varepsilon \cdot \rho}{\Lambda}\right)}\right) \tag{4}$$

where C_i is the concentration accumulated during Δt time step at the mass depth x, *epsilon* is the erosion rate of the surface and ρ is the average density at the depth $\varepsilon \cdot t$ for the time frame from $t - \Delta t$ to t.

Finally, all the calculated concentrations for the 100 time steps are summed as:

$$C = \sum_{t=0}^{T} C_i \cdot e^{-\lambda \cdot t} \tag{5}$$

where T is the landform age.

2.5 `desvmodel.m`

This function calculates the deviation of a model respect a set of cosmogenic isotope concentrations as:

$$s = \sum \frac{C - M}{\sigma_M} \tag{6}$$

where C is the model concentration, M is the measured concentration and σ_M is the uncertainty of measured concentrations. The inputs are the same as in `model.m` plus a set of sample depths, measured concentrations and their uncertainties. This function accepts erosion rates as an array of values.

Supplementary material

All scripts discussed in section 2 are included in the `CoSOILcal_v1_0.zip` file.

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Appendix 3.3: Output from CoSOILcal

Author	Year	CoSOILcal Best fit Soil Formation Rate (mm/y)	CoSOILcal Lower Soil Formation Rate (mm/y)	CoSOILcal Upper Soil Formation Rate (mm/y)
Heimsath et al	1997	0.0344445	0.0319139	0.0366477
Heimsath et al	1997	0.0123492	0.0118929	0.0127029
Heimsath et al	1997	0.0064126	0.0058275	0.0068861
Heimsath et al	1997	0.0108542	0.0101644	0.0117319
Heimsath et al	1997	0.0380189	0.0346497	0.0411391
Heimsath et al	1997	0.0132488	0.0123541	0.0149
Heimsath et al	1997	0.043229	0.0399645	0.0463251
Heimsath et al	1997	0.0188428	0.0178019	0.0198954
Heimsath et al	1997	0.0101125	0.009172	0.0112303
Heimsath et al	2001	0.0661228	0.062652	0.0707072
Heimsath et al	2001	0.0276699	0.0261457	0.030322
Heimsath et al	2001	0.0926844	0.0843856	0.1029291
Heimsath et al	2001	0.0015018	0.0014054	0.0017066
Heimsath et al	2001	0.0386206	0.0350183	0.041842
Heimsath et al	2001	0.0094512	0.00838	0.0099941
Heimsath et al	2001	0.0175474	0.0161054	0.0188159
Heimsath et al	2001	0.0160743	0.0148456	0.017887
Heimsath et al	2001	0.0570024	0.052116	0.0618698
Heimsath et al	2001	0.126915	0.1152845	0.1392033
Heimsath et al	2001	0.0468457	0.0435498	0.0533517
Heimsath et al	2001	0.1335545	0.1229163	0.1442944
Heimsath et al	2001	0.1521347	0.1379022	0.1646957
Heimsath et al	2001	0.116523	0.1152211	0.116775
Heimsath et al	2001	0.0732656	0.067336	0.0782028
Heimsath et al	2001	0.029463	0.0279944	0.0304941
Heimsath et al	1999	0.03912	0.0369967	0.0416297
Heimsath et al	1999	0.0147547	0.0142117	0.0152755
Heimsath et al	1999	0.0080359	0.0075846	0.0088425
Heimsath et al	1999	0.0135019	0.0124509	0.0144941
Heimsath et al	1999	0.045282	0.0412345	0.0491481
Heimsath et al	1999	0.0165602	0.0150389	0.0179366
Heimsath et al	1999	0.049285	0.0464217	0.0528166
Heimsath et al	1999	0.022482	0.021275	0.0237574
Heimsath et al	1999	0.0128595	0.011301	0.013966
Heimsath et al	2000	0.0015104	0.001425	0.0015309
Heimsath et al	2000	0.0472433	0.0460147	0.0483984
Heimsath et al	2000	0.0474614	0.0463702	0.0500416
Heimsath et al	2000	0.007789	0.0075522	0.007927
Heimsath et al	2000	0.0173537	0.0164699	0.0177061
Heimsath et al	2000	0.0253422	0.0242487	0.0262487
Heimsath et al	2000	0.0201335	0.0192407	0.0204965
Heimsath et al	2000	0.0134624	0.0130719	0.0136497

Heimsath et al	2000	0.0089301	0.0087766	0.0089836
Heimsath et al	2000	0.0468102	0.0459038	0.0484013
Heimsath et al	2000	0.0067831	0.0065857	0.007036
Heimsath et al	2000	0.0292723	0.0286646	0.0293954
Heimsath et al	2000	0.0072574	0.0071461	0.0074327
Heimsath et al	2000	0.0218845	0.0203231	0.0232374
Heimsath et al	2000	0.0046552	0.0044881	0.0047214
Heimsath et al	2000	0.0039231	0.0038205	0.0041329
Heimsath et al	2000	0.0233862	0.0222091	0.0243383
Heimsath et al	2000	0.00329	0.0030328	0.0034267
Heimsath et al	2000	0.0394691	0.0385203	0.0400407
Wilkinson et al	2005	0.0343225	0.0321751	0.0379784
Wilkinson et al	2005	0.0207262	0.0191146	0.0217388
Wilkinson et al	2005	0.0201419	0.01889	0.0222189
Wilkinson et al	2005	0.0255099	0.0238573	0.0284979
Wilkinson et al	2005	0.0211961	0.0200756	0.0227563
Wilkinson et al	2005	0.0191033	0.0182189	0.0204954
Wilkinson et al	2005	0.0237065	0.022124	0.0264137
Wilkinson et al	2005	0.0223311	0.0209077	0.0242336
Heimsath et al	2001a	0.0571422	0.0551867	0.0602586
Heimsath et al	2001a	0.0473704	0.0446566	0.0493877
Heimsath et al	2001a	0.0212698	0.0203242	0.0222919
Heimsath et al	2001a	0.0091762	0.0087105	0.0097763
Heimsath et al	2001a	0.0058401	0.0052796	0.0062848
Heimsath et al	2012	0.3644489	0.3428425	0.3980215
Heimsath et al	2012	0.0478951	0.0462571	0.0488798
Heimsath et al	2012	0.1931335	0.1888329	0.2041649
Heimsath et al	2012	0.0670696	0.0643591	0.070862
Heimsath et al	2012	0.0354323	0.0341849	0.0376389
Heimsath et al	2012	0.0397249	0.0368471	0.0422005
Heimsath et al	2012	0.1454127	0.1423991	0.1525173
Heimsath et al	2012	0.1009841	0.0945149	0.1077262
Heimsath et al	2012	0.09891	0.0955295	0.1027499
Heimsath et al	2012	0.0461076	0.0448313	0.0477285
Heimsath et al	2012	0.0363102	0.0350031	0.0385704
Heimsath et al	2012	0.0341007	0.0325615	0.035636
Heimsath et al	2012	0.0796083	0.075439	0.0830504
Heimsath et al	2012	0.0315624	0.0301542	0.032373
Heimsath et al	2012	0.0332942	0.0323747	0.0347048
Heimsath et al	2012	0.0089252	0.0086083	0.0091024
Heimsath et al	2012	0.0609363	0.0590831	0.0633114
Heimsath et al	2012	0.0665062	0.0638171	0.0678462
Heimsath et al	2012	0.1014731	0.0985773	0.1037334
Heimsath et al	2012	0.0414137	0.0398238	0.042767
Heimsath et al	2012	0.0877481	0.0854575	0.0909913
Heimsath et al	2012	0.1322151	0.129427	0.1361336
Heimsath et al	2012	0.0068935	0.0066849	0.0071047
Heimsath et al	2012	0.0310176	0.0300023	0.0336467
Heimsath et al	2012	0.0553779	0.0522581	0.0589623
Heimsath et al	2012	0.3032675	0.286747	0.31386

Heimsath et al	2012	0.2522359	0.2383057	0.2672564
Heimsath et al	2012	0.1934319	0.1855379	0.1986148
Heimsath et al	2012	0.2122655	0.2024987	0.2151415
Heimsath et al	2012	0.0813444	0.0791293	0.0831829
Heimsath et al	2012	0.1289619	0.1245581	0.1366502
Heimsath et al	2012	0.1421741	0.1384237	0.1504457
Heimsath et al	2012	0.1796604	0.1698558	0.183238
Heimsath et al	2012	0.0699468	0.0674392	0.0717525
Heimsath et al	2012	0.080945	0.0790073	0.085377
Heimsath et al	2012	0.4708325	0.4299359	0.5103225
Heimsath et al	2012	0.0776666	0.0744695	0.0812793
Heimsath et al	2012	0.2992131	0.282219	0.3246379
Heimsath et al	2012	0.146171	0.1417777	0.1519706
Heimsath et al	2012	0.1654442	0.1575702	0.1706747
Dixon et al.	2009	0.044688	0.04335	0.0466653
Dixon et al.	2009	0.0368861	0.0350168	0.039814
Dixon et al.	2009	0.0275183	0.0262904	0.0284497
Dixon et al.	2009	0.0378371	0.037031	0.0382165
Dixon et al.	2009	0.023907	0.0233099	0.024392
Dixon et al.	2009	0.0201612	0.0195825	0.0211053
Dixon et al.	2009	0.0344559	0.0334865	0.034951
Dixon et al.	2009	0.0311322	0.0291466	0.0338262
Dixon et al.	2009	0.0208555	0.0204161	0.0213802
Dixon et al.	2009	0.0195536	0.0194312	0.0199833
Dixon et al.	2009	0.0233889	0.0232827	0.0239404
Dixon et al.	2009	0.0167127	0.0161728	0.017315
Dixon et al.	2009	0.0339483	0.0321477	0.0348508
Dixon et al.	2009	0.0192406	0.0186921	0.019721
Heimsath et al	2005	0.0080959	0.0075508	0.0091167
Heimsath et al	2005	0.0423369	0.0390869	0.0454519
Heimsath et al	2005	0.0577595	0.0528363	0.0627409
Heimsath et al	2005	0.0159375	0.0149023	0.0168549
Heimsath et al	2005	0.0048291	0.0045578	0.0052584
Heimsath et al	2005	0.040088	0.0365941	0.0442246
Heimsath et al	2005	0.0010995	0.00096737	0.0011582
Heimsath et al	2005	0.0042978	0.003874	0.0045519
Heimsath et al	2005	0.0597234	0.0565799	0.0633386
Heimsath et al	2005	0.0556704	0.051995	0.0597157
Heimsath et al.	2009	0.0275146	0.0254717	0.0301254
Heimsath et al.	2009	0.0301513	0.0287145	0.03166
Owen et al.	2011	0.0299641	0.0283594	0.031235
Owen et al.	2011	0.0218216	0.0214462	0.0220754
Owen et al.	2011	0.0261846	0.0257883	0.0263332
Owen et al.	2011	0.0298315	0.0297628	0.0306676
Owen et al.	2011	0.0089071	0.0083667	0.0093351
Owen et al.	2011	0.0097491	0.0091343	0.0101661
Owen et al.	2011	0.0082854	0.0081829	0.0086541
Owen et al.	2011	0.008836	0.0084464	0.009121
Owen et al.	2011	0.0551371	0.0543289	0.0577201
Owen et al.	2011	0.05856	0.0571973	0.0587952

Owen et al.	2011	0.0585334	0.0572053	0.0587727
Owen et al.	2011	0.0494247	0.048409	0.0513678
Owen et al.	2011	0.0488105	0.0471247	0.04919
Owen et al.	2011	0.0486551	0.0473162	0.051499
Owen et al.	2011	0.0386227	0.0380895	0.0404805
Owen et al.	2011	0.0383468	0.037937	0.0400115
Owen et al.	2011	0.0384589	0.0375417	0.0397933
Owen et al.	2011	0.0253186	0.0251727	0.0255286
Owen et al.	2011	0.0246999	0.0237911	0.0251978
Owen et al.	2011	0.0124621	0.0121258	0.0127983
Owen et al.	2011	0.0123654	0.0121045	0.0128776
Owen et al.	2011	0.2242985	0.2123798	0.2345693
Owen et al.	2011	0.0783399	0.0749527	0.0806167
Owen et al.	2011	0.0877764	0.0860846	0.0897007
Owen et al.	2011	0.0898516	0.0879186	0.092735
Heimsath et al.	2006	0.0242881	0.0231707	0.0271705
Heimsath et al.	2006	0.0107927	0.0100034	0.0120793
Heimsath et al.	2006	0.0500597	0.046172	0.0559453
Heimsath et al.	2006	0.026796	0.0259365	0.0291846
Heimsath et al.	2006	0.0414188	0.0386309	0.0457069
Heimsath et al.	2006	0.0321081	0.0299194	0.0349615

Appendix 4.1: Global Inventory of Soil Erosion Rates

Reference Number	Author	Experiment Duration (yrs)	Soil Order	Soil Textural Class	Global Region	Location of Study	Country	Slope (°=º)	Mean Annual Rainfall or Rainfall range (mm)	Type	Management Practice	Lower Erosion Rate (mm year)	Upper Erosion Rate (mm year)
1	Lineger	5	feric Luvisol	Clay	sub-Saharan Africa	Kalalu, Laikipia	Kenya	0.05	749	Conservation	Forest	0.28057554	0.312
1	Lineger	4	vertic Paeozem	Clay	sub-Saharan Africa	Matanya, Laikipia	Kenya	0.05	869	Conventional	Crop	1.079136691	1.2
1	Lineger	8	feric Luvisol	Clay	sub-Saharan Africa	Kalalu, Laikipia	Kenya	0.05	749	Conventional	Crop	1.151079137	1.28
1	Lineger	3	feric Luvisol	Clay	sub-Saharan Africa	Kalalu, Laikipia	Kenya	0.2	749	Conventional	Crop	3.848920863	4.32
1	Lineger	3	feric Luvisol	Clay	sub-Saharan Africa	Kalalu, Laikipia	Kenya	0.2	935	Conservation	Forest	0	0
1	Lineger	4	vertic Paeozem	Clay	sub-Saharan Africa	Matanya, Laikipia	Kenya	0.05	869	Conservation	Forest	0.028776978	0.032
1	Lineger	3	feric Luvisol	Clay	sub-Saharan Africa	Kalalu, Laikipia	Kenya	0.2	749	Conservation	Cover Crop	0.71942446	0.8
1	Lineger	5	feric Luvisol	Clay	sub-Saharan Africa	Kalalu, Laikipia	Kenya	0.05	749	Conservation	Contour Ridges	0.690647482	0.768
1	Lineger	8	vertic Paeozem	Clay	sub-Saharan Africa	Matanya, Laikipia	Kenya	0.05	869	Conservation	Grassland	0.25323741	0.2816
1	Lineger	8	feric Luvisol	Clay	sub-Saharan Africa	Kalalu, Laikipia	Kenya	0.05	749	Conservation	Cover Crop	0.220323741	0.245
1	Lineger	10	feric Luvisol	Clay	sub-Saharan Africa	Kalalu, Laikipia	Kenya	0.05	749	Conservation	Grassland	0.190647482	0.212
1	Lineger	4	vertic Paeozem	Clay	sub-Saharan Africa	Matanya, Laikipia	Kenya	0.05	749	Conservation	Cover Crop	0	0
1	Lineger	4	vertic Paeozem	Clay	sub-Saharan Africa	Matanya, Laikipia	Kenya	0.05	869	Conservation	Contour Ridges	0.100719424	0.112
2	Basic et al.	12	Stagnic Luvisols	Sandy Loam	Europe and Middle East	Daruvar	Croatia	9	11.6-75.5	Conventional	Cultivating Down Slope	1.2109375	1.291666667
2	Basic et al.	12	Stagnic Luvisols	Sandy Loam	Europe and Middle East	Daruvar	Croatia	9	11.6-75.5	Conventional	Conventional Tillage	6.20625	6.62
2	Basic et al.	12	Stagnic Luvisols	Sandy Loam	Europe and Middle East	Daruvar	Croatia	9	11.6-75.5	Conservation	Zero Till	0.575	0.613333333
2	Basic et al.	12	Stagnic Luvisols	Sandy Loam	Europe and Middle East	Daruvar	Croatia	9	11.6-75.5	Conservation	Cultivating Across Slope	0.26875	0.286666667
3	Lundekvam	8		Silty Clay Loam	Europe and Middle East	Bjornebekk	Norway	13	785	Conservation	Zero Till	0.045612903	0.048758621
3	Lundekvam	8		Loam	Europe and Middle East	Syverud	Norway	13	785	Conventional	Conventional Tillage	0.010193548	0.011285714
3	Lundekvam	8		Clay	Europe and Middle East	Osaker	Norway	12	785	Conventional	Conventional Tillage	0.07381295	0.08208
3	Lundekvam	8		Silty Clay Loam	Europe and Middle East	Hellerud	Norway	13	785	Conventional	Conventional Tillage	0.157419355	0.168275862
3	Lundekvam	8		Silty Clay Loam	Europe and Middle East	Askim	Norway	13	785	Conventional	Conventional Tillage	0.302193548	0.323034483
3	Lundekvam	8		Silty Clay Loam	Europe and Middle East	Bjornebekk	Norway	13	785	Conventional	Conventional Tillage	0.410258065	0.438551724
3	Lundekvam	8			Europe and Middle East	Syverud	Norway	13	785	Conservation	Zero Till	0.006774194	0.010075
3	Lundekvam	8		Silty Clay Loam	Europe and Middle East	Hellerud	Norway	13	785	Conservation	Zero Till	0.013612903	0.014551724
3	Lundekvam	8		Clay	Europe and Middle East	Osaker	Norway	12	785	Conservation	Zero Till	0.014388489	0.016
3	Lundekvam	8		Silty Clay Loam	Europe and Middle East	Askim	Norway	13	785	Conservation	Zero Till	0.032387097	0.03462069
4	Gomez et al.	3	Vertisol	Silty Clay	Europe and Middle East	Cordoba	Spain	13.4	744	Conventional	Conventional Tillage	0.264444444	0.287439614
4	Gomez et al.	3	Vertisol	Silty Clay	Europe and Middle East	Cordoba	Spain	13.4	744	Conservation	Zero Till	0.568888889	0.618357488
4	Gomez et al.	3	Vertisol	Silty Clay	Europe and Middle East	Cordoba	Spain	13.4	744	Conservation	Conservation Tillage	0.082222222	0.089371981
5	Merten et al.	13	Oxisol	Clay	South America	Parana	Brazil	9	1511	Conventional	Conventional Tillage	0.064185548	0.07137433
5	Merten et al.	13	Oxisol	Clay	South America	Parana	Brazil	9	1511	Conservation	Zero Till	0.01283711	0.014274866
6	Wang et al.	2	Chromic Cambisol	Sandy Loam	Asia and Australia	Jingshang	China	5	225	Conventional	Conventional Tillage	0.31779661	0.31779661
6	Wang et al.	2	Chromic Cambisol	Sandy Loam	Asia and Australia	Jingshang	China	5	225	Conservation	Conservation Tillage	0.440677966	0.440677966
6	Wang et al.	2	Chromic Cambisol	Sandy Loam	Asia and Australia	Jingshang	China	5	225	Conservation	Zero Till	0.063559322	0.063559322
7	de Alba	4	Typic Haploxeralf	No Data	Europe and Middle East		Spain	9	450	Conventional	Conventional Tillage	0.375	0.428571429
7	de Alba	4	Typic Haploxeralf	No Data	Europe and Middle East		Spain	9	450	Conservation	Zero Till	0.225	0.257142857
8	Chisci and Zanchi	4	Vertic Xerorthent	Silty Clay	Europe and Middle East	Vicarello, Pisa	Italy	12	666.75	Conventional	Conventional Tillage	0.269733333	0.293188406
8	Chisci and Zanchi	4	Vertic Xerorthent	Silty Clay	Europe and Middle East	Vicarello, Pisa	Italy	12	666.75	Conservation	Conservation Tillage	0.107333333	0.116666667
8	Chisci and Zanchi	4	Vertic Xerorthent	Silty Clay	Europe and Middle East	Vicarello, Pisa	Italy	12	666.75	Conservation	Grassland	0.012266667	0.013333333
9	Veihe and Hasholt	1		Loam	Europe and Middle East	Foulum, Odum	Denmark	10		Bare	Bare Soil	0.027096774	0.03
9	Veihe and Hasholt	1		Loam	Europe and Middle East	Foulum, Odum	Denmark	10		Conventional	Cultivating Down Slope	0.061290323	0.067857143
9	Veihe and Hasholt	1		Loam	Europe and Middle East	Foulum, Odum	Denmark	10		Conservation	Grassland	0.001935484	0.002142857
9	Veihe and Hasholt	1		Loam	Europe and Middle East	Foulum, Odum	Denmark	10		Conservation	Cultivating Across Slope	0.016774194	0.018571429
9	Veihe and Hasholt	1		Loam	Europe and Middle East	Foulum, Odum	Denmark	10		Conservation	Cover Crop	0.016774194	0.018571429
10	Skrodzki	11		Sandy Loam	Europe and Middle East	Posorty	Poland	25	637	Conventional	Cultivating Down Slope	0.945625	1.008666667
10	Skrodzki	11		Sandy Loam	Europe and Middle East	Posorty	Poland	25	637	Conservation	Cultivating Across Slope	0.50375	0.537333333
11	De Alba	2	Calcic Luvisol	No Data	Europe and Middle East	Toledo	Spain	9		Conventional	Cultivating Down Slope	3.5875	4.1
11	De Alba	2	Calcic Luvisol	No Data	Europe and Middle East	Toledo	Spain	9		Conservation	Cultivating Across Slope	0.36875	0.421428571
12	USDA	8	Alfisol	Silt Loam	North America	Marcellus, New York	USA	4.9	787.4	Conservation	Cultivating Across Slope	0.055796774	0.066526923
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	3.9	787.4	Conservation	Cultivating Across Slope	0.043840323	0.052271154
12	USDA	35	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9	685.8	Conservation	Fallow	9.207606452	10.9783
12	USDA	1	Alfisol	Silt Loam	North America	Marcellus, New York	USA	18.4	939.8	Conservation	Fallow	8.736180645	10.41621538
12	USDA	1	Alfisol	Silt Loam	North America	Marcellus, New York	USA	19	939.8	Conservation	Fallow	7.811548387	9.313769231
12	USDA	1	Alfisol	Silt Loam	North America	Marcellus, New York	USA	19	864	Conventional	Crop (Corn)	0.039854839	0.047519231
12	USDA	1	Alfisol	Silt Loam	North America	Marcellus, New York	USA	16.4	939.8	Conventional	Crop (Spring planted oats)	0.079709677	0.095038462
12	USDA	5	Alfisol	Silt Loam	North America	Marcellus, New York	USA	17.2	939.8	Conservation	Cultivating Across Slope	3.366936774	4.014424615
12	USDA	6	Ultisol	Loam	North America	Beemerville, New Jersey	USA	16.5	1397	Conventional	Cultivating Down Slope	3.026576452	3.3508525
12	USDA	148	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9	838	Conventional	Cultivating Down Slope	3.656843025	4.360082069
12	USDA	2	Alfisol	Silt Loam	North America	Marcellus, New York	USA	18	940	Conventional	Crop (Corn)	5.002579355	5.964613846
12	USDA	21	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	8	686	Conventional	Cultivating Down Slope	7.645676344	9.115998718
12	USDA	3	Alfisol	Silt Loam	North America	Marcellus, New York	USA	18.9	940	Conventional	Crop (Corn)	9.66400129	11.52246308
12	USDA	1	Alfisol	Silt Loam	North America	Marcellus, New York	USA	18.4	864	Conventional	Crop (Corn)	11.06848581	13.19704077
12	USDA	17	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9	711.2	Conventional	Crop (Corn)	12.33174353	14.70323267
12	USDA	5	Alfisol	Silt Loam	North America	Marcellus, New York	USA	17.3	939.8	Conservation	Cultivating Across Slope	2.799403871	3.337750769
12	USDA	7	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	8	686	Conservation	Cultivating Across Slope	2.031230323	2.421851538
12	USDA	3	Alfisol	Silt Loam	North America	Marcellus, New York	USA	17.6	939.8	Conservation	Cultivating Across Slope	1.610135484	1.919776923
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	18.9	838.2	Conservation	Cultivating Across Slope	1.347093548	1.60615
12	USDA	8	Alfisol	Silt Loam	North America	Marcellus, New York	USA	16.8	939.8	Conservation	Cultivating Across Slope	1.325173387	1.580014423
12	USDA	5	Alfisol	Silt Loam	North America	Marcellus, New York	USA	16	939.8	Conservation	Cultivating Across Slope	1.151007742	1.372355385
12	USDA	6	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	10.2	787.4	Conservation	Cultivating Across Slope	1.073423656	1.279851282
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	18.4	838.2	Conservation	Cultivating Across Slope	1.064124194	1.268763462
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	19	838.2	Conservation	Cultivating Across Slope	1.044196774	1.245003846
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	18	838.2	Conservation	Cultivating Across Slope	1.044196774	1.245003846
12	USDA	17	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9	838	Conservation	Cultivating Across Slope	0.934947628	1.114745249
12	USDA	8	Alfisol	Silt Loam	North America	Marcellus, New York	USA	9.6	787.4	Conservation	Cultivating Across Slope	0.767205645	0.914745192
12	USDA	7	Alfisol	Silt Loam	North America	Marcellus, New York	USA	16.4	939.8	Conservation	Cultivating Across Slope	0.74243871	0.885215385
12	USDA	6	Ultisol	Loam	North America	Beemerville, New Jersey	USA	16.5	1397	Conservation	Cultivating Across Slope	0.512001828	0.566859167
12	USDA	12	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9.2	787.4	Conservation	Cultivating Across Slope	0.502170968	0.598742308
12	USDA	6	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	10.3	787.4	Conservation	Cultivating Across Slope	0.443717204	0.529047436
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	9.7	787.4	Conservation	Cultivating Across Slope	0.306882258	0.365898077
12	USDA	16	Alfisol	Silt Loam	North America	Marcellus, New York	USA	9.4	787.4	Conservation	Cultivating Across Slope	0.302896774	0.361146154
12	USDA	3	Alfisol	Silt Loam	North America	Marcellus, New York	USA	16.6	939.8	Conservation	Cultivating Across Slope	0.292268817	0.348474359
12	USDA	57	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9	711.2	Conservation	Grassland	0.257298432	0.306798823
12	USDA	6	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9.3	787.4	Conservation	Cultivating Across Slope	0.239129032	0.285115385
12	USDA	5	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9.7	787.4	Conservation	Cultivating Across Slope	0.223187097	0.266107692
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	8.8	787.4	Conservation	Cultivating Across Slope	0.163404839	0.194828846
12	USDA	2	Alfisol	Silt Loam	North America	Marcellus, New York	USA	17.3	863.6	Conservation	Grassland	0	0
12	USDA	3	Alfisol	Silt Loam	North America	Marcellus, New York	USA	16.8	863.6	Conservation	Grassland	0	0
12	USDA	2	Alfisol	Silt Loam	North America	Marcellus, New York	USA	16	863.6	Conservation	Grassland	0	0
12	USDA	2	Alfisol	Silt Loam	North America	Marcellus, New York	USA	3.9	863.6	Conservation	Grassland	0	0
12	USDA	2	Alfisol	Silt Loam	North America	Marcellus, New York	USA	3.7	863.6	Conservation	Grassland	0	0
12	USDA	2	Alfisol	Silt Loam	North America	Marcellus, New York	USA	5.3	863.6	Conservation	Grassland	0	0
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	4.9	863.6	Conservation	Grassland	0	0
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	5	863.6	Conservation	Grassland	0	0
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	9.6	863.6	Conservation	Grassland	0	0
12	USDA	2	Alfisol	Silt Loam	North America	Marcellus, New York	USA	9.7	863.6	Conservation	Grassland	0	0
12	USDA	1	Alfisol	Silt Loam	North America	Marcellus, New York	USA	17.6	838.2	Conservation	Grassland	0	0
12	USDA	1	Alfisol	Silt Loam	North America	Marcellus, New York	USA	16.6	838.2	Conservation	Grassland	0	0
12	USDA	2	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	8.9	660.4	Conservation	Grassland	0	0
12	USDA	2	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9.2	660.4	Conservation	Grassland	0	0
12	USDA	1	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9.3	660.4	Conservation	Grassland	0	0
12	USDA	1	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9.7	660.4	Conservation	Grassland	0	0
12	USDA	1	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9.8	660.4	Conservation	Grassland	0	0
12	USDA	2	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	10.5	660.4	Conservation	Grassland	0	0
12	USDA	1	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	10.3	660.4	Conservation	Grassland	0	0
12	USDA	1	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	10.2	660.4	Conservation	Grassland	0	0
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	8.5	787.4	Conservation	Cultivating Across Slope	0.143477419	0.171069231
12	USDA	12	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	10.5	787.4	Conservation	Cultivating Across Slope	0.136834946	0.163149359
12	USDA	3	Alfisol	Silt Loam	North America	Marcellus, New York	USA	18.4	864	Conservation	Grassland	0.005313978	0.006335897
12	USDA	3	Alfisol	Silt Loam	North America	Marcellus, New York	USA	16.4	863.6	Conservation	Grassland	0.005313978	0.006335897
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	5.3	787.4	Conservation	Cultivating Across Slope	0.119564516	0.142557692
12	USDA	2	Alfisol	Silt Loam	North America	Marcellus, New York	USA	8.5	863.6	Conservation	Grassland	0.007970968	0.009503846
12	USDA	2	Alfisol	Silt Loam	North America	Marcellus, New York	USA	8.8	863.6	Conservation	Grassland	0.007970968	0.009503846
12	USDA	6	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	9.8	787.4	Conservation	Cultivating Across Slope	0.116907527	0.139389744
12	USDA	3	Alfisol	Silt Loam	North America	Marcellus, New York	USA	19	864	Conservation	Grassland	0.010627957	0.012671795
12	USDA	2	Alfisol	Silt Loam	North America	Marcellus, New York	USA	17.2	863.6	Conservation	Grassland	0.015941935	0.019007692
12	USDA	5	Alfisol	Silt Loam	North America	Marcellus, New York	USA	18	940	Conservation	Grassland	0.02231871	0.026610769
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	4.5	863.6	Conservation	Grassland	0.023912903	0.028511538
12	USDA	4	Alfisol	Silt Loam	North America	Marcellus, New York	USA	3.7	787.4	Conservation	Cultivating Across Slope	0.063767742	0.076030769
12	USDA	8	Alfisol	Silt Loam	North America	Marcellus, New York	USA	4.5	787.4	Conservation	Cultivating Across Slope	0.061775	0.073654808
12	USDA	6	Alfisol	Silt Loam	North America	Marcellus, New York	USA	18.9	940	Conservation	Grassland	0.061110753	0.072862821
12	USDA	10	Typic Hapludoll	Silt Loam	North America	Clarinda, Iowa	USA	8.9	787.4	Conservation	Cultivating Across Slope	0.038260645	0.045618462
12	USDA	8	Alfisol	Silt Loam	North America	Marcellus, New York	USA	5	787.4	Conservation	Cultivating Across Slope	0.057789516	0.068882885
13	Paningbatan et al	3	Typic Tropudalf	Clay	Asia and Australia	Laguna	Phillipines	14-21	1959	Conventional	Cultivating Down Slope	10.09592326	11.22666667
13	Paningbatan et al	4	Typic Tropudalf	Clay	Asia and Australia	Laguna	Phillipines	14-21	1959	Conservation	Cultivating Across Slope	1.960431655	2.18
14	Gomez et al.	4	Petrocalcic Palexeralf	Sandy Loam	Europe and Middle East	Santa Marta, Seville	Spain	11	858	Conventional	Conventional Tillage	1.21109375	1.291833333
14	Gomez et al.	4	Petrocalcic Palexeralf	Sandy Loam	Europe and Middle East	Santa Marta, Seville	Spain	11	858	Conservation	Grassland	0.025	0.026666667
15	Biddoccu et al.	2		Clay Loam	Europe and Middle East	Regione Piemonte	Italy	15	905	Conservation	Grassland	848	908.5714286
15	Biddoccu et al.	2		Clay Loam	Europe and Middle East	Regione Piemonte	Italy	15	905	Conventional	Conventional Tillage	4896	5245.714286
16	Laloy and Bielders	6	Luvisol	Silt Loam	Europe and Middle East	Nodebais	Belgium	9	368	Conservation	Cover Crop	0.040860215	0.048717949
16	Laloy and Bielders	6	Cambisol	Sandy Loam	Europe and Middle East	Bonlez	Belgium	12	336	Conservation	Cover Crop	0.047916667	0.051111111
16	Laloy and Bielders	6	Luvisol	Silt Loam	Europe and Middle East	Nodebais	Belgium	9	368	Bare	Bare Soil	0.438709677	0.523076923
16	Laloy and Bielders	6	Cambisol	Sandy Loam	Europe and Middle East	Bonlez	Belgium	12	336	Bare	Bare Soil	0.730208333	0.778888889
17	Lanzanova et al.	16	Typic Paleudalf	Sandy Loam	South America	Rio Grande do Sul	Brazil	5	1500	Bare	Bare Soil	4.425574381	4.720612673
17	Lanzanova et al.	16	Typic Paleudalf	Sandy Loam	South America	Rio Grande do Sul	Brazil	5	1500	Conservation	Grassland	0.003833582	0.004089154
17	Lanzanova et al.	64	Typic Paleudalf	Sandy Loam	South America	Rio Grande do Sul	Brazil	5	1500	Conservation	Cover Crop	0.011753414	0.012536975
18	Rejman et al.	3		Silt Loam	Europe and Middle East	Czeslawice	Poland	9	592	Bare	Bare Soil	0.64516129	0.769230769
18	Rejman et al.	3		Silt Loam	Europe and Middle East	Czeslawice	Poland	9	592	Conservation	Cover Crop	0.08	0.095384615
19	Szpilkowski	2		Sandy Loam	Europe and Middle East	Storkowo	Poland	9	687	Bare	Bare Soil	0.29	0.309333333
19	Szpilkowski	2		Sandy Loam	Europe and Middle East	Storkowo	Poland	9	687	Conservation	Cover Crop	0.11875	0.126666667
20	Ionita et al.	29	Mollisol	Loam	Europe and Middle East	Perieni, Vaslui County	Romania	12	504.3	Bare	Bare Soil	2.135483871	2.364285714
20	Ionita et al.	6	Mollisol	Loam	Europe and Middle East	Aldeni, Buzau County	Romania	18	389.6	Bare	Bare Soil	2.890322581	3.2
20	Ionita et al.	12	Mollisol	Loam	Europe and Middle East	Aldeni, Buzau County	Romania	18	389.6	Conservation	Cover Crop	1.083870968	1.2
20	Ionita et al.	58	Mollisol	Loam	Europe and Middle East	Perieni, Vaslui County	Romania	12	504.3	Conservation	Cover Crop	0.272258065	0.301428571
21	Horvat and Zemljic	5		Loam	Europe and Middle East	Soca Valley	Slovenia	55.7	2699	Conservation	Forest	0.000406452	0.00045
21	Horvat and Zemljic	5		Loam	Europe and Middle East	Soca Valley	Slovenia	55.7	2699	Bare	Bare Soil	1.44516129	1.6
21	Horvat and Zemljic	5		Loam	Europe and Middle East	Soca Valley	Slovenia	55.7	2699	Conservation	Cover Crop	0.223870968	0.247857143
21	Horvat and Zemljic	5		Loam	Europe and Middle East	Soca Valley	Slovenia	55.7	2699	Conservation	Grassland	0.002516129	0.002785714
22	Goeck	2.3		Sandy Loam	Europe and Middle East	Kiel	Germany	10		Bare	Bare Soil	0.3375	0.36
22	Goeck	4.6		Sandy Loam	Europe and Middle East	Kiel	Germany	10		Conservation	Cover Crop	0.221875	0.236666667
23	Richter	3		No Data	Europe and Middle East	Tarforst	Germany	8	680	Bare	Bare Soil	0.03125	0.035714286
23	Richter	3		No Data	Europe and Middle East	Kockelsberg	Germany	8	718	Bare	Bare Soil	0.06875	0.078571429
23	Richter	3		No Data	Europe and Middle East	Bitbg. Ch.	Germany	8	765	Bare	Bare Soil	0.1125	0.128571429
23	Richter	3		No Data	Europe and Middle East	Olewig	Germany	8	465	Bare	Bare Soil	0.1125	0.128571429
23	Richter	3		No Data	Europe and Middle East	Dickes Kreuz	Germany	8	1042	Bare	Bare Soil	0.1625	0.185714286
23	Richter	3		No Data	Europe and Middle East	Hungelsberg	Germany	8	775	Bare	Bare Soil	0.2	0.228571429
23	Richter	6		No Data	Europe and Middle East	Dickes Kreuz	Germany	8		Conservation	Cover Crop	0	0
23	Richter	6		No Data	Europe and Middle East	Olewig	Germany	8	1042	Conservation	Cover Crop	0	0
23	Richter	6		No Data	Europe and Middle East	Bitbg. Ch.	Germany	8	765	Conservation	Cover Crop	0.00625	0.007142857
23	Richter	6		No Data	Europe and Middle East	Hungelsberg	Germany	8	775	Conservation	Cover Crop	0.00625	0.007142857
23	Richter	6		No Data	Europe and Middle East	Kockelsberg	Germany	8	718	Conservation	Cover Crop	0.00625	0.007142857
23	Richter	6		No Data	Europe and Middle East	Tarforst	Germany	8	680	Conservation	Cover Crop	0.00625	0.007142857
24	Jung and Brechtel	12		Silt Loam	Europe and Middle East	Blumberg	Germany	15	809	Conservation	Cover Crop	0.051612903	0.061538462
24	Jung and Brechtel	12		Silt Loam	Europe and Middle East	Emdtebruck	Germany	10.5	652	Bare	Bare Soil	0.04516129	0.053846154

24	Jung and Brechtel	26		Clay Loam	Europe and Middle East	Rauischolzh	Germany	8	418	Bare	Bare Soil	0.106666667	0.114285714
24	Jung and Brechtel	5		Loam	Europe and Middle East	Hohenpeibenb	Germany	12	1304	Bare	Bare Soil	0.161290323	0.178571429
24	Jung and Brechtel	6		Silt Loam	Europe and Middle East	Blumberg	Germany	15	809	Bare	Bare Soil	0.232258065	0.276923077
24	Jung and Brechtel	24		Loam	Europe and Middle East	Marburg	Germany	9	1230	Bare	Bare Soil	0.412903226	0.457142857
24	Jung and Brechtel	52		Clay Loam	Europe and Middle East	Rauischolzh	Germany	8	418	Conservation	Cover Crop	0.006666667	0.007142857
24	Jung and Brechtel	10		Loam	Europe and Middle East	Hohenpeibenb	Germany	12	1304	Conservation	Cover Crop	0.019354839	0.021428571
24	Jung and Brechtel	24		Silt Loam	Europe and Middle East	Emdtebruck	Germany	10.5	652	Conservation	Cover Crop	0.019354839	0.023076923
24	Jung and Brechtel	48		Loam	Europe and Middle East	Marburg	Germany	9	1230	Conservation	Cover Crop	0.038709677	0.042857143
25	Martinez Raya et al.	4	Typic Xerorthent	Loam	Europe and Middle East	Lanjaron, Granada	Spain	35	47.1	Conventional	Crop (Barley)	0.015719355	0.017403571
25	Martinez Raya et al.	8	Typic Xerorthent	Loam	Europe and Middle East	Lanjaron, Granada	Spain	35	47.1	Conservation	Strips (Lentil)	0.130727419	0.144733929
25	Martinez Raya et al.	8	Typic Xerorthent	Loam	Europe and Middle East	Lanjaron, Granada	Spain	35	47.1	Conservation	Strips (Thyme)	0.00375	0.004151786
26	Hudek and Rey	1		Clay	Europe and Middle East	Visegrád	Hungary	13	600	Bare	Bare Soil	0.019417266	0.021592
26	Hudek and Rey	2		Clay	Europe and Middle East	Visegrád	Hungary	13	600	Conservation	Grassland	3.59712E-05	0.00004
27	Mitchell et al.	1	Dystric Cambisols	Sandy Loam	Europe and Middle East	Hilton, Shropshire	England	26.8	446	Bare	Bare Soil	1.103125	1.176666667
27	Mitchell et al.	2	Dystric Cambisols	Sandy Loam	Europe and Middle East	Hilton, Shropshire	England	26.8	446	Conservation	Grassland	0.215625	0.23
28	Gil	9		Clay Loam	Europe and Middle East	Szymbark	Poland	18	863	Conventional	Crop (Potatoes)	0.333333333	0.359285714
28	Gil	9		Clay Loam	Europe and Middle East	Szymbark	Poland	18	863	Conventional	Crop (Cereals)	0.926	0.992142857
28	Gil	36		Clay Loam	Europe and Middle East	Szymbark	Poland	18	863	Conservation	Grassland	0.008	0.008571429
29	Gil	9		Clay Loam	Europe and Middle East	Szymbark	Poland	18	803	Conventional	Crop (Potatoes)	0.158	0.169285714
29	Gil	9		Clay Loam	Europe and Middle East	Szymbark	Poland	18	803	Conventional	Crop (Cereals)	0.417333333	0.447142857
29	Gil	36		Clay Loam	Europe and Middle East	Szymbark	Poland	18	803	Conservation	Grassland	0.004	0.004285714
30	Oliveira et al.	1	Ultisol	Sandy Loam	South America	Rio Grande do Sul	Brazil	8		Bare	Bare Soil	0.752497329	0.802663817
30	Oliveira et al.	2	Ultisol	Sandy Clay Loam	South America	Rio Grande do Sul	Brazil	20		Bare	Bare Soil	38.47034556	48.85123245
30	Oliveira et al.	1	Inceptisol	Sandy Loam	South America	Rio Grande do Sul	Brazil	45		Bare	Bare Soil	100.8162409	107.5373236
30	Oliveira et al.	1	Ultisol	Sandy Loam	South America	Rio Grande do Sul	Brazil	8		Conservation	Forest	0.000836418	0.000892179
30	Oliveira et al.	2	Ultisol	Sandy Clay Loam	South America	Rio Grande do Sul	Brazil	20		Conservation	Forest	0.001756478	0.002230448
30	Oliveira et al.	1	Inceptisol	Sandy Loam	South America	Rio Grande do Sul	Brazil	45		Conservation	Forest	0.004460896	0.004758289
31	Silva et al.	18	Distrofi Red Argisol	Sandy Clay Loam	South America	Eldorado do Sol	Brazil	20	465	Bare	Bare Soil	0	0
31	Silva et al.	18	Distrofi Red Argisol	Sandy Clay Loam	South America	Eldorado do Sol	Brazil	20	1400	Conservation	Forest	0.009231576	0.011722636
32	Hammad et al.	4	Lithic Xerorthent	Silt Loam	Europe and Middle East	Ramallah District	Palestine	3	580	Conventional	Nonterraced	5.95161E-05	7.09615E-05
32	Hammad et al.	4	Lithic Xerorthent	Silt Loam	Europe and Middle East	Ramallah District	Palestine	3	580	Conservation	Terracing	0.062919355	0.075019231
33	Rousseva et al.	24		No Data	Europe and Middle East	Sandanski	Bulgaria	24-33		Conservation	Forest	0.001625	0.001857143
33	Rousseva et al.	20		No Data	Europe and Middle East	Elin Pelin	Bulgaria	17		Conservation	Forest	0.0018125	0.002071429
33	Rousseva et al.	20		No Data	Europe and Middle East	Elin Pelin	Bulgaria	17		Conservation	Grassland	0.002125	0.002428571
33	Rousseva et al.	24		No Data	Europe and Middle East	Sandanski	Bulgaria	24-32		Conservation	Grassland	0.0284375	0.0325
34	Voss	5		No Data	Europe and Middle East	Odenwald	Germany		780	Conservation	Forest	0.0001875	0.000214286
34	Voss	5		No Data	Europe and Middle East	Odenwald	Germany		780	Conservation	Grassland	0.011875	0.013571429
35	Aguiar et al.	0.5	Alfisol	No Data	South America	Sobral	Brazil	0.12	798	Conventional	Crop	0.006875	0.007857143
35	Aguiar et al.	1.5	Alfisol	No Data	South America	Sobral	Brazil	0.08	798	Conventional	Crop	0.014166667	0.016190476
35	Aguiar et al.	0.5	Alfisol	No Data	South America	Sobral	Brazil	0.11	798	Conventional	Crop	0.023125	0.026428571
35	Aguiar et al.	1	Alfisol	No Data	South America	Sobral	Brazil	0.11	798	Conservation	Forest	0.0240625	0.0275
36	Albuquerque et al.	7	Alfisol	No Data	South America	Sumé	Brazil	0.1	695	Conservation	Fallow	3.65625	4.178571429
36	Albuquerque et al.	7	Alfisol	No Data	South America	Sumé	Brazil	0.07	695	Conservation	Fallow	2.23125	2.55
36	Albuquerque et al.	7	Alfisol	No Data	South America	Sumé	Brazil	0.04	695	Conservation	Fallow	1.44375	1.65
36	Albuquerque et al.	14	Alfisol	No Data	South America	Sumé	Brazil	0.04	695	Conventional	Crop	0.53125	0.607142857
36	Albuquerque et al.	7	Alfisol	No Data	South America	Sumé	Brazil	0.04	695	Conservation	Shrubland	0.00625	0.007142857
36	Albuquerque et al.	7	Alfisol	No Data	South America	Sumé	Brazil	0.04	695	Conservation	Grassland	0.01875	0.021428571
36	Albuquerque et al.	7	Alfisol	No Data	South America	Sumé	Brazil	0.07	695	Conservation	Grassland	0.01875	0.021428571
37	Amado et al.	7.9	Ultisol	No Data	South America	Santa Maria	Brazil	0.06	92.7	Conservation	Fallow	4.335957278	4.955379747
37	Amado et al.	3.6	Ultisol	No Data	South America	Santa Maria	Brazil	0.06	620.4	Conventional	Crop	0.0725	0.082857143
38	Amaral et al.	23.2	Inceptisol	No Data	South America	Lages	Brazil	0.1	450	Conventional	Crop	0.7003125	0.800357143
39	Baptista and Levien	4	Inceptisol	No Data	South America	Arroio dos Ratos	Brazil	0.17	2010	Conservation	Shrubland	0.22140625	0.253035714
40	Bertol and Miquelluti	0.5	Inceptisol	No Data	South America	Lages	Brazil	0.09	702	Conservation	Fallow	2.866125	3.275571429
40	Bertol and Miquelluti	0.5	Inceptisol	No Data	South America	Lages	Brazil	0.09	702	Conventional	Crop	0.4359375	0.498214286
41	Bertol et al.	6	Inceptisol	No Data	South America	Lages	Brazil	0.1	1472	Conservation	Fallow	4.176875	4.773571429
41	Bertol et al.	12	Inceptisol	No Data	South America	Lages	Brazil	0.1	1472	Conventional	Crop	0.2375	0.271428571
42	Bertol et al.	9	Inceptisol	No Data	South America	Lages	Brazil	0.1	1600	Conservation	Fallow	4.154375	4.747857143
43	Bertol et al.	11	Inceptisol	No Data	South America	Lages	Brazil	0.1	1600	Conventional	Crop	0.560375	0.640428571
44	Bertol et al.	11	Inceptisol	No Data	South America	Lages	Brazil	0.1	1600	Conventional	Crop	0.1541875	0.176214286
45	Bertol et al.	11	Inceptisol	No Data	South America	Lages	Brazil	0.1	1600	Conventional	Crop	0.0653125	0.074642857
46	Bertol et al.	50	Inceptisol	No Data	South America	Lages	Brazil	0.09	1397	Conventional	Crop	0.23475	0.268285714
47	Bertolino et al.	2.5	Inceptisol	No Data	South America	Nova Friburgo	Brazil	0.26	2043	Conservation	Fallow	0.735	0.84
47	Bertolino et al.	2.5	Inceptisol	No Data	South America	Nova Friburgo	Brazil	0.26		Conservation	Shrubland	0	0
48	Bertoni and Lombardi Neto	114	Oxisol	No Data	South America	Campinas	Brazil	0.13	1400	Conventional	Orchard	0.902083333	1.030952381
48	Bertoni and Lombardi Neto	342	Oxisol	No Data	South America	Campinas	Brazil	0.13	1400	Conventional	Crop	1.347222222	1.53968254
48	Bertoni and Lombardi Neto	38	Oxisol	No Data	South America	Campinas	Brazil	0.13	1400	Conservation	Forest	0.05625	0.064285714
48	Bertoni and Lombardi Neto	38	Oxisol	No Data	South America	Campinas	Brazil	0.13	1400	Conservation	Grassland	0.025	0.028571429
49	Cabral et al.	2	Oxisol	No Data	South America	Primavera do Leste	Brazil		1500	Conventional	Crop	0.15625	0.178571429
49	Cabral et al.	2	Oxisol	No Data	South America	Campo Verde	Brazil		1500	Conventional	Crop	0.28125	0.321428571
50	Campos Filho et al.	4	Alfisol	No Data	South America	Glória do Goitá	Brazil	0.12	786	Conservation	Fallow	0.95375	1.09
51	Cândido et al.	1	Oxisol	No Data	South America	Três Lagoas	Brazil	0.05	1535	Conservation	Shrubland	0.0533125	0.060928571
51	Cândido et al.	1	Oxisol	No Data	South America	Três Lagoas	Brazil	0.03	1535	Conservation	Forest	0	0
51	Cândido et al.	1	Oxisol	No Data	South America	Três Lagoas	Brazil	0.02	2043	Conservation	Shrubland	0	0
51	Cândido et al.	3	Oxisol	No Data	South America	Três Lagoas	Brazil	0.03	1535	Conservation	Shrubland	0.0048125	0.0055
51	Cândido et al.	1	Oxisol	No Data	South America	Três Lagoas	Brazil	0.04	1535	Conservation	Shrubland	0.0114375	0.013071429
51	Cândido et al.	1	Oxisol	No Data	South America	Três Lagoas	Brazil	0.04	1535	Conservation	Fallow	0.0209375	0.023928571
51	Cândido et al.	1	Oxisol	No Data	South America	Três Lagoas	Brazil	0.03	1535	Conservation	Fallow	0.0315625	0.036071429
52	Cardoso et al.	1.5	Ultisol	No Data	South America	Lavras	Brazil		1446	Conventional	Crop	0.088229167	0.100833333
53	Carvalho and Hernani	5	Oxisol	No Data	South America	Dourados	Brazil	0.03	1350	Conservation	Fallow	12.15	13.88571429
54	Carvalho et al.	1	Oxisol	No Data	South America	Lavras	Brazil	0.12	1530	Conservation	Fallow	4.2027125	4.8031
54	Carvalho et al.	1	Oxisol	No Data	South America	Lavras	Brazil	0.12	1530	Conventional	Crop	0.01258125	0.014378571
55	Cogo et al.	1.5	Oxisol	No Data	South America	Santo Ângelo	Brazil	0.08	1726	Conservation	Fallow	3.7053125	4.234642857
55	Cogo et al.	4.5	Oxisol	No Data	South America	Santo Ângelo	Brazil	0.04	1726	Conventional	Crop	0.1034375	0.118214286
55	Cogo et al.	4.5	Oxisol	No Data	South America	Santo Ângelo	Brazil	0.08	1726	Conventional	Crop	0.354208333	0.404809524
55	Cogo et al.	4.5	Oxisol	No Data	South America	Santo Ângelo	Brazil	0.12	1726	Conventional	Crop	0.390791667	0.446619048
56	Correchel et al.	156	Oxisol	No Data	South America	Campinas	Brazil	0.07	1400	Conventional	Crop	0.53125	0.607142857
56	Correchel et al.	546	Oxisol	No Data	South America	Campinas	Brazil	0.1	1400	Conventional	Crop	1.450892857	1.658163265
56	Correchel et al.	312	Oxisol	No Data	South America	Campinas	Brazil	0.13	1400	Conventional	Crop	2.1171875	2.419642857
57	Cruz	2	Ultisol	No Data	South America	Seropédica	Brazil	0.09	542.2	Conventional	Crop	0.392992188	0.449133929
57	Cruz	0.5	Ultisol	No Data	South America	Seropédica	Brazil	0.09	542.2	Conservation	Fallow	0.4393	0.502057143
58	Debarba and Amado	1	Ultisol	No Data	South America	Santa Maria	Brazil	0.06	1777.6	Conservation	Fallow	10.92375	12.48428571
58	Debarba and Amado	5	Ultisol	No Data	South America	Santa Maria	Brazil	0.06	1778.6	Conventional	Crop	0.1495	0.170857143
58	Debarba and Amado	1	Ultisol	No Data	South America	Santa Maria	Brazil	0.06	1778.6	Conservation	Grassland	0.006875	0.007857143
59	Dedecek	7	Oxisol	No Data	South America	Planaltina	Brazil	0.055	1500	Conservation	Fallow	3.29125	3.761428571
59	Dedecek	35	Oxisol	No Data	South America	Planaltina	Brazil	0.055	1500	Conventional	Crop	0.695625	0.795
59	Dedecek	7	Oxisol	No Data	South America	Planaltina	Brazil	0.055	1500	Conservation	Grassland	0.009375	0.010714286
60	Dedecek	7	Oxisol	No Data	South America	Planaltina	Brazil	0.055	1500	Conventional	Crop	0.372142857	0.425306122
60	Dedecek	1	Oxisol	No Data	South America	Planaltina	Brazil	0.055	1500	Conservation	Fallow	0.708125	0.809285714
60	Dedecek	1	Oxisol	No Data	South America	Planaltina	Brazil	0.055	1500	Conservation	Shrubland	0.105	0.12
61	Eduardo et al.	14	Ultisol	No Data	South America	Seropédica	Brazil	0.09	1100	Conventional	Crop	0.0221875	0.025357143
61	Eduardo et al.	7	Ultisol	No Data	South America	Seropédica	Brazil	0.09	1100	Conservation	Fallow	0.059375	0.067857143
62	Encinas	1	Ultisol	No Data	South America	Coari	Brazil	0.09	2486	Conservation	Fallow	3.69345	4.221085714
62	Encinas	1	Ultisol	No Data	South America	Coari	Brazil	0.09	2486	Conservation	Forest	0.00375	0.004285714
62	Encinas	1	Ultisol	No Data	South America	Coari	Brazil	0.09	2486	Conservation	Grassland	0.01875	0.021428571
63	Falcão Sobrinho	2	Ultisol	No Data	South America	Monsenhor Tabosa	Brazil	0.31	850	Conventional	Crop	0.004375	0.005
63	Falcão Sobrinho	2	Ultisol	No Data	South America	Monsenhor Tabosa	Brazil	0.33	850	Conservation	Shrubland	0.0025	0.002857143
63	Falcão Sobrinho	2	Ultisol	No Data	South America	Monsenhor Tabosa	Brazil	0.31	850	Conservation	Grassland	0.003125	0.003571429
64	Freire et al.	2	Ultisol	No Data	South America	Maringá	Brazil	0.09	1375	Conventional	Crop	0.00540625	0.006178571
64	Freire et al.	1	Ultisol	No Data	South America	Maringá	Brazil	0.09	1375	Conservation	Fallow	0.142975	0.1634
64	Freire et al.	1	Ultisol	No Data	South America	Maringá	Brazil	0.09	1375	Conservation	Grassland	0.00249375	0.00285
65	Guadagnin et al.	40	Inceptisol	No Data	South America	Lages	Brazil	0.1	390	Conservation	Crop	0.32125	0.367142857
66	Guimarães	1.5	Ultisol	No Data	South America	Teixeira de Freitas	Brazil	0.09	1206	Conservation	Fallow	35.46375	40.53
66	Guimarães	1.5	Ultisol	No Data	South America	Teixeira de Freitas	Brazil	0.09	1206	Conservation	Forest	0.00125	0.001428571
66	Guimarães	1.5	Spodosols	No Data	South America	Caravelas	Brazil	0.04	1252	Conservation	Forest	0.001875	0.002142857
66	Guimarães	1.5	Spodosols	No Data	South America	Caravelas	Brazil	0.04	1252	Conservation	Shrubland	0.005	0.005714286
66	Guimarães	1.5	Ultisol	No Data	South America	Teixeira de Freitas	Brazil	0.09	1206	Conservation	Shrubland	0.00625	0.007142857
66	Guimarães	1.5	Spodosols	No Data	South America	Caravelas	Brazil	0.04	1252	Conservation	Fallow	0.015625	0.017857143
67	Guimarães et al.	4	Oxisol	No Data	South America	Alegre	Brazil	0.35	1082	Conventional	Crop	0.02796875	0.031964286
67	Guimarães et al.	1	Oxisol	No Data	South America	Alegre	Brazil	0.35		Conservation	Forest	0	0
68	Hernani et al.	28	Oxisol	No Data	South America	Dourados	Brazil	0.03	1350	Conventional	Crop	0.252640625	0.288732143
69	Hernani et al.	24	Oxisol	No Data	South America	Dourados	Brazil	0.03	1350	Conservation	Crop	0.242359375	0.276982143
70	Lanzanova et al.	16	Alfisol	No Data	South America	Santa Maria	Brazil	0.06	1663	Conservation	Fallow	9.920625	11.33785714
70	Lanzanova et al.	80	Alfisol	No Data	South America	Santa Maria	Brazil	0.06	1663	Conventional	Crop	0.036875	0.042142857
70	Lanzanova et al.	16	Alfisol	No Data	South America	Santa Maria	Brazil	0.06	1663	Conservation	Grassland	0.00875	0.01
71	Leite et al.	1	Oxisol	No Data	South America	Campo Verde	Brazil	0.03	1500	Conservation	Crop	0.01875	0.021428571
72	Lima	14	Entisol	No Data	South America	São Simão	Brazil	0.07	1600	Conservation	Shrubland	0.0071875	0.008214286
72	Lima	3.5	Entisol	No Data	South America	São Simão	Brazil	0.07	1600	Conservation	Fallow	0.06125	0.07
73	Marchioro and Augustin	0.25	Inceptisol	No Data	South America	Gouveia	Brazil	0.06	138	Conservation	Grassland	0.02403	0.027462857
73	Marchioro and Augustin	0.25	Inceptisol	No Data	South America	Gouveia	Brazil	0.27	138	Conservation	Grassland	0.027075	0.030942857
73	Marchioro and Augustin	0.25	Inceptisol	No Data	South America	Gouveia	Brazil	0.22	138	Conservation	Grassland	0.0274075	0.031322857
74	Margolis et al.	48	Alfisol	No Data	South America	Glória do Goitá	Brazil	0.12	959	Conventional	Crop	0.76	0.868571429
75	Marques et al.	2	Oxisol	No Data	South America	Campinas	Brazil	0.09	1400	Conventional	Crop	0.30978125	0.354035714
76	Martins	7	Ultisol	No Data	South America	Aracruz	Brazil	0.02	1078	Conservation	Shrubland	0.0425	0.048571429
76	Martins	7	Ultisol	No Data	South America	Aracruz	Brazil	0.33	1078	Conservation	Fallow	1.653875	1.890142857
76	Martins	7	Oxisol	No Data	South America	Aracruz	Brazil	0.12	1078	Conservation	Forest	0.002625	0.003
76	Martins	7	Ultisol	No Data	South America	Aracruz	Brazil	0.08	1078	Conservation	Forest	0.0029375	0.003357143
76	Martins	7	Ultisol	No Data	South America	Aracruz	Brazil	0.36	1078	Conservation	Forest	0.004375	0.005
76	Martins	7	Ultisol	No Data	South America	Aracruz	Brazil	0.04	1078	Conservation	Fallow	0.132375	0.151285714
76	Martins	7	Oxisol	No Data	South America	Aracruz	Brazil	0.03	1078	Conservation	Fallow	0.0625	0.071428571
76	Martins	7	Oxisol	No Data	South America	Aracruz	Brazil	0.01	1078	Conservation	Shrubland	0.037875	0.043285714
76	Martins	7	Ultisol	No Data	South America	Aracruz	Brazil	0.29	1078	Conservation	Shrubland	0.06125	0.07
77	Martins Filho	1	Entisol	No Data	South America	Brotas	Brazil	0.1	1338.2	Conservation	Shrubland	0.1375	0.157142857
78	Merten et al.	26	Oxisol	No Data	South America	Ponta Grossa	Brazil	0.09	1511	Conservation	Fallow	1.21875	1.392857143
78	Merten et al.	26	Oxisol	No Data	South America	Ponta Grossa	Brazil	0.09	1511	Conventional	Crop	0.075	0.085714286
79	Nacinovic et al.	1	Oxisol	No Data	South America	Teresópolis	Brazil	0.13	1098	Conservation	Crop	0.92370625	1.055664286
79	Nacinovic et al.	2	Oxisol	No Data	South America	Teresópolis	Brazil	0.13	1098	Conservation	Forest	0.00268713	0.003071796
79	Nacinovic et al.	1	Oxisol	No Data	South America	Teresópolis	Brazil	0.13	1098	Conservation	Grassland	0.00284375	0.00325
80	Nagel et al.	0.5	Ultisol	No Data	South America	Aquidauana	Brazil	0.05	1200	Conservation	Fallow	1.2784375	1.461071429
80	Nagel et al.	1.5	Ultisol	No Data	South America	Aquidauana	Brazil	0.05	1200	Conventional	Crop	0.123854167	0.141547619
80	Nagel et al.	0.5	Ultisol	No Data	South America	Aquidauana	Brazil	0.05	1200	Conservation	Grassland	0.02175	0.024857143
81	Nascimento and Lombardi N	6	Oxisol	No Data	South America	Campinas	Brazil	0.1	1300	Conservation	Fallow	1.087375	1.242714286
81	Nascimento and Lombardi N	18	Oxisol	No Data	South America	Campinas	Brazil	0.13	1300	Conventional	Crop	0.233125	0.266428571
82	Oliveira	1.5	Ultisol	No Data	South America	Campo Belo do Sul	Brazil	0.1	1402	Conservation	Fallow	0.916666667	1.047619048
82	Oliveira	1.5	Ultisol	No Data	South America	Campo Belo do Sul	Brazil	0.16	1402	Conservation	Forest	0.000333333	0.000380952
82	Oliveira	1.5	Ultisol	No Data	South America	Campo Belo do Sul	Brazil	0.18	585	Conservation	Forest	0.000416667	0.000476191
82	Oliveira	1.5	Ultisol	No Data	South America	Campo Belo do Sul	Brazil	0.11	1331	Conservation	Forest	0.001666667	0.001904762
82	Oliveira	1.5	Entisol	No Data	South America	Campo Belo do Sul	Brazil	0.06	1290	Conservation	Forest	0.003083333	0.00352381
82	Oliveira	1.5	Ultisol	No Data	South America	Campo Belo do Sul	Brazil	0.16	1373	Conservation	Grassland	0.001166667	0.001333333
83	Oliveira	4	Ultisol	No Data	South America	Terra Dura	Brazil	0.09	1542	Conservation	Fallow	0.438125	0.500714286
83	Oliveira	4	Ultisol	No Data	South America	Terra Dura	Brazil	0.09	1542	Conservation	Forest	0.0023125	0.002642857
83	Oliveira	8	Ultisol	No Data	South America	Terra Dura	Brazil	0.09	1542	Conservation	Shrubland	0.01896875	0.021678571
84	Oliveira et al.	3	Entisol	No Data	South America	Itirapina	Brazil	0.09	1412	Conservation	Fallow	0.869375	0.993571429
84	Oliveira et al.	3	Entisol	No Data	South America	Itirapina	Brazil	0.09	1412	Conservation	Shrubland	0.009375	0.010714286
85	Pereira et al.	1		No Data	South America	Silva Jardim	Brazil	0.09	2143	Conservation	Fallow	0.67	0.765714286
85	Pereira et al.	1		No Data	South America	Silva Jardim	Brazil	0.09	2143	Conservation	Grassland	0.5875	0.671428571
85	Pereira et al.	1.5	Oxisol	No Data	South America	Ubatuba	Brazil	0.04	2067	Conservation	Fallow	0.266875	0.305
86	Pinese Júnior et al.	1.5	Oxisol	No Data	South America	Uberlândia	Brazil	0.05	457.5	Conventional	Crop	6.99792E-06	7.99762E-06
86	Pinese Júnior et al.	1	Oxisol	No Data	South America	Uberlândia	Brazil	0.05	457.5	Conservation	Forest	1.5625E-07	1.78571E-07
86	Pinese Júnior et al.	0.5	Oxisol	No Data	South America	Uberlândia	Brazil	0.05	457.5	Conservation	Grassland	1.0375E-07	1.18571E-07
86	Pinese Júnior et al.	0.5	Oxisol	No Data	South America	Uberlândia	Brazil	0.05	457.5	Conservation	Fallow	9.52588E-05	0.000108867
87	Pires et al.	1	Oxisol	No Data	South America	Belo Oriente	Brazil	0.33	894	Conservation	Fallow	0.3059375	0.349642857
87	Pires et al.	1	Oxisol	No Data	South America	Belo Oriente	Brazil	0.42	894	Conservation	Forest	0.0068125	0.007785714
87	Pires et al.	1	Oxisol	No Data	South America	Belo Oriente	Brazil	0.34	894	Conservation	Shrubland	0.0025625	0.002928571
87	Pires et al.	1	Oxisol	No Data	South America	Belo Oriente	Brazil	0.25	894	Conservation	Grassland	0.00625	0.007142857

87	Pires et al.	1	Oxisol	No Data	South America	Belo Oriente	Brazil	0.31	894	Conservation	Shrubland	0.0125625	0.014357143
87	Pires et al.	1	Oxisol	No Data	South America	Belo Oriente	Brazil	0.36	894	Conservation	Shrubland	0.0366875	0.041928571
88	Prochnow	315	Ultisol	No Data	South America	Pindorama	Brazil	0.1	1444	Conventional	Crop	0.476202381	0.544231293
89	Prochnow et al.	12	Ultisol	No Data	South America	Pindorama	Brazil	0.1	1205	Conservation	Fallow	2.469375	2.822142857
89	Prochnow et al.	60	Ultisol	No Data	South America	Pindorama	Brazil	0.1	1205	Conventional	Crop	0.308125	0.352142857
90	Rieger et al.	1	Oxisol	No Data	South America	Sinop	Brazil	0.02	2209.67	Conservation	Fallow	1.05151875	1.201735714
90	Rieger et al.	2	Oxisol	No Data	South America	Sinop	Brazil	0.02	2209.67	Conventional	Crop	0.03290625	0.037607143
90	Rieger et al.	1	Oxisol	No Data	South America	Sinop	Brazil	0.03	2209.67	Conventional	Forest	0.001175	0.001342857
90	Rieger et al.	1	Oxisol	No Data	South America	Sinop	Brazil	0.02	2209.67	Conservation	Grassland	0.00973125	0.011121429
90	Rieger et al.	1	Oxisol	No Data	South America	Sinop	Brazil	0.02	2209.67	Conservation	Shrubland	0.0121125	0.013842857
91	Santos et al.	1	Inceptisol	No Data	South America	São João del Rei	Brazil	0.15	1435	Conservation	Fallow	9.45	10.8
91	Santos et al.	6	Inceptisol	No Data	South America	São João del Rei	Brazil	0.15	1435	Conservation	Grassland	1.585416667	1.811904762
92	Santos et al.	9	Alfisol	No Data	South America	Sumé	Brazil	0.07	566	Conservation	Fallow	3.25625	3.721428571
92	Santos et al.	14	Alfisol	No Data	South America	Sumé	Brazil	0.04	566	Conservation	Fallow	1.898660714	2.169897959
92	Santos et al.	16	Alfisol	No Data	South America	Sumé	Brazil	0.04	566	Conventional	Crop	0.434375	0.496428571
92	Santos et al.	7	Alfisol	No Data	South America	São João do Cariri	Brazil	0.03	456	Conservation	Fallow	0.2625	0.3
92	Santos et al.	9	Alfisol	No Data	South America	Sumé	Brazil	0.1	566	Conservation	Shrubland	0.00625	0.007142857
92	Santos et al.	9	Alfisol	No Data	South America	Sumé	Brazil	0.04	566	Conservation	Grassland	0.01875	0.021428571
92	Santos et al.	9	Alfisol	No Data	South America	Sumé	Brazil	0.07	566	Conservation	Grassland	0.01875	0.021428571
92	Santos et al.	7	Alfisol	No Data	South America	São João do Cariri	Brazil	0.04	456	Conservation	Grassland	0.0625	0.071428571
93	Santos et al.	1	Vertisols	No Data	South America	Iguatu	Brazil	0.1	1062.6	Conservation	Shrubland	0.1354125	0.154757143
94	Saraiva et al.	1	Oxisol	No Data	South America	Gualba	Brazil	0.12	1317	Conservation	Fallow	9.0271875	10.31678571
94	Saraiva et al.	5	Oxisol	No Data	South America	Gualba	Brazil	0.12	1317	Conventional	Crop	0.156	0.178285714
94	Saraiva et al.	2	Oxisol	No Data	South America	Gualba	Brazil	0.12	1317	Conservation	Grassland	0.0078125	0.008928571
95	Schick et al.	6	Inceptisol	No Data	South America	Lages	Brazil	0.1	1600	Conservation	Fallow	4.38	5.005714286
95	Schick et al.	36	Inceptisol	No Data	South America	Lages	Brazil	0.1	1600	Conventional	Crop	0.193125	0.220714286
96	Schick et al.	20	Inceptisol	No Data	South America	Lages	Brazil	0.1	1356	Conservation	Fallow	5.33125	6.092857143
97	Silva et al.	5	Inceptisol	No Data	South America	Lavras	Brazil	0.15	1287	Conservation	Fallow	12.853125	14.68928571
97	Silva et al.	5	Oxisol	No Data	South America	Lavras	Brazil	0.12	1287	Conservation	Fallow	0.93125	1.064285714
98	Silva et al.	0.5	Oxisol	No Data	South America	São João Evangelista	Brazil	0.2	714	Conservation	Shrubland	0.01624375	0.018564286
99	Silva et al.	5	Oxisol	No Data	South America	Guanhães	Brazil	0.19	1181	Conservation	Grassland	0.0532062	0.060807143
99	Silva et al.	5	Oxisol	No Data	South America	Belo Oriente	Brazil	0.33	1181	Conservation	Fallow	1.088575	1.244085714
99	Silva et al.	5	Oxisol	No Data	South America	Guanhães	Brazil	0.18	1181	Conservation	Fallow	0.3045	0.348
99	Silva et al.	5	Oxisol	No Data	South America	Guanhães	Brazil	0.27	1181	Conservation	Forest	0.0005125	0.000585714
99	Silva et al.	5	Oxisol	No Data	South America	Belo Oriente	Brazil	0.42	1181	Conservation	Forest	0.00421875	0.004821429
99	Silva et al.	15	Oxisol	No Data	South America	Guanhães	Brazil	0.18	1181	Conservation	Shrubland	0.0030604167	0.003497619
99	Silva et al.	5	Oxisol	No Data	South America	Belo Oriente	Brazil	0.36	1181	Conservation	Shrubland	0.00363125	0.00415
99	Silva et al.	5	Oxisol	No Data	South America	Belo Oriente	Brazil	0.31	1181	Conservation	Shrubland	0.00619375	0.007078571
99	Silva et al.	5	Oxisol	No Data	South America	Belo Oriente	Brazil	0.25	1181	Conservation	Grassland	0.01556875	0.017792857
99	Silva et al.	5	Oxisol	No Data	South America	Belo Oriente	Brazil	0.34	1181	Conservation	Shrubland	0.030625	0.035
100	Tenberg et al.	8	Oxisol	No Data	South America	Campinas	Brazil	0.1	1410	Conservation	Fallow	2.777890625	3.174732143
100	Tenberg et al.	24	Oxisol	No Data	South America	Campinas	Brazil	0.1	1410	Conservation	Grassland	1.631927083	1.865059524
101	Thomaz	2	Entisol	No Data	South America	Guarapuava	Brazil	0.71	1538.9	Conventional	Crop	0.22805625	0.260635714
101	Thomaz	1	Entisol	No Data	South America	Guarapuava	Brazil	0.71	1538.9	Conservation	Fallow	0.31905	0.364628571
102	Wichert	1	Ultisol	No Data	South America	Igaratá	Brazil	0.2	1360	Conservation	Fallow	0.68125	0.778571429
102	Wichert	2	Ultisol	No Data	South America	Igaratá	Brazil	0.2	1360	Conservation	Shrubland	0.48	0.548571429
103	Youlton et al.	3	Entisol	No Data	South America	Itirapina	Brazil	0.09	1412	Conservation	Grassland	0.0505375	0.057757143
103	Youlton et al.	3	Entisol	No Data	South America	Itirapina	Brazil	0.09	1412	Conventional	Crop	0.00643125	0.00735
104	Nearing et al.	20		Silt Loam	North America	Hayes	USA	7		Conservation	Grassland	0.051290323	0.061153846
104	Nearing et al.	6		Silt Loam	North America	Lacrosse	USA	16		Conservation	Fallow	27.63010753	32.94358974
104	Nearing et al.	6		Silt Loam	North America	Lacrosse	USA	30		Conservation	Cultivating Across Slope	15.8688172	18.92051282
104	Nearing et al.	6		Sandy Loam	North America	Clemson	USA	7		Conservation	Fallow	5.054166667	5.391111111
104	Nearing et al.	10		Silt Loam	North America	Bethany	USA	8		Conservation	Fallow	11.74258065	14.00076923
104	Nearing et al.	3		Silt Loam	North America	Marcellus, New York	USA	18.4		Conservation	Fallow	11.2	13.35384615
104	Nearing et al.	12		Silt Loam	North America	Holly Springs, Mississippi	USA	5		Conservation	Fallow	11.0827957	13.21410256
104	Nearing et al.	3		Silt Loam	North America	Marcellus, New York	USA	19		Conservation	Fallow	10.9870967	13.1
104	Nearing et al.	20		Silt Loam	North America	Castana	USA	14		Conservation	Fallow	10.71709677	12.77807692
104	Nearing et al.	36		Silt Loam	North America	Lacrosse	USA	16		Conservation	Cultivating Across Slope	10.45143369	12.46132479
104	Nearing et al.	35		Silt Loam	North America	Clarinda, Iowa	USA	9		Conservation	Fallow	8.354101382	9.960659341
104	Nearing et al.	9		Loam	North America	Geneva	USA	5		Conservation	Fallow	4.428673835	4.903174603
104	Nearing et al.	8		Sandy Clay Loam	North America	Statesville	USA	10		Conservation	Fallow	9.0484375	11.49007937
104	Nearing et al.	27		Sandy Loam	North America	Guthrie	USA	7.7		Conservation	Fallow	2.40462963	2.564938272
104	Nearing et al.	18		Silty Clay Loam	North America	Madison	USA	5.8		Conservation	Fallow	2.378853047	2.542911877
104	Nearing et al.	1		Silt Loam	North America	Marcellus, New York	USA	18.4		Conservation	Cultivating Across Slope	4.832258065	5.761538462
104	Nearing et al.	1		Silt Loam	North America	Marcellus, New York	USA	19		Conservation	Cultivating Across Slope	4.058064516	4.838461538
104	Nearing et al.	10		Loam	North America	Morris	USA	6.5		Conservation	Fallow	2.458709677	2.722142857
104	Nearing et al.	24		Sandy Clay Loam	North America	Statesville	USA	10		Conservation	Cultivating Across Slope	4.4640625	5.668650794
104	Nearing et al.	10		Loam	North America	Morris	USA	5.8		Conservation	Fallow	2.148387097	2.378571429
104	Nearing et al.	2		Silt Loam	North America	DixonSprings	USA	9.8		Conservation	Cultivating Across Slope	3.190322581	3.803846154
104	Nearing et al.	20		Loam	North America	Geneva	USA	8		Conservation	Fallow	1.763870968	1.952857143
104	Nearing et al.	2		Silt Loam	North America	DixonSprings	USA	9.7		Conservation	Cultivating Across Slope	2.525806452	3.011538462
104	Nearing et al.	3		No Data	North America	Ithaca	USA	18.9		Conservation	Fallow	1.864583333	2.130952381
104	Nearing et al.	10		Sandy Loam	North America	Guthrie	USA	3.5		Conservation	Cultivating Across Slope	1.035	1.104
104	Nearing et al.	2		Silt Loam	North America	DixonSprings	USA	10.2		Conservation	Cultivating Across Slope	2.258064516	2.692307692
104	Nearing et al.	2		Silt Loam	North America	DixonSprings	USA	10.1		Conservation	Cultivating Across Slope	2.206451613	2.630769231
104	Nearing et al.	15		Sandy Loam	North America	Guthrie	USA	4		Conservation	Cultivating Across Slope	1.005	1.072
104	Nearing et al.	32		Sandy Loam	North America	Watkinsville	USA	7		Conservation	Cultivating Across Slope	0.9578125	1.021666667
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	9.6		Conservation	Cultivating Across Slope	2.032258065	2.423076923
104	Nearing et al.	2		Silt Loam	North America	DixonSprings	USA	8.9		Conservation	Cultivating Across Slope	2.032258065	2.423076923
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	9.7		Conservation	Grassland	1.935483871	2.307692308
104	Nearing et al.	24		Sandy Loam	North America	Watkinsville	USA	11		Conservation	Cultivating Across Slope	0.826041667	0.881111111
104	Nearing et al.	15		Sandy Loam	North America	Guthrie	USA	4.5		Conservation	Cultivating Across Slope	0.794583333	0.847555556
104	Nearing et al.	15		Silt Loam	North America	Presqu	USA	8		Conservation	Fallow	1.617634409	1.928717949
104	Nearing et al.	8		Silt Loam	North America	DixonSprings	USA	5.3		Conservation	Grassland	1.531451613	1.825961538
104	Nearing et al.	3		No Data	North America	Ithaca	USA	18.9		Conservation	Cultivating Across Slope	1.23125	1.407142857
104	Nearing et al.	6		No Data	North America	Ithaca	USA	19.2		Conservation	Fallow	1.197916667	1.369047619
104	Nearing et al.	2		Silt Loam	North America	DixonSprings	USA	10.6		Conservation	Cultivating Across Slope	1.480645161	1.765384615
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	9.8		Conservation	Grassland	1.367741935	1.630769231
104	Nearing et al.	12		Silt Loam	North America	Lacrosse	USA	18		Conservation	Cultivating Across Slope	1.338709677	1.596153846
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	8.9		Conservation	Grassland	1.287096774	1.534615385
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	5.2		Conservation	Grassland	1.280645161	1.526923077
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	5.3		Conservation	Cultivating Across Slope	1.25483871	1.496153846
104	Nearing et al.	8		Silt Loam	North America	DixonSprings	USA	9.6		Conservation	Grassland	1.159677419	1.382692308
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	10.2		Conservation	Grassland	1.15483871	1.376923077
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	10.1		Conservation	Grassland	1.101612903	1.313461538
104	Nearing et al.	2		Silt Loam	North America	DixonSprings	USA	5.2		Conservation	Cultivating Across Slope	1.1	1.311538462
104	Nearing et al.	8		Silt Loam	North America	DixonSprings	USA	5.6		Conservation	Grassland	1.1	1.311538462
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	5.6		Conservation	Cultivating Across Slope	1.083870968	1.292307692
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	10.6		Conservation	Grassland	0.991935484	1.182692308
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	5.1		Conservation	Cultivating Across Slope	0.903225806	1.076923077
104	Nearing et al.	8		Silt Loam	North America	DixonSprings	USA	5.1		Conservation	Grassland	0.849193548	1.0125
104	Nearing et al.	4		Silt Loam	North America	DixonSprings	USA	4.5		Conservation	Grassland	0.817741935	0.975
104	Nearing et al.	2		Silt Loam	North America	DixonSprings	USA	4.5		Conservation	Cultivating Across Slope	0.806451613	0.961538462
104	Nearing et al.	8		Loam	North America	Geneva	USA	8		Conservation	Cultivating Across Slope	0.562096774	0.622321429
104	Nearing et al.	11		Silt Loam	North America	Castana	USA	14		Conservation	Cultivating Across Slope	0.789442815	0.941258741
104	Nearing et al.	16		Loamy Sand	North America	Tifton	USA	3		Conservation	Fallow	0.635227273	0.734545455
104	Nearing et al.	7		Silt Loam	North America	Marcellus, New York	USA	17.6		Conservation	Cultivating Across Slope	0.669124424	0.797802198
104	Nearing et al.	13		Silt Loam	North America	Lacrosse	USA	13		Conservation	Cultivating Across Slope	0.618362283	0.737278107
104	Nearing et al.	11		No Data	North America	Ithaca	USA	18.3		Conservation	Cultivating Across Slope	0.427840909	0.488961039
104	Nearing et al.	10		Loamy Sand	North America	Raleigh	USA	4		Conservation	Cultivating Across Slope	0.430909091	0.497202797
104	Nearing et al.	23		Silt Loam	North America	Clarinda, Iowa	USA	9		Conservation	Grassland	0.443197756	0.528428094
104	Nearing et al.	8		Sandy Loam	North America	Watkinsville	USA	3		Conservation	Cultivating Across Slope	0.26171875	0.279166667
104	Nearing et al.	10		Silt Loam	North America	Bethany	USA	8		Conventional	Crop (Alfalfa)	0.023225806	0.027692308
104	Nearing et al.	6		Loam	North America	Morris	USA	5.9		Conventional	Cultivating Down Slope	0.030107527	0.033333333
104	Nearing et al.	6		Loam	North America	Morris	USA	6.3		Conventional	Cultivating Down Slope	0.039784946	0.044047619
104	Nearing et al.	6		No Data	North America	Ithaca	USA	19.5		Conservation	Grassland	0.295833333	0.338095238
104	Nearing et al.	11		Silt Loam	North America	Clarinda, Iowa	USA	9		Conventional	Crop (Alfalfa)	0.11085044	0.132167832
104	Nearing et al.	10		Loam	North America	Geneva	USA	8		Conventional	Crop (Soybeans)	0.146451613	0.162142857
104	Nearing et al.	1		Silt Loam	North America	Lacrosse	USA	16		Conventional	Crop (Barley)	0.180645161	0.215384615
104	Nearing et al.	17		Silt Loam	North America	Lacrosse	USA	16		Conventional	Crop (Oats)	0.383301708	0.457013575
104	Nearing et al.	6		No Data	North America	Ithaca	USA	20.7		Conservation	Cultivating Across Slope	0.266666667	0.304761905
104	Nearing et al.	24		Silt Loam	North America	Hayes	USA	5		Conventional	Cultivating Down Slope	0.640591398	0.763782051
104	Nearing et al.	30		Silt Loam	North America	Lacrosse	USA	3		Conventional	Cultivating Down Slope	0.666236559	0.794358974
104	Nearing et al.	54		Silty Clay Loam	North America	Madison	USA	5.8		Conventional	Cultivating Down Slope	0.67479092	0.721328225
104	Nearing et al.	25		Silt Loam	North America	Bethany	USA	6.6		Conservation	Cultivating Across Slope	0.279225806	0.332923077
104	Nearing et al.	24		Silt Loam	North America	Hayes	USA	5		Conservation	Cultivating Across Slope	0.277688172	0.331089744
104	Nearing et al.	32		Sandy Loam	North America	Watkinsville	USA	11		Conservation	Grassland	0.188085938	0.200625
104	Nearing et al.	4		Silt Loam	North America	Holly Springs, Mississippi	USA	5		Conventional	Cultivating Down Slope	1.058064516	1.261538462
104	Nearing et al.	30		Silt Loam	North America	Presqu	USA	8		Conventional	Cultivating Down Slope	1.112903226	1.326923077
104	Nearing et al.	7		Silt Loam	North America	Marcellus, New York	USA	16.8		Conservation	Cultivating Across Slope	0.215668203	0.257142857
104	Nearing et al.	30		Silt Loam	North America	Lacrosse	USA	8		Conventional	Cultivating Down Slope	1.669677419	1.990782231
104	Nearing et al.	7		Silt Loam	North America	Marcellus, New York	USA	16.4		Conservation	Cultivating Across Slope	0.189861751	0.226373626
104	Nearing et al.	90		Silt Loam	North America	Temple	USA	4		Conventional	Cultivating Down Slope	2.165734767	2.582222222
104	Nearing et al.	30		Silt Loam	North America	Lacrosse	USA	13		Conventional	Cultivating Down Slope	3.480645161	4.15
104	Nearing et al.	81		Sandy Loam	North America	Guthrie	USA	7.7		Conventional	Cultivating Down Slope	3.605401235	3.845761317
104	Nearing et al.	95		Silt Loam	North America	Clarinda, Iowa	USA	9		Conventional	Cultivating Down Slope	4.109259949	4.89951417
104	Nearing et al.	31		Silt Loam	North America	Lacrosse	USA	18		Conventional	Cultivating Down Slope	4.506139438	5.372704715
104	Nearing et al.	21		Silt Loam	North America	Clarinda, Iowa	USA	8		Conventional	Cultivating Down Slope	5.017511521	5.982417582
104	Nearing et al.	5		Sandy Loam	North America	Guthrie	USA	3		Conservation	Cultivating Across Slope	0.12875	0.137333333
104	Nearing et al.	5		Silt Loam	North America	Lacrosse	USA	18		Conservation	Grassland	0	0
104	Nearing et al.	6		Silt Loam	North America	Lacrosse	USA	8		Conservation	Grassland	0	0
104	Nearing et al.	6		Silt Loam	North America	Lacrosse	USA	3		Conservation	Grassland	0	0
104	Nearing et al.	5		Silt Loam	North America	Lacrosse	USA	13		Conservation	Grassland	0	0
104	Nearing et al.	1		Silt Loam	North America	Marcellus, New York	USA	18.9		Conservation	Cultivating Across Slope	0	0
104	Nearing et al.	12		Silt Loam	North America	Lacrosse	USA	8		Conservation	Cultivating Across Slope	0.135483871	0.161538462
104	Nearing et al.	10		Loam	North America	Geneva	USA	8		Conservation	Grassland	0.003225806	0.003571429
104	Nearing et al.	4		Loam	North America	Morris	USA	6.3		Conservation	Grassland	0.003225806	0.003571429
104	Nearing et al.	4		Loam	North America	Morris	USA	5.9		Conservation	Grassland	0.003225806	0.003571429
104	Nearing et al.	7		Silt Loam	North America	Marcellus, New York	USA	3.9		Conservation	Cultivating Across Slope	0.005529954	0.006593407
104	Nearing et al.	7		Silt Loam	North America	Marcellus, New York	USA	4.5		Conservation	Cultivating Across Slope	0.008294931	0.00989011
104	Nearing et al.	6		Silt Loam	North America	Lacrosse	USA	30		Conservation	Grassland	0.009677419	0.011538462
104	Nearing et al.	9		Silt Loam	North America	Castana	USA	14		Conservation	Grassland	0.010035842	0.011965812
104	Nearing et al.	84		Loamy Sand	North America	Tifton	USA	3		Conservation	Cultivating Across Slope	0.103463203	0.119380619
104	Nearing et al.	1		Silt Loam	North America	Marcellus, New York	USA	18		Conservation	Cultivating Across Slope	0.012903226	0.015384615
104	Nearing et al.	2		Silt Loam	North America	Clarinda, Iowa	USA	9		Conservation	Cultivating Across Slope	0.016129032	0.019230769
104	Nearing et al.	7		Silt Loam	North America	Marcellus, New York	USA	5		Conservation	Cultivating Across Slope	0.016589862	0.019780220
104	Nearing et al.	7		Silt Loam	North America	Marcellus, New York	USA	8.8		Conservation	Cultivating Across Slope	0.017511521	0.020879121
104	Nearing et al.	8		Silt Loam	North America	Holly Springs, Mississippi	USA	5		Conservation	Grassland	0.090322581	0.107692308
104	Nearing et al.	3		Silt Loam	North America	Marcellus, New York	USA	18		Conservation	Grassland	0.019354839	0.023076923
104	Nearing et al.	32		Sandy Loam	North America	Watkinsville	USA	7		Conservation	Grassland	0.081835938	0.087291667
104	Nearing et al.	20		Loamy Sand	North America	Tifton	USA	3		Conservation	Grassland	0.081515152	0.094055944
104	Nearing et al.	3		Silt Loam	North America	Marcellus, New York	USA	18.9		Conservation	Grassland	0.023655914	0.028205128
104	Nearing et al.	14		Silt Loam	North America	Marcellus, New York	USA	9.4		Conservation	Cultivating Across Slope	0.026728111	0.031868132
104	Nearing et al.	12		Silt Loam	North America	Lacrosse	USA	3		Conservation	Cultivating Across Slope	0.029032258	0.034615385
104	Nearing et al.	5		Silt Loam	North America	Bethany	USA	6.6		Conservation	Grassland	0.029677419	0.035384615
104	Nearing et al.	42		Silt Loam	North America	Lacrosse	USA	16		Conservation	Grassland	0.035023041	0.041758242
105	Prashun	1		Sandy Loam	Europe and Middle East	Napfbergland, Napf Highland	Switzerland		1200	Conservation	Fallow	0.9375	1
105	Prashun	1		Clay Loam	Europe and Middle East	Jura I, Swiss Jura Plateau	Switzerland		1150	Conservation	Fallow	0.866666667	0.928571429
105	Prashun	1		Silt Loam	Europe and Middle East	Hochrhein II, High Rhine Valley	Switzerland			Conservation	Fallow	1.419354839	1.692307692
105	Prashun	1		Clay Loam	Europe and Middle East	Jura II, Swiss Jura Plateau	Switzerland		1100	Conservation	Fallow	0.4	0.428571429
105	Prashun	1		Silt Loam	Europe and Middle East	Hochrhein I, High Rhine Valley	Switzerland		1000	Conservation	Fallow	0.580645161	0.692307692
106	Maass	1	Entisols	No Data	North America	Chamela, Jalisco	Mexico	50	733	Conservation	Cover Crop	0.3125	0.357142857
106	Maass	1	Entisols	No Data	North America	Chamela, Jalisco	Mexico	50	733	Conventional	Crop	6.2375	7.128571429
106	Maass	1	Entisols	No Data	North America	Chamela, Jalisco	Mexico	50	733	Conservation	Forest	0.0125	0.014285714

107	Rodriguez and De La Paz	1	Aquic Paleudult	No Data	South America	Bajo Seco	Venezuela	15	865	Conventional	Conventional Tillage	1.2625	1.442857143
107	Rodriguez and De La Paz	6	Aquic Paleudult	No Data	South America	Bajo Seco	Venezuela	15	865	Conventional	Crop	3.082291667	3.522619048
107	Rodriguez and De La Paz	3	Aquic Paleudult	No Data	South America	Bajo Seco	Venezuela	20	865	Conventional	Crop	3.84375	4.392857143
108	Bekele and Thomas	4	Humic Nitosols	Clay	sub-Saharan Africa	Kabete, Nairobi	Kenya		1030	Conventional	Conventional Tillage	24.93705036	27.73
109	Temple	2		Sandy Loam	sub-Saharan Africa	Mpwapwa	Tanzania	3.5	690	Conservation	Contour Ridges	4.875	5.2
109	Temple	10		Clay Loam	sub-Saharan Africa	Lyamungu, Moshi	Tanzania	9.5	1660	Conservation	Cover Crop	0.211	0.226071429
109	Temple	10		Clay Loam	sub-Saharan Africa	Lyamungu, Moshi	Tanzania	9.5	1660	Conservation	Contour Ridges	0.184	0.197142857
109	Temple	3	Andisol	No Data	sub-Saharan Africa	Tengeru, Arusha	Tanzania	18	1300	Conventional	Crop (Bananas and Banana Mulch)	0.046875	0.053571429
109	Temple	3	Andisol	No Data	sub-Saharan Africa	Tengeru, Arusha	Tanzania	18	1300	Conventional	Crop	0.675	0.771428571
109	Temple	3	Andisol	No Data	sub-Saharan Africa	Tengeru, Arusha	Tanzania	18	1300	Conventional	Crop (Maize)	1.125	1.285714286
109	Temple	3	Andisol	No Data	sub-Saharan Africa	Tengeru, Arusha	Tanzania	18	1300	Conventional	Crop (Coffee)	2.1	2.4
109	Temple	8		Sandy Loam	sub-Saharan Africa	Mpwapwa	Tanzania	3.5	780	Conventional	Crop (Sorghum)	3.420703125	3.64875
109	Temple	4		Sandy Loam	sub-Saharan Africa	Mpwapwa	Tanzania	3.5	690	Bare	Bare soil	8.58046875	9.1525
109	Temple	6		No Data	sub-Saharan Africa	Rhodesia	Zimbabwe	1.5-3.5	1000	Bare	Bare Soil	13.246875	15.13928571
109	Temple	3	Andisol	No Data	sub-Saharan Africa	Tengeru, Arusha	Tanzania	18	1300	Conservation	Grassland	0	0
109	Temple	4		Sandy Loam	sub-Saharan Africa	Mpwapwa	Tanzania	4.5	690	Conservation	Forest	0	0
109	Temple	18		Sandy Loam	sub-Saharan Africa	Mpwapwa	Tanzania	3.5	690	Conservation	Grassland	0.106770833	0.113888889
109	Temple	6		No Data	sub-Saharan Africa	Rhodesia	Zimbabwe	1.5-3.5	1000	Conservation	Wire Gauze Cover	0.109375	0.125
110	Duran Zuazo et al.	64	Typic Xerorthent	Loam	Europe and Middle East	Lanjaron-Las Alpujarras, Granada	Spain	20	442	Conventional	Crop	0.062056814	0.068705758
111	Chirino et al.	3		Loam	Europe and Middle East	Ventos-Agost, Alicante	Spain	22	291.7	Bare	Bare Soil	0.067853196	0.067853196
111	Chirino et al.	3		Loam	Europe and Middle East	Ventos-Agost, Alicante	Spain	21	291.7	Conservation	Shrubland	0.000689952	0.000689952
111	Chirino et al.	3		Loam	Europe and Middle East	Ventos-Agost, Alicante	Spain	23	291.7	Conservation	Grassland	0.001249051	0.001249051
111	Chirino et al.	3		Loam	Europe and Middle East	Ventos-Agost, Alicante	Spain	26	291.7	Conservation	Grassland	0.001272842	0.001272842
111	Chirino et al.	3		Loam	Europe and Middle East	Ventos-Agost, Alicante	Spain	29	291.7	Conservation	Shrubland	0.001498861	0.001498861
112	Borst et al	18		Silt Loam	North America	Zanesville, Ohio	USA	12	1041.4	Conventional	Crop	2.084921749	2.485868239
112	Borst et al	9		Silt Loam	North America	Zanesville, Ohio	USA	14	1041.4	Conventional	Crop	2.738151412	3.264139991
112	Borst et al	9		Silt Loam	North America	Zanesville, Ohio	USA	8	1041.4	Conventional	Crop (Corn)	11.22170552	13.37972581
112	Borst et al	36		Silt Loam	North America	Zanesville, Ohio	USA	12	1041.4	Conventional	Crop (Corn)	15.25611342	18.18998138
112	Borst et al	9		Silt Loam	North America	Zanesville, Ohio	USA	20	1041.4	Conventional	Crop (Corn)	17.43482689	20.78767821
112	Borst et al	9		Silt Loam	North America	Zanesville, Ohio	USA	12	1041.4	Bare	Bare Soil	157.1022831	187.3142606
112	Borst et al	9		Silt Loam	North America	Zanesville, Ohio	USA	14	1041.4	Conservation	Woodland	0.001948459	0.002323162
112	Borst et al	27		Silt Loam	North America	Zanesville, Ohio	USA	12	1041.4	Conservation	Grassland	0.003920535	0.004674484
112	Borst et al	9		Silt Loam	North America	Zanesville, Ohio	USA	14	1041.4	Conservation	Grassland	0.016030502	0.019113291
113	McGregor et al.	9	Typic Fragiudalfs	Silt Loam	North America	Holly Springs, Mississippi	USA	5	1386	Conservation	Zero Till	0.203584229	0.242735043
113	McGregor et al.	6	Typic Fragiudalfs	Silt Loam	North America	Holly Springs, Mississippi	USA	5	1386	Conventional	Conventional Tillage	1.953763441	2.329487179
114	Kramer	24	Udollic Ochraqualfs	Silt Loam	North America	Kingdom City, Columbia, Missouri	USA	3.5	894	Conventional	Conventional Tillage	0.173459288	0.206818643
114	Kramer	48	Udollic Ochraqualfs	Silt Loam	North America	Kingdom City, Columbia, Missouri	USA	3.5	894	Conservation	Conservation Tillage	0.069947323	0.083398731
115	McGregor et al.	12	Typic Fragiudalfs	Silt Loam	North America	Holly Springs, Mississippi	USA	5	1350	Conservation	Zero Till	0.191303226	0.228092308
115	McGregor et al.	3	Typic Fragiudalfs	Silt Loam	North America	Holly Springs, Mississippi	USA	5	1350	Conventional	Conventional Tillage	1.243470968	1.4826
116	McGregor et al.	5	Typic Fragiudalfs	Silt Loam	North America	Holly Springs, Mississippi	USA	5	1350	Conservation	Zero Till	0.049548387	0.059076923
116	McGregor et al.	5	Typic Fragiudalfs	Silt Loam	North America	Holly Springs, Mississippi	USA	5	1350	Conventional	Conventional Tillage	1.384129032	1.650307692
116	McGregor et al.	3	Typic Fragiudalfs	Silt Loam	North America	Holly Springs, Mississippi	USA	7.8	1350	Conservation	Conservation Tillage	0.092473118	0.11025641
117	Mutchler et al.	4	Typic Fragiudalfs	Silt Loam	North America	Holly Springs, Mississippi	USA	5	1364	Conservation	Zero Till	1.122193548	1.338
117	Mutchler et al.	5	Typic Fragiudalfs	Silt Loam	North America	Holly Springs, Mississippi	USA	5	1343	Conservation	Conservation Tillage	0.826696774	0.985676923
117	Mutchler et al.	6	Typic Fragiudalfs	Silt Loam	North America	Holly Springs, Mississippi	USA	5	1365	Conventional	Conventional Tillage	4.516419355	5.384961538
118	bu	16	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	15*	1016	Conservation	Contour Cultivation	2.14578125	2.452321429
118	bu	4	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	15*	1016	Conventional	Crop	3.87375	4.427142857
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	19*	661.8	Conventional	Orchard	0.006451613	0.007142857
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	27.03*	661.8	Bare	Bare soil	0.009032258	0.01
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	16.82*	661.8	Conventional	Orchard	0.018064516	0.02
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	11.67*	661.8	Conventional	Orchard	0.021290323	0.023571429
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	16.8*	661.8	Conventional	Orchard	0.026451613	0.029285714
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	3.83*	661.8	Conventional	Crop	0.075483871	0.083571429
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	16.78*	661.8	Conventional	Crop	0.336129032	0.372142857
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	17.2*	661.8	Conservation	Forest	0.004516129	0.005
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	19*	661.8	Conservation	Forest	0.004516129	0.005
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	27.03*	661.8	Conservation	Forest	0.006451613	0.007142857
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	19.5*	661.8	Conservation	Grassland	0.005806452	0.006428571
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	9.67*	661.8	Conservation	Grassland	0.006451613	0.007142857
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	27.03*	661.8	Conservation	Grassland	0.01483871	0.016428571
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	3.83*	661.8	Conservation	Terracing	0.023070968	0.025428571
119	Cai	5	(stone_zone)	Loam	Asia and Australia	miyun beijing	China	6.05*	661.8	Conservation	Zero Till	0.072258065	0.08
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Conservation	Terracing	0.048125	0.055
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	meihekou jilin	China	7*		Conservation	Cultivating Across Slope	0.70875	0.81
120	Chen et al.	4	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Conservation	Grassland	0.599375	0.685
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	zhalantun neimonggu	China	7*		Conservation	Cultivating Across Slope	0.474375	0.542142857
120	Chen et al.	5	(black_soil)	No Data	Asia and Australia	zhalantun neimonggu	China	7*		Conservation	Grassland	0.463625	0.529857143
120	Chen et al.	4	(black_soil)	No Data	Asia and Australia	meihekou jilin	China	7*		Conservation	Grassland	0.3078125	0.351785714
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Conservation	Cultivating Across Slope	0.16375	0.187142857
120	Chen et al.	1	(black_soil)	No Data	Asia and Australia	zhalantun neimonggu	China	7*		Bare	Bare soil	1.5375	1.757142857
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	zhalantun neimonggu	China	7*		Conventional	Crop	1.578125	1.803571429
120	Chen et al.	1	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Bare	Bare soil	1.64125	1.875714286
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Conventional	Crop	1.924375	2.199285714
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	meihekou jilin	China	7*		Conventional	Crop	2.640625	3.017857143
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	meihekou jilin	China	7*		Bare	Bare soil	3.605	4.12
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	meihekou jilin	China	7*		Conservation	Contour Cultivation	0.000625	0.000714286
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	meihekou jilin	China	7*		Conservation	Terracing	0.1175	0.134285714
120	Chen et al.	2	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Conservation	Contour Cultivation	0.019375	0.022142857
120	Chen et al.	1	(black_soil)	No Data	Asia and Australia	zhalantun neimonggu	China	7*		Conservation	Terracing	0.0625	0.071428571
121	Chen	18	(red_soil)	No Data	Asia and Australia	fu'an fujian	China	18*		Conventional	Orchard	0.3121875	0.356785714
122	Chen and Dai	6	(red_soil)	No Data	Asia and Australia	nan'an fujian	China	9*	1610	Conventional	Orchard	0.13496246	0.134962406
123	Chen	6	(red_soil)	No Data	Asia and Australia	changding fujian	China	14*	1700	Conservation	Grassland	0.475684932	0.475684932
123	Chen	1	(Yun_Gui_Plateau)	No Data	Asia and Australia	yao'an yunnan	China	14*	886.9	Conventional	Crop	0.129375	0.147857143
123	Chen	2	(Yun_Gui_Plateau)	No Data	Asia and Australia	yao'an yunnan	China	14*	886.9	Conservation	Terracing	0.031875	0.036428571
124	Chen et al.	4	(black_soil)	No Data	Asia and Australia	be'an heilongjiang	China	3*	553	Conservation	Crop	0.144375	0.165
124	Chen et al.	6	(black_soil)	No Data	Asia and Australia	be'an heilongjiang	China	3*	553	Conservation	Contour Cultivation	0.023333333	0.026666667
125	Chen et al.	1	(red_soil)	clay	Asia and Australia	dean jiangxi	China	10*	1350.9	Conservation	Contour Cultivation	0.284172662	0.316
125	Chen et al.	1	(Yun_Gui_Plateau)	clay	Asia and Australia	yunnan	China	15*	785.1	Conservation	Terracing	0.141007194	0.1568
125	Chen et al.	20	(red_soil)	Sandy Loam	Asia and Australia	huoshan anhui	China	8*		Conventional	Orchard	0.329375	0.351333333
125	Chen et al.	20	(red_soil)	Sandy Loam	Asia and Australia	huoshan anhui	China	8*		Conventional	Crop	3.764375	4.015333333
125	Chen et al.	20	(red_soil)	Sandy Loam	Asia and Australia	huoshan anhui	China	8*		Conservation	Terracing	0.075	0.08
125	Chen et al.	1	(red_soil)	clay	Asia and Australia	dean jiangxi	China	10*	1350.9	Conservation	Cultivating Across Slope	0.064028777	0.0712
126	Chen et al.	1	(black_soil)	clay	Asia and Australia	hailun helongjiang	China	5*	530	Conservation	Conservation Tillage	0.271942446	0.3024
126	Chen et al.	1	(black_soil)	clay	Asia and Australia	hailun helongjiang	China	5*	530	Conservation	Zero Till	7.19424E-05	0.00008
126	Chen et al.	1	(black_soil)	clay	Asia and Australia	hailun helongjiang	China	5*	530	Conventional	Crop	0.442446043	0.492
127	Chen et al.	8	(purple_soil)	Sandy Loam	Asia and Australia	jianyang sichuan	China	20*	890	Conservation	Contour Cultivation	1.18359375	1.2625
127	Chen et al.	4	(purple_soil)	Sandy Loam	Asia and Australia	jianyang sichuan	China	20*	890	Conservation	Terracing	0.715625	0.763333333
127	Chen et al.	8	(purple_soil)	Sandy Loam	Asia and Australia	jianyang sichuan	China	12*	890	Conservation	Contour Cultivation	0.2278125	0.243
127	Chen et al.	4	(purple_soil)	Sandy Loam	Asia and Australia	jianyang sichuan	China	12*	890	Conventional	Crop	0.404375	0.431333333
127	Chen et al.	4	(purple_soil)	Sandy Loam	Asia and Australia	jianyang sichuan	China	20*	890	Conventional	Crop	3.6734375	3.918333333
128	Chen et al.	2	(stone_zone)	No Data	Asia and Australia	fuxin liaoning	China	12*	524	Conservation	Cultivating Across Slope	1.898125	2.169285714
128	Chen et al.	5	(stone_zone)	No Data	Asia and Australia	fuxin liaoning	China	12*	524	Conservation	Grassland	0.627375	0.717
128	Chen et al.	2	(stone_zone)	No Data	Asia and Australia	fuxin liaoning	China	12*	524	Conventional	Crop	2.558125	2.923571429
128	Chen et al.	2	(stone_zone)	No Data	Asia and Australia	fuxin liaoning	China	12*	524	Conservation	Terracing	0.06	0.068571429
129	Cui et al.	3	(loess_plateau)	No Data	Asia and Australia	xixian shanxi	China	10*	513	Conventional	Crop	0.1675	0.191428571
129	Cui et al.	3	(loess_plateau)	No Data	Asia and Australia	xixian shanxi	China	10*	513	Conservation	Zero Till	0.0565625	0.076071429
130	Fan et al.	7	(stone_zone)	No Data	Asia and Australia	miyun beijing	China	17.2*	1535	Conservation	Forest	0	0
130	Fan et al.	7	(stone_zone)	No Data	Asia and Australia	miyun beijing	China	27*		Conservation	Forest	0.0000625	7.14286E-05
130	Fan et al.	7	(stone_zone)	No Data	Asia and Australia	miyun beijing	China	9.6*		Conservation	Forest	0.00125	0.001428571
130	Fan et al.	7	(stone_zone)	No Data	Asia and Australia	miyun beijing	China	16.8*		Conservation	Forest	0.028125	0.032142857
130	Fan et al.	7	(stone_zone)	No Data	Asia and Australia	miyun beijing	China	3.8*		Conservation	Crop	0.716875	0.819285714
130	Fan et al.	7	(stone_zone)	No Data	Asia and Australia	miyun beijing	China	3.8*		Conservation	Terracing	0.02625	0.03
132	Feng et al.	1	(Yun_Gui_Plateau)	No Data	Asia and Australia	zanyi yunnan	China	20*		Conservation	Terracing	0.1575	0.18
132	Feng et al.	1	(Yun_Gui_Plateau)	No Data	Asia and Australia	zanyi yunnan	China	20*		Conventional	Crop	0.996875	1.139285714
133	Fu et al.	2	(loess_plateau)	No Data	Asia and Australia	ansai shaanxi	China	24*		Conservation	Cultivating Across Slope	0.754375	0.862142857
133	Fu et al.	2	(loess_plateau)	No Data	Asia and Australia	ansai shaanxi	China	25*		Conservation	Cultivating Across Slope	0.475625	0.543571429
133	Fu et al.	2	(loess_plateau)	No Data	Asia and Australia	ansai shaanxi	China	20*		Conservation	Cultivating Across Slope	0.4325	0.494285714
133	Fu et al.	2	(loess_plateau)	No Data	Asia and Australia	ansai shaanxi	China	30*		Conservation	Cultivating Across Slope	0.410625	0.469285714
133	Fu et al.	2	(loess_plateau)	No Data	Asia and Australia	ansai shaanxi	China	15*		Conservation	Cultivating Across Slope	0.265625	0.303571429
133	Fu et al.	2	(loess_plateau)	No Data	Asia and Australia	ansai shaanxi	China	10*		Conservation	Cultivating Across Slope	0.164375	0.187857143
134	Fu et al.	6	(stone_zone)	No Data	Asia and Australia	yanqing beijing	China	15*	475	Conservation	Fallow	2.443125	2.792142857
134	Fu et al.	12	(stone_zone)	No Data	Asia and Australia	yanqing beijing	China	15*	475	Conservation	Forest	0.1475	0.168571429
134	Fu et al.	6	(stone_zone)	No Data	Asia and Australia	yanqing beijing	China	15*	475	Bare	Bare soil	0.230625	0.263571429
134	Fu et al.	6	(stone_zone)	No Data	Asia and Australia	yanqing beijing	China	15*	475	Conservation	Contour Ridges	0.07625	0.087142857
135	Fu et al.	8	(Yun_Gui_Plateau)	No Data	Asia and Australia	qingzhen guizhou	China	15*	1100	Conservation	Terracing	0.048125	0.055
135	Fu et al.	8	(Yun_Gui_Plateau)	No Data	Asia and Australia	qingzhen guizhou	China	8*	1100	Conventional	Crop	0.330625	0.377857143
135	Fu et al.	4	(Yun_Gui_Plateau)	No Data	Asia and Australia	qingzhen guizhou	China	15*	1100	Conventional	Crop	1.785	2.04
135	Fu et al.	8	(Yun_Gui_Plateau)	No Data	Asia and Australia	qingzhen guizhou	China	8*	1100	Conservation	Terracing	0.0246875	0.028214286
136	Gu et al.	3	(stone_zone)	No Data	Asia and Australia	chicheng hebei	China	11*	415.2	Conservation	Forest	0.121875	0.139285714
137	guan	9	(Yun_Gui_Plateau)	No Data	Asia and Australia	baoshan yunnan	China	23.5*	953	Conservation	Forest	0.140064103	0.140064103
138	guo	2	(loess_plateau)	No Data	Asia and Australia	dingxi gansu	China	11.5*	415.2	Conventional	Crop	0.01625	0.018571429
138	guo	4	(loess_plateau)	No Data	Asia and Australia	dingxi gansu	China	11.5*	415.2	Conservation	Zero Till	0.00625	0.007142857
139	Han et al.	5	(stone_zone)	sandy loam	Asia and Australia	mentougou beijing	China	15*		Conservation	Terracing	0.397103993	0.397103993
139	Han et al.	5	(stone_zone)	sandy loam	Asia and Australia	mentougou beijing	China	15*		Conventional	Crop	0.127248793	0.127248793
139	Han et al.	5	(stone_zone)	sandy loam	Asia and Australia	mentougou beijing	China	15*		Conventional	Orchard	0.252303642	0.252303642
139	Han et al.	5	(stone_zone)	sandy loam	Asia and Australia	mentougou beijing	China	15*		Bare	Bare soil	0.995319585	0.995319585
140	He et al.	2	(stone_zone)	No Data	Asia and Australia	huaian hebei	China	7*	383.5	Conservation	Grassland	0.050625	0.057857143
140	He et al.	2	(stone_zone)	sandy loam	Asia and Australia	chongli hebei	China	17*	488	Conservation	Grassland	1.36	1.450666667
140	He et al.	2	(stone_zone)	Loam	Asia and Australia	chicheng hebei	China	20*	417.4	Conservation	Shrubland	0.715483871	0.792142857
140	He et al.	2	(stone_zone)	Loam	Asia and Australia	chicheng hebei	China	9*	417.4	Conservation	Grassland	0.574193548	0.635714286
140	He et al.	2	(stone_zone)	No Data	Asia and Australia	huaian hebei	China	23*	383.5	Conservation	Grassland	0.306875	0.350714286
140	He et al.	2	(stone_zone)	Sand	Asia and Australia	wanquan hebei	China	0*	1082	Conservation	Terracing	0	0
140	He et al.	2	(stone_zone)	sandy loam	Asia and Australia	chongli hebei	China	0*	488	Conservation	Terracing	0.00125	0.001333333
140	He et al.	2	(stone_zone)	No Data	Asia and Australia	huaian hebei	China	7*	383.5	Conservation	Forest	0.0475	0.054285714
140	He et al.	4	(stone_zone)	Loam	Asia and Australia	chicheng hebei	China	19*	417.4	Conservation	Forest	0.710967742	0.787142857
140	He et al.	2	(stone_zone)	sandy loam	Asia and Australia	chongli hebei	China	8*	488	Conservation	Forest	0.5125	0.546666667
140	He et al.	2	(stone_zone)	Loam	Asia and Australia	chicheng hebei	China	0*	417.4	Conservation	Forest	0.193548387	0.214285714
140	He et al.	2	(stone_zone)	Sand	Asia and Australia	wanquan hebei	China	5*	464	Conservation	Forest	0.184117647	0.217361111
140	He et al.	4	(stone_zone)	Sand	Asia and Australia	wanquan hebei	China	18*	464	Conservation	Forest	0.011176471	0.013194444
140	He et al.	2	(stone_zone)	No Data	Asia and Australia	huaian hebei	China	23*	383.5	Conservation	Forest	0.016875	0.019285714
140	He et al.	2	(stone_zone)	sandy loam	Asia and Australia	chongli hebei	China	17*	488	Conservation	Forest	0.078125	0.083333333
140	He et al.	2	(stone_zone)	No Data	Asia and Australia	huaian hebei	China	23*	383.5	Conservation	Shrubland	0.01125	0.012857143
140	He et al.	2	(stone_zone)	sandy loam	Asia and Australia	chongli hebei	China	17*	488	Conservation	Shrubland	0.033125	0.035333333
140	He et al.	4	(stone_zone)	Sand	Asia and Australia	wanquan hebei	China	18*	464	Conservation	Grassland	0.033529412	0.039583333
141	Huang et al.	20	(red_soil)	clay	Asia and Australia	youxi fujian	China	15*	1700	Conservation	Grassland	2.156967213	2.156967213
141	Huang et al.	2	(Yun_Gui_Plateau)	No Data	Asia and Australia	xingwen jiangxi	China	5*	1659	Conservation	Terracing	0.3775	0.431428571
142	Huang et al.	24	(red_soil)	No Data	Asia and Australia	fuzhou fujian	China	23*		Conventional	Orchard	1.526875	1.745
143	Huang et al.	1	(purple_soil)	No Data	Asia and Australia	kaixian sichuan	China	25*	1006	Conservation	Contour Cultivation	0.001875	0.002142857
144	Huang	2	(red_soil)	No Data	Asia and Australia	ninghua fujian	China	15*		Conservation	Forest	0.13625	0.155714286
144	Huang	2	(red_soil)	No Data	Asia and Australia	ninghua fujian	China	15*		Conventional	Orchard	0.0305625	0.034928571
144	Huang	1	(red_soil)	No Data	Asia and Australia	ninghua fujian	China	15*		Conventional	Crop	0.25125	0.29857143
144	Huang	1	(red_soil)	No Data	Asia and Australia	ninghua fujian	China	15*		Conservation	Cultivating Across Slope	0.101875	0.116428571
145	Huang et al.	5	(Yun_Gui_Plateau)	Loam	Asia and Australia	songyao guizhou	China	0*	1400	Conservation	Terracing	0.000645161	0.000714286
145	Huang et al.	5	(Yun_Gui_Plateau)	Loam	Asia and Australia	songyao guizhou	China	21.1*	1400	Conventional	Crop	0.00516129	0.005714286
146	Jiang and Shao	3	(purple_soil)	No Data	Asia and Australia	zhongxian chongqin	China	11*		Conventional	Orchard	0.814814815	0.814814815
147	Jiang et al.	1	(black_soil)	clay	Asia and Australia	keshan helongjiang	China	3*	479.4	Conservation	Cultivating Across Slope	0.000300882	0.000300882
147	Jiang et al.	1	(black_soil)	clay	Asia and Australia	keshan helongjiang	China	5*	479.4	Conservation	Contour Cultivation	0.000610294	0.000610294
147	Jiang et al.	1	(black_soil)	clay	Asia and Australia	keshan helongjiang	China	3*	479.4	Conventional	Crop	1.297794118	1.297794118
147	Jiang et al.	1	(black_soil)	clay	Asia and Australia	keshan helongjiang	China	5*	479.4	Conventional	Crop	3.810294118	3.810294118
149	Lan et al.	1	(stone_zone)	No Data	Asia and Australia	fuxin liaoning	China	12*	524	Conservation	Grassland	1.784375	2.039285714
149	Lan et al.	1	(stone_zone)	No Data	Asia and Australia	fuxin liaoning	China	12*	524	Conservation	Cultivating Across Slope	1.50375	1.718571429
149	Lan et al.	1	(stone_zone)	No Data	Asia and Australia	fuxin liaoning	China	12*	524	Conservation	Contour Cultivation	0.4025	0.46
149	Lan et al.	2	(stone_zone)	No Data	Asia and Australia	fuxin liaoning	China	12*	524	Conservation	Terracing	0.223125	0.255
149	Lan et al.	1	(stone_zone)	No Data	Asia and Australia	fuxin liaoning	China	12*	524	Conventional	Crop	2.0575	2.351428571

149	Lan et al.	1	(stone_zone)	No Data	Asia and Australia	fuxin liaoning	China	12*	524	Bare	Bare soil	2.515625	2.875		
150	Li et al.	6	(purple_soil)	loam	Asia and Australia	yongchuan chongqin	China	20*	1068.2	Conventional	Orchard	0.008172043	0.009047619		
151	Li et al.	10	(purple_soil)	No Data	Asia and Australia	nanbu sichuan	China	23.5*		Conservation	Forest	0.028909375	0.033039286		
151	Li et al.	10	(purple_soil)	No Data	Asia and Australia	nanbu sichuan	China	23.5*		Conservation	Terracing	0.006209375	0.007096429		
152	Li et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	5*	530	Conservation	Contour Ridges	0.5475	0.625714286		
152	Li et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	3*	530	Conservation	Contour Ridges	0.284375	0.325		
152	Li et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	3*	530	Conservation	Cultivating Across Slope	0.23125	0.264285714		
152	Li et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	1.8*	530	Conservation	Contour Ridges	0.0046875	0.005357143		
152	Li et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	1.8*	530	Conventional	Crop	0.080625	0.092142857		
152	Li et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	3*	530	Conventional	Crop	0.734375	0.839285714		
152	Li et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	5*	530	Conventional	Crop	0.883125	1.009285714		
152	Li et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	5.8*	530	Conservation	Terracing	0.1	0.114285714		
152	Li et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	5.8*	530	Conservation	Cultivating Across Slope	0.09375	0.107142857		
153	liang	5.5	(red_soil)	No Data	Asia and Australia	guiping guangxi	China	18.2*	1709.8	Conservation	Forest	0.581875	0.665		
153	liang	5.5	(red_soil)	No Data	Asia and Australia	guiping guangxi	China	19.5*	1709.8	Conservation	Forest	0.255625	0.292142857		
153	liang	5.5	(red_soil)	No Data	Asia and Australia	guiping guangxi	China	19.2*	1709.8	Conservation	Forest	0.136875	0.156428571		
153	liang	5.5	(red_soil)	No Data	Asia and Australia	guiping guangxi	China	17.8*	1709.8	Conservation	Forest	0.103125	0.117857143		
154	Lin et al.	16	(purple_soil)	No Data	Asia and Australia	ziyang sichuan	China	20*	965.8	Conservation	Contour Cultivation	0.1828125	0.208928571		
154	Lin et al.	8	(purple_soil)	No Data	Asia and Australia	ziyang sichuan	China	20*	965.8	Conventional	Crop	1.253125	1.432142857		
155	Liu	18	(red_soil)	No Data	Asia and Australia	jimei fujian	China	10*	1305.5	Conventional	Orchard	1.6215625	1.853214286		
156	Liu	32	(red_soil)	No Data	Asia and Australia	xinjian jiangxi	China	14*		Conventional	Orchard	0.5921875	0.639107143		
158	Lu et al.	2	(stone_zone)	No Data	Asia and Australia	mongguxian liaoning	China	12*	524	Conservation	Cultivating Across Slope	0.89625	1.024285714		
158	Lu et al.	2	(stone_zone)	No Data	Asia and Australia	mongguxian liaoning	China	12*	524	Conservation	Contour Cultivation	0.48625	0.555714286		
158	Lu et al.	2	(stone_zone)	No Data	Asia and Australia	mongguxian liaoning	China	12*	524	Conservation	Terracing	0.284375	0.325		
158	Lu et al.	2	(stone_zone)	No Data	Asia and Australia	mongguxian liaoning	China	12*	524	Conventional	Crop	1.270625	1.452142857		
160	Lv	7	(purple_soil)	clay loam	Asia and Australia	shunqing sichuan	China	25*	1014	Conservation	Cultivating Across Slope	3.817904762	4.060612245		
160	Lv	7	(purple_soil)	clay loam	Asia and Australia	shunqing sichuan	China	20*	1014	Conservation	Cultivating Across Slope	2.873904762	3.079183673		
160	Lv	7	(purple_soil)	clay loam	Asia and Australia	shunqing sichuan	China	15*	1014	Conservation	Cultivating Across Slope	2.177428571	2.332959184		
160	Lv	3	(purple_soil)	No Data	Asia and Australia	jialing sichuan	China	10*	1014	Conservation	Cultivating Across Slope	2.5625	2.928571429		
160	Lv	7	(purple_soil)	clay loam	Asia and Australia	shunqing sichuan	China	10*	1014	Conservation	Cultivating Across Slope	1.480190476	1.585918367		
160	Lv	7	(purple_soil)	clay loam	Asia and Australia	shunqing sichuan	China	5*	1014	Conservation	Cultivating Across Slope	1.012380952	1.084693878		
160	Lv	6	(purple_soil)	No Data	Asia and Australia	jialing sichuan	China	10*	1014	Conservation	Contour Cultivation	0.5359375	0.6125		
160	Lv	5	(purple_soil)	clay loam	Asia and Australia	shunqing sichuan	China	5*	1014	Conventional	Crop	1.324666667	1.419285714		
160	Lv	3	(purple_soil)	No Data	Asia and Australia	jialing sichuan	China	10*	1014	Conventional	Crop	1.90625	2.178571429		
160	Lv	5	(purple_soil)	clay loam	Asia and Australia	shunqing sichuan	China	10*	1014	Conventional	Crop	2.303333333	2.467857143		
160	Lv	5	(purple_soil)	clay loam	Asia and Australia	shunqing sichuan	China	15*	1014	Conventional	Crop	2.987333333	3.200714286		
160	Lv	5	(purple_soil)	clay loam	Asia and Australia	shunqing sichuan	China	20*	1014	Conventional	Crop	3.792666667	4.063571429		
160	Lv	5	(purple_soil)	clay loam	Asia and Australia	shunqing sichuan	China	25*	1014	Conventional	Crop	4.756	5.095714286		
161	lv	1	(stone_zone)	No Data	Asia and Australia	luanping hebei	China	15*		Conservation	Zero Till	0.341875	0.390714286		
161	lv	1	(stone_zone)	No Data	Asia and Australia	luanping hebei	China	15*		Conventional	Crop	1.651875	1.887857143		
162	Ma and Wang	3	(loess_plateau)	No Data	Asia and Australia	yanggao shanxi	China	12*	425	Conservation	Grassland	0.211333333	0.211333333		
162	Ma and Wang	3	(loess_plateau)	No Data	Asia and Australia	yanggao shanxi	China	12*	425	Bare	Bare soil	0.303333333	0.303333333		
162	Ma and Wang	3	(loess_plateau)	No Data	Asia and Australia	yanggao shanxi	China	12*	425	Conservation	Shrubland	0.082666667	0.082666667		
163	Mao et al.	1	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1200	Conventional	Crop	0.0575	0.065714286		
163	Mao et al.	6	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1200	Conventional	Orchard	0.096770833	0.110595238		
163	Mao et al.	1	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1200	Conservation	Contour Cultivation	0.099375	0.113571429		
163	Mao et al.	1	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1200	Conservation	Terracing	0.075	0.085714286		
164	Meng and Yang	3	(purple_soil)	No Data	Asia and Australia	fangxian hubei	China	25*	1016	Conservation	Cultivating Across Slope	13.610625	15.555		
164	Meng and Yang	3	(purple_soil)	No Data	Asia and Australia	fangxian hubei	China	25*	1016	Conservation	Terracing	4.275625	4.886428571		
164	Meng and Yang	6	(purple_soil)	No Data	Asia and Australia	fangxian hubei	China	25*	1016	Conventional	Orchard	3.989375	4.559285714		
164	Meng and Yang	3	(purple_soil)	No Data	Asia and Australia	fangxian hubei	China	25*	1016	Conventional	Crop	14.215625	16.24642857		
165	Mi et al.	6	(Yun_Gui_Plateau)	Loam	Asia and Australia	fumin yunan	China	19.5*	862	Conservation	Shrubland	1.711827957	1.895238095		
165	Mi et al.	2	(Yun_Gui_Plateau)	Loam	Asia and Australia	fumin yunan	China	19.5*	862	Bare	Bare soil	3.819354839	4.228571429		
166	NDSIESS	2	(loess_plateau)	No Data	Asia and Australia	hantai shannxi	China	10*		Conservation	Cultivating Across Slope	0.0424375	0.0485		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	hantai shannxi	China	20*		Conservation	Contour Ridges	4.363125	4.986428571		
166	NDSIESS	3	(loess_plateau)	No Data	Asia and Australia	hantai shannxi	China	20*		Conservation	Cultivating Across Slope	3.634479167	4.153606476		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	30*		Conservation	Strips	3.341875	3.819285714		
166	NDSIESS	4	(loess_plateau)	No Data	Asia and Australia	hantai shannxi	China	20*		Conservation	Strips	2.5266875	2.887642857		
166	NDSIESS	4	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	31*		Conservation	Strips	1.86515625	2.131607143		
166	NDSIESS	3	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	26*		Conservation	Strips	1.817083333	2.076666667		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	luonan Shannxi	China	29.5*		Conservation	Strips	1.240625	1.417857143		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	16*		Conservation	Terracing	0.665625	0.760714286		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	suide shannxi	China	27*		Conservation	Strips	0.646875	0.739285714		
166	NDSIESS	2	(loess_plateau)	No Data	Asia and Australia	jiangbian shannxi	China	19*		Conservation	Strips	0.5961875	0.681357143		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	luonan Shannxi	China	18*		Conservation	Contour Ridges	0.4564375	0.521642857		
166	NDSIESS	7	(loess_plateau)	No Data	Asia and Australia	lishi shanxi	China	1*		Conservation	Terracing	0.370625	0.423571429		
166	NDSIESS	8	(loess_plateau)	No Data	Asia and Australia	lishi shanxi	China	37*		Conservation	Grassland	0.305625	0.349285714		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	27*		Conservation	Strips	0.281875	0.322142857		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	suide shannxi	China	18*		Conservation	Strips	0.27875	0.318571429		
166	NDSIESS	2	(loess_plateau)	No Data	Asia and Australia	luonan Shannxi	China	20*		Conservation	Contour Ridges	0.2761875	0.315642857		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	21.5*		Conservation	Terracing	0.198125	0.226428571		
166	NDSIESS	24	(loess_plateau)	No Data	Asia and Australia	lishi shanxi	China	31*		Conservation	Forest	0.37609375	0.429821429		
166	NDSIESS	8	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	30*		Conservation	Forest	0.296484375	0.338839286		
166	NDSIESS	2	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	29*	869	Conservation	Forest	0	0		
166	NDSIESS	2	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	30.5*		Conservation	Forest	0.0078125	0.008928571		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	luonan Shannxi	China	20*		Conservation	Forest	0.10675	0.122		
166	NDSIESS	2	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	27.5*		Conservation	Forest	0.0159375	0.018214286		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	28*		Conventional	Crop	0.038125	0.043571429		
166	NDSIESS	3	(loess_plateau)	No Data	Asia and Australia	hantai shannxi	China	10*		Conventional	Crop	0.192770833	0.220309524		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	luonan Shannxi	China	29*		Conventional	Crop	0.241375	0.275857143		
166	NDSIESS	2	(loess_plateau)	No Data	Asia and Australia	hantai shannxi	China	10*		Conservation	Contour Ridges	0.00896875	0.010125		
166	NDSIESS	2	(loess_plateau)	No Data	Asia and Australia	luonan Shannxi	China	20*		Conventional	Crop	0.48753125	0.557178571		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	suide shannxi	China	27*		Conventional	Crop	0.831875	0.950714286		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	30*		Conventional	Crop	1.394375	1.593571429		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	jiangbian shannxi	China	19*		Conventional	Crop	1.44625	1.652857143		
166	NDSIESS	3	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	18*		Conventional	Crop	1.494375	1.707857143		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	luonan Shannxi	China	18*		Conventional	Crop	1.63	1.862857143		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	21.5*		Conventional	Crop	1.6925	1.934285714		
166	NDSIESS	2	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	31*		Conventional	Crop	2.93375	3.352857143		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	luonan Shannxi	China	29.5*		Conventional	Crop	3.5275	4.031428571		
166	NDSIESS	3	(loess_plateau)	No Data	Asia and Australia	hantai shannxi	China	20*		Conventional	Crop	9.175	10.48857143		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	27*		Conventional	Crop	14.48125	16.55		
166	NDSIESS	3	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	18*		Conservation	Terracing	0.103125	0.117857143		
166	NDSIESS	2	(loess_plateau)	No Data	Asia and Australia	lishi shanxi	China	0*		Conservation	Terracing	0.018125	0.020714286		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	hantai shannxi	China	10*		Conservation	Strips	0.018625	0.021285714		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	yanan shaanxi	China	29*		Conservation	Strips	0.03375	0.038571429		
166	NDSIESS	1	(loess_plateau)	No Data	Asia and Australia	luonan Shannxi	China	29*		Conservation	Strips	0.034625	0.039571429		
167	Ng et al.	25	(purple_soil)	silty clay	Asia and Australia	zigui hubei	China	25*	994.1	Conservation	Contour Cultivation	0.277333333	0.301449275		
167	Ng et al.	5	(purple_soil)	silty clay	Asia and Australia	zigui hubei	China	25*	994.1	Conventional	Crop	0.506666667	0.550724638		
168	ning	6	(Yun_Gui_Plateau)	Loam	Asia and Australia	xundian yunnan	China	14*	908	Conservation	Cover Crop	0.053978495	0.059761905		
168	ning	2	(Yun_Gui_Plateau)	Loam	Asia and Australia	xundian yunnan	China	14*	908	Conventional	Crop	0.614193548	0.68		
169	Qin et al.	7	(purple_soil)	No Data	Asia and Australia	suining sichuan	China	15*	885	Conservation	Cultivating Across Slope	0.667946429	0.763367347		
169	Qin et al.	7	(purple_soil)	No Data	Asia and Australia	suining sichuan	China	10*	885	Conservation	Cultivating Across Slope	0.344464286	0.393673469		
169	Qin et al.	2	(purple_soil)	No Data	Asia and Australia	suining sichuan	China	10*	885	Conventional	Crop	1.3828125	1.580357143		
169	Qin et al.	6	(purple_soil)	No Data	Asia and Australia	suining sichuan	China	10*	885	Conventional	Cultivating Down slope	1.7671875	2.019642857		
169	Qin et al.	1	(purple_soil)	No Data	Asia and Australia	suining sichuan	China	15*	885	Conventional	Crop	2.05625	2.35		
170	Ruan	3	(red_soil)	loam	Asia and Australia	anxi fujian	China	26*	1750	Conservation	Contour Cultivation	0.051612903	0.057142857		
170	Ruan	6	(red_soil)	loam	Asia and Australia	anxi fujian	China	22*	1750	Conservation	Fallow	6.670645161	7.385357143		
170	Ruan	3	(red_soil)	No Data	Asia and Australia	nan'an fujian	China	12*		Conventional	Crop	1.188125	1.357857143		
170	Ruan	3	(red_soil)	loam	Asia and Australia	anxi fujian	China	18*	1750	Conservation	Terracing	0.012903226	0.014285714		
170	Ruan	3	(red_soil)	loam	Asia and Australia	anxi fujian	China	22*	1750	Conservation	Terracing	0.076774194	0.085		
170	Ruan	3	(red_soil)	loam	Asia and Australia	anxi fujian	China	14*	1750	Conservation	Contour Cultivation	0.035483871	0.039285714		
171	Shen et al.	24	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1439	Conventional	Orchard	0.031458333	0.035952381		
171	Shen et al.	4	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1439	Conventional	Crop	0.0375	0.042857143		
171	Shen et al.	8	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1439	Conservation	Terracing	0.018375	0.021071429		
172	sheng	5	(red_soil)	No Data	Asia and Australia	fenyi jiangxi	China	37.5*	1593.7	Conservation	Forest	0.000625	0.000714286		
172	sheng	5	(red_soil)	No Data	Asia and Australia	fenyi jiangxi	China	29*	1593.7	Conservation	Forest	0.001875	0.002142857		
172	sheng	21	(red_soil)	No Data	Asia and Australia	fenyi jiangxi	China	32*	1593.7	Conservation	Forest	0.002708333	0.003095238		
172	sheng	3	(red_soil)	No Data	Asia and Australia	fenyi jiangxi	China	‹ VT EF	1593.7	Conservation	Forest	0.015625	0.017857143		
173	Shui et al.	14	(red_soil)	No Data	Asia and Australia	lanxi zhejiang	China	15*	1676.7	Conventional	Crop	0.369375	0.422142857		
173	Shui et al.	14	(red_soil)	No Data	Asia and Australia	lanxi zhejiang	China	15*	1676.7	Conservation	Cultivating Across Slope	0.066875	0.076428571		
174	song	3	(stone_zone)	loam	Asia and Australia	daiyue shandong	China	5*	757	Conservation	Cultivating Across Slope	0.652112676	0.652112676		
175	Su and Liu	1	(Yun_Gui_Plateau)	clay	Asia and Australia	panlong yunnan	China	15*	785.1	Conservation	Terracing	0.141007194	0.1568		
175	Su and Liu	1	(Yun_Gui_Plateau)	clay	Asia and Australia	panlong yunnan	China	5*	785.1	Conservation	Terracing	0.118705036	0.132		
175	Su and Liu	1	(Yun_Gui_Plateau)	clay	Asia and Australia	panlong yunnan	China	5*	785.1	Conventional	Crop	0.212230216	0.236		
175	Su and Liu	2	(Yun_Gui_Plateau)	clay	Asia and Australia	panlong yunnan	China	25*	785.1	Bare	Bare soil	0.289568345	0.322		
175	Su and Liu	1	(Yun_Gui_Plateau)	clay	Asia and Australia	panlong yunnan	China	15*	785.1	Conventional	Crop	0.311510791	0.3464		
176	Sun et al.	22	(black_soil)	Loam	Asia and Australia	xifeng liaoning	China	15*	705	Conservation	Cultivating Across Slope	0.856	0.856		
176	Sun et al.	22	(black_soil)	Loam	Asia and Australia	xifeng liaoning	China	10*	705	Conservation	Cultivating Across Slope	0.341059603	0.341059603		
176	Sun et al.	22	(black_soil)	Loam	Asia and Australia	xifeng liaoning	China	6*	705	Conservation	Cultivating Across Slope	0.096308725	0.096308725		
176	Sun et al.	22	(black_soil)	Loam	Asia and Australia	xifeng liaoning	China	6*	705	Conventional	Crop	0.238590604	0.238590604		
176	Sun et al.	22	(black_soil)	Loam	Asia and Australia	xifeng liaoning	China	10*	705	Conventional	Crop	0.571523179	0.571523179		
176	Sun et al.	22	(black_soil)	Loam	Asia and Australia	xifeng liaoning	China	15*	705	Conventional	Crop	1.103666667	1.103666667		
177	SUN	2	(Yun_Gui_Plateau)	No Data	Asia and Australia	ningnan sichuan	China	25*	910	Conservation	Contour Cultivation	0.036875	0.042142857		
178	SUN	2	(Yun_Gui_Plateau)	No Data	Asia and Australia	ningnan sichuan	China	25*	910	Conservation	Contour Cultivation	0.04125	0.047142857		
179	SUN	2	(Yun_Gui_Plateau)	No Data	Asia and Australia	ningnan sichuan	China	18*	910	Conservation	Contour Cultivation	0.0775	0.088571429		
180	SUN	2	(Yun_Gui_Plateau)	No Data	Asia and Australia	ningnan sichuan	China	25*	910	Conservation	Contour Cultivation	0.081875	0.093571429		
181	SUN	2	(Yun_Gui_Plateau)	No Data	Asia and Australia	ningnan sichuan	China	18*	910	Conservation	Contour Cultivation	0.0825	0.094285714		
182	SUN	2	(Yun_Gui_Plateau)	No Data	Asia and Australia	ningnan sichuan	China	18*	910	Conservation	Contour Cultivation	0.086875	0.099285714		
183	SUN	2	(Yun_Gui_Plateau)	No Data	Asia and Australia	ningnan sichuan	China	25*	910	Conventional	Crop	0.44375	0.507142857		
184	Sun et al.	2	(Yun_Gui_Plateau)	No Data	Asia and Australia	ningnan sichuan	China	18*	910	Conventional	Crop	0.67	0.765714286		
185	Tang et al.	2	(purple_soil)	No Data	Asia and Australia	beibei chongqin	China	15*	1173.6	Conservation	Contour Cultivation	0.004375	0.005		
185	Tang et al.	2	(purple_soil)	No Data	Asia and Australia	beibei chongqin	China	15*	1173.6	Conservation	Cultivating Across Slope	0.00625	0.007142857		
185	Tang et al.	2	(purple_soil)	No Data	Asia and Australia	beibei chongqin	China	15*	1173.6	Conventional	Crop	0.00875	0.01		
186	Tang and Tian	10	(red_soil)	No Data	Asia and Australia	guigang guangxi	China	10*		Conventional	Orchard	0.517	0.590857143		
187	Tao et al.	3	(red_soil)	No Data	Asia and Australia	changding fujian	China	18*		Conservation	Shrubland	0.013333333	0.015238095		
188	Tian et al.	6	(Yun_Gui_Plateau)	No Data	Asia and Australia	yuanmou yunnan	China	7*	582	Conservation	Grassland	0.055	0.062857143		
189	tian	5	(purple_soil)	loam	Asia and Australia	beibei chongqin	China	15*	1173.6	Conservation	Cultivating Across Slope	0.045701558	0.050598153		
190	Tian et al.	2	(stone_zone)	No Data	Asia and Australia	pingquan hebei	China	17*	540.8	Conservation	Terracing	0.11	0.125714286		
190	Tian et al.	2	(stone_zone)	No Data	Asia and Australia	pingquan hebei	China	17*	540.8	Conventional	Crop	3.51	4.011428571		
191	Wang et al.	6	(loess_plateau)	sandy loam	Asia and Australia	shouyang shanxi	China	3*	518.3	Conservation	Zero Till	0.24011294	0.240112994		
191	Wang et al.	2	(loess_plateau)	sandy loam	Asia and Australia	shouyang shanxi	China	3*	518.3	Conservation	Mulching	0.101694915	0.101694915		
191	Wang et al.	2	(loess_plateau)	sandy loam	Asia and Australia	shouyang shanxi	China	3*	518.3	Conventional	Crop	0.31779661	0.31779661		
192	Wang et al.	8	(red_soil)	No Data	Asia and Australia	xinfeng jiangxi	China	22*	1517.3	Conservation	Forest	0.5390625	0.616071429		
192	Wang et al.	2	(red_soil)	No Data	Asia and Australia	xinfeng jiangxi	China	10*	1517.3	Conservation	Forest	0.009375	0.010714286		
192	Wang et al.	4	(red_soil)	No Data	Asia and Australia	xinfeng jiangxi	China	29*	1517.3	Conventional	Orchard	0.25125	0.287142857		
193	Wang	2	(red_soil)	No Data	Asia and Australia	jian'ou fujian	China	15*	1663.7	Conservation	Terracing	0.253125	0.289285714		
193	Wang	2	(red_soil)	No Data	Asia and Australia	jian'ou fujian	China	15*	1663.7	Conventional	Orchard	0.72625	0.83		
194	Wang et al.	15	(loess_plateau)	No Data	Asia and Australia	heyang shaanxi	China	15*	600	Conservation	Cover Crop	0.355	0.405714286		
194	Wang et al.	15	(loess_plateau)	No Data	Asia and Australia	heyang shaanxi	China	10*	600	Conservation	Cover Crop	0.275125	0.314428571		
194	Wang et al.	8	(Yun_Gui_Plateau)	No Data	Asia and Australia	yuanmou yunnan	China	8*	613.9	Conservation	Forest	0.01125	0.012857143		
194	Wang et al.	3	(loess_plateau)	No Data	Asia and Australia	heyang shaanxi	China	5*	600	Conventional	Crop	0.125	0.142857143		
194	Wang et al.	3	(loess_plateau)	No Data	Asia and Australia	heyang shaanxi	China	10*	600	Conventional	Crop	0.775	0.885714286		
194	Wang et al.	3	(loess_plateau)	No Data	Asia and Australia	heyang shaanxi	China	15*	600	Conventional	Crop	1.848125	2.112142857		
194	Wang et al.	15	(loess_plateau)	No Data	Asia and Australia	heyang shaanxi	China	5*	600	Conservation	Cover Crop	0.03525	0.040285714		
195	Wang et al.	4	(red_soil)	No Data	Asia and Australia	yingtan jiangxi	China	5*		Conservation	Zero Till	0.44625	0.51		
195	Wang et al.	4	(red_soil)	No Data	Asia and Australia	yingtan jiangxi	China	5*		Conventional	Crop	2.53125	2.892857143		
196	wang	12	(loess_plateau)	No Data	Asia and Australia	dingxi gansu	China	7*	390.9	Conservation	Zero Till	1.621736724	1.621736724		
196	wang	12	(loess_plateau)	No Data	Asia and Australia	dingxi gansu	China	7*	390.9	Conventional	Crop	1.979268433	1.979268433		
197	Wu and Li	4	(stone_zone)	No Data	Asia and Australia	fangshan beijing	China	23*	550	Conservation	Forest	0.5175	0.591428571		
197	Wu and Li	4	(stone_zone)	No Data	Asia and Australia	fangshan beijing	China	20*	550	Conservation	Forest	0.058125	0.066428571		
197	Wu and Li	4	(stone_zone)	No Data	Asia and Australia	fangshan beijing	China	11*	550	Conventional	Crop	1.129375	1.290714286		
197	Wu and Li	8	(stone_zone)	No Data	Asia and Australia	fangshan beijing	China	22*	550	Conservation	Grassland	0.033125	0.037857143		
197	Wu and Li	4	(stone_zone)	No Data	Asia and Australia	fangshan beijing	China	11*	550	Conservation	Terracing	0.0625	0.071428571		

198	Wu et al.	4	(loess_plateau)	No Data	Asia and Australia	changwu shaanxi	China	25.5*		Conservation	Grassland	5.79265625	6.620178571
198	Wu et al.	2	(loess_plateau)	No Data	Asia and Australia	binxian shaanxi	China	20*		Conservation	Cultivating Across Slope	1.326875	1.516428571
198	Wu et al.	6	(loess_plateau)	No Data	Asia and Australia	binxian shaanxi	China	20*		Conventional	Crop	5.0678125	5.791785714
198	Wu et al.	2	(loess_plateau)	No Data	Asia and Australia	yaoxian shaanxi	China	3*		Conservation	Fallow	0.0196875	0.0225
198	Wu et al.	2	(loess_plateau)	No Data	Asia and Australia	binxian shaanxi	China	10*		Conservation	Contour Ridges	0.0384375	0.043928571
199	Xiang et al.	9	(purple_soil)	No Data	Asia and Australia	tianquan sichuan	China	25*	1404.6	Conservation	Zero Till	0.095833333	0.10952381
199	Xiang et al.	3	(purple_soil)	No Data	Asia and Australia	tianquan sichuan	China	5*	1404.6	Conventional	Crop	0.06375	0.072857143
199	Xiang et al.	3	(purple_soil)	No Data	Asia and Australia	tianquan sichuan	China	15*	1404.6	Conventional	Conventional Tillage	0.08	0.091428571
199	Xiang et al.	3	(purple_soil)	No Data	Asia and Australia	tianquan sichuan	China	15*	1404.6	Conventional	Crop	0.081875	0.093571429
199	Xiang et al.	3	(purple_soil)	No Data	Asia and Australia	tianquan sichuan	China	25*	1404.6	Conventional	Crop	0.10125	0.115714286
199	Xiang et al.	6	(purple_soil)	No Data	Asia and Australia	tianquan sichuan	China	15*	1404.6	Conservation	Zero Till	0.076875	0.087857143
199	Xiang et al.	9	(purple_soil)	No Data	Asia and Australia	tianquan sichuan	China	5*	1404.6	Conservation	Zero Till	0.057916667	0.066190476
200	Xie et al.	15	(red_soil)	loam	Asia and Australia	de'an jiangxi	China	12*	1350	Conservation	Grassland	0.013978495	0.01547619
200	Xie et al.	55	(red_soil)	loam	Asia and Australia	de'an jiangxi	China	12*	1350	Conventional	Orchard	0.507096774	0.561428571
201	Xie et al.	3	(red_soil)	Loam	Asia and Australia	hengnan hunan	China	2.7*	1268.8	Conservation	Cultivating Across Slope	0.499354839	0.552857143
201	Xie et al.	3	(red_soil)	No Data	Asia and Australia	hennan hunan	China	2.7*	1268.8	Conservation	Cultivating Across Slope	0.48375	0.552857143
201	Xie et al.	6	(red_soil)	Loam	Asia and Australia	hengnan hunan	China	2.7*	1268.8	Conservation	Contour Ridges	0.369354839	0.408928571
201	Xie et al.	6	(red_soil)	No Data	Asia and Australia	hennan hunan	China	2.7*	1268.8	Conservation	Contour Ridges	0.3578125	0.408928571
201	Xie et al.	3	(red_soil)	No Data	Asia and Australia	hennan hunan	China	7.7*	1268.8	Conventional	Crop	0.63625	0.727142857
201	Xie et al.	3	(red_soil)	Loam	Asia and Australia	hengnan hunan	China	7.7*	1268.8	Conventional	Crop	0.656774194	0.727142857
202	Xu et al.	5	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	3*	1016	Conservation	Terracing	0.268461538	0.268461538
202	Xu et al.	10	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1016	Conservation	Contour Cultivation	0.243076923	0.243076923
202	Xu et al.	5	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	3*	1016	Conventional	Orchard	0.277692308	0.277692308
202	Xu et al.	10	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1016	Conventional	Crop	0.645384615	0.645384615
202	Xu et al.	5	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1016	Conventional	Orchard	0.863846154	0.863846154
203	Xue et al.	3	(Yun_Gui_Plateau)	Loam	Asia and Australia	kunmin yunnan	China	20*	1200	Conservation	Mulching	0.25483871	0.282857857
203	Xue et al.	3	(Yun_Gui_Plateau)	Loam	Asia and Australia	kunmin yunnan	China	20*	1200	Conventional	Crop	4.256129032	4.712142857
204	Yan et al.	1	(loess_plateau)	No Data	Asia and Australia	gangu Gansu	China	12.97*		Conservation	Grassland	1.479375	1.690714286
204	Yan et al.	1	(loess_plateau)	No Data	Asia and Australia	gangu Gansu	China	12.35*		Conservation	Grassland	0.95	1.085714286
204	Yan et al.	2	(loess_plateau)	No Data	Asia and Australia	suide shannxi	China	12.98*		Conservation	Grassland	0.9475	1.082857143
204	Yan et al.	1	(loess_plateau)	No Data	Asia and Australia	xifeng gansu	China	12.35*		Conservation	Contour Cultivation	0.91	1.04
204	Yan et al.	1	(loess_plateau)	No Data	Asia and Australia	xifeng gansu	China	19.45*		Conservation	Contour Cultivation	0.710625	0.812142857
204	Yan et al.	1	(loess_plateau)	No Data	Asia and Australia	suide shannxi	China	12.35*		Conservation	Grassland	0.195	0.222857143
204	Yan et al.	1	(loess_plateau)	No Data	Asia and Australia	xifeng gansu	China	2.85*		Conservation	Contour Cultivation	0.00125	0.001428571
204	Yan et al.	1	(loess_plateau)	No Data	Asia and Australia	xifeng gansu	China	2.73*		Conservation	Cultivating Across Slope	0.109375	0.125
204	Yan et al.	1	(loess_plateau)	No Data	Asia and Australia	xifeng gansu	China	12.47*		Conservation	Contour Cultivation	0.015	0.017142857
204	Yan et al.	1	(loess_plateau)	No Data	Asia and Australia	suide shannxi	China	14.82*		Conservation	Grassland	0.029375	0.033571429
204	Yan et al.	1	(loess_plateau)	No Data	Asia and Australia	xifeng gansu	China	2.43*		Conservation	Contour Cultivation	0.066875	0.076428571
205	Yang et al.	24	(red_soil)	clay	Asia and Australia	de'an jiangxi	China	12*	1350	Conventional	Orchard	0.656594724	0.730133333
206	Yao et al.	15	(purple_soil)	No Data	Asia and Australia	yongchuan chongqin	China	25*	1068.2	Conventional	Orchard	0.23375	0.267142857
206	Yao et al.	2	(purple_soil)	No Data	Asia and Australia	wanzhou chongqin	China	5*	1068.2	Conventional	Orchard	0.319375	0.365
206	Yao et al.	2	(purple_soil)	No Data	Asia and Australia	wanzhou chongqin	China	15*	1068.2	Conventional	Orchard	0.8865625	1.013214286
206	Yao et al.	2	(purple_soil)	No Data	Asia and Australia	wanzhou chongqin	China	25*	1068.2	Conventional	Orchard	1.2540625	1.433214286
207	Yin et al.	18	(Yun_Gui_Plateau)	No Data	Asia and Australia	luodian guizhou	China	21.8*		Conservation	Contour Cultivation	0.71875	0.821428571
207	Yin et al.	9	(Yun_Gui_Plateau)	No Data	Asia and Australia	luodian guizhou	China	21.8*		Conventional	Crop	2.6875	3.071428571
208	You	2	(red_soil)	No Data	Asia and Australia	nanjing fujian	China	22.3*	1720	Conservation	Forest	0.0071875	0.008214286
209	Yu et al.	2	(stone_zone)	Clay Loam	Asia and Australia	changping beijing	China	2.86*	640	Conservation	Shrubland	0.009489051	0.009489051
209	Yu et al.	2	(stone_zone)	Clay Loam	Asia and Australia	changping beijing	China	11.31*	640	Conservation	Shrubland	0.086131387	0.086131387
209	Yu et al.	2	(stone_zone)	Clay Loam	Asia and Australia	changping beijing	China	5.71*	640	Conservation	Shrubland	0.021532847	0.021532847
209	Yu et al.	1	(stone_zone)	Clay Loam	Asia and Australia	changping beijing	China	2.86*	640	Bare	Bare soil	0.1	0.1
209	Yu et al.	1	(stone_zone)	Clay Loam	Asia and Australia	changping beijing	China	5.71*	640	Bare	Bare soil	0.189051095	0.189051095
209	Yu et al.	1	(stone_zone)	Clay Loam	Asia and Australia	changping beijing	China	8.53*	640	Bare	Bare soil	0.332846715	0.332846715
209	Yu et al.	1	(stone_zone)	Clay Loam	Asia and Australia	changping beijing	China	11.31*	640	Bare	Bare soil	0.364963504	0.364963504
209	Yu et al.	2	(stone_zone)	Clay Loam	Asia and Australia	changping beijing	China	8.53*	640	Conservation	Shrubland	0.060218978	0.060218978
210	Yuan et al.	1	(red_soil)	Clay Loam	Asia and Australia	lanxi zhejiang	China	15*	1500	Conservation	Cultivating Across Slope	0.054666667	0.058571429
210	Yuan et al.	2	(red_soil)	Clay Loam	Asia and Australia	lanxi zhejiang	China	15*	1500	Conservation	Contour Cultivation	0.152	0.162857143
210	Yuan et al.	1	(red_soil)	Clay Loam	Asia and Australia	lanxi zhejiang	China	15*	1500	Conventional	Crop	0.333333333	0.357142857
210	Yuan et al.	1	(red_soil)	Clay Loam	Asia and Australia	lanxi zhejiang	China	15*	1500	Conservation	Terracing	0.03	0.032142857
211	Yue	1	(red_soil)	No Data	Asia and Australia	changding fujian	China	15*	1628.2	Conservation	Grassland	0.690076336	0.690076336
211	Yue	1	(red_soil)	No Data	Asia and Australia	changding fujian	China	15*	1628.2	Bare	Bare soil	4.921568627	4.921568627
212	Zhang et al.	3	(purple_soil)	clay loam	Asia and Australia	jianyang sichuan	China	4*	587	Conservation	Terracing	0.01496063	0.01496063
212	Zhang et al.	3	(purple_soil)	clay loam	Asia and Australia	jianyang sichuan	China	9*	587	Conventional	Crop	0.025581395	0.025581395
212	Zhang et al.	3	(purple_soil)	clay loam	Asia and Australia	jianyang sichuan	China	4*	587	Conventional	Orchard	0.059541985	0.059541985
213	Zhang et al.	9	(stone_zone)	sandy loam	Asia and Australia	gangyu jiangsu	China	8*	875.4	Conservation	Terracing	0.156296296	0.156296296
213	Zhang et al.	9	(stone_zone)	Loam	Asia and Australia	gangyu jiangsu	China	8*	875.4	Conservation	Forest	0.137410072	0.137410072
214	Zhang et al.	9	(stone_zone)	sandy loam	Asia and Australia	gangyu jiangsu	China	8*	875.4	Conservation	Crop	3.225714286	3.225714286
214	Zhang et al.	5	(red_soil)	No Data	Asia and Australia	zhuji zhejiang	China	20*	1373.6	Conservation	Shrubland	0.301875	0.345
214	Zhang et al.	1	(red_soil)	No Data	Asia and Australia	zhuji zhejiang	China	20*	1373.6	Bare	Bare soil	0.825	0.942857143
215	Zhang et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	5*	530	Conservation	Conservation Tillage	3.318125	3.792142857
215	Zhang et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	5*	530	Conservation	Cultivating Across Slope	0.014375	0.016428571
215	Zhang et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	5*	530	Conservation	Zero Till	0.02125	0.024285714
215	Zhang et al.	1	(black_soil)	No Data	Asia and Australia	hailun heilongjiang	China	5*	530	Conventional	Crop	1.926875	2.202142857
216	zhang	20	(red_soil)	No Data	Asia and Australia	taojiang hunan	China	20*	1553	Conventional	Orchard	0.4171875	0.476785714
217	Zhao and Wei	2	(black_soil)	No Data	Asia and Australia	gannan heilongjiang	China	5*	455.2	Conservation	Zero Till	0.186875	0.213571429
217	Zhao and Wei	4	(black_soil)	No Data	Asia and Australia	gannan heilongjiang	China	5*	455.2	Conservation	Contour Ridges	0.1221875	0.139642857
217	Zhao and Wei	2	(black_soil)	No Data	Asia and Australia	gannan heilongjiang	China	5*	455.2	Conventional	Crop	0.468125	0.5355
218	Zhao et al.	5	(stone_zone)	No Data	Asia and Australia	fengning hebei	China	18*	478	Conservation	Forest	0.025	0.028571429
218	Zhao et al.	5	(stone_zone)	No Data	Asia and Australia	fengning hebei	China	16*	478	Conservation	Forest	0.02875	0.032857143
219	Zheg et al.	18	(purple_soil)	No Data	Asia and Australia	zigui hubei	China	25*	1016	Conventional	Orchard	0.166875	0.190714286
220	Zheg et al.	3	(red_soil)	No Data	Asia and Australia	yudu jiangxi	China	25*	1507.5	Conventional	Orchard	0.513095238	0.513095238
221	Zhou	1	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Conservation	Contour Cultivation	0.17	0.194285714
221	Zhou	1	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Conservation	Cultivating Across Slope	0.129375	0.147857143
221	Zhou	1	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Conservation	Terracing	0.011875	0.013571429
221	Zhou	1	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Conventional	Crop	0.570625	0.652142857
221	Zhou	1	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	8*	600	Bare	Bare soil	1.381875	1.579285714
221	Zhou	1	(black_soil)	No Data	Asia and Australia	binxian heilongjiang	China	6*	600	Conservation	Grassland	0.0325	0.037142857
222	Zhou et al.	1	(purple_soil)	No Data	Asia and Australia	cili hunan	China	36*	1642	Conservation	Terracing	0.156875	0.179285714
222	Zhou et al.	1	(purple_soil)	No Data	Asia and Australia	cili hunan	China	38*	1642	Conservation	Forest	0.05125	0.058571429
222	Zhou et al.	1	(purple_soil)	No Data	Asia and Australia	cili hunan	China	35*	1642	Conservation	Forest	0.05125	0.058571429
222	Zhou et al.	1	(purple_soil)	No Data	Asia and Australia	cili hunan	China	39*	1642	Conservation	Forest	0.078125	0.089285714
222	Zhou et al.	1	(purple_soil)	No Data	Asia and Australia	cili hunan	China	37*	1642	Conservation	Forest	0.06375	0.072857143
222	Zhou et al.	1	(purple_soil)	No Data	Asia and Australia	cili hunan	China	34*	1642	Conservation	Forest	0.0375	0.042857143
223	ZHU	1	(Yun_Gui_Plateau)	No Data	Asia and Australia	chengjiang yunnan	China	18.58*	1050	Conservation	Terracing	0.465467626	0.465467626
223	ZHU	1	(Yun_Gui_Plateau)	No Data	Asia and Australia	chengjiang yunnan	China	18.58*	1050	Conventional	Crop	2.268345324	2.268345324
224	Zhuang	3	(red_soil)	No Data	Asia and Australia	anxi fujian	China	14*	1745	Conservation	Terracing	0.799166667	0.913333333
224	Zhuang	3	(red_soil)	No Data	Asia and Australia	anxi fujian	China	10*	1745	Conservation	Terracing	0.700416667	0.80047619
224	Zhuang	3	(red_soil)	No Data	Asia and Australia	anxi fujian	China	26*	1745	Conservation	Terracing	0.65	0.742857143
225	Zuo et al.	8	(red_soil)	No Data	Asia and Australia	taihe jiangxi	China	10*	1336	Conservation	Grassland	2.86828125	3.278035714
226	Ciesiolka et al.	3	Lithic Eutropept	Clay Loam	Asia and Australia	Imbil, Gympie	Australia	34	1238	Conventional	Cultivating Down slope	1.777777778	1.904761905
226	Ciesiolka et al.	3	Lithic Eutropept	Clay Loam	Asia and Australia	Imbil, Gympie	Australia	33	1238	Conventional	Cultivating Down slope	2.022222222	2.166666667
226	Ciesiolka et al.	3	Lithic Eutropept	Clay Loam	Asia and Australia	Imbil, Gympie	Australia	38	1238	Conventional	Cultivating Down slope	7.711111111	8.261904762
227	Sombatpanit et al.	3	Oxic Paleustult	Loam	Asia and Australia	Khon Kaen	Thailand	3.6	1000	Conservation	Contour Cultivation	0.096107527	0.106404762
227	Sombatpanit et al.	3	Oxic Paleustult	Loam	Asia and Australia	Khon Kaen	Thailand	3.6	1000	Conservation	Zero Till	0.022064516	0.024428571
227	Sombatpanit et al.	3	Oxic Paleustult	Loam	Asia and Australia	Khon Kaen	Thailand	3.6	1000	Conventional	Cultivating Down slope	0.179397849	0.198619048
227	Sombatpanit et al.	2	Oxic Paleustult	Loam	Asia and Australia	Khon Kaen	Thailand	3.6	1000	Bare	Bare Soil	3.122290323	3.456821429
227	Sombatpanit et al.	3	Oxic Paleustult	Loam	Asia and Australia	Khon Kaen	Thailand	3.6	1000	Conservation	Cultivating Across Slope	0.06453764	0.071428571
228	Kothyari et al.	4		Sandy Loam	Asia and Australia	Bhetagad, Uttaranchal State	India	18.5*	1400	Conservation	Forest	0.282867133	0.282867133
228	Kothyari et al.	4		Sandy Loam	Asia and Australia	Bhetagad, Uttaranchal State	India	22.5*	1400	Conventional	Crop (Rainfed Agriculture)	0.019285714	0.019285714
228	Kothyari et al.	4		Sandy Loam	Asia and Australia	Bhetagad, Uttaranchal State	India	20.1*	1400	Conventional	Crop (Tea)	0.16	0.16
229	Mitchell	5	Humic nitosol	No Data	sub-Saharan Africa	Lyanungu	Tanzania	9.5*	1660	Conservation	Contour Ridges	0.1875	0.214285714
229	Mitchell	10	Humic nitosol	No Data	sub-Saharan Africa	Lyanungu	Tanzania	9.5*	1660	Conservation	Cover Crop	0.09375	0.107142857
229	Mitchell	3	Humic nitosol	No Data	sub-Saharan Africa	Tengeru, Arusha	Tanzania	18*	1300	Conventional	Crop (Bananas)	0.0625	0.071428571
229	Mitchell	6	Humic nitosol	No Data	sub-Saharan Africa	Tengeru, Arusha	Tanzania	18*	1300	Conventional	Crop (Maize)	0.90625	1.035714286
229	Mitchell	3	Humic nitosol	No Data	sub-Saharan Africa	Tengeru, Arusha	Tanzania	18*	1300	Conventional	Crop (Coffee)	2.125	2.428571429
229	Mitchell	5	Humic nitosol	No Data	sub-Saharan Africa	Lyanungu	Tanzania	9.5*	1660	Conventional	Crop (Coffee)	2.6875	3.071428571
230	Roose	2	Ferralitic	No Data	sub-Saharan Africa	Divo	Ivory Coast	5.5*	1750	Conservation	Forest	0.0375	0.042857143
231	Othieno	3	Humic nitosol	No Data	sub-Saharan Africa	Kericho	Kenya	6*	2160	Conventional	Crop (Oats)	2.5	2.857142857
231	Othieno	9	Humic nitosol	No Data	sub-Saharan Africa	Kericho	Kenya	6*	2160	Conventional	Crop (Tea)	9.722916667	11.11190476
232	Lal	2	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	3*	1010	Conservation	Zero Till	0.05625	0.064285714
232	Lal	2	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	8.5*	1010	Conservation	Zero Till	0.28125	0.321428571
232	Lal	2	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	5.5*	1010	Conservation	Zero Till	0.16875	0.192857143
232	Lal	2	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	0.5*	1010	Conservation	Zero Till	0.0125	0.014285714
232	Lal	4	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	0.5*	1010	Conventional	Conventional Tillage	0.1875	0.214285714
232	Lal	4	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	5.5*	1010	Conventional	Conventional Tillage	0.19375	0.221428571
232	Lal	4	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	3*	1010	Conventional	Conventional Tillage	0.221875	0.253571429
232	Lal	2	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	0.5*	1010	Bare	Bare Soil	0.5	0.571428571
232	Lal	4	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	8.5*	1010	Conventional	Conventional Tillage	0.815625	0.932142857
232	Lal	2	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	3*	1010	Bare	Bare Soil	6.25	7.142857143
232	Lal	2	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	5.5*	1010	Bare	Bare Soil	9.125	10.42857143
232	Lal	2	Alfisol	No Data	sub-Saharan Africa	Ibadan	Nigeria	8.5*	1010	Bare	Bare Soil	10.8125	12.35714286
233	Rhensburg	8		Loam	sub-Saharan Africa	Mpwapwa	Tanzania	3.5*	690	Conservation	Grassland	0.0456129	0.05
233	Rhensburg	8		Loam	sub-Saharan Africa	Mpwapwa	Tanzania	3.5*	690	Conservation	Contour Cultivation	1.935483871	2.142857143
233	Rhensburg	8		Loam	sub-Saharan Africa	Mpwapwa	Tanzania	3.5*	690	Conventional	Crop	3.548387097	3.928571429
234	Hudson and Jackson	6		Clay Loam	sub-Saharan Africa	Henderson Research Station	Zimbabwe	4*	700	Conservation	Grassland	0.08	0.085714286
234	Hudson and Jackson	6		Clay Loam	sub-Saharan Africa	Henderson Research Station	Zimbabwe	2*	700	Conservation	Grassland	0.033333333	0.035714286
234	Hudson and Jackson	12		Clay Loam	sub-Saharan Africa	Henderson Research Station	Zimbabwe	2.5*	700	Conventional	Crop (Maize)	0.4	0.428571429
234	Hudson and Jackson	6		Clay Loam	sub-Saharan Africa	Henderson Research Station	Zimbabwe	2*	700	Conventional	Crop (Maize)	0.466666667	0.5
234	Hudson and Jackson	12		Clay Loam	sub-Saharan Africa	Henderson Research Station	Zimbabwe	4*	700	Conventional	Crop (Maize)	0.966666667	1.035714286
234	Hudson and Jackson	6		Clay Loam	sub-Saharan Africa	Henderson Research Station	Zimbabwe	2.5*	700	Conservation	Grassland	0.066666667	0.071428571
235	Haylett	130		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	3.75	721	Conservation	Grassland	0.07413	0.079072
235	Haylett	105		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	7	737	Conservation	Grassland	0.07104125	0.075977333
235	Haylett	26		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	3.75	721	Conventional	Crop (Teff)	0.84940625	0.906033333
235	Haylett	26		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	3.75	721	Conventional	Crop (Hay)	1.12739375	1.202553333
235	Haylett	104		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	3.75	721	Bare	Bare Soil	1.293414063	1.379641667
235	Haylett	52		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	3.75	721	Conventional	Crop (Maize)	1.505765625	1.60615
235	Haylett	21		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	7	737	Conventional	Crop (Teff)	2.33200625	2.487473333
235	Haylett	21		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	7	737	Conventional	Crop (Maize, Teff and Babala Rotation)	2.57910625	2.751046667
235	Haylett	21		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	7	737	Conventional	Crop (Babala)	2.6254375	2.800466667
235	Haylett	63		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	7	737	Conventional	Crop (Maize)	3.757979167	4.008511111
235	Haylett	63		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	7	737	Bare	Bare Soil	4.380877083	4.672935556
235	Haylett	21		Sandy Loam	sub-Saharan Africa	Pretoria	South Africa	7	737	Bare	Bare Soil	5.9304	6.3255
236	Rao et al.	4	Alfisol	No Data	Asia and Australia	ICRISAT Centre, Patancheru	India	2	765	Conservation	Mulching	0.00625	0.007142857
236	Rao et al.	3	Alfisol	No Data	Asia and Australia	ICRISAT Centre, Patancheru	India	2	765	Conventional	Crop (Leucaena)	0.013541667	0.01547619
236	Rao et al.	1	Alfisol	No Data	Asia and Australia	ICRISAT Centre, Patancheru	India	2	765	Conventional	Crop (Groundnut)	0.028125	0.032142857
237	Jirasuktaveekul	4		No Data	Asia and Australia	Mae Taeng	Thailand	20	1053.8	Conservation	Forest	0.2143125	0.244928571
237	Jirasuktaveekul	4		No Data	Asia and Australia	Khun Sa Than	Thailand	20	1615.6	Conservation	Forest	0.0015	0.001714286
237	Jirasuktaveekul	4		No Data	Asia and Australia	Khun Sa Than	Thailand	30	1615.6	Conservation	Forest	0.002	0.002285714
237	Jirasuktaveekul	4		No Data	Asia and Australia	Khun Sa Than	Thailand	40	1615.6	Conservation	Forest	0.0025	0.002857143
237	Jirasuktaveekul	4		No Data	Asia and Australia	Wang	Thailand	30	1562.2	Conservation	Forest	0.0026875	0.003071429
237	Jirasuktaveekul	4		No Data	Asia and Australia	Wang	Thailand	20	1562.2	Conservation	Forest	0.003375	0.003857143
237	Jirasuktaveekul	4		No Data	Asia and Australia	Wang	Thailand	40	1562.2	Conservation	Forest	0.004	0.004571429
237	Jirasuktaveekul	4		No Data	Asia and Australia	Yom	Thailand	20	1156	Conservation	Forest	0.0146875	0.016785714
237	Jirasuktaveekul	4		No Data	Asia and Australia	Wang	Thailand	20	1562.2	Conventional	Crop (Pinus Kesiya and Vetiver)	0.0025625	0.002928571
237	Jirasuktaveekul	4		No Data	Asia and Australia	Wang	Thailand	20	1562.2	Conventional	Crop (Pinus Kesiya)	0.0028125	0.003214286
237	Jirasuktaveekul	4		No Data	Asia and Australia	Wang	Thailand	30	1562.2	Conventional	Crop (Pinus Kesiya and Vetiver)	0.003	0.003428571
237	Jirasuktaveekul	4		No Data	Asia and Australia	Wang	Thailand	40	1562.2	Conventional	Crop (Pinus Kesiya and Vetiver)	0.0030625	0.0035
237	Jirasuktaveekul	4		No Data	Asia and Australia	Khun Sa Than	Thailand	20	1615.6	Conventional	Crop (Pinus Kesiya and Vetiver)	0.0038125	0.004357143
237	Jirasuktaveekul	4		No Data	Asia and Australia	Khun Sa Than	Thailand	20	1615.6	Conventional	Crop (Pinus Kesiya)	0.0040625	0.004642857
237	Jirasuktaveekul	4		No Data	Asia and Australia	Wang	Thailand	30	1562.2	Conventional	Crop (Pinus Kesiya)	0.0041875	0.004785714
237	Jirasuktaveekul	4		No Data	Asia and Australia	Wang	Thailand	40	1562.2	Conventional	Crop (Pinus Kesiya)	0.0043125	0.004928571
237	Jirasuktaveekul	4		No Data	Asia and Australia	Khun Sa Than	Thailand	40	1615.6	Conventional	Crop (Pinus Kesiya)	0.0043125	0.004928571
237	Jirasuktaveekul	4		No Data	Asia and Australia	Khun Sa Than	Thailand	40	1615.6	Conventional	Crop (Pinus Kesiya and Vetiver)	0.0043125	0.004928571
237	Jirasuktaveekul	4		No Data	Asia and Australia	Khun Sa Than	Thailand	30	1615.6	Conventional	Crop (Pinus Kesiya and Vetiver)	0.0051875	0.005928571
237	Jirasuktaveekul	4		No Data	Asia and Australia	Khun Sa Than	Thailand	30	1615.6	Conventional	Crop (Pinus Kesiya)	0.0054375	0.006214286

237	Jirasuktaveekul	4		No Data	Asia and Australia	Yom	Thailand	30	1156	Conventional	Crop (Teak and Vetiver)	0.017875	0.020428571
237	Jirasuktaveekul	4		No Data	Asia and Australia	Yom	Thailand	40	1156	Conventional	Crop (Teak and Vetiver)	0.0205625	0.0235
237	Jirasuktaveekul	4		No Data	Asia and Australia	Yom	Thailand	30	1156	Conventional	Crop (Teak)	0.0215	0.024571429
237	Jirasuktaveekul	4		No Data	Asia and Australia	Yom	Thailand	20	1156	Conventional	Crop (Teak and Vetiver)	0.02425	0.027714286
237	Jirasuktaveekul	4		No Data	Asia and Australia	Yom	Thailand	20	1156	Conventional	Crop (Teak)	0.0345625	0.0395
237	Jirasuktaveekul	4		No Data	Asia and Australia	Yom	Thailand	40	1156	Conventional	Crop (Teak)	0.0365	0.041714286
237	Jirasuktaveekul	4		No Data	Asia and Australia	Mae Taeng	Thailand	20	1053.8	Conventional	Crop (Teak and Vetiver)	0.157	0.179428571
237	Jirasuktaveekul	4		No Data	Asia and Australia	Mae Taeng	Thailand	30	1053.8	Conventional	Crop (Teak and Vetiver)	0.282875	0.323285714
237	Jirasuktaveekul	4		No Data	Asia and Australia	Mae Taeng	Thailand	40	1053.8	Conventional	Crop (Teak and Vetiver)	0.3275625	0.374357143
237	Jirasuktaveekul	4		No Data	Asia and Australia	Mae Taeng	Thailand	30	1053.8	Conventional	Crop (Teak)	0.428875	0.490142857
237	Jirasuktaveekul	4		No Data	Asia and Australia	Mae Taeng	Thailand	20	1053.8	Conventional	Crop (Teak)	0.4595	0.525142857
237	Jirasuktaveekul	4		No Data	Asia and Australia	Mae Taeng	Thailand	40	1053.8	Conventional	Crop (Teak)	0.765625	0.875
237	Jirasuktaveekul	4		No Data	Asia and Australia	Yom	Thailand	30	1156	Conservation	Forest	0.0154375	0.017642857
237	Jirasuktaveekul	4		No Data	Asia and Australia	Yom	Thailand	40	1156	Conservation	Forest	0.0156875	0.017928571
237	Jirasuktaveekul	4		No Data	Asia and Australia	Mae Taeng	Thailand	40	1053.8	Conservation	Forest	0.0845625	0.096642857
237	Jirasuktaveekul	4		No Data	Asia and Australia	Mae Taeng	Thailand	30	1053.8	Conservation	Forest	0.0783125	0.0895
238	Herweg and Ludi	7	Haplic Phaeozem	No Data	sub-Saharan Africa	Maybar	Ethiopia	28	1211	Conservation	Strips (Lentil)	0.05625	0.064285714
238	Herweg and Ludi	4	Haplic Lixisol	No Data	sub-Saharan Africa	Dizi	Ethiopia	18	1512	Conservation	Terracing (Stone and Soil Bunds)	0.04375	0.05
238	Herweg and Ludi	5	Vertic Luvisol	No Data	sub-Saharan Africa	Anjeni I	Ethiopia	28	1690	Conservation	Terracing (Stone and Soil Bunds)	2.375	2.714285714
238	Herweg and Ludi	5	Vertic Luvisol	No Data	sub-Saharan Africa	Anjeni I	Ethiopia	28	1690	Conservation	Terracing (Fanya Juu Graded)	2.25	2.571428571
238	Herweg and Ludi	1	Eutric Nitosol	No Data	sub-Saharan Africa	Anjeni II	Ethiopia	12	1690	Conservation	Terracing (Stone and Soil Bunds)	2.125	2.428571429
238	Herweg and Ludi	9	Eutric Regosol	No Data	sub-Saharan Africa	Andit Tid	Ethiopia	24	1358	Conservation	Terracing (Stone and Soil Bunds)	1.8125	2.071428571
238	Herweg and Ludi	1	Eutric Nitosol	No Data	sub-Saharan Africa	Anjeni II	Ethiopia	12	1690	Conservation	Terracing (Fanya Juu Graded)	1.06875	1.221428571
238	Herweg and Ludi	5	Chromic Cambisol	No Data	sub-Saharan Africa	Afdeyu	Eritrea	31	382	Conservation	Contour Ridges (Stone and Soil)	0.8625	0.985714286
238	Herweg and Ludi	9	Eutric Regosol	No Data	sub-Saharan Africa	Andit Tid	Ethiopia	24	1358	Conservation	Strips (Lentil)	0.8125	0.928571429
238	Herweg and Ludi	18	Eutric Regosol	No Data	sub-Saharan Africa	Andit Tid	Ethiopia	24	1358	Conservation	Terracing (Fanya Juu Graded)	0.74375	0.85
238	Herweg and Ludi	5	Chromic Cambisol	No Data	sub-Saharan Africa	Afdeyu	Eritrea	31	382	Conservation	Strips (Lentil)	0.5	0.571428571
238	Herweg and Ludi	5	Chromic Cambisol	No Data	sub-Saharan Africa	Afdeyu	Eritrea	31	935	Conservation	Terracing (Fanya Juu Graded)	0.45	0.514285714
238	Herweg and Ludi	9	Eutric Regosol	No Data	sub-Saharan Africa	Andit Tid	Ethiopia	24	1358	Conservation	Contour Ridges (Stone and Soil)	0.43125	0.492857143
238	Herweg and Ludi	7	Haplic Phaeozem	No Data	sub-Saharan Africa	Maybar	Ethiopia	28	1211	Conservation	Terracing (Stone and Soil Bunds)	0.20625	0.235714286
238	Herweg and Ludi	7	Pellic Vertisol	No Data	sub-Saharan Africa	Hunde Lafto	Ethiopia	21	935	Conservation	Strips (Lentil)	0.18125	0.207142857
238	Herweg and Ludi	7	Pellic Vertisol	No Data	sub-Saharan Africa	Hunde Lafto	Ethiopia	21	935	Conservation	Terracing (Stone and Soil Bunds)	0.15	0.171428571
238	Herweg and Ludi	7	Pellic Vertisol	No Data	sub-Saharan Africa	Hunde Lafto	Ethiopia	21	464	Conservation	Contour Ridges (Stone and Soil)	0	0
238	Herweg and Ludi	10	Humic Nitosol	No Data	sub-Saharan Africa	Gununo	Ethiopia	14	1211	Conservation	Strips (Lentil)	0.11875	0.135714286
238	Herweg and Ludi	4	Haplic Lixisol	No Data	sub-Saharan Africa	Dizi	Ethiopia	18	1512	Conservation	Contour Ridges (Stone and Soil)	0.0125	0.014285714
238	Herweg and Ludi	14	Pellic Vertisol	No Data	sub-Saharan Africa	Hunde Lafto	Ethiopia	21	935	Conservation	Terracing (Fanya Juu Graded)	0.103125	0.117857143
238	Herweg and Ludi	4	Haplic Lixisol	No Data	sub-Saharan Africa	Dizi	Ethiopia	18	1512	Conservation	Strips (Lentil)	0.09375	0.107142857
238	Herweg and Ludi	10	Humic Nitosol	No Data	sub-Saharan Africa	Gununo	Ethiopia	14	1314	Conservation	Contour Ridges (Stone and Soil)	0.01875	0.021428571
238	Herweg and Ludi	10	Humic Nitosol	No Data	sub-Saharan Africa	Gununo	Ethiopia	14	1314	Conservation	Terracing (Stone and Soil Bunds)	0.08125	0.092857143
238	Herweg and Ludi	7	Haplic Phaeozem	No Data	sub-Saharan Africa	Maybar	Ethiopia	28	1211	Conservation	Contour Ridges (Stone and Soil)	0.075	0.085714286
238	Herweg and Ludi	14	Haplic Phaeozem	No Data	sub-Saharan Africa	Maybar	Ethiopia	28	1211	Conservation	Terracing (Fanya Juu Graded)	0.071875	0.082142857
238	Herweg and Ludi	20	Humic Nitosol	No Data	sub-Saharan Africa	Gununo	Ethiopia	14	1314	Conservation	Terracing (Fanya Juu Graded)	0.03125	0.035714286
238	Herweg and Ludi	7	Haplic Phaeozem	No Data	sub-Saharan Africa	Maybar	Ethiopia	28	1314	Conventional	Crop	0.11875	0.135714286
238	Herweg and Ludi	4	Haplic Lixisol	No Data	sub-Saharan Africa	Dizi	Ethiopia	18	1512	Conventional	Crop	0.31875	0.364285714
238	Herweg and Ludi	7	Pellic Vertisol	No Data	sub-Saharan Africa	Hunde Lafto	Ethiopia	21	382	Conventional	Crop	0.45	0.514285714
238	Herweg and Ludi	10	Humic Nitosol	No Data	sub-Saharan Africa	Gununo	Ethiopia	14	1314	Conventional	Crop	0.7125	0.814285714
238	Herweg and Ludi	5	Chromic Cambisol	No Data	sub-Saharan Africa	Afdeyu	Eritrea	31	382	Conventional	Crop	2.625	3
238	Herweg and Ludi	9	Eutric Regosol	No Data	sub-Saharan Africa	Andit Tid	Ethiopia	24	1358	Conventional	Crop	3	3.428571429
238	Herweg and Ludi	1	Eutric Nitosol	No Data	sub-Saharan Africa	Anjeni II	Ethiopia	12	1690	Conventional	Crop	5.625	6.428571429
238	Herweg and Ludi	5	Vertic Luvisol	No Data	sub-Saharan Africa	Anjeni I	Ethiopia	28	1690	Conventional	Crop	6.875	7.857142857
238	Herweg and Ludi	8	Haplic Lixisol	No Data	sub-Saharan Africa	Dizi	Ethiopia	18	1512	Conservation	Terracing (Fanya Juu Graded)	0.040625	0.046428571
239	Hashim	8	#N/A	No Data	Asia and Australia	Kemaman	Malaysia		2738	Conservation	Cover Crop	2.74109375	3.132678571
240	Coughlan and Rose	4.5	#N/A	Sandy Clay Loam	Asia and Australia	Kemaman	Malaysia	17	3638	Conservation	Grassland	1.0625	1.349206349
240	Coughlan and Rose	6	#N/A	Clay	Asia and Australia	Los Banos	Phillipines	18	2037	Conservation	Mulching	0.431654676	0.48
240	Coughlan and Rose	2	#N/A	Clay	Asia and Australia	ViSCA	Phillipines	50	2800	Conservation	Mulching	0.215827338	0.24
240	Coughlan and Rose	3	#N/A	Loamy Sand	Asia and Australia	Goomboorian, Gympie	Australia	6	1045	Conservation	Mulching	0.181818182	0.20979021
240	Coughlan and Rose	3	#N/A	Loamy Sand	Asia and Australia	Khon Kaen	Thailand	4	913	Conservation	Contour Cultivation	0.060606061	0.06993007
240	Coughlan and Rose	3	#N/A	Loamy Sand	Asia and Australia	Khon Kaen	Thailand	4	913	Conventional	Cultivating Down slope	0.16969697	0.195804196
240	Coughlan and Rose	1	#N/A	Clay	Asia and Australia	Nan	Thailand	30	1886	Bare	Bare Soil	0.517985612	0.576
240	Coughlan and Rose	3	#N/A	Sandy Loam	Asia and Australia	Imbil, Gympie	Australia	38	1232	Conventional	Cultivating Down slope	1.875	2
240	Coughlan and Rose	2	#N/A	Clay	Asia and Australia	ViSCA	Phillipines	50	2800	Conventional	Cultivating Down slope	2.73381295	3.04
240	Coughlan and Rose	3	#N/A	Loamy Sand	Asia and Australia	Khon Kaen	Thailand	4	913	Bare	Bare Soil	2.909090909	3.356643357
240	Coughlan and Rose	3	#N/A	Loamy Sand	Asia and Australia	Goomboorian, Gympie	Australia	14	1045	Conventional	Conventional Tillage	3.090909091	3.566433566
240	Coughlan and Rose	2	#N/A	Clay	Asia and Australia	ViSCA	Phillipines	50	2800	Bare	Bare Soil	4.964028777	5.52
240	Coughlan and Rose	9	#N/A	Sandy Clay Loam	Asia and Australia	Kemaman	Malaysia	17	3638	Bare	Bare Soil	6.78125	8.611111111
240	Coughlan and Rose	6	#N/A	Clay	Asia and Australia	Los Banos	Phillipines	18	2037	Conventional	Conventional Tillage	8.561151079	9.52
240	Coughlan and Rose	6	#N/A	Clay	Asia and Australia	Los Banos	Phillipines	18	2037	Bare	Bare Soil	13.23741007	14.72
240	Coughlan and Rose	3	#N/A	Loamy Sand	Asia and Australia	Goomboorian, Gympie	Australia	14	1045	Bare	Bare Soil	13.09090909	15.1048951

Appendix 4.2: Soil Lifespan Analysis

Reference Number	Author	Lifespan (30cm) Lower Erosion Lower Formation	Lifespan (30cm) Lower Erosion Upper Formation	Lifespan (30cm) Upper Erosion Lower Formation	Lifespan (30cm) Upper Erosion Upper Formation	Median Lifespan (years)	Annual Soil Gain Lower Erosion, Lower Formation (mm year)	Annual Soil Gain Lower Erosion, Upper Formation (mm year)	Annual Soil Gain Upper Erosion, Lower Formation (mm year)	Annual Soil Gain Upper Erosion, Upper Formation (mm year)	Median Annual Soil Gain (mm year)
1	Lineger						0.0110625	0.05875	0.0110625	0.05875	0.034906
1	Lineger						0.0110625	0.05875	0.0110625	0.05875	0.034906
1	Lineger	16935.29964		14328.35821		15631.83		0.029973022		0.02675	
1	Lineger	77.44274582	78.40796113	69.62273182	70.40187738	73.92231					
1	Lineger	263.1540544	274.6424955	236.4182633	245.6499488	254.402					
1	Lineger	280.8793646	294.0061868	252.3261315	262.8696605	271.8745					
1	Lineger	423.5122956	454.0814243	380.2582587	404.7217538	414.117					
1	Lineger	441.4458941	474.7605562	396.3339113	422.9820233	432.214					
1	Lineger	1113.118684	1352.414157	996.8847352	1184.600197	1148.859					
1	Lineger	1238.774074	1542.516299	1108.903572	1346.196993	1292.486					
1	Lineger	1433.614742	1856.737352	1282.393802	1610.738255	1522.176					
1	Lineger	1670.518306	2274.493762	1493.001555	1957.585644	1814.052					
1	Lineger	3346.088457	7148.060853	2972.136223	5633.802817	4489.946					
2	Basic et al.	48.42468448	48.80032534	45.39307566	45.72299486	47.07384					
2	Basic et al.	250.0260444	260.374288	234.264426	243.3254478	246.6757					
2	Basic et al.	531.9738446	581.1138015	498.1147739	540.9466566	536.4603					
2	Basic et al.	1164.200825	1428.571429	1088.517651	1316.270567	1240.236					
3	Lundekvam	8682.96668		7958.378595		8320.673		0.013137097		0.009991379	
3	Lundekvam			1344000		1344000	0.000868952	0.048556452		0.047464286	
3	Lundekvam	14068.26132		12734.42503		13401.34		0.026362903		0.02412931	
3	Lundekvam	90198.72921		60759.49367		75479.11		0.044361511		0.04275	
3	Lundekvam	117628.4585		85978.99938		101803.7		0.045137097		0.044198276	
3	Lundekvam						0.004288306	0.051975806	0.0035625	0.05125	0.027769
3	Lundekvam	751.511356	853.4654828	701.7720753	789.8858297	770.6986					
3	Lundekvam	1030.463778	1232.318548	961.6248143	1135.140425	1082.802					
3	Lundekvam	2049.784414	3040.457703	1908.234746	2739.079103	2394.432					
3	Lundekvam	4780.842237	19916.41791	4224.310909	12858.97985	8819.911					
4	Gomez et al.	537.8017354	588.0751429	493.9938678	536.090039	536.9459					
4	Gomez et al.	1183.983337	1458.474004	1085.473382	1311.821711	1247.903					
4	Gomez et al.	4215.868059	12781.06509	3830.953767	9796.884244	7006.376					
5	Merten et al.	169051.2589		93389.11059		131220.2		0.04591289		0.044475134	
5	Merten et al.	5647.266283	55192.22325	4974.148537	23763.63772	14705.45					
6	Wang et al.	698.2988828	785.488434	698.2988828	785.488434	741.8937					
6	Wang et al.	978.0457734	1158.092746	978.0457734	1158.092746	1068.069					
6	Wang et al.	5714.631636	62378.85463	5714.631636	62378.85463	34046.74					
7	de Alba	824.3173622	948.6166008	718.5475075	811.2023177	817.7598					
7	de Alba	1402.278703	1804.511278	1219.113965	1512.151215	1457.215					
8	Chisci and Zanchi	249134.9481		132110.0917		190622.5		0.046483333		0.045416667	
8	Chisci and Zanchi	1159.775132	1421.913263	1063.355026	1279.653813	1219.714					
8	Chisci and Zanchi	3116.208613	6174.957118	2840.797001	5179.856115	4148.032					
9	Veihe and Hasholt	18709.92078		15841.58416		17275.75		0.031653226		0.02875	
9	Veihe and Hasholt	52523.82633		39952.43757		46238.13		0.041975806		0.040178571	
9	Veihe and Hasholt	52523.82633		39952.43757		46238.13		0.041975806		0.040178571	
9	Veihe and Hasholt						0.009127016	0.056814516	0.008919643	0.056607143	0.032867
9	Veihe and Hasholt	5972.785293	118095.2381	5282.188335	32941.17647	19456.98					
10	Skrodzki	321.0058182	338.2663848	300.7204761	315.8171769	318.4115					
10	Skrodzki	608.9052391	674.1573034	570.0486917	626.8500784	617.8777					
11	De Alba	83.882355	85.01594049	73.36869297	74.23445716	79.05841					
11	De Alba	838.7209506	967.7419355	731.0545898	827.1787297	832.9498					
12	USDA	6420.268719		5186.687502	29548.25268	6420.269		0.000960484			
12	USDA	6706.267295		5408.872631	38575.66766	6706.267		0.002953226			
12	USDA	9152.529863		7280.024267		8216.277		0.014909677		0.006478846	
12	USDA	23345.57093		17192.92445		20269.25		0.034837097		0.030238462	
12	USDA	26651.95555		19294.75207		22973.35		0.03643129		0.032139231	
12	USDA	10419.43841		8228.93314		9324.186		0.018895161		0.011230769	
12	USDA	61482.52211		37758.68329		49620.6		0.042808065		0.039742308	
12	USDA	24.34930336	24.44391413	20.41903929	20.48553075	22.41742					
12	USDA	27.1310948	27.24861025	22.7514405	22.83402044	24.98256					
12	USDA	31.07861829	31.2329153	26.06112071	26.16953146	28.62407					
12	USDA	32.62094995	32.7909834	27.35419927	27.47365963	30.0473					
12	USDA	34.38348857	34.57244572	28.83186853	28.96461527	31.67405					
12	USDA	38.45914272	38.69570509	32.24867866	32.4148435	35.43699					
12	USDA	39.29471826	39.54170456	32.94915997	33.12264125	36.20868					
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA	60.10197075	60.68170612	50.39009199	50.79697193	55.44947					
12	USDA	82.28690617	83.37749966	68.98106464	69.74583576	76.01637					
12	USDA	89.39548251	90.68411806	74.93701328	75.84041388	82.61795					
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA	99.48552877	101.0840778	89.82600702	91.12717481	95.30635					
12	USDA	107.5908435	109.462929	90.17977512	91.49128686	99.54107					
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA	148.5025138	152.092772	124.4405857	126.9518026	137.7272					
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA	187.6086977	193.3755363	157.1738529	161.2013219	174.405					
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA	224.5456798	232.8571446	188.0774566	193.8735944	209.2096					
12	USDA	228.291237	236.8876026	191.2104479	197.2043752	212.7478					
12	USDA	263.1705357	274.6604473	220.3787322	228.3790882	245.7748					
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA	282.389843	295.6615639	236.4459745	245.6798665	264.0349					
12	USDA	284.883594	298.3963602	238.5304688	247.931126	266.4074					
12	USDA	290.3785185	304.430445	243.1233875	252.8969672	271.6377					
12	USDA	290.3785185	304.430445	243.1233875	252.8969672	271.6377					
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA	324.7156934	342.3885096	271.8172412	284.0921873	304.4039					
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.0110625	0.05875	0.0110625	0.05875	0.034906
12	USDA						0.005748522	0.053436022	0.004726603	0.052414103	0.029081
12	USDA						0.005748522	0.053436022	0.004726603	0.052414103	0.029081
12	USDA						0.003091532	0.050779032	0.001558654	0.049246154	0.026169
12	USDA						0.003091532	0.050779032	0.001558654	0.049246154	0.026169
12	USDA	396.750274	423.4562912	331.9749316	350.4692581	373.6098					
12	USDA	410.1856145	438.7961886	343.1893954	362.9916093	386.5886					
12	USDA	598.8749201	661.8837068	539.7657417	590.4243019	594.6496					

12	USDA	610.8630164	676.557993	510.482062	555.5634696	583.2132						
12	USDA	693.3935931	779.2871617	579.1674221	637.8941859	665.6439						
12	USDA			186417.0484		186417	0.000434543	0.048122043		0.046078205		
12	USDA	1014.131044	1209.032644	845.4620098	976.7275869	995.4293						
12	USDA	1027.980695	1228.769051	856.9380395	992.07611	1010.028						
12	USDA	1066.832363	1284.693044	889.1210905	1035.466956	1051.15						
12	USDA	1218.294236	1510.890252	1014.444598	1209.478327	1213.886						
12	USDA	1315.405628	1663.164483	1094.679227	1325.290969	1320.348						
12	USDA	1414.263148	1824.405842	1176.262125	1446.77536	1430.519						
12	USDA	1969.249012	2866.565977	1632.507836	2204.604231	2086.927						
12	USDA	2265.60573	3540.766405	1874.921127	2670.958463	2468.282						
12	USDA	2385.260118	3841.969732	1972.557011	2873.580862	2629.42						
12	USDA	2764.925581	4933.032754	2281.452232	3579.623681	3172.275						
12	USDA	2834.332503	5158.403668	2337.773271	3720.249924	3277.291						
12	USDA	4370.172399	14313.19738	3572.450907	8267.09062	6318.632						
12	USDA	5692.033448	59787.84957	4617.638788	17360.3383	11526.19						
12	USDA	11030.16394		8681.570029		9855.867		0.020489355		0.013131538		
12	USDA	5915.701257	99173.55372	4792.921224	20127.73369	13021.72						
12	USDA	5994.21526	127078.1143	4854.343756	21257.26744	13625.74						
13	Paningbatan et al	29.74755994	29.88889324	26.74844757	26.86266463	28.30511						
13	Paningbatan et al	153.8959408	157.7551107	138.3165721	141.426046	147.661						
14	Gomez et al.	21524.66368		19225.63418		20375.15		0.03375		0.032083333		
14	Gomez et al.	249.9934898	260.3389831	234.2339411	243.2925593	246.643						
15	Biddoccu et al.	0.061274648	0.061275245	0.057189663	0.057190183	0.059232						
15	Biddoccu et al.	0.3537782	0.353798096	0.3301927	0.330210031	0.341994						
16	Laloy and Bielders	10067.88606		7966.974507		9017.43		0.017889785		0.010032051		
16	Laloy and Bielders	8140.192199		7490.89648		7815.544		0.010833333		0.007638889		
16	Laloy and Bielders	417.1615632	446.7887062	390.7133231	416.5863067	416.8739						
16	Laloy and Bielders	701.5128729	789.5574658	585.9209946	646.0965003	673.8047						
17	Lanzanova et al.	434207.1788		203462.197		318834.7		0.046996586		0.046213025		
17	Lanzanova et al.	67.95768323	68.69980879	63.7003512	64.35195995	66.15482						
17	Lanzanova et al.						0.007228918	0.054916418	0.006973346	0.054660846	0.030945	
18	Rejman et al.	473.1123992	511.5863302	395.6905244	422.2492895	447.6808						
18	Rejman et al.	4351.767906	14117.64706	3557.785507	8188.976378	6270.372						
19	Szpikowski	1075.509747	1297.297297	1005.797304	1197.206518	1136.358						
19	Szpikowski	2785.838654	5000	2595.062173	4417.177914	3601.508						
20	Ionita et al.	104.1934357	105.9481936	94.07522098	95.50338241	99.84841						
20	Ionita et al.	141.2149228	144.4576044	127.4847189	130.1216017	135.6683						
20	Ionita et al.	279.6398509	292.6483893	252.3261315	262.8696605	271.2548						
20	Ionita et al.	1148.56468	1405.09915	1033.178562	1236.203091	1192.384						
21	Horvat and Zemljic	209.1906095	216.3860047	188.8054124	194.6472019	201.9189						
21	Horvat and Zemljic						0.010656048	0.058343548	0.0106125	0.0583	0.034478	
21	Horvat and Zemljic						0.008546371	0.056233871	0.008276786	0.055964286	0.032255	
21	Horvat and Zemljic	1409.718341	1816.849817	1266.920554	1586.402266	1498.06						
22	Goeck	919.012062	1076.233184	859.7528211	995.8506224	957.4313						
22	Goeck	1423.06552	1839.08046	1329.762674	1686.18267	1554.624						
23	Richter	14860.68111		12169.5038		13515.09		0.0275		0.023035714		
23	Richter						0.0110625	0.05875	0.0110625	0.05875	0.034906	
23	Richter						0.0110625	0.05875	0.0110625	0.05875	0.034906	
23	Richter						0.0048125	0.0525	0.003919643	0.051607143	0.02821	
23	Richter						0.0048125	0.0525	0.003919643	0.051607143	0.02821	
23	Richter						0.0048125	0.0525	0.003919643	0.051607143	0.02821	
23	Richter						0.0048125	0.0525	0.003919643	0.051607143	0.02821	
23	Richter	1587.826662	2123.893805	1379.253725	1766.561514	1677.194						
23	Richter	1981.01527	2891.566265	1717.703594	2362.869198	2171.942						
23	Richter	2957.486137	5581.395349	2552.997493	4296.675192	3627.081						
23	Richter	2957.486137	5581.395349	2552.997493	4296.675192	3627.081						
23	Richter	5200.433369	30000	4443.856633	15135.13514	10167.78						
24	Jung and Brechtel	7398.200169		5943.423183	107586.2069	7398.2		0.007137097				
24	Jung and Brechtel	36177.97228		28940.56848		32559.27		0.039395161		0.037321429		
24	Jung and Brechtel	36177.97228		24969.988		30573.98		0.039395161		0.035673077		
24	Jung and Brechtel	8797.966062		7012.023823		7904.995		0.01358871		0.004903846		
24	Jung and Brechtel						0.004395833	0.052083333	0.003919643	0.051607143	0.028001	
24	Jung and Brechtel	746.5644489	847.0909712	672.5245692	753.0255491	749.795						
24	Jung and Brechtel	1356.265894	1729.026261	1128.411002	1375.05509	1365.66						
24	Jung and Brechtel	1996.966972	2925.678333	1790.94931	2503.725782	2250.346						
24	Jung and Brechtel	3137.938549	6260.869565	2906.322982	5401.92926	4269.934						
24	Jung and Brechtel	10851.01728		9435.551811		10143.28		0.020040323		0.015892857		
25	Martinez Raya et al.	64421.16201		47310.61673		55865.89		0.043030645		0.041346429		
25	Martinez Raya et al.						0.0073125	0.055	0.006910714	0.054598214	0.030955	
25	Martinez Raya et al.	2507.000394	4167.973827	2244.309073	3489.024112	2998.012						
26	Hudek and Rey	35907.6476		28491.38136		32199.51		0.039332734		0.037158		
26	Hudek and Rey						0.011026529	0.058714029	0.0110225	0.05871	0.034868	
27	Mitchell et al.	274.7095519	287.2531418	257.3772543	268.3563176	271.5329						
27	Mitchell et al.	1466.544455	1912.350598	1370.254068	1751.824818	1609.185						
28	Gil	327.8912494	345.9210147	305.7853496	321.4080735	324.6497						
28	Gil						0.0030625	0.05075	0.002491071	0.050178571	0.026621	
28	Gil	925.1525859	1084.664055	861.5163714	998.2174688	961.685						
29	Gil						0.0070625	0.05475	0.006776786	0.054464286	0.030763	
29	Gil	738.4236706	836.62561	687.9466022	772.4137931	755.4187						
29	Gil	2041.68439	3022.670025	1896.055527	2714.054927	2377.87						
30	Oliveira et al.	2.97603759	2.977446118	2.790016104	2.791254015	2.883646						
30	Oliveira et al.	7.800457423	7.81014159	6.142484768	6.148488147	6.974473						
30	Oliveira et al.	404.6208627	432.4340975	378.9786518	403.2725203	403.9467						
30	Oliveira et al.						0.010226082	0.057913582	0.010170321	0.057857821	0.034042	
30	Oliveira et al.						0.009306022	0.056993522	0.008832052	0.056519552	0.032913	
30	Oliveira et al.						0.006601604	0.054289104	0.006304211	0.053991711	0.030297	
31	Silva et al.			454451.9907		454452	0.001830924	0.049518424		0.047027364		
31	Silva et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
32	Hammad et al.						0.011002984	0.058690484	0.010991538	0.058679038	0.034841	
32	Hammad et al.	5785.156098	71953.57834	4690.671277	18439.71631	12112.44						
33	Rousseva et al.	17266.18705		13994.1691		15630.18		0.0303125		0.02625		
33	Rousseva et al.						0.0094375	0.057125	0.009205357	0.056892857	0.033165	
33	Rousseva et al.						0.00925	0.0569375	0.008991071	0.056678571	0.032964	
33	Rousseva et al.						0.0089375	0.056625	0.008633929	0.056321429	0.032629	
34	Voss	369230.7692		119572.9537		244401.9		0.046875		0.045178571		
34	Voss						0.010875	0.0585625	0.010848214	0.058535714	0.034705	
35	Aguiar et al.	23076.92308		18250.95057		20663.94		0.0346875		0.03125		
35	Aguiar et al.	24870.46632		19523.53283		22197		0.035625		0.032321429		
35	Aguiar et al.	96644.2953		58502.61172		77573.45		0.044583333		0.042559524		
35	Aguiar et al.						0.0041875	0.051875	0.003205357	0.050892857	0.02754	
36	Albuquerque et al.	39024.39024		28940.56848		33982.48		0.04		0.037321429		
36	Albuquerque et al.	39024.39024		28940.56848		33982.48		0.04		0.037321429		
36	Albuquerque et al.	82.30029319	83.39124392	71.98544866	72.81869013	77.55949						
36	Albuquerque et al.	135.1237227	138.0897583	118.1596632	120.4214752	127.7726						
36	Albuquerque et al.	209.3966758	216.6064982	183.0454181	188.5310291	198.9639						
36	Albuquerque et al.						0.0048125	0.0525	0.003919643	0.051607143	0.02821	
36	Albuquerque et al.	576.7151268	634.9206349	503.2878477	547.0530772	561.8841						
37	Amado et al.	69.36584943	70.13922414	60.67571821	61.2666294	65.31624						
37	Amado et al.	4883.01119	21818.18182	4178.584753	12444.44444	8663.728						
38	Amaral et al.	435.2557127	467.608378	380.0861981	404.5268481	419.8913						
39	Baptista and Levien	1426.236815	1844.380403	1239.806649	1544.117647	1485.177						
40	Bertol and Miquelluti	105.0765088	106.8613919	91.8974359	93.25976174	99.16814						
40	Bertol and Miquelluti	706.0900265	795.3603977	615.82449	682.6493295	694.3697						
41	Bertol et al.	72.01476303	72.84868721	62.99200789	63.62913305	67.82195						

41	Bertol et al.	1324.868893	1678.321678	1152.223861	1410.579345	1367.724						
42	Bertol et al.	72.4058347	73.24889364	63.33396793	63.97806466	68.19195						
43	Bertol et al.	546.137217	598.056317	476.6701187	515.7487567	530.943						
44	Bertol et al.	2096.069869	3143.418468	1816.510786	2553.967771	2325.019						
45	Bertol et al.	5529.953917	45714.28571	4718.438422	18876.40449	12203.18						
46	Bertol et al.	1341.156748	1704.545455	1166.302197	1431.736833	1386.447						
47	Bertolino et al.	414.4004144	443.6229205	361.9090703	384	399.2002						
47	Bertolino et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
48	Bertoni and Lombardi Neto	6639.004149		5636.638148	54193.54839	6639.004		0.0025				
48	Bertoni and Lombardi Neto	21524.66368		17134.11525		19329.39		0.03375		0.030178571		
48	Bertoni and Lombardi Neto	224.5240558	232.8338903	196.255441	202.5750613	213.5496						
48	Bertoni and Lombardi Neto	336.6924642	355.7312253	294.1494034	308.5777261	322.6351						
49	Cabral et al.	1110.340042	1348.314607	966.6005006	1142.080218	1126.21						
49	Cabral et al.	2066.293586	3076.923077	1790.94931	2503.725782	2285.01						
50	Campos Filho et al.	318.2390771	335.1955307	278.0513236	290.9090909	304.5741						
51	Cândido et al.	7100.591716		6016.114593	137704.918	7100.592		0.0054375				
51	Cândido et al.	14634.14634		11995.71582		13314.93		0.0271875		0.022678571		
51	Cândido et al.	30379.74684		23317.14087		26848.44		0.0378125		0.034821429		
51	Cândido et al.	800000		149333.3333		474666.7		0.0473125		0.045678571		
51	Cândido et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
51	Cândido et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
51	Cândido et al.						0.00625	0.0539375	0.0055625	0.05325	0.02975	
52	Cardoso et al.	3887.688985	10176.67845	3341.842655	7128.712871	5508.201						
53	Carvalho and Hernani	24.71385984	24.81133051	21.62216426	21.69673645	23.2053						
54	Carvalho et al.	197530.8642		90468.49758		143999.7		0.04616875		0.044371429		
54	Carvalho et al.	71.57086112	72.39447751	62.60385066	63.23310886	67.40198						
55	Cogo et al.	81.20728159	82.26926043	71.02978389	71.84092367	76.5241						
55	Cogo et al.	790.0367587	903.5010666	688.7739414	773.4569227	781.7468						
55	Cogo et al.	874.2638577	1015.371598	761.9105209	866.9028862	870.5834						
55	Cogo et al.	3247.631935	6713.286713	2799.766686	5045.045045	4146.338						
56	Correchel et al.	142.4416879	145.7416123	124.5546984	127.0705695	134.7561						
56	Correchel et al.	208.3578795	215.4951257	182.1382191	187.5687832	197.9633						
56	Correchel et al.	576.7151268	634.9206349	503.2878477	547.0530772	561.8841						
57	Cruz	700.545842	788.3326764	611.0046298	676.7317081	688.6388						
57	Cruz	785.4848937	897.5527663	684.8198272	768.4742584	776.9796						
58	Debarba and Amado	27.49093658	27.61159687	24.0515218	24.14382823	25.81738						
58	Debarba and Amado						0.0041875	0.051875	0.003205357	0.050892857	0.02754	
58	Debarba and Amado	2167.042889	3305.785124	1877.409622	2676.011469	2421.527						
59	Dedecek	91.45818646	92.80742459	79.99219124	81.02242585	86.24031						
59	Dedecek						0.0016875	0.049375	0.000348214	0.048035714	0.024862	
59	Dedecek	438.2360997	471.0500491	382.6835685	407.4702886	422.8532						
60	Dedecek	430.3774769	461.9826756	375.8347222	399.7144897	415.046						
60	Dedecek	830.8399891	957.2649573	724.2115116	818.4285615	824.6343						
60	Dedecek	3193.612774	6486.486486	2753.872633	4897.959184	4045.786						
61	Eduardo et al.	26966.29213		20986.8832		23976.59		0.0365625		0.033392857		
61	Eduardo et al.	6209.573092	480000	5282.188335	32941.17647	19575.37						
62	Encinas	39024.39024		28940.56848		33982.48		0.04		0.037321429		
62	Encinas	81.46888398	82.53776103	71.25851444	72.07491673	76.7719						
62	Encinas						0.0073125	0.055	0.006776786	0.054464286	0.030888	
63	Falcão Sobrinho						0.0066875	0.054375	0.0060625	0.05375	0.030219	
63	Falcão Sobrinho						0.0085625	0.05625	0.008205357	0.055892857	0.032228	
63	Falcão Sobrinho						0.0079375	0.055625	0.007491071	0.055178571	0.031558	
64	Freire et al.						0.00565625	0.05334375	0.004883929	0.052571429	0.029114	
64	Freire et al.						0.00856875	0.05625625	0.0082125	0.0559	0.032234	
64	Freire et al.	2274.234815	3561.887801	1969.311561	2866.698519	2570.467						
65	Guadagnin et al.	967.1569615	1142.857143	842.5064567	972.7851766	969.9711						
66	Guimarães	65753.42466		44152.43101		54952.93		0.043125		0.040892857		
66	Guimarães	8.461981902	8.473379466	7.403945377	7.412669488	7.937326						
66	Guimarães						0.0098125	0.0575	0.009633929	0.057321429	0.033567	
66	Guimarães						0.0091875	0.056875	0.008919643	0.056607143	0.032897	
66	Guimarães						0.0060625	0.05375	0.005348214	0.053035714	0.029549	
66	Guimarães						0.0048125	0.0525	0.003919643	0.051607143	0.02821	
67	Guimarães et al.	17744.91682		14352.84067		16048.88		0.03078125		0.026785714		
67	Guimarães et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
68	Hernani et al.	1241.834293	1547.264083	1080.420592	1304.449103	1273.142						
69	Hernani et al.	1297.034385	1633.903498	1128.16036	1374.682923	1335.859						
70	Lanzanova et al.	30.27378858	30.42017872	26.48586908	26.59785001	28.43582						
70	Lanzanova et al.	11622.27603		9652.398736		10637.34		0.021875		0.016607143		
70	Lanzanova et al.						0.0023125	0.05	0.0010625	0.04875	0.025531	
71	Leite et al.	39024.39024		28940.56848		33982.48		0.04		0.037321429		
72	Lima						0.003875	0.0515625	0.002848214	0.050535714	0.027205	
72	Lima	5977.58406	120000	5090.137858	26666.66667	16322.13						
73	Marchioro and Augustin	18354.23677		14807.24145		16580.74		0.0313425		0.027427143		
73	Marchioro and Augustin	18735.363		15090.27216		16912.82		0.031675		0.027807143		
73	Marchioro and Augustin	23134.75998		18292.28458		20713.52		0.03472		0.031287143		
74	Margolis et al.	400.5674706	427.8074866	349.8505846	370.4520397	385.5098						
75	Marques et al.	1004.289152	1195.070335	874.7038763	1015.965167	1010.127						
76	Martins	9542.743539		7998.095692		8770.42		0.01625		0.010178571		
76	Martins	182.613658	188.073035	159.6525656	163.8097467	173.2117						
76	Martins						0.0084375	0.056125	0.0080625	0.05575	0.032094	
76	Martins						0.008125	0.0558125	0.007705357	0.055392857	0.031759	
76	Martins						0.0066875	0.054375	0.0060625	0.05375	0.030219	
76	Martins	2472.952087	4074.702886	2139.446036	3241.991509	2857.472						
76	Martins	11188.81119		9310.058188		10249.43		0.020875		0.015464286		
76	Martins	5832.320778	80000	4969.679042	23661.97183	14747.15						
76	Martins	5977.58406	120000	5090.137858	26666.66667	16322.13						
77	Martins Filho	2372.713791	3809.52381	2053.664201	3049.001815	2710.858						
78	Merten et al.	248.4086322	258.6206897	217.1089616	224.8694954	236.6391						
78	Merten et al.	4692.082111	18461.53846	4018.658055	11125.82781	7908.955						
79	Nacinovic et al.	328.7153394	346.8383517	287.1907784	300.9285796	314.822						
79	Nacinovic et al.						0.008374688	0.056062188	0.007990714	0.055678214	0.032026	
79	Nacinovic et al.						0.00821875	0.05590625	0.0078125	0.0555	0.031859	
80	Nagel et al.	28070.17544		21747.57282		24908.87		0.037		0.033892857		
80	Nagel et al.	236.7097347	245.9646426	206.8952777	213.9309818	225.3204						
80	Nagel et al.	2659.770964	4608	2299.112743	3623.292595	3141.532						
81	Nascimento and Lombardi Neto	278.7294582	291.6514765	243.575338	253.3860215	266.0577						
81	Nascimento and Lombardi Neto	1350.97101	1720.430108	1174.784098	1444.539983	1397.755						
82	Oliveira	331.2705606	349.6843127	289.4198108	303.3768735	317.3237						
82	Oliveira						0.010729167	0.058416667	0.010681548	0.058369048	0.034549	
82	Oliveira						0.010645833	0.058333333	0.01058631	0.05827381	0.03446	
82	Oliveira						0.009395833	0.057083333	0.009157738	0.056845238	0.033121	
82	Oliveira						0.007979167	0.055666667	0.007538691	0.055226191	0.031603	
82	Oliveira						0.009895833	0.057583333	0.009729167	0.057416667	0.033656	
83	Oliveira	37944.66403		28259.04121		33101.85		0.03978125		0.037071429		
83	Oliveira						0.00875	0.0564375	0.008419643	0.056107143	0.032429	
83	Oliveira	702.4732914	790.7742998	612.6802939	678.7878788	690.6306						
84	Oliveira et al.	349.5230467	370.0848111	305.3407366	320.9169054	335.22						
84	Oliveira et al.						0.0016875	0.049375	0.000348214	0.048035714	0.024862	
85	Pereira et al.	455.2783838	490.797546	397.5343406	424.3495832	439.814						
85	Pereira et al.	520.4380353	567.3758865	454.293479	489.6531623	505.0456						
85	Pereira et al.	1172.733936	1441.441441	1020.625133	1218.274112	1195.504						
86	Pinese Júnior et al.						0.011055502	0.058743002	0.011054502	0.058742002	0.034899	
86	Pinese Júnior et al.						0.011062344	0.058749844	0.011062321	0.058749821	0.034906	
86	Pinese Júnior et al.						0.011062396	0.058749896	0.011062381	0.058749881	0.034906	
86	Pinese Júnior et al.						0.010967241	0.058654741	0.010953633	0.058641133	0.034804	

87	Pires et al.	200000		91056.91057		145528.5		0.0461875		0.044392857	
87	Pires et al.						0.00425	0.0519375	0.003276786	0.050964286	0.027607
87	Pires et al.						0.0085	0.0561875	0.008133929	0.055821429	0.032161
87	Pires et al.						0.0048125	0.0525	0.003919643	0.051607143	0.02821
87	Pires et al.	1017.380246	1213.653603	886.052583	1031.307551	1024.344					
87	Pires et al.	11707.31707		9719.409893		10713.36		0.0220625		0.016821429	
88	Prochnow	644.9672718	718.6448412	562.6735927	617.9434813	631.4554					
89	Prochnow et al.	122.0349325	124.4490537	106.7205351	108.5621971	115.2986					
89	Prochnow et al.	1009.888491	1203.007519	879.5581268	1022.519781	1016.204					
90	Rieger et al.	285714.2857		107899.8073		196807		0.0466375		0.044907143	
90	Rieger et al.	13733.90558		11301.71544		12517.81		0.02584375		0.021142857	
90	Rieger et al.	288.3350453	302.1851766	251.9583009	262.4704721	275.4028					
90	Rieger et al.						0.0098875	0.057575	0.009719643	0.057407143	0.033647
90	Rieger et al.			5090909.091		5090909	0.00133125	0.04901875		0.047628571	
91	Santos et al.	31.78323831	31.94462931	27.80625988	27.92971023	29.85647					
91	Santos et al.	190.5543278	196.5065502	166.5887159	171.1200896	180.8372					
92	Santos et al.	39024.39024		28940.56848		33982.48		0.04		0.037321429	
92	Santos et al.	39024.39024		28940.56848		33982.48		0.04		0.037321429	
92	Santos et al.	92.4445814	93.82329945	80.85455565	81.90726927	87.17593					
92	Santos et al.	158.9321275	163.0513903	138.9638097	142.1027828	150.5175					
92	Santos et al.						0.0048125	0.0525	0.003919643	0.051607143	0.02821
92	Santos et al.	708.6962941	798.6688852	618.0901749	685.4345165	697.0654					
92	Santos et al.	1193.139448	1472.392638	1038.286827	1243.523316	1218.331					
92	Santos et al.	5832.320778	80000	4969.679042	23661.97183	14747.15					
93	Santos et al.	2412.545235	3913.256155	2087.760504	3124.767502	2768.656					
94	Saraiva et al.	33.27371792	33.45064288	29.11003854	29.24536513	31.25954					
94	Saraiva et al.						0.00325	0.0509375	0.002133929	0.049821429	0.026536
94	Saraiva et al.	2069.857697	3084.832905	1794.00929	2509.710188	2289.784					
95	Schick et al.	68.66658083	69.42435638	60.06424729	60.64325163	64.65492					
95	Schick et al.	1647.785788	2232.55814	1430.944168	1852.260198	1750.023					
96	Schick et al.	56.38899005	56.89900427	49.32754518	49.71738037	53.05319					
97	Silva et al.	23.36073353	23.44780421	20.43844106	20.50505914	21.9329					
97	Silva et al.	326.0205121	343.8395415	284.8399047	298.3484283	312.1845					
98	Silva et al.	57901.08565		39990.47846		48945.78		0.04250625		0.040185714	
99	Silva et al.	7118.493252		6030.800158	145833.3333	7118.493		0.00554375			
99	Silva et al.	15335.46326		12532.63708		13934.05		0.028125		0.02375	
99	Silva et al.	66574.2025		44574.1576		55574.18		0.04318125		0.040957143	
99	Silva et al.	278.4190439	291.3116306	243.3044216	253.0928549	265.7559					
99	Silva et al.						0.01055	0.0582375	0.010476786	0.058164286	0.034357
99	Silva et al.						0.00684375	0.05453125	0.006241071	0.053928571	0.030386
99	Silva et al.						0.008002083	0.055689583	0.007564881	0.055252381	0.031627
99	Silva et al.						0.00743125	0.05511875	0.0069125	0.0546	0.031016
99	Silva et al.						0.00486875	0.05255625	0.003983929	0.051671429	0.02827
99	Silva et al.	1022.364217	1220.752798	890.3728436	1037.165082	1029.765					
100	Tenberg et al.	108.4274073	110.3289757	94.8265887	96.27783031	102.3526					
100	Tenberg et al.	185.0864058	190.6969045	161.8125575	166.0844922	175.5854					
101	Thomaz	974.0655059	1152.516327	848.4977045	980.7813558	977.4234					
101	Thomaz	1382.528299	1771.936949	1202.052075	1485.989244	1434.259					
102	Wichert	447.6359228	481.9277108	390.8749317	416.7700323	432.203					
102	Wichert	639.7441024	712.1661721	558.1302636	612.4681006	626.1061					
103	Youlton et al.	7599.746675		6424.719875		7012.233		0.0082125		0.000992857	
103	Youlton et al.						0.00463125	0.05231875	0.0037125	0.0514	0.028016
104	Nearing et al.	7457.525184		5989.058451	124800	7457.525		0.007459677			
104	Nearing et al.	15752.14369		13470.53321		14611.34		0.028642473		0.025416667	
104	Nearing et al.	16116.10527		12334.45345		14225.28		0.029072581		0.023365385	
104	Nearing et al.	16694.71558		12737.29333		14716		0.029717742		0.024134615	
104	Nearing et al.	19150.22706		14419.17275		16784.7		0.032021889		0.026881868	
104	Nearing et al.	23821.97556		17500.23371		20661.1		0.035094086		0.030544872	
104	Nearing et al.	24664.3461		18039.89592		21352.12		0.035524194		0.031057692	
104	Nearing et al.	36177.97228		24969.988		30573.98		0.039395161		0.035673077	
104	Nearing et al.	46518.69055		30560.41419		38539.55		0.041238479		0.037870879	
104	Nearing et al.	54275.44161		34412.6684		44344.06		0.042160138		0.03896978	
104	Nearing et al.	59212.0971		36727.48676		47969.79		0.042620968		0.039519231	
104	Nearing et al.	162979.1895		69410.45606		116194.8		0.045846774		0.043365385	
104	Nearing et al.	10.86206998	10.88085705	9.10953471	9.122744777	9.992407					
104	Nearing et al.	18.91818896	18.97525141	15.86508306	15.90519417	17.41169					
104	Nearing et al.	25.57213792	25.67651048	21.44433802	21.51768657	23.54491					
104	Nearing et al.	26.81219732	26.92696062	22.48406388	22.56471082	24.68845					
104	Nearing et al.	27.09602865	27.21323988	22.72203966	22.80440593	24.95022					
104	Nearing et al.	27.33227617	27.4515447	22.92011861	23.00392984	25.1681					
104	Nearing et al.	28.02158038	28.14695434	23.49805444	23.58615372	25.80387					
104	Nearing et al.	28.73461053	28.86646115	24.09587791	24.18852578	26.46157					
104	Nearing et al.	33.19547988	33.37157159	26.13464232	26.24366689	29.71957					
104	Nearing et al.	35.9581208	36.16483331	30.15197548	30.29718711	33.12765					
104	Nearing et al.	59.48717101	60.05505046	55.76157795	56.26025578	57.87371					
104	Nearing et al.	59.92271144	60.49897716	50.23985274	50.64430031	55.28351					
104	Nearing et al.	62.2252294	62.84686146	52.16959466	52.60584397	57.41554					
104	Nearing et al.	66.7396808	67.45530253	55.95300619	56.4551292	61.5974					
104	Nearing et al.	67.37031215	68.09959566	53.02612782	53.47688151	60.4236					
104	Nearing et al.	67.91000322	68.65108211	61.32320635	61.92685914	64.91843					
104	Nearing et al.	73.2027365	74.06456548	61.36912467	61.97368627	67.58821					
104	Nearing et al.	74.1289475	75.01285503	62.14526655	62.76529401	68.44712					
104	Nearing et al.	83.46458755	84.58683422	78.23300195	79.21814193	81.34136					
104	Nearing et al.	86.46573069	87.67071633	72.48237017	73.32722273	79.89648					
104	Nearing et al.	94.3615786	95.79851409	79.09757776	80.10475237	87.23317					
104	Nearing et al.	119.2964396	121.6024059	99.98413713	101.5988798	110.4477					
104	Nearing et al.	122.5666848	125.0021002	110.656993	112.6382836	117.6025					
104	Nearing et al.	125.3359458	127.8837994	117.4685172	119.7036964	122.5198					
104	Nearing et al.	126.700396	129.3046016	118.490461	120.7650768	123.7327					
104	Nearing et al.	133.5112287	136.4061383	111.8883125	113.9143452	123.7128					
104	Nearing et al.	136.6500354	139.6842086	114.5166352	116.6398744	126.645					
104	Nearing et al.	139.2323114	142.3835638	116.6788657	118.8838131	129.0581					
104	Nearing et al.	140.3623953	143.5655983	126.7154672	129.3202987	134.8413					
104	Nearing et al.	148.4270029	152.0135668	124.3773657	126.8860059	137.6565					
104	Nearing et al.	148.4270029	152.0135668	124.3773657	126.8860059	137.6565					
104	Nearing et al.	155.8910146	159.8521797	130.6261893	133.3960409	144.6435					
104	Nearing et al.	161.854129	166.128288	141.5167848	144.7735042	153.3138					
104	Nearing et al.	171.153897	175.9405964	154.4962548	158.3859715	164.7699					
104	Nearing et al.	180.8738101	186.2281295	151.5375966	155.2779575	168.0759					
104	Nearing et al.	186.7330048	192.4453143	156.4410333	160.4305572	173.5818					
104	Nearing et al.	197.3179086	203.707253	165.2984511	169.758964	183.5384					
104	Nearing et al.	204.1395887	210.9860193	171.0062236	175.7845512	189.9621					
104	Nearing et al.	221.1281399	229.1839941	185.2187154	190.8373601	205.9827					
104	Nearing et al.	225.9636484	234.3823835	189.2635404	195.1341547	210.5489					
104	Nearing et al.	235.1034028	244.2307061	196.9081632	203.2705714	219.187					
104	Nearing et al.	236.2981231	245.5202455	197.9073832	204.3355819	220.3169					
104	Nearing et al.	241.2009473	250.8175168	202.007776	208.7096127	224.9553					
104	Nearing et al.	10444.79281		9095.010376		9769.902		0.018965054		0.014702381	
104	Nearing et al.	245.8638529	255.8635394	214.887344	222.4870878	234.1755					
104	Nearing et al.	252.7690498	263.3504023	220.9155283	228.9556171	240.8623					
104	Nearing et al.	261.1841401	272.4975277	218.7179065	226.5959765	243.8901					
104	Nearing et al.	262.2890715	273.7004746	219.6417446	227.5877161	244.9384					
104	Nearing et al.	272.2716568	284.5886088	227.9876799	236.5607703	254.4162					
104	Nearing et al.	275.0904489	287.6696439	230.3441504	239.0987815	257.0946					
104	Nearing et al.	275.4979051	288.1152461	230.6847715	239.465807	257.4819					

104	Nearing et al.	275.4979051	288.1152461	230.6847715	239.465807	257.4819						
104	Nearing et al.	279.6398509	292.6483893	234.1472201	243.1990023	261.4194						
104	Nearing et al.	286.5323995	300.2057862	239.9086502	249.4204173	267.9764						
104	Nearing et al.	292.9866325	307.2983355	274.4896209	287.0126764	289.9997						
104	Nearing et al.	301.8298434	317.0409511	282.7687776	296.07698	298.9534						
104	Nearing et al.	305.8499978	321.479497	256.0535743	266.9176149	286.3838						
104	Nearing et al.	316.8735147	333.6809176	296.8521305	311.5534401	314.2135						
104	Nearing et al.	336.2613076	355.2499642	281.4627039	294.6453867	315.4533						
104	Nearing et al.	357.9392514	379.5337448	299.569369	314.5478375	336.2435						
104	Nearing et al.	368.1075692	390.9856096	344.8083201	364.8032427	366.4554						
104	Nearing et al.	371.8949397	395.2611167	311.2234974	327.4215553	349.6582						
104	Nearing et al.	377.1738827	401.2295745	315.6313386	332.3037597	354.7388						
104	Nearing et al.	382.8870749	407.7010193	358.6401561	380.321865	381.6045						
104	Nearing et al.	385.4157076	410.5692484	322.5125911	339.9399756	362.6778						
104	Nearing et al.	451.9920964	486.9806376	422.3771323	452.776727	452.3844						
104	Nearing et al.	455.8841487	491.5015902	381.3205319	405.9253201	430.9047						
104	Nearing et al.	457.8935869	493.8380866	382.9967449	407.8253671	432.8595						
104	Nearing et al.	476.5468289	515.6044261	398.554813	425.5125699	451.0297						
104	Nearing et al.	480.6423129	520.4021289	415.5746027	444.9688185	462.8056						
104	Nearing et al.	493.9899675	536.0854455	413.1004585	442.1334903	468.0617						
104	Nearing et al.	544.4307442	596.0105744	490.790377	532.3193916	538.3751						
104	Nearing et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
104	Nearing et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
104	Nearing et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
104	Nearing et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
104	Nearing et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
104	Nearing et al.						0.007836694	0.055524194	0.007491071	0.055178571	0.031508	
104	Nearing et al.						0.007836694	0.055524194	0.007491071	0.055178571	0.031508	
104	Nearing et al.						0.007836694	0.055524194	0.007491071	0.055178571	0.031508	
104	Nearing et al.						0.005532546	0.053220046	0.004469093	0.052156593	0.028845	
104	Nearing et al.						0.002767569	0.050455069	0.00117239	0.04885989	0.025814	
104	Nearing et al.	694.2270871	780.3400991	579.8607478	638.7353467	666.4812						
104	Nearing et al.	714.5467094	806.1068702	617.1058061	684.2241671	699.3854						
104	Nearing et al.	719.8069609	812.8078818	627.7483096	697.3321761	708.5696						
104	Nearing et al.	805.9333722	924.3519378	672.7195359	753.2699928	779.6017						
104	Nearing et al.			630303.0303		630303	0.001385081	0.049072581		0.047211538		
104	Nearing et al.			332111.1768		332111.2	0.001026658	0.048714158		0.046784188		
104	Nearing et al.	1053.478674	1265.377856	917.3393519	1073.939911	1063.709						
104	Nearing et al.	1118.72129	1360.693515	932.0806011	1094.199341	1106.46						
104	Nearing et al.	1125.172973	1370.249862	937.4201916	1101.565258	1113.369						
104	Nearing et al.	1173.689787	1442.885772	1021.45253	1219.453182	1196.571						
104	Nearing et al.	1196.858247	1478.060046	1118.968063	1361.058601	1278.958						
104	Nearing et al.	1466.234792	1911.824089	1219.113965	1512.151215	1489.193						
104	Nearing et al.	1677.859376	2288.124423	1393.332547	1789.723838	1733.792						
104	Nearing et al.	1694.690851	2319.540924	1582.591494	2114.537445	1904.614						
104	Nearing et al.	1769.04878	2461.131326	1468.269842	1915.285451	1842.167						
104	Nearing et al.	2215.83548	3420.689655	1985.698245	2901.554404	2558.695						
104	Nearing et al.	2411.161344	3909.616395	1993.673919	2918.615529	2664.888						
104	Nearing et al.	2549.123739	4285.714286	2375.84557	3817.603393	3183.364						
104	Nearing et al.	3006.375323	5758.108774	2477.182422	4086.200738	3546.288						
104	Nearing et al.	3246.728529	6709.427569	2769.619725	4947.994975	4097.362						
104	Nearing et al.	3785.007504	9501.915709	3104.632071	6129.666012	4957.337						
104	Nearing et al.	4238.878463	12994.92386	3935.501503	10510.94891	7374.914						
104	Nearing et al.	4258.178983	13178.03661	3614.74335	8497.152761	6377.666						
104	Nearing et al.	12520.58516		9773.342582		11146.96		0.023726959		0.016991758		
105	Prashun	213.0239523	220.4901757	178.439172	183.648243	198.3361						
105	Prashun	323.8210888	341.3940256	303.3558744	318.7250996	321.2731						
105	Prashun	350.6294285	371.3254255	326.9722949	344.8983782	347.7639						
105	Prashun	526.7014261	574.8280924	440.3700802	473.5164668	500.1089						
105	Prashun	771.3321549	879.1208791	718.5475075	811.2023177	791.2672						
106	Maass	208695.6522		93074.79224		150885.2		0.04625		0.044464286		
106	Maass	48.1816448	48.55351001	42.14957832	42.43388649	45.30777						
106	Maass	995.2311839	1182.26601	866.8507004	1005.385996	1000.309						
107	Rodriguez and De La Paz	78.27405704	79.26023778	68.46509808	69.2184088	73.74623						
107	Rodriguez and De La Paz	97.68076028	99.22138772	85.43219963	86.60835496	92.14456						
107	Rodriguez and De La Paz	239.724317	249.2211838	209.5272541	216.7462263	228.2353						
108	Bekele and Thomas	12.03563131	12.05870159	10.82292566	10.84157745	11.4386						
109	Temple	22.66577892	22.74773707	19.83048477	19.8931925	21.27949						
109	Temple	35.00825976	35.20416583	32.8175957	32.98969072	33.99898						
109	Temple	61.67842412	62.28912536	57.81530419	58.3515682	60.015						
109	Temple	87.98581229	89.23384379	82.46997577	83.56545961	85.77564						
109	Temple	143.6136792	146.9687691	125.57884	128.1366791	135.8752						
109	Temple	269.3149301	281.3599062	235.3583962	244.5058943	256.9104						
109	Temple	8376.963351		7057.340895		7717.152		0.011875		0.005178571		
109	Temple	451.84976	486.8154158	394.5467996	420.947131	436.3984						
109	Temple						0.0110625	0.05875	0.0110625	0.05875	0.034906	
109	Temple						0.0110625	0.05875	0.0110625	0.05875	0.034906	
109	Temple	1500.468897	1970.44335	1395.290893	1792.956243	1646.713						
109	Temple	1734.730755	2395.209581	1612.206708	2167.741935	1951.236						
109	Temple	3051.493961	5925.925926	2633.02249	4528.301887	3789.898						
109	Temple	3134.523291	6247.288503	2917.539002	5440.806045	4287.665						
110	Duran Zuazo et al.	5883.008843	90721.76506	5204.424745	30133.31484	18008.16						
111	Chirino et al.						0.010372548	0.058060048	0.010372548	0.058060048	0.034216	
111	Chirino et al.						0.009813449	0.057500949	0.009813449	0.057500949	0.033657	
111	Chirino et al.						0.009789658	0.057477158	0.009789658	0.057477158	0.033633	
111	Chirino et al.						0.009563639	0.057251139	0.009563639	0.057251139	0.033407	
111	Chirino et al.	5282.55542	32955.45799	5282.55542	32955.45799	19119.01						
112	Borst et al	60386.45165		37263.42107		48824.94		0.042719498		0.039636709		
112	Borst et al	1.909718435	1.910298336	1.601681141	1.602089034	1.755904						
112	Borst et al	17.21786368	17.26511697	14.43931024	14.47252829	15.8452						
112	Borst et al	19.67851741	19.74026624	16.50263153	16.5460356	18.11228						
112	Borst et al	26.7602848	26.87460319	22.44053822	22.52087266	24.64058						
112	Borst et al	110.0074144	111.9653064	92.20395601	93.57545279	101.7914						
112	Borst et al	144.6578403	148.0624731	121.2216358	123.6033726	134.1306						
112	Borst et al						0.009114041	0.056801541	0.008739338	0.056426838	0.03277	
112	Borst et al						0.007141965	0.054829465	0.006388016	0.054075516	0.030609	
113	McGregor et al.	154.4241801	158.3102228	129.3982085	132.1156859	143.2699						
113	McGregor et al.	1558.265661	2071.33356	1294.931184	1630.567331	1594.416						
114	Kramer	1847.32718	2615.306972	1532.533048	2026.111949	1936.72						
114	Kramer	5094.691388	26792.11838	4147.29929	12171.01191	8632.852						
115	McGregor et al.	243.4257861	253.2241837	203.8684029	210.6963514	227.0611						
115	McGregor et al.	1664.440701	2263.24179	1382.298603	1771.559654	1718						
116	McGregor et al.	7795.065221		6248.122559	917647.0588	7795.065		0.009201613				
116	McGregor et al.	218.4890484	226.3503441	183.0110599	188.4945808	203.4918						
116	McGregor et al.	3685.02299	8895.974492	3024.379211	5824.517735	4754.77						
117	Mutchler et al.	66.58740021	67.29974256	55.82538821	56.32521312	61.45631						
117	Mutchler et al.	269.9951553	282.1024214	226.0844991	234.5124096	252.2538						
117	Mutchler et al.	367.8119097	390.6520739	307.8140369	323.6501093	345.731						
118	bu	77.66613271	78.63695937	67.93354643	68.67514205	73.17064						
118	bu	140.5337354	143.7448529	122.8874154	125.3357207	132.9347						
119	Cai	19494.30106		16462.51837		17978.41		0.032298387		0.029464286		
119	Cai	23422.00535		19523.53283		21472.77		0.034879032		0.032321429		
119	Cai	29331.75636		23982.86938		26657.31		0.037459677		0.035178571		
119	Cai	42844.80276		33566.43357		38205.62		0.040685484		0.03875		
119	Cai	79444.74106		55906.82196		67675.78		0.04391129		0.042321429		

119	Cai						0.004610887	0.052298387	0.003919643	0.051607143	0.028109	
119	Cai						0.002030242	0.049717742	0.0010625	0.04875	0.02539	
119	Cai						0.006546371	0.054233871	0.0060625	0.05375	0.030148	
119	Cai						0.006546371	0.054233871	0.0060625	0.05375	0.030148	
119	Cai						0.004610887	0.052298387	0.003919643	0.051607143	0.028109	
119	Cai						0.005256048	0.052943548	0.004633929	0.052321429	0.028789	
119	Cai						0.004610887	0.052298387	0.003919643	0.051607143	0.028109	
119	Cai	922.8879944	1081.552551	830.8399891	957.2649573	940.0765						
119	Cai	4656.839733	17927.71084	4137.4215	12086.33094	8371.585						
119	Cai	4902.316081	22208.95522	4351.767906	14117.64706	9509.982						
120	Chen et al.	8094.435076		6827.880512		7461.158		0.010625		0.00375		
120	Chen et al.	36090.22556		27074.93956		31582.58		0.039375		0.036607143		
120	Chen et al.	83.47390571	84.59640465	73.01157538	73.86888273	78.67139						
120	Chen et al.	114.0874195	116.194626	99.77402371	101.3819323	107.7347						
120	Chen et al.	156.7961324	160.8040201	137.097531	140.1518312	148.474						
120	Chen et al.	184.0279109	189.5734597	160.8879482	165.1105651	174.5692						
120	Chen et al.	191.4409923	197.4496092	167.3631831	171.9373657	181.6892						
120	Chen et al.	196.5360521	202.874049	171.8133984	176.6375775	186.5868						
120	Chen et al.	429.9919377	461.5384615	375.4987092	399.3344426	414.6632						
120	Chen et al.	509.9330713	554.9132948	445.1451359	479.0419162	494.4875						
120	Chen et al.	647.5111291	721.8045113	564.8862662	620.613225	634.0622						
120	Chen et al.	662.8918658	740.969435	578.2634885	636.7978167	649.8448						
120	Chen et al.						0.0104375	0.058125	0.010348214	0.058035714	0.034237	
120	Chen et al.	1010.95198	1204.516939	880.4800713	1023.765996	1017.359						
120	Chen et al.	1964.79738	2857.142857	1703.767557	2336.578581	2150.688						
120	Chen et al.	2818.55549	5106.382979	2434.606188	3971.631206	3395.093						
120	Chen et al.	5832.320778	80000	4969.679042	23661.97183	14747.15						
121	Chen	996.26401	1183.723798	867.7461842	1006.590773	1001.427						
122	Chen and Dai	2421.309343	3936.367	2421.309343	3936.367	3178.838						
123	Chen	14414.41441		11826.82154		13120.62		0.026875		0.022321429		
123	Chen	645.685571	719.5367366	645.685571	719.5367366	682.6112						
123	Chen	2535.657686	4247.787611	2193.068338	3366.733467	2951.196						
124	Chen et al.	24448.21732		19225.63418		21836.93		0.035416667		0.032083333		
124	Chen et al.	2250.351617	3503.649635	1948.842875	2823.529412	2536.941						
125	Chen et al.	79.9293957	80.95800304	74.92000728	75.82299543	77.8762						
125	Chen et al.	942.4700569	1108.545035	881.6506459	1025.348903	983.9095						
125	Chen et al.	1098.457846	1330.833367	983.8081574	1166.180758	1132.319						
125	Chen et al.	2308.674485	3647.097409	2058.495583	3059.663437	2684.169						
125	Chen et al.	4692.082111	18461.53846	4351.767906	14117.64706	9404.865						
125	Chen et al.	5663.981256	56831.34583	4988.567865	24096.38554	14880.18						
126	Chen et al.	695.4368213	781.8688916	623.7816764	692.440854	693.9388						
126	Chen et al.						0.010990558	0.058678058	0.0109825	0.05867	0.03483	
126	Chen et al.	1149.95424	1407.179314	1029.733556	1231.274369	1190.614						
127	Chen et al.	81.9140585	82.99472638	76.77993484	77.72859765	79.82133						
127	Chen et al.	255.8567202	266.7037088	239.724317	249.2211838	252.539						
127	Chen et al.	425.7961501	456.7078972	398.7925448	425.78356	425.7899						
127	Chen et al.	762.7522644	867.9927667	713.8254102	805.1889958	783.9706						
127	Chen et al.	1384.083045	1774.491682	1293.4519	1628.222524	1506.153						
128	Chen et al.	117.7827399	120.0300075	103.0039761	104.7185688	111.2507						
128	Chen et al.	158.9772464	163.0988787	139.003231	142.1440054	150.5606						
128	Chen et al.	486.7660481	527.588481	424.9667995	455.7538929	471.26						
128	Chen et al.	6130.268199	240000	5216.581276	30545.45455	18337.86						
129	Cui et al.	1917.698761	2758.62069	1663.283996	2261.103634	2089.401						
129	Cui et al.	5405.405405	38400	4614.750721	17319.58763	11362.5						
130	Fan et al.	17582.41758		14231.25794		15906.84		0.030625		0.026607143		
130	Fan et al.	19753.08642		15841.58416		17797.34		0.0325		0.02875		
130	Fan et al.	425.0420615	455.8404558	371.184587	394.4587931	409.7504						
130	Fan et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
130	Fan et al.						0.011	0.0586875	0.010991071	0.058678571	0.034839	
130	Fan et al.						0.0098125	0.0575	0.009633929	0.057321429	0.033567	
132	Feng et al.	304.3175046	319.7868088	265.9048282	277.6400595	290.9788						
132	Feng et al.	2048.65557	3037.974684	1775.804661	2474.226804	2261.441						
133	Fu et al.	403.5987556	431.2668464	352.4931547	373.4163147	388.5075						
133	Fu et al.	645.7688686	719.6401799	563.3708355	618.7845304	632.2767						
133	Fu et al.	711.8493252	802.6755853	620.8311007	688.8068881	700.3281						
133	Fu et al.	750.8212107	852.5754885	654.7027533	730.7525011	740.7869						
133	Fu et al.	1178.492512	1450.151057	1025.609719	1225.382932	1201.938						
133	Fu et al.	1956.787607	2840.236686	1696.883996	2323.651452	2140.22						
134	Fu et al.	123.3520931	125.819135	107.8717482	109.7537075	116.5529						
134	Fu et al.	1366.353544	1745.454545	1188.076801	1464.690497	1415.522						
134	Fu et al.	2198.808978	3380.28169	1904.653931	2731.707317	2465.258						
134	Fu et al.	4602.1093	17142.85714	3943.199155	10566.03774	7584.074						
135	Fu et al.	8094.435076		6827.880512		7461.158		0.010625		0.00375		
135	Fu et al.	22018.34862		17490.89016		19754.62		0.0340625		0.030535714		
135	Fu et al.	169.1153155	173.7871108	147.8606413	151.4195584	160.2674						
135	Fu et al.	938.7834931	1103.448276	817.8963511	940.1231114	939.4533						
136	Gu et al.	2707.275804	4752.475248	2339.669939	3725.055432	3216.166						
137	guan	2325.552505	3689.396926	2325.552505	3689.396926	3007.475						
138	guo	57831.3253		39952.43757		48891.88		0.0425		0.040178571		
138	guo						0.0048125	0.0525	0.003919643	0.051607143	0.02821	
139	Han et al.	304.7984157	320.3178973	304.7984157	320.3178973	312.5582						
139	Han et al.	777.1185364	886.6453662	777.1185364	886.6453662	831.882						
139	Han et al.	1243.568977	1549.957919	1243.568977	1549.957919	1396.763						
139	Han et al.	2582.060167	4379.639194	2582.060167	4379.639194	3480.85						
140	He et al.	13597.73371		12360.51502		12979.12		0.025625		0.023416667		
140	He et al.	7582.938389		6410.990269		6996.964		0.008125		0.000892857		
140	He et al.	51612.90323		36482.08469		44047.49		0.041875		0.039464286		
140	He et al.	1600000		167164.1791		883582.1		0.0475		0.045892857		
140	He et al.	2632258.065		140716.6124		1386487		0.047573529		0.045555556		
140	He et al.	222.3972571	230.5475504	208.3906166	215.5301443	218.9637						
140	He et al.	425.8814573	456.8060416	384.083401	409.0577064	417.4696						
140	He et al.	428.6294516	459.9690881	386.5579089	411.8656533	420.2476						
140	He et al.	532.7356765	582.0229993	480.2675777	519.9628598	526.3493						
140	He et al.	8233.276158		6940.714728		7586.995		0.01125		0.004464286		
140	He et al.	598.2799452	661.1570248	560.1151348	614.8590948	606.5695						
140	He et al.						0.0110625	0.05875	0.0110625	0.05875	0.034906	
140	He et al.						0.0098125	0.0575	0.009729167	0.057416667	0.033615	
140	He et al.	1014.155926	1209.06801	883.2575379	1027.522936	1020.839						
140	He et al.	1643.962746	2225.545917	1476.209305	1928.817451	1786.39						
140	He et al.	1733.551444	2392.961877	1454.202713	1891.418564	1812.485						
140	He et al.	4473.438956	15483.87097	4151.052176	12203.38983	8338.414						
140	He et al.	13352.97005		10518.62673		11935.8		0.025220588		0.019166667		
141	Huang et al.	139.8011748	142.9785239	139.8011748	142.9785239	141.3898						
141	Huang et al.	818.6935016	941.1764706	713.663686	804.9832295	811.8384						
142	Huang et al.	197.9136602	204.3422733	173.0166168	177.9095626	187.9116						
143	Huang et al.						0.0091875	0.056875	0.008919643	0.056607143	0.032897	
144	Huang	15384.61538		12570.1459		13977.38		0.0281875		0.023821429		
144	Huang	1199.100674	1481.481481	1043.445856	1250.930752	1225.016						
144	Huang	2396.405392	3870.967742	2073.946053	3093.922652	2745.164						
144	Huang	3303.509979	6956.521739	2847.216338	5201.23839	4252.374						
145	Huang et al.						0.010417339	0.058104839	0.010348214	0.058035714	0.034227	
145	Huang et al.						0.00590121	0.05358871	0.005348214	0.053035714	0.029468	
146	Jiang and Shao	373.2493138	396.7913784	373.2493138	396.7913784	385.0203						
147	Jiang et al.	78.96333527	79.96707238	78.96333527	79.96707238	79.4652						
147	Jiang et al.	233.1488524	242.1221293	233.1488524	242.1221293	237.6355						

147	Jiang et al.						0.010731618	0.058419118	0.010731618	0.058419118	0.034575	
147	Jiang et al.						0.010452206	0.058139706	0.010452206	0.058139706	0.034296	
149	Lan et al.	119.7813989	122.1063343	104.7508893	106.5246338	113.153						
149	Lan et al.	146.596219	150.0938086	128.1850748	130.8513124	138.7238						
149	Lan et al.	169.1749198	173.8500543	147.9127139	151.4741682	160.3245						
149	Lan et al.	200.9797764	207.6124567	175.6945425	180.7423346	190.8611						
149	Lan et al.	766.4058758	872.7272727	668.2444661	747.6635514	757.0347						
149	Lan et al.	1414.677277	1825.095057	1229.823213	1528.66242	1471.67						
150	Li et al.						0.002890457	0.050577957	0.002014881	0.049702381	0.026296	
151	Li et al.	16809.66556		13650.76786		15230.22		0.029840625		0.025710714		
151	Li et al.						0.004853125	0.052540625	0.003966071	0.051653571	0.028253	
152	Li et al.	344.0120404	363.9120546	300.5339845	315.6114973	329.8118						
152	Li et al.	414.7584896	444.0333025	362.2211921	384.351407	399.5549						
152	Li et al.	559.2450192	613.8107417	488.0812307	529.1338583	544.1894						
152	Li et al.						0.006375	0.0540625	0.005705357	0.053392857	0.029884	
152	Li et al.	1097.644638	1329.639889	955.6042206	1126.760563	1112.203						
152	Li et al.	1362.475163	1739.130435	1184.725503	1459.600348	1411.038						
152	Li et al.	3373.155306	7272.727273	2906.322982	5401.92926	4387.542						
152	Li et al.	3628.117914	8571.428571	3122.386395	6199.261993	4913.69						
152	Li et al.	4312.668464	13714.28571	3700.033036	8983.957219	6648.313						
153	liang	525.5666265	573.4767025	458.759438	494.8453608	510.206						
153	liang	1226.680296	1523.809524	1067.310441	1285.386381	1256.033						
153	liang	2384.500745	3840	2063.755298	3071.297989	2727.899						
153	liang	3258.655804	6760.56338	2809.129671	5075.528701	4167.092						
154	Lin et al.	241.5337392	251.177394	211.1069923	218.4371343	229.9854						
154	Lin et al.	1746.724891	2418.13602	1516.177068	1997.621879	1872.173						
155	Liu	186.2775536	191.9616077	162.85303	167.180814	176.7292						
156	Liu	547.2892081	599.4380268	477.6730499	516.9230769	532.1061						
158	Lu et al.	238.1779388	247.5502837	208.1771488	215.301807	226.7399						
158	Lu et al.	338.9112476	358.2089552	296.0848071	310.708341	324.8098						
158	Lu et al.	631.3297383	701.754386	550.8106424	603.6651096	617.4974						
158	Lu et al.	1097.644638	1329.639889	955.6042206	1126.760563	1112.203						
160	Lv	63.22527957	63.86715631	59.00109047	59.55968377	61.39248						
160	Lv	78.80547166	79.80517404	73.53752712	74.40730406	76.60639						
160	Lv	79.33141248	80.34458902	74.02821444	74.90970705	77.12056						
160	Lv	100.7972785	102.438608	94.05415392	95.48167093	98.13947						
160	Lv	104.7909639	106.5660773	97.77971046	99.32348544	102.0572						
160	Lv	117.5807755	119.8202696	102.8274488	104.536121	111.0584						
160	Lv	130.8745876	133.6550956	122.1103281	124.5274628	127.701						
160	Lv	138.4807508	141.597694	129.2047153	131.9139867	135.1974						
160	Lv	158.2956831	162.3815968	138.4077344	141.5213546	149.9085						
160	Lv	204.2027685	211.0535088	190.4936231	196.4419945	200.3224						
160	Lv	228.3793	236.9824238	213.0344089	220.5013781	224.4403						
160	Lv	299.6049851	314.5871044	279.4255144	292.4136559	296.0093						
160	Lv	571.5646583	628.6836935	498.8049465	541.7607223	556.6627						
161	lv	182.8362473	188.3091408	159.8470036	164.0144489	173.4253						
161	lv	906.8581145	1059.602649	790.1977846	903.7116729	905.2849						
162	Ma and Wang	1026.445221	1226.575809	1026.445221	1226.575809	1126.511						
162	Ma and Wang	1497.971497	1966.138722	1497.971497	1966.138722	1732.055						
162	Ma and Wang	4189.70032	12543.55401	4189.70032	12543.55401	8366.627						
163	Mao et al.	6460.296097		5489.299134	43076.92308	6460.296		0.00125				
163	Mao et al.	3397.027601	7384.615385	2926.57434	5472.312704	4434.67						
163	Mao et al.	3500.243072	7890.410959	3014.083665	5786.452354	4643.348						
163	Mao et al.	4692.082111	18461.53846	4018.658055	11125.82781	7908.955						
164	Meng and Yang	21.11997466	21.19111739	18.47817898	18.53261409	19.82629						
164	Meng and Yang	22.05953317	22.13715814	19.30012907	19.35952247	20.70953						
164	Meng and Yang	70.34719271	71.1427301	61.53384087	62.14166821	66.24443						
164	Meng and Yang	75.4088574	76.32373986	65.9598234	66.6587311	71.03379						
165	Mi et al.	78.77546504	79.77440142	71.13203673	71.94552696	75.3605						
165	Mi et al.	176.3911648	181.4796445	159.2208289	163.3552653	169.8732						
166	NDSIESS	9561.752988		8013.355593		8787.554		0.0163125		0.01025		
166	NDSIESS	39669.42149		29344.97817		34507.2		0.040125		0.037464286		
166	NDSIESS	42477.87611		31082.33117		36780.1		0.040625		0.038035714		
166	NDSIESS	61538.46154		41947.56554		51743.01		0.0428125		0.040535714		
166	NDSIESS	20.73228146	20.80083203	18.13901286	18.19146517	19.46187						
166	NDSIESS	32.73701943	32.9082682	28.64057022	28.77155726	30.75429						
166	NDSIESS	68.93283357	69.69652969	60.29707075	60.88059431	64.90671						
166	NDSIESS	82.79478393	83.89897165	72.41779897	73.26113816	78.02796						
166	NDSIESS	85.31361641	86.48648649	74.62007058	75.51579988	80.41471						
166	NDSIESS	90.06811401	91.37635637	78.77689492	79.7758678	84.92199						
166	NDSIESS	102.6452537	104.3478261	89.77212308	91.07171898	96.85849						
166	NDSIESS	119.2546584	121.5589941	104.2904987	106.0485551	112.6516						
166	NDSIESS	161.8041159	166.075599	141.4730885	144.7277739	153.2659						
166	NDSIESS	166.1110406	170.6161137	145.235958	148.6681809	157.3896						
166	NDSIESS	178.4187637	183.6266259	155.9881338	159.9542988	169.1865						
166	NDSIESS	185.3067212	190.9307876	162.0050048	166.2872414	175.797						
166	NDSIESS	202.2500316	208.9682194	176.8039528	181.9166215	192.0833						
166	NDSIESS	209.0319209	216.2162162	182.7268723	188.193122	198.6125						
166	NDSIESS	216.870736	224.6139448	189.5723901	195.4624782	206.1666						
166	NDSIESS	243.9892238	253.8339503	213.250741	220.7331494	232.3612						
166	NDSIESS	365.4915099	388.0355699	319.2672057	336.3363363	350.9139						
166	NDSIESS	458.3213979	494.3357364	400.1858006	427.3721699	442.8468						
166	NDSIESS	471.8372162	510.0956429	411.9615993	440.8291787	456.3332						
166	NDSIESS	512.7109592	558.2044424	447.5643707	481.8447771	497.2779						
166	NDSIESS	629.6320588	699.6574594	549.3337693	601.8916595	615.7619						
166	NDSIESS	673.5896716	754.3611504	587.5666696	648.0981406	660.8439						
166	NDSIESS						0.0110625	0.05875	0.0110625	0.05875	0.034906	
166	NDSIESS						0.00325	0.0509375	0.002133929	0.049821429	0.026536	
166	NDSIESS						0.00209375	0.04978125	0.0008125	0.0485	0.025297	
166	NDSIESS	11085.45035		9228.234002		10156.84		0.020625		0.015178571		
166	NDSIESS	821.8474446	945.3471196	716.4026353	808.4696824	815.1586						
166	NDSIESS	834.3472971	961.9238477	727.2569858	822.3201175	828.3337						
166	NDSIESS	1018.45958	1215.189873	886.9881999	1032.575292	1025.517						
166	NDSIESS	1051.07571	1261.912586	915.2570074	1071.087026	1061.081						
166	NDSIESS	1107.777521	1344.537815	964.3810453	1138.983051	1123.38						
166	NDSIESS	1120.709783	1363.636364	975.5814291	1154.639175	1137.674						
166	NDSIESS	1131.541726	1379.706812	984.9617448	1167.80203	1149.672						
166	NDSIESS	1302.578019	1642.710472	1132.953434	1381.806218	1342.192						
166	NDSIESS	1603.742065	2152.466368	1392.977074	1789.13738	1696.44						
166	NDSIESS	1650.997478	2238.457951	1433.712148	1856.900744	1753.949						
166	NDSIESS	3135.205748	6250	2704.225352	4743.083004	3939.144						
166	NDSIESS	3258.655804	6760.56338	2809.129671	5075.528701	4167.092						
166	NDSIESS	13223.1405		10905.55015		12064.35		0.025		0.020178571		
166	NDSIESS	12732.09549		10523.0191		11627.56		0.024125		0.019178571		
167	Ng et al.	605.3217874	669.7674419	555.9033682	609.7875318	607.5547						
167	Ng et al.	1126.672404	1372.474266	1033.104898	1236.097634	1181.385						
168	ning	6990.400727		6160.239565	296470.5882	6990.401		0.004771505				
168	ning	497.4043382	540.1088929	448.4723909	482.8973843	490.1509						
169	Qin et al.	146.6858173	150.1877347	128.2633674	130.9328969	138.8094						
169	Qin et al.	170.8306641	175.5990488	149.3592223	152.9915308	161.9111						
169	Qin et al.	218.6987425	226.5754071	191.1686893	197.1599578	207.9294						
169	Qin et al.	456.7016895	492.4520006	398.7745144	425.7630064	441.2323						
169	Qin et al.	899.8152165	1050	784.0862495	895.7270165	897.7711						
170	Ruan	7398.200169		6510.366208		6954.283		0.007137097		0.001607143		
170	Ruan	162979.1895		93074.79224		128027		0.045846774		0.044464286		

170	Ruan	45.0478679	45.37277024	40.68185698	40.94664749	42.99726						
170	Ruan	254.8717676	265.6336469	222.7511088	230.9278351	242.8998						
170	Ruan	12284.32263		10629.54761		11456.94		0.023266129		0.019464286		
170	Ruan	4565.397478	16644.2953	4057.480981	11428.57143	7996.984						
171	Shen et al.	14708.88662		12053.091		13380.99		0.027291667		0.022797619		
171	Shen et al.	40677.9661		29973.23818		35325.6		0.0403125		0.037678571		
171	Shen et al.	11347.51773		9435.551811		10391.53		0.02125		0.015892857		
172	sheng	65753.42466		44152.43101		54952.93		0.043125		0.040892857		
172	sheng						0.0104375	0.058125	0.010348214	0.058035714	0.034237	
172	sheng						0.0091875	0.056875	0.008919643	0.056607143	0.032897	
172	sheng						0.008354167	0.056041667	0.007967262	0.055654762	0.032004	
173	Shui et al.	837.2579801	965.7947686	729.7843227	825.5528256	831.4054						
173	Shui et al.	5375.139978	36923.07692	4589.536949	16969.69697	11172.42						
174	song	467.9820882	505.5929739	467.9820882	505.5929739	486.7875						
175	Su and Liu	998.5079251	1186.892945	894.6210907	1042.934121	1020.721						
175	Su and Liu	1077.176673	1299.72338	964.8241206	1139.60114	1108.389						
175	Su and Liu	1491.292968	1954.649323	1333.703807	1692.524683	1591.909						
175	Su and Liu	2308.674485	3647.097409	2058.495583	3059.663437	2684.169						
175	Su and Liu	2787.002343	5003.749813	2480.620155	4095.56314	3441.283						
176	Sun et al.	274.5733626	287.1042348	274.5733626	287.1042348	280.8388						
176	Sun et al.	355.0558473	376.2935089	355.0558473	376.2935089	365.6747						
176	Sun et al.	535.2739476	585.0540013	535.2739476	585.0540013	560.164						
176	Sun et al.	909.0988908	1062.663109	909.0988908	1062.663109	985.881						
176	Sun et al.	1318.518437	1668.143863	1318.518437	1668.143863	1493.331						
176	Sun et al.	3519.217427	7987.491624	3519.217427	7987.491624	5753.355						
177	SUN	11622.27603		9652.398736		10637.34		0.021875		0.016607143		
178	SUN	9937.888199		8314.773571		9126.331		0.0175		0.011607143		
179	SUN	4515.522107	16000	3870.521829	10059.88024	7287.701						
180	SUN	4236.540159	12972.97297	3635.970133	8615.384615	6425.962						
181	SUN	4199.475066	12631.57895	3604.763437	8442.211055	6320.843						
182	SUN	3957.13108	10666.66667	3400.46554	7400.881057	5679.006						
183	SUN	693.3410371	779.2207792	604.7407354	669.0561529	681.1986						
184	Sun et al.	455.2783838	490.797546	397.5343406	424.3495832	439.814						
185	Tang et al.						0.0066875	0.054375	0.0060625	0.05375	0.030219	
185	Tang et al.						0.0048125	0.0525	0.003919643	0.051607143	0.02821	
185	Tang et al.						0.0023125	0.05	0.0010625	0.04875	0.025531	
186	Tang and Tian	592.9586164	654.6644845	517.4245807	563.7962279	578.3774						
187	Tao et al.	132110.0917		71846.04419		101978.1		0.045416667		0.043511905		
188	Tian et al.	6827.880512		5792.10481	73043.47826	6827.881		0.00375				
189	tian	8660.7437		7588.08763		8124.416		0.013048442		0.008151847		
190	Tian et al.	85.74031402	86.92502716	74.99313679	75.89789925	80.81911						
190	Tian et al.	3032.217309	5853.658537	2616.618643	4480	3756.109						
191	Wang et al.	978.0457734	1158.092746	978.0457734	1158.092746	1068.069						
191	Wang et al.	1309.754868	1654.141194	1309.754868	1654.141194	1481.948						
191	Wang et al.	3310.073986	6985.693143	3310.073986	6985.693143	5147.884						
192	Wang et al.	568.1818182	624.5933637	495.8604507	538.2890099	553.2354						
192	Wang et al.						0.0016875	0.049375	0.000348214	0.048035714	0.024862	
192	Wang et al.	1249.0242	1558.441558	1086.640147	1313.526192	1281.275						
193	Wang	419.4704186	449.4382022	366.3283218	388.9789303	404.2247						
193	Wang	1239.349342	1543.40836	1078.270916	1301.316809	1270.333						
194	Wang et al.	1600000		167164.1791		883582.1		0.0475		0.045892857		
194	Wang et al.	163.3041881	167.6563046	142.783687	146.0996608	154.7019						
194	Wang et al.	392.7022826	418.8481675	342.9936403	362.7726193	377.7375						
194	Wang et al.	872.2514992	1012.658228	760.1637972	864.6423057	868.4469						
194	Wang et al.	1136.094675	1386.481802	988.9042588	1173.348233	1154.721						
194	Wang et al.	2633.02249	4528.301887	2276.268545	3566.878981	3099.951						
194	Wang et al.	12403.10078		10265.81118		11334.46		0.0235		0.018464286		
195	Wang et al.	119.038762	121.3346815	104.1017967	105.8534434	112.4461						
195	Wang et al.	689.3580353	774.1935484	601.2777151	664.8199446	677.089						
196	wang	152.4230747	156.2078212	152.4230747	156.2078212	154.3154						
196	wang	186.2574043	191.94021	186.2574043	191.94021	189.0988						
197	Wu and Li	6374.501992		5418.48089	39069.76744	6374.502		0.000625				
197	Wu and Li	268.2613312	280.2101576	234.4387773	243.5135527	255.8874						
197	Wu and Li	592.3731951	653.9509537	516.9151244	563.191418	577.7823						
197	Wu and Li	13597.73371		11196.26791		12397		0.025625		0.020892857		
197	Wu and Li	5832.320778	80000	4969.679042	23661.97183	14747.15						
198	Wu et al.	34782.6087		26229.5082		30506.06		0.0390625		0.03625		
198	Wu et al.	51.88880661	52.32035316	45.39184919	45.72175049	48.80528						
198	Wu et al.	59.32664261	59.89144675	51.8966207	52.32829777	55.82747						
198	Wu et al.	227.9960101	236.5697388	199.2870742	205.8066887	216.9013						
198	Wu et al.	10958.90411		9127.95436		10043.43		0.0203125		0.014821429		
199	Xiang et al.	6402.845709		5441.883064	40320	6402.846		0.000833333				
199	Xiang et al.	3326.403326	7058.823529	2866.649603	5266.45768	4296.431						
199	Xiang et al.	3538.95306	8089.88764	3046.882084	5908.55803	4723.756						
199	Xiang et al.	4236.540159	12972.97297	3635.970133	8615.384615	6425.962						
199	Xiang et al.	4351.767906	14117.64706	3732.918565	9180.327869	6766.048						
199	Xiang et al.	4558.404558	16551.72414	3906.522497	10306.74847	7432.577						
199	Xiang et al.	5693.950178	60000	4854.78977	21265.82278	13479.89						
200	Xie et al.	102880.8481		67970.33041		85425.59		0.044771505		0.04327381		
200	Xie et al.	604.7969175	669.1249213	545.0917409	596.8028419	600.7999						
201	Xie et al.	464.603635	501.6519452	418.9473947	448.8378306	456.7207						
201	Xie et al.	479.8560432	519.4805195	418.9473947	448.8378306	464.3469						
201	Xie et al.	614.3860475	680.8822184	553.715331	607.1557644	610.7709						
201	Xie et al.	634.6687822	705.8823529	553.715331	607.1557644	620.9123						
201	Xie et al.	837.305093	965.8574581	754.0225758	856.7057624	847.0054						
201	Xie et al.	865.1766402	1003.134796	754.0225758	856.7057624	860.9412						
202	Xu et al.	351.7891069	372.6262988	351.7891069	372.6262988	362.2077						
202	Xu et al.	472.945831	511.3915752	472.945831	511.3915752	492.1687						
202	Xu et al.	1125.15552	1370.223979	1125.15552	1370.223979	1247.69						
202	Xu et al.	1165.505519	1430.536451	1165.505519	1430.536451	1298.021						
202	Xu et al.	1293.023063	1627.543036	1293.023063	1627.543036	1460.283						
203	Xue et al.	70.67027047	71.47317354	63.81511849	64.46908937	67.56968						
203	Xue et al.	1230.636904	1529.919803	1106.682916	1342.925659	1286.781						
204	Yan et al.	16382.25256		13328.04443		14855.15		0.029375		0.025178571		
204	Yan et al.	76190.47619		49339.20705		62764.84		0.04375		0.041607143		
204	Yan et al.	204.3161793	211.174659	178.6084488	183.8275522	194.0719						
204	Yan et al.	319.5100845	336.6058906	279.1601931	292.123109	305.8166						
204	Yan et al.	320.3630782	337.5527426	279.904366	292.9380994	306.6506						
204	Yan et al.	333.727317	352.4229075	291.5628986	305.7324841	319.7299						
204	Yan et al.	428.8394532	460.21093	374.4942656	398.1986253	413.519						
204	Yan et al.						0.0098125	0.0575	0.009633929	0.057321429	0.033567	
204	Yan et al.	1630.988787	2201.834862	1416.466422	1828.073993	1729.531						
204	Yan et al.	3051.493961	5925.925926	2633.02249	4528.301887	3789.898						
204	Yan et al.	5375.139978	36923.07692	4589.536949	16969.69697	11172.42						
205	Yang et al.	464.732803	501.8025381	417.2050737	446.8386168	455.7857						
206	Yao et al.	241.3515688	250.9803922	210.9479473	218.2668572	229.8092						
206	Yao et al.	342.6613364	362.400906	299.3558504	314.3124415	328.4869						
206	Yao et al.	973.0387188	1151.079137	847.6072753	979.5918367	976.3153						
206	Yao et al.	1347.179343	1714.285714	1171.50727	1439.588689	1393.384						
207	Yin et al.	112.0892978	114.1226819	98.02748854	99.5791595	105.8342						
207	Yin et al.	423.9159233	454.5454545	370.2030608	393.3505034	408.6332						
208	You						0.003875	0.0515625	0.002848214	0.050535714	0.027205	
209	Yu et al.	28652.3463		28652.3463		28652.35		0.037217153		0.037217153		
209	Yu et al.						0.001573449	0.049260949	0.001573449	0.049260949	0.025417	
209	Yu et al.	847.6946855	979.7085903	847.6946855	979.7085903	913.7016						

209	Yu et al.	932.3017902	1094.504178	932.3017902	1094.504178	1013.403					
209	Yu et al.	1685.501255	2302.359779	1685.501255	2302.359779	1993.931					
209	Yu et al.	3373.155306	7272.727273	3373.155306	7272.727273	5322.941					
209	Yu et al.	3996.329405	10956.34788	3996.329405	10956.34788	7476.339					
209	Yu et al.	6102.959601	204223.6025	6102.959601	204223.6025	105163.3					
210	Yuan et al.	6880.076445		6314.602518		6597.339		0.004083333		0.000178571	
210	Yuan et al.	15841.58416		14231.25794		15036.42		0.02875		0.026607143	
210	Yuan et al.	930.8940462	1092.564492	866.8507004	1005.385996	968.14					
210	Yuan et al.	2128.603104	3217.158177	1976.354332	2881.646655	2505.125					
211	Yue	61.09349876	61.69261554	61.09349876	61.69261554	61.39306					
211	Yue	441.8172122	475.1900609	441.8172122	475.1900609	458.5036					
212	Zhang et al.	20662.729		20662.729		20662.73		0.033168605		0.033168605	
212	Zhang et al.	76959.9798		76959.9798		76959.98		0.04378937		0.04378937	
212	Zhang et al.	6188.184583	378795.1807	6188.184583	378795.1807	192491.7					
213	Zhang et al.	93.32270491	94.7279391	93.32270491	94.7279391	94.02532					
213	Zhang et al.	2065.634912	3075.462743	2065.634912	3075.462743	2570.549					
213	Zhang et al.	2374.402574	3813.879044	2374.402574	3813.879044	3094.141					
214	Zhang et al.	368.5786685	391.5171289	321.9593526	339.3253888	353.952					
214	Zhang et al.	1031.592521	1233.933162	898.3717013	1048.034934	1039.814					
215	Zhang et al.	29447.85276		22687.3734		26067.61		0.0375		0.034464286	
215	Zhang et al.	90566.03774		55906.82196		73236.43		0.044375		0.042321429	
215	Zhang et al.	90.71494718	92.042186	79.34240261	80.35586167	85.5354					
215	Zhang et al.	156.5915245	160.5888257	136.9187575	139.9650087	148.2783					
216	zhang	738.6888273	836.9659983	644.1594295	717.6420333	728.1654					
217	Zhao and Wei	656.3653767	732.8244275	572.5873792	629.9212598	643.1433					
217	Zhao and Wei	1706.363313	2341.463415	1481.416163	1937.716263	1822.04					
217	Zhao and Wei	2699.662542	4729.064039	2333.171308	3708.609272	3204.136					
218	Zhao et al.	16961.13074		13764.85047		15362.99		0.03		0.025892857	
218	Zhao et al.	21524.66368		17134.11525		19329.39		0.03375		0.030178571	
219	Zheg et al.	1925.391095	2774.566474	1669.897122	2273.342355	2099.367					
220	Zheg et al.	597.570591	660.2908424	597.570591	660.2908424	628.9307					
221	Zhou	13994.1691		11502.90996		12748.54		0.02625		0.021607143	
221	Zhou	369230.7692		119572.9537		244401.9		0.046875		0.045178571	
221	Zhou	218.8483108	226.7359471	191.299298	197.2988843	208.0736					
221	Zhou	536.1331397	586.0805861	467.9600563	505.5672585	520.8502					
221	Zhou	1887.534408	2696.629213	1637.347108	2213.438735	2050.487					
221	Zhou	2535.657686	4247.787611	2193.068338	3366.733467	2951.196					
222	Zhou et al.	7465.007776		6314.602518		6889.805		0.0075		0.000178571	
222	Zhou et al.	7465.007776		6314.602518		6889.805		0.0075		0.000178571	
222	Zhou et al.	11347.51773		9435.551811		10391.53		0.02125		0.015892857	
222	Zhou et al.	2057.436777	3057.324841	1783.344833	2488.888889	2273.163					
222	Zhou et al.	4473.438956	15483.87097	3835.178633	9824.561404	7149					
222	Zhou et al.	5693.950178	60000	4854.78977	21265.82278	13479.89					
223	ZHU	132.903151	135.7714676	132.903151	135.7714676	134.3373					
223	ZHU	660.2038201	737.6124881	660.2038201	737.6124881	698.9082					
224	Zhuang	380.66034	405.1772651	332.4944007	351.0482691	365.8543					
224	Zhuang	435.1899423	467.5324675	380.0288792	404.4619212	419.8259					
224	Zhuang	469.5294923	507.3995772	409.9510743	438.5277995	454.0286					
225	Zuo et al.	104.997211	106.7793782	91.82811744	93.18837364	99.09279					
226	Ciesiolka et al.	38.960793	39.2035864	36.35992429	36.57129589	37.76604					
226	Ciesiolka et al.	149.1676651	152.7905496	139.1721192	142.3206167	145.7441					
226	Ciesiolka et al.	169.8066484	174.5172497	158.4200741	162.5124948	166.1596					
227	Sombatpanit et al.	27267.72952		22444.88978		24856.31		0.036685484		0.034321429	
227	Sombatpanit et al.	96.4249541	97.92591852	87.06354862	88.28537195	92.35516					
227	Sombatpanit et al.	1782.156873	2486.575611	1599.517606	2144.863393	1963.51					
227	Sombatpanit et al.	3527.543126	8030.510182	3146.558452	6295.278541	4911.411					
227	Sombatpanit et al.	5610.084076	51834.64933	4967.719679	23617.61949	14613.85					
228	Kothyari et al.	36482.08469		36482.08469		36482.08		0.039464286		0.039464286	
228	Kothyari et al.	1103.733946	1338.585748	1103.733946	1338.585748	1221.16					
228	Kothyari et al.	2014.26773	2962.962963	2014.26773	2962.962963	2488.615					
229	Mitchell	112.0892978	114.1226819	98.02748854	99.5791595	105.8342					
229	Mitchell	141.9152648	145.1905626	124.0946813	126.5918167	134.2535					
229	Mitchell	335.1253229	353.9823009	292.7823912	307.0736611	321.0995					
229	Mitchell	1700.31881	2330.097087	1476.209305	1928.817451	1814.568					
229	Mitchell	3628.117914	8571.428571	3122.386395	6199.261993	4913.69					
229	Mitchell	5832.320778	80000	4969.679042	23661.97183	14747.15					
230	Roose	11347.51773		9435.551811		10391.53		0.02125		0.015892857	
231	Othieno	30.89008493	31.04251099	27.02497639	27.14157238	29.01583					
231	Othieno	120.5333601	122.8878648	105.4081271	107.2043903	113.8689					
232	Lal	6639.004149		5636.638148	54193.54839	6639.004		0.0025			
232	Lal	208695.6522		93074.79224		150885.2		0.04625		0.044464286	
232	Lal	27.774081	27.89724515	24.29921006	24.3934312	26.08376					
232	Lal	32.91661809	33.08975596	28.7976715	28.93010281	30.92336					
232	Lal	48.08511065	48.45548153	42.0651484	42.34831489	45.21671					
232	Lal	372.8734561	396.3666391	325.7044813	343.4880393	358.1807					
232	Lal	613.5753547	679.8866856	535.3643186	585.1619645	599.3687					
232	Lal	1110.340042	1348.314607	966.6005006	1142.080218	1126.21					
232	Lal	1423.06552	1839.08046	1237.067855	1539.871677	1481.469					
232	Lal	1642.148478	2222.222222	1426.08548	1844.127333	1743.138					
232	Lal	1700.31881	2330.097087	1476.209305	1928.817451	1814.568					
232	Lal	1902.497027	2727.272727	1650.213644	2237.01731	2069.757					
233	Rhensburg	8797.966062		7704.654896		8251.31		0.01358871		0.00875	
233	Rhensburg	84.80985892	85.96882475	76.57927664	77.52295695	81.16641					
233	Rhensburg	155.8910146	159.8521797	140.7265006	143.9465341	149.9188					
234	Hudson and Jackson	13470.53321		12169.5038		12820.02		0.025416667		0.023035714	
234	Hudson and Jackson	313.9375177	330.4268013	292.7823912	307.0736611	310.5056					
234	Hudson and Jackson	658.4663222	735.4443309	613.5753547	679.8866856	669.1765					
234	Hudson and Jackson	771.3321549	879.1208791	718.5475075	811.2023177	791.2672					
234	Hudson and Jackson	4351.767906	14117.64706	4018.658055	11125.82781	7738.798					
234	Hudson and Jackson	5395.279131	37894.73684	4969.679042	23661.97183	14528.63					
235	Haylett	50.68134736	51.09296365	47.50821397	47.86971778	49.27553					
235	Haylett	68.65279848	69.41026819	64.35181662	65.01689115	66.83484					
235	Haylett	80.06583191	81.09797649	75.04786907	75.95396065	78.0099					
235	Haylett	114.7501793	116.8821682	107.5498501	109.4204969	112.0853					
235	Haylett	116.8204397	119.0307918	109.4896838	111.4290278	114.1247					
235	Haylett	129.2577642	131.9692841	121.1430656	123.5216856	126.3897					
235	Haylett	200.7087528	207.3232623	188.0774566	193.8735944	197.2912					
235	Haylett	233.9452056	242.9810741	219.2054412	227.119307	230.5323					
235	Haylett	268.7374379	280.7296632	251.7854033	262.2828517	265.5101					
235	Haylett	357.8484363	379.431643	335.2064546	354.072821	355.9606					
235	Haylett	4756.808182	19505.85176	4411.148442	14762.32654	9759.567					
235	Haylett	5001.771461	24407.60704	4635.722361	17618.73067	11310.25					
236	Rao et al.	17582.41758		14231.25794		15906.84		0.030625		0.026607143	
236	Rao et al.	121008.4034		67970.33041		94489.37		0.045208333		0.04327381	
236	Rao et al.						0.0048125	0.0525	0.003919643	0.051607143	0.02821
237	Jirasuktaveekul	22748.81517		18016.08579		20382.45		0.0345		0.031035714	
237	Jirasuktaveekul	28742.51497		22207.5347		25475.02		0.03725		0.034178571	
237	Jirasuktaveekul	31578.94737		24120.60302		27849.78		0.0381875		0.03525	
237	Jirasuktaveekul	44036.69725		32030.50524		38033.6		0.040875		0.038321429	
237	Jirasuktaveekul	64864.86486		43693.10793		54278.99		0.0430625		0.040821429	
237	Jirasuktaveekul	68571.42857		45590.23066		57080.83		0.0433125		0.041107143	
237	Jirasuktaveekul	82758.62069		52418.09672		67588.36		0.0440625		0.041964286	
237	Jirasuktaveekul	397.5813799	424.403183	347.2473414	367.5344564	382.5579					
237	Jirasuktaveekul	668.989547	748.5963818	583.5663546	643.2345509	656.112					
237	Jirasuktaveekul	718.0254301	810.5369807	626.1997503	695.4218064	706.7236					

237	Jirasuktaveekul	947.8672986	1116.01953	825.7760083	950.5488288	949.2081					
237	Jirasuktaveekul	1103.702	1338.538762	960.8510395	1134.062373	1118.882					
237	Jirasuktaveekul						0.0095625	0.05725	0.009348214	0.057035714	0.033299
237	Jirasuktaveekul	1476.01476	1928.485335	1282.785477	1611.356225	1543.685					
237	Jirasuktaveekul	2055.674518	3053.435115	1781.831681	2485.942587	2270.809					
237	Jirasuktaveekul						0.0090625	0.05675	0.008776786	0.056464286	0.032763
237	Jirasuktaveekul						0.0085625	0.05625	0.008205357	0.055892857	0.032228
237	Jirasuktaveekul						0.008375	0.0560625	0.007991071	0.055678571	0.032027
237	Jirasuktaveekul						0.0076875	0.055375	0.007205357	0.054892857	0.03129
237	Jirasuktaveekul						0.0070625	0.05475	0.006491071	0.054178571	0.030621
237	Jirasuktaveekul						0.0085	0.0561875	0.008133929	0.055821429	0.032161
237	Jirasuktaveekul	4081.632653	11622.27603	3505.477308	7917.059378	5999.346					
237	Jirasuktaveekul						0.00825	0.0559375	0.007848214	0.055535714	0.031893
237	Jirasuktaveekul						0.0080625	0.05575	0.007633929	0.055321429	0.031692
237	Jirasuktaveekul						0.008	0.0556875	0.0075625	0.05525	0.031625
237	Jirasuktaveekul						0.00725	0.0549375	0.006705357	0.054392857	0.030821
237	Jirasuktaveekul						0.007	0.0546875	0.006419643	0.054107143	0.030554
237	Jirasuktaveekul						0.006875	0.0545625	0.006276786	0.053964286	0.03042
237	Jirasuktaveekul						0.00675	0.0544375	0.006133929	0.053821429	0.030286
237	Jirasuktaveekul						0.00675	0.0544375	0.006133929	0.053821429	0.030286
237	Jirasuktaveekul						0.00675	0.0544375	0.006133929	0.053821429	0.030286
237	Jirasuktaveekul						0.005875	0.0535625	0.005133929	0.052821429	0.029348
237	Jirasuktaveekul						0.005625	0.0533125	0.004848214	0.052535714	0.02908
237	Jirasuktaveekul	4460.966543	15335.46326	3824.701195	9756.097561	7108.532					
237	Jirasuktaveekul	12765.95745		10549.45055		11657.7		0.0241875		0.01925	
237	Jirasuktaveekul	11793.61179		9787.357996		10790.48		0.02225		0.017035714	
238	Herweg and Ludi	9177.820268		7704.654896		8441.238		0.015		0.00875	
238	Herweg and Ludi	6639.004149		5636.638148	54193.54839	6639.004		0.0025			
238	Herweg and Ludi	14860.68111		12169.5038		13515.09		0.0275		0.023035714	
238	Herweg and Ludi	39024.39024		28940.56848		33982.48		0.04		0.037321429	
238	Herweg and Ludi	208695.6522		93074.79224		150885.2		0.04625		0.044464286	
238	Herweg and Ludi	43.70669168	44.0124702	38.23565224	38.46946486	41.08808					
238	Herweg and Ludi	53.43842891	53.89624972	46.74711065	47.09708166	50.26776					
238	Herweg and Ludi	100.3701148	101.9974501	87.7832381	89.02548885	94.6978					
238	Herweg and Ludi	114.7693853	116.9020945	100.3701148	101.9974501	108.3834					
238	Herweg and Ludi	126.9069085	129.5196978	110.9786267	112.9715554	119.9392					
238	Herweg and Ludi	133.992128	136.9081574	117.170745	119.3944993	126.6933					
238	Herweg and Ludi	141.9152648	145.1905626	124.0946813	126.5918167	134.2535					
238	Herweg and Ludi	166.533671	171.06201	145.6051933	149.0550972	157.7944					
238	Herweg and Ludi	283.6376529	297.029703	247.8588975	258.024881	270.8313					
238	Herweg and Ludi	352.3452984	373.2503888	307.8022371	323.6370641	337.9912					
238	Herweg and Ludi	374.3273805	398.0099502	326.9722949	344.8983782	359.6129					
238	Herweg and Ludi	409.4515056	437.9562044	357.5951725	379.1469194	394.2992					
238	Herweg and Ludi	427.6931302	458.8910134	373.4951812	397.0692508	412.3812					
238	Herweg and Ludi	613.5753547	679.8866856	535.3643186	585.1619645	599.3687					
238	Herweg and Ludi	683.4686032	766.7731629	596.156917	658.5652685	671.0169					
238	Herweg and Ludi	683.4686032	766.7731629	596.156917	658.5652685	671.0169					
238	Herweg and Ludi	713.966979	805.3691275	622.6719297	691.0736323	702.5203					
238	Herweg and Ludi	975.0152346	1153.846154	849.3213013	981.8819404	978.4486					
238	Herweg and Ludi	1536.98367	2033.898305	1335.400024	1695.257316	1616.12					
238	Herweg and Ludi	1762.76166	2448.979592	1529.984973	2021.66065	1892.211					
238	Herweg and Ludi	2159.244265	3287.671233	1870.719893	2662.440571	2410.842					
238	Herweg and Ludi	2785.838654	5000	2406.704391	3897.911833	3341.875					
238	Herweg and Ludi	2785.838654	5000	2406.704391	3897.911833	3341.875					
238	Herweg and Ludi	3258.655804	6760.56338	2809.129671	5075.528701	4167.092					
238	Herweg and Ludi	3628.117914	8571.428571	3122.386395	6199.261993	4913.69					
238	Herweg and Ludi	4274.265361	13333.33333	3667.721864	8795.811518	6535.038					
238	Herweg and Ludi						0.0110625	0.05875	0.0110625	0.05875	0.034906
238	Herweg and Ludi	4692.082111	18461.53846	4018.658055	11125.82781	7908.955					
238	Herweg and Ludi	4933.1963	22857.14286	4220.575305	12824.42748	8878.812					
238	Herweg and Ludi	10147.99154		8482.706387		9315.349		0.018125		0.012321429	
239	Hashim	109.888852	111.8424885	96.10406698	97.59498083	103.7419					
240	Coughlan and Rose	22.68199882	22.76407452	20.39576278	20.46210248	21.57205					
240	Coughlan and Rose	22.93604882	23.01997681	19.87566762	19.93866189	21.43736					
240	Coughlan and Rose	35.08735579	35.28415058	31.54926615	31.70828379	33.39782					
240	Coughlan and Rose	44.31191898	44.62625511	34.88352375	35.07803238	39.69498					
240	Coughlan and Rose	60.5697643	61.15860355	54.45696198	54.93247883	57.75112					
240	Coughlan and Rose	97.40744909	98.93939962	84.37937824	85.52652892	91.46699					
240	Coughlan and Rose	103.5186539	105.2505681	89.67052744	90.96716223	97.24291					
240	Coughlan and Rose	110.1827015	112.1468936	99.04463199	100.6289308	105.4058					
240	Coughlan and Rose	160.9496027	165.175499	150.8343022	154.5396008	157.7446					
240	Coughlan and Rose	285.323664	298.879203	224.1911437	232.4758991	258.8998					
240	Coughlan and Rose	591.8057259	653.2594435	531.0321938	579.9903335	585.898					
240	Coughlan and Rose	713.2800298	804.4951407	639.7441024	712.1661721	712.7231					
240	Coughlan and Rose	1465.09529	1909.887216	1310.40131	1655.172414	1560.134					
240	Coughlan and Rose	1756.89615	2437.67313	1509.603267	1986.226055	1871.561					
240	Coughlan and Rose	1891.140057	2703.994537	1623.888959	2188.915109	2040.028					
240	Coughlan and Rose	6055.277342	161632.6531	5096.184544	26833.46364	16444.37					

Appendix 4.3: Definitions of Land Use and Management practices

Management Practice (Conventional)	
Conventional Tillage	Includes all ploughing, harrowing and discing operations that subject surface (0-0.3 m) soils to high invasive maximum disturbance, irrespective of the crop per se, tillage direction and frequency of passes.
Downslope Cultivation	Includes all ploughing, harrowing and discing operations that are conducted with passes up and down the maximum slope, irrespective of the crop per se or thefrequency of passes. The operations, including the level of disturbance on surface soil, accord on the whole with those defined as conventional tillage (e.g: ploughing to 0.3 m, followed by seedbed harrowing).
Bare Soil	An experimental control plot, where weeds and other invasives are suppressed with regular herbicidal applications throughout the year.
Crop	Includes plots cultivating crops (such as potatoes or cereals), irrespective of ploughing, harrowing and discing operations, tillage direction and frequency of passes.

Management Practice (Conservation)	
Cover Crop	Includes plots that cultivate a vegetative cover during typical intercropping months, rather than practicing fallow management, irrespective of ploughing, harrowing and discing operations, tillage direction and frequency of passes. The cover crops per se are itemised in the supplementary data tables.
Conservation Tillage	Includes all ploughing, harrowing and discing operations that subject soils to low-invasive, shallow disturbance (0.05-0.08 m) whereby residues are typically not retained, irrespective of the crop per se, tillage direction and frequency of passes.
Contour Cultivation	Includes all ploughing, harrowing and discing operations that are conducted with passes either perpendicular to the maximum slope or along contours, irrespective of the crop per se or the frequency of passes. The operations, including the level of disturbance on surface soil, accord on the whole with those defined as conventional tillage (e.g: ploughing to 0.3 m, followed by seedbed harrowing).
Terracing	A terraced hillslope (of similar slope to partnering non-terraced plot), with risers 1-1.2 m in height, and 15-18 m between each terrace. These are subject to conventional tillage and hoeing throughout the year, irrespective of the crop per se , tillage direction and frequency of passes.
Contour Ridges	A ridged hillslope constructed with earth and/or stones. These are subject to conventional tillage and hoeing throughout the year, irrespective of the crop per se, tillage direction and frequency of passes.
Zero Tillage	Includes operations that subject soils to minimum disturbance, whereby residues are typically retained. In most cases, sowing takes place into dead mulch, irrespective of the crop per se , tillage direction and frequency of passes.
Grassland	A permanent grass cover throughout the year, irrespective of the grass species per se. Occasionally, this treatment is subject to a mower, which clips the grass and leaves the residues on the surface.
Forest	Typically, a permanent pine plantation or mixed forest, irrepective of the forest age.

Appendix 4.4: List of studies included in the Soil Lifespan Analysis

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Appendix 5.1: Output from AMS for Rufford and Comer

Site	Catena Position	AMS ID	Latitude	Longitude	Elevation/pressure. Meters or hPa	Shielding correction	10Be concentration (atoms g-1)	Uncertainty in 10Be concentration (atoms g-1)	Name of Be-10 standardization	26Al concentration (atoms g-1)	Uncertainty in 26Al concentration (atoms g-1)	Name of Al-26 standardization
Rufford	Summit	CNR01	53.1204	-1.0776693	98.692	0.9999999	35266	2364	NIST_27900	0	0	Z92-0222
Rufford	Summit	CNR02	53.1204	-1.0776693	98.692	0.9999999	22683	1586	NIST_27900	0	0	Z92-0222
Rufford	Shoulder	CNR03	53.11989	-1.0776654	99.275	0.99999991	54380	2030	NIST_27900	0	0	Z92-0222
Rufford	Shoulder	CNR04	53.11989	-1.0776654	99.275	0.99999991	30064	1850	NIST_27900	0	0	Z92-0222
Rufford	Backslope	CNR05	53.11954	-1.0776727	97.893	0.99999904	45603	1833	NIST_27900	0	0	Z92-0222
Rufford	Backslope	CNR06	53.11954	-1.0776727	97.893	0.99999904	28876	1661	NIST_27900	0	0	Z92-0222
Rufford	Toeslope	CNR07	53.11905	-1.0776833	95.707	0.99998338	32738	2006	NIST_27900	0	0	Z92-0222
Rufford	Toeslope	CNR08	53.11905	-1.0776833	95.707	0.99998338	25237	1562	NIST_27900	0	0	Z92-0222
Comer	Summit	CNR09	52.50954	-2.3789442	70.545	0.99999715	24507	1696	NIST_27900	0	0	Z92-0222
Comer	Shoulder	CNR10	52.50816	-2.3791828	65.318	0.99999713	24811	1333	NIST_27900	0	0	Z92-0222
Comer	Backslope	CNR11	52.50795	-2.3791515	58.93	0.996952	31263	2035	NIST_27900	0	0	Z92-0222
Comer	Toeslope	CNR12	52.50766	-2.3788101	50.099	0.99859266	41276	1522	NIST_27900	0	0	Z92-0222

Appendix 5.2: Soil analysis for Rufford and Comer

Sample Code	Site Name	Sampling Date	Catena Position	GPS SO	GPS BNG	GPS Elevation (m)	Sample Material	Depth extracted (cm)	Dry Bulk Density (g cm3)	LOI Organic Matter (%)	LOI-derived C Content (%)	C Stock (t/ha)	Clay (%)	Silt (%)	Sand (%)
R.2.1.4.1.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	5		3.79	2.20				
R.2.1.4.2.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	10		3.60	2.09		1.56	16.34	81.7
R.2.1.4.3.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	15		3.91	2.27				
R.2.1.4.4.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	20		3.33	1.94				
R.2.1.4.5.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	25		3.26	1.90				
R.2.1.4.6.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	30	1.41	3.19	1.86	13	1.81	17.85	79.9
R.2.1.4.7.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	35	1.39						
R.2.1.4.8.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	40	1.31	2.83	1.64	22			
R.2.1.4.9.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	45	1.44						
R.2.1.4.10.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	50	1.46	2.88	1.67	24	1.95	18.44	79.1
R.2.1.4.11.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	55	1.51						
R.2.1.4.12.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	60	1.37	2.45	1.43	20			
R.2.1.4.13.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	65	1.57						
R.2.1.4.14.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	70	1.63	2.17	1.26	21	0.95	8.97	89.8
R.2.1.4.15.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	75	1.70						
R.2.1.4.16.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	80	1.20	1.05	0.61	7			
R.2.1.4.17.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	85	1.24						
R.2.1.4.18.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	90	1.42	1.11	0.65	9	1.77	10.87	87
R.2.1.4.19.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	95							
R.2.1.4.20.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	100	0.96	2.00	1.17	11			
R.2.1.4.21.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	105	1.12						
R.2.1.4.22.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	110	1.28	1.23	0.71	9	0.66	5.91	93.33
R.2.1.4.23.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	115	1.29						
R.1.1.4.1.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	115-130	2.72						
R.1.1.4.2.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	140	2.83						
R.1.1.4.3.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	150	2.73						
R.1.1.4.4.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	160	2.70						
R.1.1.4.5.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	160-170	2.67						
R.1.1.4.6.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	180	2.81						
R.1.1.4.7.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	190	2.49						
R.1.1.4.8.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	200							
R.1.1.4.9.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	210							
R.1.1.4.10.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	220							
R.1.1.4.11.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	230							
R.1.1.4.12.A	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	240							
R.2.1.4.1.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	5							
R.2.1.4.2.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	10							
R.2.1.4.3.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	15							
R.2.1.4.4.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	20							
R.2.1.4.5.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	25							
R.2.1.4.6.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	30							
R.2.1.4.7.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	35							
R.2.1.4.8.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	40							
R.2.1.4.9.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	45							
R.2.1.4.10.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	50							
R.2.1.4.11.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	55							
R.2.1.4.12.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	60							
R.2.1.4.13.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	65							
R.2.1.4.14.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	70							
R.2.1.4.15.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	75							
R.2.1.4.16.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	80							
R.2.1.4.17.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	85							
R.2.1.4.18.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	90							
R.2.1.4.19.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	95							
R.2.1.4.20.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	100							
R.2.1.4.21.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	105							
R.2.1.4.22.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	110							
R.2.1.4.23.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Soil	115							
R.1.1.4.1.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	115-130							
R.1.1.4.2.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	140							
R.1.1.4.3.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	150							
R.1.1.4.4.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	160							
R.1.1.4.5.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	160-170							
R.1.1.4.6.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	180							
R.1.1.4.7.B	Rufford Forest	07/09/2017	Toeslope	61825	58583	86	Saprolite	190							
R.2.1.3.1.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	5	0.76	3.12	1.81	7			
R.2.1.3.2.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	10	1.33	3.70	2.15	14	1.69	15.22	82.7
R.2.1.3.3.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	15	1.42	3.97	2.31	16			
R.2.1.3.4.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	20	1.38	2.72	1.58	11			
R.2.1.3.5.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	25	1.43	3.49	2.03	15			
R.2.1.3.6.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	30	1.51	2.57	1.50	11	1.98	17.37	80.2
R.2.1.3.7.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	35	1.57						
R.2.1.3.8.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	40	1.63	2.07	1.20	20			
R.2.1.3.9.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	45	1.06						
R.2.1.3.10.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	45-50	1.42				0.79	8.79	90.29
R.2.1.3.11.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	55	1.39						
R.2.1.3.12.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	60	1.41						
R.2.1.3.13.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	65	1.45						
R.2.1.3.14.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	70	1.35						
R.2.1.3.15.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	75	1.45						
R.2.1.3.16.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	80	1.48						
R.2.1.3.17.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	85	1.40						
R.2.1.3.18.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	90	1.45						
R.2.1.3.19.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	95	1.16						
R.2.1.3.20.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	95-100							
R.2.1.3.21.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	105	1.01						
R.2.1.3.22.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	110	1.15						
R.2.1.3.23.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	115	1.42						
R.2.1.3.24.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	120	0.61						
R.1.1.3.1.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	130	2.76						
R.1.1.3.2.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	140	2.89						
R.1.1.3.3.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	150	2.77						
R.1.1.3.4.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	160	2.68						
R.1.1.3.5.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	170	2.59						
R.1.1.3.6.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	180	2.76						
R.1.1.3.7.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	190	2.45						
R.1.1.3.8.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	200	1.80						
R.1.1.3.9.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	210	2.27						
R.1.1.3.10.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	220	2.57						
R.1.1.3.11.A	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	226	1.37						
R.2.1.3.1.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	5							
R.2.1.3.2.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	10							
R.2.1.3.3.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	15							
R.2.1.3.4.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	20							
R.2.1.3.5.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	25							
R.2.1.3.6.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	30							
R.2.1.3.7.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	35							
R.2.1.3.8.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	40							
R.2.1.3.9.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	45							
R.2.1.3.10.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	45-50							
R.2.1.3.11.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	55							
R.2.1.3.12.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	60							
R.2.1.3.13.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	65							

R.2.1.3.14.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	70							
R.2.1.3.15.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	75							
R.2.1.3.16.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	80							
R.2.1.3.17.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	85							
R.2.1.3.18.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	90							
R.2.1.3.19.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	95							
R.2.1.3.20.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	95-100							
R.2.1.3.21.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	105							
R.2.1.3.22.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	110							
R.2.1.3.23.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Soil	115							
R.1.1.3.1.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	130							
R.1.1.3.2.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	140							
R.1.1.3.3.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	150							
R.1.1.3.4.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	160							
R.1.1.3.5.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	170							
R.1.1.3.6.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	180							
R.1.1.3.7.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	190							
R.1.1.3.8.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	200							
R.1.1.3.9.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	210							
R.1.1.3.10.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	220							
R.1.1.3.11.B	Rufford Forest	07/09/2017	Backslope	61825	58438	94	Saprolite	226							
R.2.1.1A.1.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	5		3.65	2.12				
R.2.1.1A.2.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	10	1.36	3.08	1.79	12	2.02	18.27	79.2
R.2.1.1A.3.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	15	1.40	3.84	2.23	16			
R.2.1.1A.4.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	20	1.41	2.52	1.47	10			
R.2.1.1A.5.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	25	1.69	2.93	1.70	14			
R.2.1.1A.6.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	30	1.71	2.45	1.43	12	1.63	15.16	82.8
R.2.1.1A.7.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	35	1.38						
R.2.1.1A.8.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	40	1.07	1.11	0.64	7			
R.2.1.1A.9.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	45	1.44						
R.2.1.1A.10.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	50	1.34	0.68	0.39	5	1.31	6.66	91.76
R.2.1.1A.11.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	55	1.34						
R.2.1.1A.12.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	60	1.33	0.80	0.46	6			
R.2.1.1A.13.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	65	1.34						
R.2.1.1A.14.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	70	1.39	0.67	0.39	5	1.01	6.88	91.91
R.2.1.1A.15.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	75	1.40						
R.2.1.1A.16.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	80	1.36	0.80	0.46	6			
R.2.1.1A.17.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	85	1.44						
R.2.1.1A.18.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	90	1.37	0.80	0.46	6	1.13	8.5	90.15
R.2.1.1A.19.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	95	1.54						
R.2.1.1A.20.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	100		1.13	0.66				
R.2.1.1A.21.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	105	0.94						
R.2.1.1A.22.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	110	1.02	0.89	0.52	5	1	7.94	90.89
R.2.1.1A.23.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	115	1.16						
R.2.1.1A.24.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	120	1.11	0.83	0.48	5			
R.2.1.1A.25.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	125	1.38						
R.2.1.1A.26.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	130	1.26	0.89	0.52	7	0.87	6.85	92.13
R.2.1.1A.27.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	135	1.36						
R.2.1.1A.28.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	140	1.37	0.86	0.50	7			
R.2.1.1A.29.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	145	1.38						
R.2.1.1A.30.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	150	1.42	0.76	0.44	6	1.17	8.62	90
R.1.1.1A.1.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	155- 165	2.62						
R.1.1.1A.2.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	175	2.68						
R.1.1.1A.3.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	185	2.67						
R.1.1.1A.4.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	195	2.46						
R.1.1.1A.5.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	205	2.54						
R.1.1.1A.6.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	205-210	1.97						
R.1.1.1A.7.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	220	2.74						
R.1.1.1A.8.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	230	2.78						
R.1.1.1A.9.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	240	2.85						
R.1.1.1A.10.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	250	2.84						
R.1.1.1A.11.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	260	3.09						
R.1.1.1A.12.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	270	3.21						
R.1.1.1A.13.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	280	3.26						
R.1.1.1A.14.A	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	290	3.53						
R.2.1.1A.1.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	5							
R.2.1.1A.2.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	10							
R.2.1.1A.3.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	15							
R.2.1.1A.4.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	20							
R.2.1.1A.5.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	25							
R.2.1.1A.6.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	30							
R.2.1.1A.7.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	35							
R.2.1.1A.8.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	40							
R.2.1.1A.9.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	45							
R.2.1.1A.10.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	50							
R.2.1.1A.11.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	55							
R.2.1.1A.12.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	60							
R.2.1.1A.13.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	65							
R.2.1.1A.14.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	70							
R.2.1.1A.15.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	75							
R.2.1.1A.16.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	80							
R.2.1.1A.17.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	85							
R.2.1.1A.18.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	90							
R.2.1.1A.19.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	95							
R.2.1.1A.20.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	100							
R.2.1.1A.21.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	105							
R.2.1.1A.22.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	110							
R.2.1.1A.23.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	115							
R.2.1.1A.24.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	120							
R.2.1.1A.25.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	125							
R.2.1.1A.26.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	130							
R.2.1.1A.27.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	135							
R.2.1.1A.28.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	140							
R.2.1.1A.29.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	145							
R.2.1.1A.30.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Soil	150							
R.1.1.1A.1.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	155- 165							
R.1.1.1A.2.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	175							
R.1.1.1A.3.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	185							
R.1.1.1A.4.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	195							
R.1.1.1A.5.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	205							
R.1.1.1A.6.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	205-210							
R.1.1.1A.7.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	220							
R.1.1.1A.8.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	230							
R.1.1.1A.9.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	240							
R.1.1.1A.10.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	250							
R.1.1.1A.11.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	260							
R.1.1.1A.12.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	270							
R.1.1.1A.13.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	280							
R.1.1.1A.14.B	Rufford Forest	06/09/2017	Summit	61824	58533	98	Saprolite	290							
R.2.1.1B.1.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	5	0.96	2.77	1.61	8			
R.2.1.1B.2.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	10	1.58	2.79	1.62	13	1.8	16.74	81
R.2.1.1B.3.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	15	1.32	2.64	1.53	10			
R.2.1.1B.4.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	20	1.50	2.28	1.33	10			
R.2.1.1B.5.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	25	1.55	2.36	1.37	11			
R.2.1.1B.6.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	30	1.72	2.23	1.30	11	1.68	14.5	83.4
R.2.1.1B.7.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	35	1.54						
R.2.1.1B.8.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	40	1.36	1.67	0.97	13			
R.2.1.1B.9.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	45	1.62						
R.2.1.1B.10.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	50	1.33	0.70	0.40	5	1.05	7.58	91.15

R.2.1.1B.11.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	55	1.41							
R.1.1.1B.1.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	65	2.89							
R.1.1.1B.2.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	75	2.73							
R.1.1.1B.3.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	85	2.80							
R.1.1.1B.4.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	95	2.06							
R.1.1.1B.5.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	105	2.08							
R.1.1.1B.6.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	115	2.94							
R.1.1.1B.7.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	125	2.78							
R.1.1.1B.8.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	135	2.78							
R.1.1.1B.9.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	145	2.84							
R.1.1.1B.10.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	155	2.76							
R.1.1.1B.11.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	165	2.78							
R.1.1.1B.12.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	175	2.58							
R.1.1.1B.13.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	185	2.08							
R.1.1.1B.14.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	195	2.11							
R.1.1.1B.15.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	205	2.41							
R.1.1.1B.16.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	215	2.77							
R.1.1.1B.17.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	225	2.67							
R.1.1.1B.18.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	235	2.76							
R.1.1.1B.19.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	245	2.88							
R.1.1.1B.20.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	255	2.84							
R.1.1.1B.21.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	265	3.06							
R.1.1.1B.22.A	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	273	2.46							
R.2.1.1B.1.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	5								
R.2.1.1B.2.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	10								
R.2.1.1B.3.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	15								
R.2.1.1B.4.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	20								
R.2.1.1B.5.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	25								
R.2.1.1B.6.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	30								
R.2.1.1B.7.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	35								
R.2.1.1B.8.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	40								
R.2.1.1B.9.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	45								
R.2.1.1B.10.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	50								
R.2.1.1B.11.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Soil	55								
R.1.1.1B.1.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	65								
R.1.1.1B.2.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	75								
R.1.1.1B.3.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	85								
R.1.1.1B.4.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	95								
R.1.1.1B.5.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	105								
R.1.1.1B.6.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	115								
R.1.1.1B.7.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	125								
R.1.1.1B.8.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	135								
R.1.1.1B.9.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	145								
R.1.1.1B.10.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	155								
R.1.1.1B.11.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	165								
R.1.1.1B.12.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	175								
R.1.1.1B.13.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	185								
R.1.1.1B.14.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	195								
R.1.1.1B.15.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	205								
R.1.1.1B.16.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	215								
R.1.1.1B.17.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	225								
R.1.1.1B.18.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	235								
R.1.1.1B.19.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	245								
R.1.1.1B.20.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	255								
R.1.1.1B.21.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	265								
R.1.1.1B.22.B	Rufford Forest	06/09/2017	Summit	61832	58535	99	Saprolite	273								
R.2.1.2.1.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	5	1.19	2.93	1.70	10				
R.2.1.2.2.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	10	1.53	2.73	1.59	12	1.74	15.16	82.7	
R.2.1.2.3.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	15	1.45	2.69	1.57	11				
R.2.1.2.4.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	20	1.89	2.49	1.45	14				
R.2.1.2.5.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	25	1.92	2.57	1.49	14				
R.2.1.2.6.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	30	1.52	2.44	1.42	11	1.61	13.9	84.1	
R.2.1.2.7.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	35	1.86							
R.2.1.2.8.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	40	1.75	1.52	0.88	15				
R.2.1.2.9.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	45	1.39							
R.2.1.2.10.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	50	1.48	1.01	0.59	9	1.59	12.4	85.7	
R.2.1.2.11.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	55	1.41							
R.1.1.2.1.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	55-65	2.82							
R.1.1.2.2.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	75	2.74							
R.1.1.2.3.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	85	2.75							
R.1.1.2.4.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	95								
R.1.1.2.5.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	105								
R.1.1.2.6.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	105-115								
R.1.1.2.7.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	125								
R.1.1.2.8.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	135								
R.1.1.2.9.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	145								
R.1.1.2.10.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	155								
R.1.1.2.11.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	165								
R.1.1.2.12.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	175								
R.1.1.2.13.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	185								
R.1.1.2.14.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	195	3.38							
R.1.1.2.15.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	205	3.28							
R.1.1.2.16.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	215	3.39							
R.1.1.2.17.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	225	3.39							
R.1.1.2.18.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	235	3.29							
R.1.1.2.19.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	245	3.13							
R.1.1.2.20.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	255	3.02							
R.1.1.2.21.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	265	3.12							
R.1.1.2.22.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	275	2.34							
R.1.1.2.23.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	285	2.29							
R.1.1.2.24.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	295	3.18							
R.1.1.2.25.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	305	2.89							
R.1.1.2.26.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	315	2.75							
R.1.1.2.27.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	325	2.72							
R.1.1.2.28.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	335	2.99							
R.1.1.2.29.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	345	2.93							
R.1.1.2.30.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	355	3.05							
R.1.1.2.31.A	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	360	1.85							
R.2.1.2.1.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	5								
R.2.1.2.2.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	10								
R.2.1.2.3.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	15								
R.2.1.2.4.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	20								
R.2.1.2.5.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	25								
R.2.1.2.6.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	30								
R.2.1.2.7.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	35								
R.2.1.2.8.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	40								
R.2.1.2.9.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	45								
R.2.1.2.10.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	50								
R.2.1.2.11.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Soil	55								
R.1.1.2.1.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	55-65								
R.1.1.2.2.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	75								
R.1.1.2.3.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	85								
R.1.1.2.4.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	90								
R.1.1.2.13.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	185								
R.1.1.2.14.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	195								
R.1.1.2.15.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	205								
R.1.1.2.16.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	215								
R.1.1.2.17.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	225								
R.1.1.2.18.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	235								

R.1.1.2.19.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	245						
R.1.1.2.20.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	255						
R.1.1.2.21.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	265						
R.1.1.2.22.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	275						
R.1.1.2.23.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	285						
R.1.1.2.24.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	295						
R.1.1.2.25.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	305						
R.1.1.2.26.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	315						
R.1.1.2.27.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	325						
R.1.1.2.28.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	335						
R.1.1.2.29.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	345						
R.1.1.2.30.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	355						
R.1.1.2.31.B	Rufford Forest	06/09/2017	Shoulder	61825	58476	92	Saprolite	360						
C.1.1.1.A	Comer	03/08/2017	Summit	74341	90121	76	Saprolite	30						
C.1.1.1.B	Comer	03/08/2017	Summit	74341	90121	76	Saprolite	40						
C.1.1.1.C	Comer	03/08/2017	Summit	74341	90121	76	Saprolite	50						
C.1.1.1.D	Comer	03/08/2017	Summit	74341	90121	76	Saprolite	60						
C.1.1.1.E	Comer	03/08/2017	Summit	74341	90121	76	Saprolite	70						
C.1.1.1.F	Comer	03/08/2017	Summit	74341	90121	76	Saprolite	80						
C.1.1.1.G	Comer	03/08/2017	Summit	74341	90121	76	Saprolite	90						
C.1.1.1.H	Comer	03/08/2017	Summit	74341	90121	76	Saprolite	100						
C.1.1.1.I	Comer	03/08/2017	Summit	74341	90121	76	Saprolite	110						
C.1.1.1.J	Comer	03/08/2017	Summit	74341	90121	76	Saprolite	120						
C.1.1.3.A	Comer	03/08/2017	Shoulder	74361	90097	73	Saprolite	30						
C.1.1.3.B	Comer	03/08/2017	Shoulder	74361	90097	73	Saprolite	40						
C.1.1.3.C	Comer	03/08/2017	Shoulder	74361	90097	73	Saprolite	50						
C.1.1.3.D	Comer	03/08/2017	Shoulder	74361	90097	73	Saprolite	60						
C.1.1.3.E	Comer	03/08/2017	Shoulder	74361	90097	73	Saprolite	70						
C.1.1.3.F	Comer	03/08/2017	Shoulder	74361	90097	73	Saprolite	80						
C.1.1.3.G	Comer	03/08/2017	Shoulder	74361	90097	73	Saprolite	90						
C.1.1.3.H	Comer	03/08/2017	Shoulder	74361	90097	73	Saprolite	100						
C.1.1.3.I	Comer	03/08/2017	Shoulder	74361	90097	73	Saprolite	110						
C.1.1.5.A	Comer	03/08/2017	Backslope	74363	90074	63	Saprolite	30						
C.1.1.5.B	Comer	03/08/2017	Backslope	74363	90074	63	Saprolite	40						
C.1.1.5.C	Comer	03/08/2017	Backslope	74363	90074	63	Saprolite	50						
C.1.1.5.D	Comer	03/08/2017	Backslope	74363	90074	63	Saprolite	60						
C.1.1.5.E	Comer	03/08/2017	Backslope	74363	90074	63	Saprolite	70						
C.1.1.5.F	Comer	03/08/2017	Backslope	74363	90074	63	Saprolite	80						
C.1.1.7.A	Comer	05/08/2017	Toeslope	74386	90041	61	Saprolite	90						
C.1.1.7.B	Comer	05/08/2017	Toeslope	74386	90041	61	Saprolite	90						
C.1.1.7.C	Comer	05/08/2017	Toeslope	74386	90041	61	Saprolite	90						
C.1.1.5.F.a	Comer	05/08/2017	Backslope	74363	90074	63	Saprolite	80						
C.1.1.5.F.b	Comer	05/08/2017	Backslope	74363	90074	63	Saprolite	80						
C.1.1.5.F.c	Comer	05/08/2017	Backslope	74363	90074	63	Saprolite	80						
C.1.1.5.F.d	Comer	05/08/2017	Backslope	74363	90074	63	Saprolite	80						
C.1.1.3.F.a	Comer	05/08/2017	Shoulder	74361	90097	73	Saprolite	80						
C.1.1.3.F.b	Comer	05/08/2017	Shoulder	74361	90097	73	Saprolite	80						
C.1.1.3.F.c	Comer	05/08/2017	Shoulder	74361	90097	73	Saprolite	80						
C.1.1.3.F.d	Comer	05/08/2017	Shoulder	74361	90097	73	Saprolite	80						
C.2.1.4.1.A	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	5		18.68	10.86			
C.2.1.4.1.B	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	10		5.12	2.98	0.4	4.51	95.03
C.2.1.4.1.C	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	15		4.08	2.37			
C.2.1.4.1.D	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	20		3.68	2.14			
C.2.1.4.1.E	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	25		3.75	2.18			
C.2.1.4.1.F	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	30		3.03	1.76	0.55	4.98	94.32
C.2.1.4.1.G	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	35						
C.2.1.4.1.H	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	40		1.88	1.09			
C.2.1.4.2.A	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	5						
C.2.1.4.2.B	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	10						
C.2.1.4.2.C	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	15						
C.2.1.4.2.D	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	20						
C.2.1.4.2.E	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	25						
C.2.1.4.2.F	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	30						
C.2.1.4.2.G	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	35						
C.2.1.4.2.H	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	40						
C.2.1.4.3.A	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	5						
C.2.1.4.3.B	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	10						
C.2.1.4.3.C	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	15						
C.2.1.4.3.D	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	20						
C.2.1.4.3.E	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	25						
C.2.1.4.3.F	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	30						
C.2.1.4.3.G	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	35						
C.2.1.4.3.H	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	40						
C.2.2.4.1.A	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	10	0.38					
C.2.2.4.1.B	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	20	1.02					
C.2.2.4.1.C	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	30	0.90					
C.2.2.4.1.D	Comer	09/08/2017	Toeslope	74384	90035	56	Soil	40	0.87					
C.2.1.3.1.A	Comer	09/08/2017	Backslope	74373	90080	69	Soil	5		8.68	5.04			
C.2.1.3.1.B	Comer	09/08/2017	Backslope	74373	90080	69	Soil	10		49.92	29.02			
C.2.1.3.1.C	Comer	09/08/2017	Backslope	74373	90080	69	Soil	15		5.40	3.14			
C.2.1.3.1.D	Comer	09/08/2017	Backslope	74373	90080	69	Soil	20		5.27	3.06			
C.2.1.3.1.E	Comer	09/08/2017	Backslope	74373	90080	69	Soil	25		5.04	2.93			
C.2.1.3.1.F	Comer	09/08/2017	Backslope	74373	90080	69	Soil	30		4.01	2.33			
C.2.1.3.1.G	Comer	09/08/2017	Backslope	74373	90080	69	Soil	35						
C.2.1.3.1.H	Comer	09/08/2017	Backslope	74373	90080	69	Soil	40		4.69	2.73			
C.2.1.3.1.I	Comer	09/08/2017	Backslope	74373	90080	69	Soil	45						
C.2.1.3.1.J	Comer	09/08/2017	Backslope	74373	90080	69	Soil	50		3.60	2.09			
C.2.1.3.1.K	Comer	09/08/2017	Backslope	74373	90080	69	Soil	55						
C.2.1.3.1.L	Comer	09/08/2017	Backslope	74373	90080	69	Soil	60		5.39	3.13			
C.2.1.3.2.A	Comer	09/08/2017	Backslope	74373	90080	69	Soil	5						
C.2.1.3.2.B	Comer	09/08/2017	Backslope	74373	90080	69	Soil	10						
C.2.1.3.2.C	Comer	09/08/2017	Backslope	74373	90080	69	Soil	15						
C.2.1.3.2.D	Comer	09/08/2017	Backslope	74373	90080	69	Soil	20						
C.2.1.3.2.E	Comer	09/08/2017	Backslope	74373	90080	69	Soil	25						
C.2.1.3.2.F	Comer	09/08/2017	Backslope	74373	90080	69	Soil	30						
C.2.1.3.2.G	Comer	09/08/2017	Backslope	74373	90080	69	Soil	35						
C.2.1.3.2.H	Comer	09/08/2017	Backslope	74373	90080	69	Soil	40						
C.2.1.3.2.I	Comer	09/08/2017	Backslope	74373	90080	69	Soil	45						
C.2.1.3.2.J	Comer	09/08/2017	Backslope	74373	90080	69	Soil	50						
C.2.1.3.2.K	Comer	09/08/2017	Backslope	74373	90080	69	Soil	55						
C.2.1.3.2.L	Comer	09/08/2017	Backslope	74373	90080	69	Soil	60						
C.2.1.3.3.A	Comer	09/08/2017	Backslope	74373	90080	69	Soil	5						
C.2.1.3.3.B	Comer	09/08/2017	Backslope	74373	90080	69	Soil	10						
C.2.1.3.3.C	Comer	09/08/2017	Backslope	74373	90080	69	Soil	15						
C.2.1.3.3.D	Comer	09/08/2017	Backslope	74373	90080	69	Soil	20						
C.2.1.3.3.E	Comer	09/08/2017	Backslope	74373	90080	69	Soil	25						
C.2.1.3.3.F	Comer	09/08/2017	Backslope	74373	90080	69	Soil	30						
C.2.1.3.3.G	Comer	09/08/2017	Backslope	74373	90080	69	Soil	35						
C.2.1.3.3.H	Comer	09/08/2017	Backslope	74373	90080	69	Soil	40						
C.2.1.3.3.I	Comer	09/08/2017	Backslope	74373	90080	69	Soil	45						
C.2.1.3.3.J	Comer	09/08/2017	Backslope	74373	90080	69	Soil	50						
C.2.1.3.3.K	Comer	09/08/2017	Backslope	74373	90080	69	Soil	55						
C.2.1.3.3.L	Comer	09/08/2017	Backslope	74373	90080	69	Soil	60						
C.2.2.3.1.A	Comer	09/08/2017	Backslope	74373	90080	69	Soil	10	0.39					
C.2.2.3.1.B	Comer	09/08/2017	Backslope	74373	90080	69	Soil	20	1.41					
C.2.2.3.1.C	Comer	09/08/2017	Backslope	74373	90080	69	Soil	30	1.31					
C.2.2.3.1.D	Comer	09/08/2017	Backslope	74373	90080	69	Soil	40	1.31					
C.2.1.2.1.A	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	5		7.50	4.36			
C.2.1.2.1.B	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	10		7.98	4.64			

C.2.1.2.1.C	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	15		5.03	2.92			
C.2.1.2.1.D	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	20		4.86	2.83			
C.2.1.2.1.E	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	25		4.79	2.79			
C.2.1.2.1.F	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	30		4.13	2.40			
C.2.1.2.1.G	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	35						
C.2.1.2.1.H	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	40		2.76	1.60			
C.2.1.2.1.I	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	45						
C.2.1.2.1.J	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	50		2.93	1.70			
C.2.1.2.1.K	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	55						
C.2.1.2.1.L	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	60		3.15	1.83			
C.2.1.2.1.M	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	65						
C.2.1.2.1.N	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	70		1.50	0.87	0.79	3.77	95.21
C.2.1.2.1.O	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	75						
C.2.1.2.1.P	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	80		1.16	0.67			
C.2.1.2.2.A	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	5						
C.2.1.2.2.B	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	10						
C.2.1.2.2.C	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	15						
C.2.1.2.2.D	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	20						
C.2.1.2.2.E	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	25						
C.2.1.2.2.F	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	30						
C.2.1.2.2.G	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	35						
C.2.1.2.2.H	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	40						
C.2.1.2.2.I	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	45						
C.2.1.2.2.J	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	50						
C.2.1.2.2.K	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	55						
C.2.1.2.2.L	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	60						
C.2.1.2.2.M	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	65						
C.2.1.2.2.N	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	70						
C.2.1.2.2.O	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	75						
C.2.1.2.2.P	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	80						
C.2.1.2.3.A	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	5						
C.2.1.2.3.B	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	10						
C.2.1.2.3.C	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	15						
C.2.1.2.3.D	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	20						
C.2.1.2.3.E	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	25						
C.2.1.2.3.F	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	30						
C.2.1.2.3.G	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	35						
C.2.1.2.3.H	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	40						
C.2.1.2.3.I	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	45						
C.2.1.2.3.J	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	50						
C.2.1.2.3.K	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	55						
C.2.1.2.3.L	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	60						
C.2.1.2.3.M	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	65						
C.2.1.2.3.N	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	70						
C.2.1.2.3.O	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	75						
C.2.1.2.3.P	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	80						
C.2.2.2.1.A	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	10	0.37					
C.2.2.2.1.B	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	20	0.98					
C.2.2.2.1.C	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	30	1.17					
C.2.2.2.1.D	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	40	1.33					
C.2.2.2.1.E	Comer	09/08/2017	Shoulder	74361	90097	66	Soil	50	1.36					
C.2.1.1.1.A	Comer	10/08/2017	Summit	74881	90246	77	Soil	5		12.89	7.49			
C.2.1.1.1.B	Comer	10/08/2017	Summit	74881	90246	77	Soil	10		9.33	5.43			
C.2.1.1.1.C	Comer	10/08/2017	Summit	74881	90246	77	Soil	15		2.57	1.49			
C.2.1.1.1.D	Comer	10/08/2017	Summit	74881	90246	77	Soil	20		1.73	1.01			
C.2.1.1.1.E	Comer	10/08/2017	Summit	74881	90246	77	Soil	25		1.58	0.92			
C.2.1.1.1.F	Comer	10/08/2017	Summit	74881	90246	77	Soil	30		1.70	0.99	0.78	6.57	92.36
C.2.1.1.1.G	Comer	10/08/2017	Summit	74881	90246	77	Soil	35						
C.2.1.1.1.H	Comer	10/08/2017	Summit	74881	90246	77	Soil	40		1.60	0.93			
C.2.1.1.1.I	Comer	10/08/2017	Summit	74881	90246	77	Soil	45						
C.2.1.1.1.J	Comer	10/08/2017	Summit	74881	90246	77	Soil	50		1.37	0.79	0.84	5.68	93.2
C.2.1.1.1.K	Comer	10/08/2017	Summit	74881	90246	77	Soil	55						
C.2.1.1.1.L	Comer	10/08/2017	Summit	74881	90246	77	Soil	60		1.17	0.68			
C.2.1.1.1.M	Comer	10/08/2017	Summit	74881	90246	77	Soil	65						
C.2.1.1.1.N	Comer	10/08/2017	Summit	74881	90246	77	Soil	70		1.01	0.59	0.72	3.06	95.99
C.2.1.1.1.O	Comer	10/08/2017	Summit	74881	90246	77	Soil	75						
C.2.1.1.1.P	Comer	10/08/2017	Summit	74881	90246	77	Soil	80		0.86	0.50			
C.2.1.1.1.Q	Comer	10/08/2017	Summit	74881	90246	77	Soil	85						
C.2.1.1.1.R	Comer	10/08/2017	Summit	74881	90246	77	Soil	90		0.79	0.46	0.67	2.55	96.62
C.2.1.1.1.S	Comer	10/08/2017	Summit	74881	90246	77	Soil	95						
C.2.1.1.1.T	Comer	10/08/2017	Summit	74881	90246	77	Soil	100		0.71	0.41			
C.2.1.1.1.U	Comer	10/08/2017	Summit	74881	90246	77	Soil	105						
C.2.1.1.1.V	Comer	10/08/2017	Summit	74881	90246	77	Soil	110		0.64	0.37	0.63	2.41	96.8
C.2.1.1.1.W	Comer	10/08/2017	Summit	74881	90246	77	Soil	115						
C.2.1.1.1.X	Comer	10/08/2017	Summit	74881	90246	77	Soil	120		0.59	0.34			
C.2.1.1.1.Y	Comer	10/08/2017	Summit	74881	90246	77	Soil	125						
C.2.1.1.1.Z	Comer	10/08/2017	Summit	74881	90246	77	Soil	130		0.59	0.34	0.438	1.43	98.07
C.2.1.1.1.AA	Comer	10/08/2017	Summit	74881	90246	77	Soil	135						
C.2.1.1.1.AB	Comer	10/08/2017	Summit	74881	90246	77	Soil	140		0.55	0.32			
C.2.1.1.1.AC	Comer	10/08/2017	Summit	74881	90246	77	Soil	145						
C.2.1.1.1.AD	Comer	10/08/2017	Summit	74881	90246	77	Soil	150		0.65	0.38	0.535	2.79	96.58
C.2.1.1.2.A	Comer	10/08/2017	Summit	74881	90246	77	Soil	5						
C.2.1.1.2.B	Comer	10/08/2017	Summit	74881	90246	77	Soil	10						
C.2.1.1.2.C	Comer	10/08/2017	Summit	74881	90246	77	Soil	15						
C.2.1.1.2.D	Comer	10/08/2017	Summit	74881	90246	77	Soil	20						
C.2.1.1.2.E	Comer	10/08/2017	Summit	74881	90246	77	Soil	25						
C.2.1.1.2.F	Comer	10/08/2017	Summit	74881	90246	77	Soil	30						
C.2.1.1.2.G	Comer	10/08/2017	Summit	74881	90246	77	Soil	35						
C.2.1.1.2.H	Comer	10/08/2017	Summit	74881	90246	77	Soil	40						
C.2.1.1.2.I	Comer	10/08/2017	Summit	74881	90246	77	Soil	45						
C.2.1.1.2.J	Comer	10/08/2017	Summit	74881	90246	77	Soil	50						
C.2.1.1.2.K	Comer	10/08/2017	Summit	74881	90246	77	Soil	55						
C.2.1.1.2.L	Comer	10/08/2017	Summit	74881	90246	77	Soil	60						
C.2.1.1.2.M	Comer	10/08/2017	Summit	74881	90246	77	Soil	65						
C.2.1.1.2.N	Comer	10/08/2017	Summit	74881	90246	77	Soil	70						
C.2.1.1.2.O	Comer	10/08/2017	Summit	74881	90246	77	Soil	75						
C.2.1.1.2.P	Comer	10/08/2017	Summit	74881	90246	77	Soil	80						
C.2.1.1.2.Q	Comer	10/08/2017	Summit	74881	90246	77	Soil	85						
C.2.1.1.2.R	Comer	10/08/2017	Summit	74881	90246	77	Soil	90						
C.2.1.1.2.S	Comer	10/08/2017	Summit	74881	90246	77	Soil	95						
C.2.1.1.2.T	Comer	10/08/2017	Summit	74881	90246	77	Soil	100						
C.2.1.1.2.U	Comer	10/08/2017	Summit	74881	90246	77	Soil	105						
C.2.1.1.2.V	Comer	10/08/2017	Summit	74881	90246	77	Soil	110						
C.2.1.1.2.W	Comer	10/08/2017	Summit	74881	90246	77	Soil	115						
C.2.1.1.2.X	Comer	10/08/2017	Summit	74881	90246	77	Soil	120						
C.2.1.1.2.Y	Comer	10/08/2017	Summit	74881	90246	77	Soil	125						
C.2.1.1.2.Z	Comer	10/08/2017	Summit	74881	90246	77	Soil	130						
C.2.1.1.2.AA	Comer	10/08/2017	Summit	74881	90246	77	Soil	135						
C.2.1.1.2.AB	Comer	10/08/2017	Summit	74881	90246	77	Soil	140						
C.2.1.1.2.AC	Comer	10/08/2017	Summit	74881	90246	77	Soil	145						
C.2.1.1.2.AD	Comer	10/08/2017	Summit	74881	90246	77	Soil	150						
C.2.1.1.3.A	Comer	10/08/2017	Summit	74881	90246	77	Soil	5						
C.2.1.1.3.B	Comer	10/08/2017	Summit	74881	90246	77	Soil	10						
C.2.1.1.3.C	Comer	10/08/2017	Summit	74881	90246	77	Soil	15						
C.2.1.1.3.D	Comer	10/08/2017	Summit	74881	90246	77	Soil	20						
C.2.1.1.3.E	Comer	10/08/2017	Summit	74881	90246	77	Soil	25						
C.2.1.1.3.F	Comer	10/08/2017	Summit	74881	90246	77	Soil	30						
C.2.1.1.3.G	Comer	10/08/2017	Summit	74881	90246	77	Soil	35						
C.2.1.1.3.H	Comer	10/08/2017	Summit	74881	90246	77	Soil	40						

C.2.1.1.3.I	Comer	10/08/2017	Summit	74881	90246	77	Soil	45	
C.2.1.1.3.J	Comer	10/08/2017	Summit	74881	90246	77	Soil	50	
C.2.1.1.3.K	Comer	10/08/2017	Summit	74881	90246	77	Soil	55	
C.2.1.1.3.L	Comer	10/08/2017	Summit	74881	90246	77	Soil	60	
C.2.1.1.3.M	Comer	10/08/2017	Summit	74881	90246	77	Soil	65	
C.2.1.1.3.N	Comer	10/08/2017	Summit	74881	90246	77	Soil	70	
C.2.1.1.3.O	Comer	10/08/2017	Summit	74881	90246	77	Soil	75	
C.2.1.1.3.P	Comer	10/08/2017	Summit	74881	90246	77	Soil	80	
C.2.1.1.3.Q	Comer	10/08/2017	Summit	74881	90246	77	Soil	85	
C.2.1.1.3.R	Comer	10/08/2017	Summit	74881	90246	77	Soil	90	
C.2.1.1.3.S	Comer	10/08/2017	Summit	74881	90246	77	Soil	95	
C.2.1.1.3.T	Comer	10/08/2017	Summit	74881	90246	77	Soil	100	
C.2.1.1.3.U	Comer	10/08/2017	Summit	74881	90246	77	Soil	105	
C.2.1.1.3.V	Comer	10/08/2017	Summit	74881	90246	77	Soil	110	
C.2.1.1.3.W	Comer	10/08/2017	Summit	74881	90246	77	Soil	115	
C.2.1.1.3.X	Comer	10/08/2017	Summit	74881	90246	77	Soil	120	
C.2.1.1.3.Y	Comer	10/08/2017	Summit	74881	90246	77	Soil	125	
C.2.1.1.3.Z	Comer	10/08/2017	Summit	74881	90246	77	Soil	130	
C.2.1.1.3.AA	Comer	10/08/2017	Summit	74881	90246	77	Soil	135	
C.2.1.1.3.AB	Comer	10/08/2017	Summit	74881	90246	77	Soil	140	
C.2.1.1.3.AC	Comer	10/08/2017	Summit	74881	90246	77	Soil	145	
C.2.1.1.3.AD	Comer	10/08/2017	Summit	74881	90246	77	Soil	150	
C.2.2.1.1.A	Comer	10/08/2017	Summit	74881	90246	77	Soil	20	1.35
C.2.2.1.1.B	Comer	10/08/2017	Summit	74881	90246	77	Soil	40	1.28
C.2.2.1.1.C	Comer	10/08/2017	Summit	74881	90246	77	Soil	60	1.56
C.2.2.1.1.D	Comer	10/08/2017	Summit	74881	90246	77	Soil	80	1.56
C.2.2.1.1.E	Comer	10/08/2017	Summit	74881	90246	77	Soil	100	1.55
C.1.1.1	Comer	10/08/2017	Summit	74881	90246	77	Saprolite	150	

Appendix 6.1: Output from AMS for Hilton and Woburn

Site	Catena Position	AMS ID	Latitude	Longitude	Shielding correction	10Be concentration (atoms g-1)	Uncertainty in 10Be concentration (atoms g-1)	Name of Be-10 standardization
Woburn	Summit	CRN_1	52.01265	-0.590347	0.999993	38324	2081	NIST_27900
Woburn	Summit	CRN_2	52.01265	-0.590347	0.999993			NIST_27900
Woburn	Shoulder	CRN_3	52.01249	-0.590342	0.999882	27931	2215	NIST_27900
Woburn	Shoulder	CRN_4	52.01249	-0.590342	0.999882	18129	1710	NIST_27900
Woburn	Backslope	CRN_5	52.01224	-0.590299	0.999952	21863	1553	NIST_27900
Woburn	Backslope	CRN_6	52.01224	-0.590299	0.999952	20488	1695	NIST_27900
Woburn	Toeslope	CRN_7	52.01182	-0.590253	1	49291	2592	NIST_27900
Woburn	Toeslope	CRN_8	52.01182	-0.590253	1	27384	4009	NIST_27900
Hilton	Summit	CRN_9	52.55159	-2.323442	0.999753	26958	1933	NIST_27900
Hilton	Summit	CRN_10	52.55159	-2.323442	0.999753	24110	2637	NIST_27900
Hilton	Shoulder	CRN_11	52.55156	-2.323781	0.998285	15983	1525	NIST_27900
Hilton	Shoulder	CRN_12	52.55156	-2.323781	0.998285	15878	1541	NIST_27900
Hilton	Backslope	CRN_13	52.55152	-2.324105	0.998391	32121	2373	NIST_27901
Hilton	Backslope	CRN_14	52.55152	-2.324105	0.998391	22656	1797	NIST_27902
Hilton	Toeslope	CRN_15	52.55147	-2.324557	0.999995	35605	5203	NIST_27903
Hilton	Toeslope	CRN_16	52.55147	-2.324557	0.999995	22512	1564	NIST_27904

Appendix 6.2: Soil analysis for Hilton and Woburn

Sample Code	Site Name	Sampling Date	Catena Position	Sample Material	Depth extracted (cm)	Dry Bulk Density (g cm3)	LOI Organic Matter (%)	LOI-derived C Content (%)	C Stock (t/ha)	Clay (%)	Silt (%)	Sand (%)
H.2.2.1.1	Hilton	25/02/2019	Summit	Soil	10	1.097506						
H.2.2.1.2	Hilton	25/02/2019	Summit	Soil	20	1.435318				94.8	3.2	1.9
H.2.2.1.3	Hilton	25/02/2019	Summit	Soil	30	1.565191						
H.2.2.1.4	Hilton	25/02/2019	Summit	Soil	40	1.622087						
H.2.2.1.5	Hilton	25/02/2019	Summit	Soil	50	1.681018						
H.2.2.1.6	Hilton	25/02/2019	Summit	Soil	60	1.537099				96.6	2.1	1.3
H.2.2.1.7	Hilton	25/02/2019	Summit	Soil	70	1.511756						
H.2.2.1.8	Hilton	25/02/2019	Summit	Soil	80	1.647125				90.3	6.0	3.6
H.2.2.1.9	Hilton	25/02/2019	Summit	Soil	90	1.639084						
H.2.2.1.10	Hilton	25/02/2019	Summit	Saprolite	100	1.613232						
H.2.2.1.11	Hilton	25/02/2019	Summit	Saprolite	110	1.310433						
H.2.2.2.1	Hilton	25/02/2019	Shoulder	Soil	10	0.992163						
H.2.2.2.2	Hilton	25/02/2019	Shoulder	Soil	20	1.195522				94.9	3.2	1.9
H.2.2.2.3	Hilton	25/02/2019	Shoulder	Soil	30	1.34402						
H.2.2.2.4	Hilton	25/02/2019	Shoulder	Soil	40	1.407023				99.3	0.4	0.3
H.2.2.2.5	Hilton	25/02/2019	Shoulder	Soil	50	1.414555						
H.2.2.2.6	Hilton	25/02/2019	Shoulder	Soil	60	1.48112						
H.2.2.2.7	Hilton	25/02/2019	Shoulder	Soil	70	1.425852						
H.2.2.2.8	Hilton	25/02/2019	Shoulder	Saprolite	80	1.384936						
H.2.2.2.9	Hilton	25/02/2019	Shoulder	Saprolite	90	1.467379						
H.2.2.3.1	Hilton	25/02/2019	Backslope	Soil	10	0.80458						
H.2.2.3.2	Hilton	25/02/2019	Backslope	Soil	20	1.22229				95.7	2.7	1.6
H.2.2.3.3	Hilton	25/02/2019	Backslope	Soil	30	1.292417						
H.2.2.3.4	Hilton	25/02/2019	Backslope	Soil	40	1.322748				99.8	0.1	0.1
H.2.2.3.5	Hilton	25/02/2019	Backslope	Saprolite	50	1.207634						
H.2.2.3.6	Hilton	25/02/2019	Backslope	Saprolite	60	1.533333						
H.2.2.4.1	Hilton	25/02/2019	Toeslope	Soil	10	1.200712						
H.2.2.4.2	Hilton	25/02/2019	Toeslope	Soil	20	1.287125				99.3	0.4	0.2
H.2.2.4.3	Hilton	25/02/2019	Toeslope	Soil	30	1.487837						
H.2.2.4.4	Hilton	25/02/2019	Toeslope	Soil	40	1.415471						
H.2.2.4.5	Hilton	25/02/2019	Toeslope	Soil	50	1.523766						
H.2.2.4.6	Hilton	25/02/2019	Toeslope	Soil	60	1.541985				99.2	0.5	0.3
H.2.2.4.7	Hilton	25/02/2019	Toeslope	Soil	70	1.358168						
H.2.2.4.8	Hilton	25/02/2019	Toeslope	Soil	80	1.512977				96.9	1.9	1.1
H.2.2.4.9	Hilton	25/02/2019	Toeslope	Soil	90	1.552163						
H.2.2.4.10	Hilton	25/02/2019	Toeslope	Saprolite	100	1.478982						
H.2.2.4.11	Hilton	25/02/2019	Toeslope	Saprolite	110	1.611807						
H.2.2.4.12	Hilton	25/02/2019	Toeslope	Saprolite	120	1.592061						
H2.1.1.1	Hilton	25/02/2019	Summit	Soil	10	1.097506	1.38231	4.62	51			
H2.1.1.3	Hilton	25/02/2019	Summit	Soil	30	1.565191	0.11875	1.17	18			
H2.1.1.5	Hilton	25/02/2019	Summit	Soil	50	1.681018	0.06898	0.46	8			
H2.1.1.7	Hilton	25/02/2019	Summit	Soil	70	1.511756	0.08159	0.40	6			
H2.1.1.9	Hilton	25/02/2019	Summit	Soil	90	1.639084	0.33396	0.79	13			
H2.1.1.11	Hilton	25/02/2019	Summit	Saprolite	110	1.310433	0.06105	0.31	4			
H2.1.1.13	Hilton	25/02/2019	Summit	Saprolite	130	1.310433	0.05346	0.29	4			
H2.1.2.1	Hilton	25/02/2019	Shoulder	Soil	10	0.992163	0.51861	2.85	28			
H2.1.2.3	Hilton	25/02/2019	Shoulder	Soil	30	1.34402	0.12262	1.03	14			
H2.1.2.5	Hilton	25/02/2019	Shoulder	Soil	50	1.414555	0.05494	0.34	5			
H2.1.2.7	Hilton	25/02/2019	Shoulder	Soil	70	1.425852	0.0326	0.30	4			
H2.1.2.9	Hilton	25/02/2019	Shoulder	Saprolite	90	1.467379	0.13003	0.49	7			
H2.1.3.1	Hilton	25/02/2019	Backslope	Soil	10	0.80458	0.43457	2.42	19			
H2.1.3.3	Hilton	25/02/2019	Backslope	Soil	30	1.292417	0.15562	1.25	16			
H2.1.4.1	Hilton	25/02/2019	Toeslope	Soil	10	1.200712	0.22742	2.08	25			
H2.1.4.2	Hilton	25/02/2019	Toeslope	Soil	20	1.287125	0.21767	2.06	27			
H2.1.4.3	Hilton	25/02/2019	Toeslope	Soil	30	1.487837	0.2884	1.67	25			
H2.1.4.4	Hilton	25/02/2019	Toeslope	Soil	40	1.415471	0.25025	1.31	18			
H2.1.4.5	Hilton	25/02/2019	Toeslope	Soil	50	1.523766	0.18915	1.03	16			
H2.1.4.6	Hilton	25/02/2019	Toeslope	Soil	60	1.541985	0.20741	0.99	15			
H2.1.4.7	Hilton	25/02/2019	Toeslope	Soil	70	1.358168	0.15212	0.86	12			
H2.1.4.8	Hilton	25/02/2019	Toeslope	Soil	80	1.512977	0.23712	0.81	12			
H2.1.4.9	Hilton	25/02/2019	Toeslope	Soil	90	1.552163	0.11865	0.63	10			
H2.1.4.10	Hilton	25/02/2019	Toeslope	Saprolite	100	1.478982	0.28615	0.75	11			
H2.1.4.11	Hilton	25/02/2019	Toeslope	Saprolite	110	1.611807	0.32431	0.84	14			
H2.1.4.12	Hilton	25/02/2019	Toeslope	Saprolite	120	1.592061	0.44032	0.85	14			
H2.1.4.13	Hilton	25/02/2019	Toeslope	Saprolite	130	1.592061	0.26275	0.60	10			
W2.2.1.1	Woburn	01/04/2019	Summit	Soil	10	1.417405						
W2.2.1.2	Woburn	01/04/2019	Summit	Soil	20	1.244275						
W2.2.1.3	Woburn	01/04/2019	Summit	Soil	30	1.584835						
W2.2.1.4	Woburn	01/04/2019	Summit	Soil	40	1.569364						
W2.2.1.5	Woburn	01/04/2019	Summit	Soil	50	1.482646						
W2.2.1.6	Woburn	01/04/2019	Summit	Soil	60	1.566005						
W2.2.1.7	Woburn	01/04/2019	Summit	Soil	70	1.452723						
W2.2.1.8	Woburn	01/04/2019	Summit	Soil	80	1.334656						
W2.2.1.9	Woburn	01/04/2019	Summit	Soil	90	1.519186						
W2.2.1.10	Woburn	01/04/2019	Summit	Saprolite	100	1.501883						
W2.2.1.11	Woburn	01/04/2019	Summit	Saprolite	110	1.52285						
W2.2.1.12	Woburn	01/04/2019	Summit	Saprolite	120	1.445191						
W2.2.1.13	Woburn	01/04/2019	Summit	Saprolite	130	1.518575						
W2.2.1.14	Woburn	01/04/2019	Summit	Saprolite	140	1.513588						
W2.2.1.15	Woburn	01/04/2019	Summit	Saprolite	150	1.579644						
W2.2.2.1	Woburn	01/04/2019	Shoulder	Soil	10	1.266768						
W2.2.2.2	Woburn	01/04/2019	Shoulder	Soil	20	1.524885						
W2.2.2.3	Woburn	01/04/2019	Shoulder	Soil	30	1.578015						
W2.2.2.4	Woburn	01/04/2019	Shoulder	Saprolite	40	1.505852						
W2.2.2.5	Woburn	01/04/2019	Shoulder	Saprolite	50	1.462494						
W2.2.2.6	Woburn	01/04/2019	Shoulder	Saprolite	60	1.551858						
W2.2.2.7	Woburn	01/04/2019	Shoulder	Saprolite	70	1.496183						
W2.2.2.8	Woburn	01/04/2019	Shoulder	Saprolite	80	1.452112						

W2.2.2.9	Woburn	01/04/2019	Shoulder	Saprolite	90	1.545852						
W2.2.3.1	Woburn	01/04/2019	Backslope	Soil	10	1.595827						
W2.2.3.2	Woburn	01/04/2019	Backslope	Soil	20	1.394198						
W2.2.3.3	Woburn	01/04/2019	Backslope	Soil	30	1.630636						
W2.2.3.4	Woburn	01/04/2019	Backslope	Soil	40	1.489364						
W2.2.3.5	Woburn	01/04/2019	Backslope	Soil	50	1.515929						
W2.2.3.6	Woburn	01/04/2019	Backslope	Soil	60	1.539847						
W2.2.3.7	Woburn	01/04/2019	Backslope	Saprolite	70	1.57374						
W2.2.3.8	Woburn	01/04/2019	Backslope	Saprolite	80	1.487837						
W2.2.3.9	Woburn	01/04/2019	Backslope	Saprolite	90	1.493944						
W2.2.3.10	Woburn	01/04/2019	Backslope	Saprolite	100	1.483257						
W2.2.4.1	Woburn	01/04/2019	Toeslope	Soil	10	1.258524						
W2.2.4.2	Woburn	01/04/2019	Toeslope	Soil	20	1.309008						
W2.2.4.3	Woburn	01/04/2019	Toeslope	Soil	30	1.488855						
W2.2.4.4	Woburn	01/04/2019	Toeslope	Soil	40	1.582188						
W2.2.4.5	Woburn	01/04/2019	Toeslope	Soil	50	1.630636						
W2.2.4.6	Woburn	01/04/2019	Toeslope	Soil	60	1.523053						
W2.2.4.7	Woburn	01/04/2019	Toeslope	Soil	70	1.398982						
W2.2.4.8	Woburn	01/04/2019	Toeslope	Soil	80	1.407634						
W2.2.4.9	Woburn	01/04/2019	Toeslope	Soil	90	1.385445						
W2.2.4.10	Woburn	01/04/2019	Toeslope	Soil	100	1.428092						
W2.2.4.11	Woburn	01/04/2019	Toeslope	Soil	110	1.425445						
W2.2.4.12	Woburn	01/04/2019	Toeslope	Soil	120	1.501374						
W2.2.4.13	Woburn	01/04/2019	Toeslope	Soil	130	1.433079						
W2.2.4.14	Woburn	01/04/2019	Toeslope	Soil	140	1.422697						
W2.2.4.15	Woburn	01/04/2019	Toeslope	Soil	150	1.484377						
W2.2.4.16	Woburn	01/04/2019	Toeslope	Soil	160	1.614758						
W2.2.4.17	Woburn	01/04/2019	Toeslope	Saprolite	170	1.670025						
W2.2.4.18	Woburn	01/04/2019	Toeslope	Saprolite	180	1.526514						
W2.2.4.19	Woburn	01/04/2019	Toeslope	Saprolite	190	1.630738						
W2.2.4.20	Woburn	01/04/2019	Toeslope	Saprolite	200	1.510331						
W2.2.4.21	Woburn	01/04/2019	Toeslope	Saprolite	210	1.581883						
W2.1.1.1	Woburn	01/04/2019	Summit	Soil	10		0.22527	1.57	22			
W2.1.1.2	Woburn	01/04/2019	Summit	Soil	20		0.26011	1.50	19	97.5	1.6	0.9
W2.1.1.3	Woburn	01/04/2019	Summit	Soil	30		0.15742	1.26	20			
W2.1.1.4	Woburn	01/04/2019	Summit	Soil	40		0.1824	0.89	14	98.4	1.0	0.6
W2.1.1.5	Woburn	01/04/2019	Summit	Soil	50		0.23308	1.03	15			
W2.1.1.6	Woburn	01/04/2019	Summit	Soil	60		0.28897	1.16	18			
W2.1.1.7	Woburn	01/04/2019	Summit	Soil	70		0.15653	1.10	16			
W2.1.1.8	Woburn	01/04/2019	Summit	Soil	80		0.24939	0.65	9			
W2.1.1.9	Woburn	01/04/2019	Summit	Soil	90		0.15587	0.72	11			
W2.1.1.10	Woburn	01/04/2019	Summit	Saprolite	100		0.14771	0.68	10			
W2.1.1.11	Woburn	01/04/2019	Summit	Saprolite	110		0.12633	0.53	8			
W2.1.1.12	Woburn	01/04/2019	Summit	Saprolite	120		0.13462	0.50	7			
W2.1.1.13	Woburn	01/04/2019	Summit	Saprolite	130		0.11769	0.41	6			
W2.1.1.14	Woburn	01/04/2019	Summit	Saprolite	140		0.0646	0.43	7			
W2.1.1.15	Woburn	01/04/2019	Summit	Saprolite	150		0.16246	0.51	8			
W2.1.2.1	Woburn	01/04/2019	Shoulder	Soil	10		0.16081	1.52	19			
W2.1.2.2	Woburn	01/04/2019	Shoulder	Soil	20		0.0299	1.55	24	99.7	0.2	0.1
W2.1.2.3	Woburn	01/04/2019	Shoulder	Soil	30		0.15821	0.79	12	99.7	0.2	0.1
W2.1.2.4	Woburn	01/04/2019	Shoulder	Saprolite	40		0.09444	0.49	7			
W2.1.2.5	Woburn	01/04/2019	Shoulder	Saprolite	50		0.14397	0.62	9			
W2.1.2.6	Woburn	01/04/2019	Shoulder	Saprolite	60		0.15566	0.68	10			
W2.1.2.7	Woburn	01/04/2019	Shoulder	Saprolite	70		0.10605	0.43	6			
W2.1.2.8	Woburn	01/04/2019	Shoulder	Saprolite	80		0.16819	0.58	8			
W2.1.2.9	Woburn	01/04/2019	Shoulder	Saprolite	90		0.1182	0.48	7			
W2.1.3.1	Woburn	01/04/2019	Backslope	Soil	10		0.06818	1.49	24			
W2.1.3.2	Woburn	01/04/2019	Backslope	Soil	20		0.05803	1.38	19	97.1	1.8	1.1
W2.1.3.3	Woburn	01/04/2019	Backslope	Soil	30		0.02537	0.71	12			
W2.1.3.4	Woburn	01/04/2019	Backslope	Soil	40		0.01655	0.67	10			
W2.1.3.5	Woburn	01/04/2019	Backslope	Soil	50		0.02066	0.55	8	98.3	1.0	0.6
W2.1.3.6	Woburn	01/04/2019	Backslope	Soil	60		0.03144	0.56	9			
W2.1.3.7	Woburn	01/04/2019	Backslope	Saprolite	70		0.05193	0.63	10			
W2.1.3.8	Woburn	01/04/2019	Backslope	Saprolite	80		0.01378	0.55	8			
W2.1.3.9	Woburn	01/04/2019	Backslope	Saprolite	90		0.02053	0.53	8			
W2.1.3.10	Woburn	01/04/2019	Backslope	Saprolite	100		0.01427	0.53	8			
W2.1.4.1	Woburn	01/04/2019	Toeslope	Soil	10		0.05542	1.82	23			
W2.1.4.2	Woburn	01/04/2019	Toeslope	Soil	20		0.01687	1.63	21	96.5	2.2	1.3
W2.1.4.3	Woburn	01/04/2019	Toeslope	Soil	30		0.04851	1.53	23			
W2.1.4.4	Woburn	01/04/2019	Toeslope	Soil	40		0.10788	1.37	22	95.3	2.9	1.7
W2.1.4.5	Woburn	01/04/2019	Toeslope	Soil	50		0.05307	1.01	16			
W2.1.4.6	Woburn	01/04/2019	Toeslope	Soil	60		0.06673	0.77	12			
W2.1.4.7	Woburn	01/04/2019	Toeslope	Soil	70		0.00938	0.72	10			
W2.1.4.8	Woburn	01/04/2019	Toeslope	Soil	80		0.0445	0.59	8			
W2.1.4.9	Woburn	01/04/2019	Toeslope	Soil	90		0.03256	0.72	10			
W2.1.4.10	Woburn	01/04/2019	Toeslope	Soil	100		0.0467	0.65	9	96.2	2.4	1.4
W2.1.4.11	Woburn	01/04/2019	Toeslope	Soil	110		0.03675	0.73	10			
W2.1.4.12	Woburn	01/04/2019	Toeslope	Soil	120		0.02201	0.67	10			
W2.1.4.13	Woburn	01/04/2019	Toeslope	Soil	130		0.06857	0.73	11			
W2.1.4.14	Woburn	01/04/2019	Toeslope	Soil	140		0.03619	0.64	9			
W2.1.4.15	Woburn	01/04/2019	Toeslope	Soil	150		0.03986	0.64	10			
W2.1.4.16	Woburn	01/04/2019	Toeslope	Soil	160		0.02058	0.60	10			
W2.1.4.17	Woburn	01/04/2019	Toeslope	Saprolite	170		0.04364	0.62	10			
W2.1.4.18	Woburn	01/04/2019	Toeslope	Saprolite	180		0.03617	0.71	11			
W2.1.4.19	Woburn	01/04/2019	Toeslope	Saprolite	190		0.05914	0.77	13	88.1	7.4	4.5
W2.1.4.20	Woburn	01/04/2019	Toeslope	Saprolite	200		0.65181	0.94	14			
W2.1.4.21	Woburn	01/04/2019	Toeslope	Saprolite	210		0.04446	0.93	15			

Appendix 6.3: Soil Production Function analysis

Site / Paper	Mean Soil Formation Rate (mm/y)	Mean Depth (m)	Formation Rate at Zero Soil Thickness (mm/y)	Gamma
Hilton	0.128430138	0.89125	0.164	3.00142
Woburn	0.099671671	1.031429	0.229	1.14674
Comer	0.045917153	1	0.076	1.86897
Rufford	0.037194872	1.175	0.058	2.5039
Heimsath et al. 1997	0.034777778	0.393333	0.068	0.53654
Heimsath et al. 1999	0.117050667	0.565167	0.2	0.95969
Wilkinson et al. 2005	0.012233333	0.452222	0.02	1.53374

Appendix 6.4: Particle Size Analysis for Saprolite at Hilton and Woburn

Site	Catena Position	Sampling Position	Particle Bin Size (µm)	Run 1 (%)	Run 2 (%)	Run 3 (%)	Mean (%)	Std Dev (%)
Woburn	Summit	Soil-Sap Interface	0.375124	0.009521	0.00882	0.01009	0.00948	0.00063
Woburn	Summit	Soil-Sap Interface	0.411798	0.018164	0.01683	0.01926	0.01809	0.00121
Woburn	Summit	Soil-Sap Interface	0.452057	0.030576	0.02833	0.03243	0.03044	0.00205
Woburn	Summit	Soil-Sap Interface	0.496252	0.042254	0.03913	0.04483	0.04207	0.00285
Woburn	Summit	Soil-Sap Interface	0.544768	0.053286	0.04932	0.05657	0.05306	0.00363
Woburn	Summit	Soil-Sap Interface	0.598027	0.063501	0.05872	0.06746	0.06323	0.00437
Woburn	Summit	Soil-Sap Interface	0.656493	0.072715	0.06718	0.07731	0.0724	0.00507
Woburn	Summit	Soil-Sap Interface	0.720675	0.080703	0.07448	0.08589	0.08036	0.00571
Woburn	Summit	Soil-Sap Interface	0.791132	0.087238	0.08041	0.09295	0.08687	0.00628
Woburn	Summit	Soil-Sap Interface	0.868477	0.092084	0.08476	0.09823	0.09169	0.00675
Woburn	Summit	Soil-Sap Interface	0.953383	0.095014	0.08732	0.10149	0.09461	0.0071
Woburn	Summit	Soil-Sap Interface	1.04659	0.095833	0.08792	0.1025	0.09542	0.0073
Woburn	Summit	Soil-Sap Interface	1.14891	0.094576	0.08662	0.10129	0.09416	0.00734
Woburn	Summit	Soil-Sap Interface	1.26123	0.091379	0.08355	0.09799	0.09097	0.00723
Woburn	Summit	Soil-Sap Interface	1.38454	0.086486	0.07895	0.09284	0.08609	0.00695
Woburn	Summit	Soil-Sap Interface	1.5199	0.080271	0.07316	0.08622	0.07989	0.00654
Woburn	Summit	Soil-Sap Interface	1.66849	0.073236	0.06666	0.07869	0.07286	0.00602
Woburn	Summit	Soil-Sap Interface	1.83161	0.066005	0.06001	0.0709	0.06564	0.00546
Woburn	Summit	Soil-Sap Interface	2.01068	0.059279	0.05383	0.06363	0.05891	0.00491
Woburn	Summit	Soil-Sap Interface	2.20725	0.053776	0.04877	0.05767	0.0534	0.00446
Woburn	Summit	Soil-Sap Interface	2.42304	0.050137	0.04538	0.05373	0.04975	0.00419
Woburn	Summit	Soil-Sap Interface	2.65993	0.048826	0.04408	0.05235	0.04842	0.00415
Woburn	Summit	Soil-Sap Interface	2.91998	0.050058	0.04505	0.05376	0.04962	0.00437
Woburn	Summit	Soil-Sap Interface	3.20545	0.053746	0.0482	0.05786	0.05327	0.00485
Woburn	Summit	Soil-Sap Interface	3.51883	0.059492	0.0532	0.06423	0.05897	0.00553
Woburn	Summit	Soil-Sap Interface	3.86284	0.066625	0.05946	0.07209	0.06606	0.00633
Woburn	Summit	Soil-Sap Interface	4.24049	0.074321	0.06627	0.08052	0.0737	0.00714
Woburn	Summit	Soil-Sap Interface	4.65506	0.081757	0.07292	0.08859	0.08109	0.00786
Woburn	Summit	Soil-Sap Interface	5.11017	0.088274	0.07885	0.09558	0.08757	0.00838
Woburn	Summit	Soil-Sap Interface	5.60976	0.093492	0.08373	0.10104	0.09275	0.00868
Woburn	Summit	Soil-Sap Interface	6.1582	0.097354	0.08748	0.10494	0.09659	0.00876
Woburn	Summit	Soil-Sap Interface	6.76025	0.100114	0.09033	0.10757	0.09934	0.00864
Woburn	Summit	Soil-Sap Interface	7.42117	0.102227	0.09267	0.10943	0.10144	0.00841
Woburn	Summit	Soil-Sap Interface	8.14669	0.104378	0.09509	0.11128	0.10358	0.00813
Woburn	Summit	Soil-Sap Interface	8.94315	0.107474	0.09838	0.11413	0.10666	0.00791
Woburn	Summit	Soil-Sap Interface	9.81748	0.112562	0.10347	0.11912	0.11172	0.00786
Woburn	Summit	Soil-Sap Interface	10.7773	0.120724	0.11136	0.12743	0.11984	0.00807
Woburn	Summit	Soil-Sap Interface	11.8309	0.132782	0.12282	0.13994	0.13185	0.0086
Woburn	Summit	Soil-Sap Interface	12.9876	0.148993	0.13817	0.15691	0.14802	0.00941
Woburn	Summit	Soil-Sap Interface	14.2573	0.168709	0.15694	0.17759	0.16774	0.01036
Woburn	Summit	Soil-Sap Interface	15.6512	0.190306	0.17778	0.20013	0.18941	0.01121
Woburn	Summit	Soil-Sap Interface	17.1813	0.211326	0.19858	0.22176	0.21056	0.01161
Woburn	Summit	Soil-Sap Interface	18.861	0.229025	0.21688	0.23935	0.22842	0.01125
Woburn	Summit	Soil-Sap Interface	20.705	0.24149	0.23086	0.25073	0.24103	0.00994
Woburn	Summit	Soil-Sap Interface	22.7292	0.248409	0.24001	0.25557	0.248	0.00779
Woburn	Summit	Soil-Sap Interface	24.9513	0.251515	0.24565	0.25597	0.25104	0.00518
Woburn	Summit	Soil-Sap Interface	27.3906	0.254051	0.25061	0.25585	0.2535	0.00267
Woburn	Summit	Soil-Sap Interface	30.0685	0.2592	0.25783	0.25913	0.25872	0.00077
Woburn	Summit	Soil-Sap Interface	33.0081	0.267997	0.26845	0.26727	0.2679	0.0006
Woburn	Summit	Soil-Sap Interface	36.2352	0.27715	0.27961	0.27661	0.27779	0.0016
Woburn	Summit	Soil-Sap Interface	39.7777	0.280291	0.28532	0.27971	0.28177	0.00309
Woburn	Summit	Soil-Sap Interface	43.6665	0.273773	0.28159	0.27198	0.27578	0.00511
Woburn	Summit	Soil-Sap Interface	47.9356	0.260992	0.2707	0.25695	0.26288	0.00707
Woburn	Summit	Soil-Sap Interface	52.622	0.250922	0.26065	0.24472	0.2521	0.00803
Woburn	Summit	Soil-Sap Interface	57.7666	0.252911	0.2611	0.24565	0.25322	0.00773
Woburn	Summit	Soil-Sap Interface	63.4141	0.27004	0.27694	0.26248	0.26982	0.00723
Woburn	Summit	Soil-Sap Interface	69.6138	0.29736	0.30515	0.28875	0.29709	0.0082
Woburn	Summit	Soil-Sap Interface	76.4196	0.331351	0.34141	0.32065	0.33114	0.01038
Woburn	Summit	Soil-Sap Interface	83.8907	0.375704	0.38529	0.36422	0.37507	0.01055
Woburn	Summit	Soil-Sap Interface	92.0923	0.429863	0.43321	0.42122	0.4281	0.00619
Woburn	Summit	Soil-Sap Interface	101.096	0.487288	0.48141	0.48411	0.48427	0.00294
Woburn	Summit	Soil-Sap Interface	110.979	0.569273	0.5581	0.57015	0.56584	0.00672
Woburn	Summit	Soil-Sap Interface	121.829	0.763589	0.75495	0.7639	0.76081	0.00508
Woburn	Summit	Soil-Sap Interface	133.74	1.22707	1.22665	1.22219	1.2253	0.0027
Woburn	Summit	Soil-Sap Interface	146.815	2.13478	2.14099	2.12384	2.1332	0.00868
Woburn	Summit	Soil-Sap Interface	161.168	3.56234	3.56476	3.55028	3.55913	0.00776

Woburn	Summit	Soil-Sap Interface	176.925	5.38962	5.37568	5.3849	5.3834	0.00709
Woburn	Summit	Soil-Sap Interface	194.222	7.29704	7.26204	7.30576	7.28828	0.02314
Woburn	Summit	Soil-Sap Interface	213.21	8.84454	8.79711	8.86165	8.83443	0.03344
Woburn	Summit	Soil-Sap Interface	234.054	9.63717	9.59446	9.64461	9.62541	0.02706
Woburn	Summit	Soil-Sap Interface	256.936	9.5006	9.47777	9.47987	9.48608	0.01262
Woburn	Summit	Soil-Sap Interface	282.056	8.54624	8.54886	8.49581	8.5303	0.0299
Woburn	Summit	Soil-Sap Interface	309.631	7.10468	7.12826	7.04867	7.09387	0.04088
Woburn	Summit	Soil-Sap Interface	339.902	5.57852	5.61459	5.55877	5.58396	0.0283
Woburn	Summit	Soil-Sap Interface	373.132	4.28348	4.32765	4.33684	4.31599	0.02853
Woburn	Summit	Soil-Sap Interface	409.611	3.35367	3.40818	3.49042	3.41742	0.06884
Woburn	Summit	Soil-Sap Interface	449.657	2.75017	2.81742	2.94359	2.83706	0.09819
Woburn	Summit	Soil-Sap Interface	493.617	2.3392	2.41182	2.52756	2.42619	0.095
Woburn	Summit	Soil-Sap Interface	541.876	1.98502	2.04093	2.09173	2.03923	0.05338
Woburn	Summit	Soil-Sap Interface	594.852	1.61797	1.62843	1.59101	1.61247	0.01931
Woburn	Summit	Soil-Sap Interface	653.008	1.241	1.19103	1.09045	1.17416	0.07668
Woburn	Summit	Soil-Sap Interface	716.849	0.890234	0.79638	0.68904	0.79189	0.10067
Woburn	Summit	Soil-Sap Interface	786.932	0.606324	0.50795	0.44746	0.52058	0.08018
Woburn	Summit	Soil-Sap Interface	863.866	0.406798	0.33772	0.34938	0.36463	0.03698
Woburn	Summit	Soil-Sap Interface	948.322	0.264545	0.24649	0.30918	0.27341	0.03227
Woburn	Summit	Soil-Sap Interface	1041.03	0.157714	0.19281	0.25627	0.20226	0.04995
Woburn	Summit	Soil-Sap Interface	1142.81	0.107549	0.1758	0.20468	0.16268	0.04988
Woburn	Summit	Soil-Sap Interface	1254.54	0.108028	0.19486	0.15867	0.15385	0.04362
Woburn	Summit	Soil-Sap Interface	1377.19	0.119846	0.20906	0.09722	0.14204	0.05913
Woburn	Summit	Soil-Sap Interface	1511.83	0.141808	0.22015	0.04388	0.13528	0.08832
Woburn	Summit	Soil-Sap Interface	1659.63	0.166669	0.21285	0.01221	0.13058	0.10508
Woburn	Summit	Soil-Sap Interface	1821.88	0.155586	0.15865	0.00089	0.10504	0.09021
Woburn	Summit	~30 cm below interface	0.375124	0.022967	0.02893	0.03175	0.02788	0.00449
Woburn	Summit	~30 cm below interface	0.411798	0.043865	0.05532	0.06076	0.05332	0.00863
Woburn	Summit	~30 cm below interface	0.452057	0.074012	0.09365	0.10297	0.09021	0.01478
Woburn	Summit	~30 cm below interface	0.496252	0.102646	0.1305	0.14374	0.12563	0.02098
Woburn	Summit	~30 cm below interface	0.544768	0.130067	0.16641	0.18371	0.16006	0.02738
Woburn	Summit	~30 cm below interface	0.598027	0.155948	0.2011	0.2226	0.19321	0.03402
Woburn	Summit	~30 cm below interface	0.656493	0.179917	0.23418	0.26004	0.22471	0.04089
Woburn	Summit	~30 cm below interface	0.720675	0.20147	0.26505	0.29537	0.25396	0.04792
Woburn	Summit	~30 cm below interface	0.791132	0.22007	0.293	0.32777	0.28028	0.05497
Woburn	Summit	~30 cm below interface	0.868477	0.235098	0.31709	0.35616	0.30278	0.06179
Woburn	Summit	~30 cm below interface	0.953383	0.245905	0.33622	0.37921	0.32044	0.06804
Woburn	Summit	~30 cm below interface	1.04659	0.25184	0.34915	0.39533	0.33211	0.07325
Woburn	Summit	~30 cm below interface	1.14891	0.252722	0.35509	0.40348	0.33709	0.07697
Woburn	Summit	~30 cm below interface	1.26123	0.248601	0.35353	0.40283	0.33499	0.07877
Woburn	Summit	~30 cm below interface	1.38454	0.239778	0.3443	0.393	0.32569	0.07829
Woburn	Summit	~30 cm below interface	1.5199	0.226937	0.32786	0.37434	0.30971	0.07536
Woburn	Summit	~30 cm below interface	1.66849	0.211159	0.30542	0.34815	0.28824	0.07009
Woburn	Summit	~30 cm below interface	1.83161	0.193988	0.27916	0.31697	0.26337	0.06299
Woburn	Summit	~30 cm below interface	2.01068	0.177339	0.25217	0.28454	0.23802	0.05498
Woburn	Summit	~30 cm below interface	2.20725	0.163368	0.22832	0.25559	0.21576	0.04737
Woburn	Summit	~30 cm below interface	2.42304	0.154168	0.21164	0.23519	0.20033	0.04168
Woburn	Summit	~30 cm below interface	2.65993	0.151421	0.20566	0.22775	0.19495	0.03928
Woburn	Summit	~30 cm below interface	2.91998	0.15606	0.21259	0.23602	0.20156	0.04111
Woburn	Summit	~30 cm below interface	3.20545	0.167968	0.23258	0.26015	0.22023	0.04732
Woburn	Summit	~30 cm below interface	3.51883	0.185916	0.26349	0.29729	0.2489	0.0571
Woburn	Summit	~30 cm below interface	3.86284	0.207656	0.30085	0.34165	0.28338	0.06868
Woburn	Summit	~30 cm below interface	4.24049	0.230402	0.33896	0.38588	0.31841	0.07975
Woburn	Summit	~30 cm below interface	4.65506	0.251513	0.37235	0.42315	0.349	0.08817
Woburn	Summit	~30 cm below interface	5.11017	0.269118	0.39738	0.44922	0.3719	0.09271
Woburn	Summit	~30 cm below interface	5.60976	0.282642	0.41326	0.46372	0.38654	0.09345
Woburn	Summit	~30 cm below interface	6.1582	0.292764	0.42206	0.47	0.39494	0.09168
Woburn	Summit	~30 cm below interface	6.76025	0.301326	0.42798	0.47403	0.40111	0.08943
Woburn	Summit	~30 cm below interface	7.42117	0.310726	0.43596	0.48227	0.40965	0.08874
Woburn	Summit	~30 cm below interface	8.14669	0.324012	0.45123	0.50082	0.42535	0.0912
Woburn	Summit	~30 cm below interface	8.94315	0.344467	0.47827	0.53369	0.45214	0.09728
Woburn	Summit	~30 cm below interface	9.81748	0.375339	0.52059	0.58271	0.49288	0.10643
Woburn	Summit	~30 cm below interface	10.7773	0.419648	0.58068	0.64815	0.54949	0.1174
Woburn	Summit	~30 cm below interface	11.8309	0.478575	0.65847	0.72783	0.62163	0.12865
Woburn	Summit	~30 cm below interface	12.9876	0.55138	0.75176	0.81935	0.7075	0.13936
Woburn	Summit	~30 cm below interface	14.2573	0.635037	0.8566	0.92117	0.80427	0.15007
Woburn	Summit	~30 cm below interface	15.6512	0.725859	0.97019	1.03545	0.9105	0.1632
Woburn	Summit	~30 cm below interface	17.1813	0.819397	1.08776	1.16016	1.02244	0.17953
Woburn	Summit	~30 cm below interface	18.861	0.91061	1.20051	1.28274	1.13129	0.19548
Woburn	Summit	~30 cm below interface	20.705	0.997526	1.30188	1.38828	1.22923	0.20526

Woburn	Summit	~30 cm below interface	22.7292	1.08022	1.39008	1.46793	1.31274	0.2051
Woburn	Summit	~30 cm below interface	24.9513	1.16452	1.4759	1.53622	1.39221	0.19948
Woburn	Summit	~30 cm below interface	27.3906	1.26206	1.57657	1.61996	1.4862	0.19532
Woburn	Summit	~30 cm below interface	30.0685	1.38371	1.71081	1.74375	1.61276	0.19904
Woburn	Summit	~30 cm below interface	33.0081	1.53055	1.88697	1.91634	1.77795	0.21476
Woburn	Summit	~30 cm below interface	36.2352	1.67717	2.05188	2.07218	1.93374	0.22243
Woburn	Summit	~30 cm below interface	39.7777	1.78473	2.12406	2.11534	2.00804	0.19344
Woburn	Summit	~30 cm below interface	43.6665	1.83942	2.09889	2.04714	1.99515	0.13733
Woburn	Summit	~30 cm below interface	47.9356	1.85473	2.03446	1.94056	1.94325	0.0899
Woburn	Summit	~30 cm below interface	52.622	1.85684	1.98897	1.86452	1.90344	0.07417
Woburn	Summit	~30 cm below interface	57.7666	1.87462	1.9997	1.86502	1.91311	0.07514
Woburn	Summit	~30 cm below interface	63.4141	1.89993	2.03439	1.89299	1.94244	0.07971
Woburn	Summit	~30 cm below interface	69.6138	1.89668	1.9781	1.78707	1.88728	0.09586
Woburn	Summit	~30 cm below interface	76.4196	1.88983	1.86192	1.59891	1.78355	0.16051
Woburn	Summit	~30 cm below interface	83.8907	1.94768	1.92519	1.65337	1.84208	0.16381
Woburn	Summit	~30 cm below interface	92.0923	2.01325	2.14898	1.97637	2.0462	0.0909
Woburn	Summit	~30 cm below interface	101.096	1.86862	2.08713	2.06627	2.00734	0.12059
Woburn	Summit	~30 cm below interface	110.979	1.39988	1.74129	1.72696	1.62271	0.19311
Woburn	Summit	~30 cm below interface	121.829	1.17467	1.95571	1.72689	1.61909	0.40152
Woburn	Summit	~30 cm below interface	133.74	2.23612	3.94548	3.44245	3.20802	0.87846
Woburn	Summit	~30 cm below interface	146.815	5.71874	9.01639	8.70317	7.81277	1.82023
Woburn	Summit	~30 cm below interface	161.168	11.1653	14.6436	14.9137	13.5742	2.09054
Woburn	Summit	~30 cm below interface	176.925	15.8169	13.1944	13.3834	14.1316	1.4626
Woburn	Summit	~30 cm below interface	194.222	14.4317	4.77136	4.7182	7.97375	5.59281
Woburn	Summit	~30 cm below interface	213.21	5.66392	0.34866	0.33629	2.11629	3.07234
Woburn	Summit	~30 cm below interface	234.054	0.447004	0	0	0.149	0.25808
Woburn	Summit	~30 cm below interface	256.936	0	0	0	0	0
Woburn	Summit	~30 cm below interface	282.056	0	0	0	0	0
Woburn	Summit	~30 cm below interface	309.631	0	0	0	0	0
Woburn	Summit	~30 cm below interface	339.902	0	0	0	0	0
Woburn	Summit	~30 cm below interface	373.132	0	0	0	0	0
Woburn	Summit	~30 cm below interface	409.611	0	0	0	0	0
Woburn	Summit	~30 cm below interface	449.657	0	0	0	0	0
Woburn	Summit	~30 cm below interface	493.617	0	0	0	0	0
Woburn	Summit	~30 cm below interface	541.876	0	0	0	0	0
Woburn	Summit	~30 cm below interface	594.852	0	0	0	0	0
Woburn	Summit	~30 cm below interface	653.008	0	0	0	0	0
Woburn	Summit	~30 cm below interface	716.849	0	0	0	0	0
Woburn	Summit	~30 cm below interface	786.932	0	0	0	0	0
Woburn	Summit	~30 cm below interface	863.866	0	0	0	0	0
Woburn	Summit	~30 cm below interface	948.322	0	0	0	0	0
Woburn	Summit	~30 cm below interface	1041.03	0	0	0	0	0
Woburn	Summit	~30 cm below interface	1142.81	0	0	0	0	0
Woburn	Summit	~30 cm below interface	1254.54	0	0	0	0	0
Woburn	Summit	~30 cm below interface	1377.19	0	0	0	0	0
Woburn	Summit	~30 cm below interface	1511.83	0	0	0	0	0
Woburn	Summit	~30 cm below interface	1659.63	0	0	0	0	0
Woburn	Summit	~30 cm below interface	1821.88	0	0	0	0	0
Woburn	Shoulder	Soil-Sap Interface	0.375124	0.009019	0.00822	0.00894	0.00872	0.00044
Woburn	Shoulder	Soil-Sap Interface	0.411798	0.017217	0.01477	0.01606	0.01602	0.00122
Woburn	Shoulder	Soil-Sap Interface	0.452057	0.029017	0.02205	0.02397	0.02501	0.0036
Woburn	Shoulder	Soil-Sap Interface	0.496252	0.040175	0.03175	0.0345	0.03548	0.0043
Woburn	Shoulder	Soil-Sap Interface	0.544768	0.050793	0.03977	0.04322	0.0446	0.00564
Woburn	Shoulder	Soil-Sap Interface	0.598027	0.060727	0.04727	0.05137	0.05312	0.0069
Woburn	Shoulder	Soil-Sap Interface	0.656493	0.06982	0.05447	0.05918	0.06116	0.00786
Woburn	Shoulder	Soil-Sap Interface	0.720675	0.077869	0.06182	0.06714	0.06894	0.00818
Woburn	Shoulder	Soil-Sap Interface	0.791132	0.084667	0.06791	0.07376	0.07545	0.0085
Woburn	Shoulder	Soil-Sap Interface	0.868477	0.089986	0.07325	0.07954	0.08093	0.00845
Woburn	Shoulder	Soil-Sap Interface	0.953383	0.0936	0.07787	0.08453	0.08533	0.0079
Woburn	Shoulder	Soil-Sap Interface	1.04659	0.0953	0.08192	0.08889	0.0887	0.00669
Woburn	Shoulder	Soil-Sap Interface	1.14891	0.095076	0.08492	0.09213	0.09071	0.00523
Woburn	Shoulder	Soil-Sap Interface	1.26123	0.093013	0.087	0.09438	0.09146	0.00392
Woburn	Shoulder	Soil-Sap Interface	1.38454	0.089298	0.08836	0.09584	0.09116	0.00407
Woburn	Shoulder	Soil-Sap Interface	1.5199	0.08425	0.08916	0.09669	0.09003	0.00627
Woburn	Shoulder	Soil-Sap Interface	1.66849	0.078325	0.0895	0.09708	0.0883	0.00944
Woburn	Shoulder	Soil-Sap Interface	1.83161	0.07212	0.08937	0.09698	0.08616	0.01274
Woburn	Shoulder	Soil-Sap Interface	2.01068	0.06633	0.08899	0.09663	0.08398	0.01576
Woburn	Shoulder	Soil-Sap Interface	2.20725	0.061698	0.08853	0.09621	0.08215	0.01812
Woburn	Shoulder	Soil-Sap Interface	2.42304	0.058902	0.08831	0.09608	0.0811	0.01961
Woburn	Shoulder	Soil-Sap Interface	2.65993	0.058465	0.08833	0.09624	0.08101	0.01992

Woburn	Shoulder	Soil-Sap Interface	2.91998	0.060639	0.08872	0.09683	0.08206	0.01899
Woburn	Shoulder	Soil-Sap Interface	3.20545	0.065345	0.08959	0.09793	0.08429	0.01693
Woburn	Shoulder	Soil-Sap Interface	3.51883	0.072144	0.09111	0.09976	0.08767	0.01412
Woburn	Shoulder	Soil-Sap Interface	3.86284	0.080282	0.09328	0.10227	0.09194	0.01105
Woburn	Shoulder	Soil-Sap Interface	4.24049	0.088826	0.09611	0.10548	0.09681	0.00835
Woburn	Shoulder	Soil-Sap Interface	4.65506	0.096846	0.09961	0.10938	0.10195	0.00659
Woburn	Shoulder	Soil-Sap Interface	5.11017	0.103615	0.10383	0.114	0.10715	0.00593
Woburn	Shoulder	Soil-Sap Interface	5.60976	0.108741	0.10875	0.11931	0.11227	0.0061
Woburn	Shoulder	Soil-Sap Interface	6.1582	0.112231	0.11444	0.12539	0.11735	0.00705
Woburn	Shoulder	Soil-Sap Interface	6.76025	0.114463	0.12092	0.13227	0.12255	0.00901
Woburn	Shoulder	Soil-Sap Interface	7.42117	0.11607	0.12832	0.14005	0.12815	0.01199
Woburn	Shoulder	Soil-Sap Interface	8.14669	0.117971	0.13682	0.1489	0.13456	0.01559
Woburn	Shoulder	Soil-Sap Interface	8.94315	0.121364	0.14673	0.15917	0.14242	0.01927
Woburn	Shoulder	Soil-Sap Interface	9.81748	0.127635	0.15839	0.17122	0.15241	0.0224
Woburn	Shoulder	Soil-Sap Interface	10.7773	0.138246	0.17219	0.18542	0.16528	0.02433
Woburn	Shoulder	Soil-Sap Interface	11.8309	0.154397	0.18848	0.20216	0.18168	0.0246
Woburn	Shoulder	Soil-Sap Interface	12.9876	0.176645	0.20762	0.22178	0.20201	0.02308
Woburn	Shoulder	Soil-Sap Interface	14.2573	0.204522	0.22992	0.24463	0.22636	0.02029
Woburn	Shoulder	Soil-Sap Interface	15.6512	0.236445	0.25554	0.27086	0.25428	0.01724
Woburn	Shoulder	Soil-Sap Interface	17.1813	0.269953	0.28449	0.30046	0.28497	0.01526
Woburn	Shoulder	Soil-Sap Interface	18.861	0.302477	0.31634	0.3329	0.31724	0.01523
Woburn	Shoulder	Soil-Sap Interface	20.705	0.332717	0.35053	0.3675	0.35025	0.01739
Woburn	Shoulder	Soil-Sap Interface	22.7292	0.361444	0.38637	0.40346	0.38376	0.02113
Woburn	Shoulder	Soil-Sap Interface	24.9513	0.391689	0.42356	0.44039	0.41855	0.02473
Woburn	Shoulder	Soil-Sap Interface	27.3906	0.428	0.46234	0.47835	0.45623	0.02573
Woburn	Shoulder	Soil-Sap Interface	30.0685	0.474421	0.5034	0.51782	0.49855	0.0221
Woburn	Shoulder	Soil-Sap Interface	33.0081	0.531772	0.54758	0.55936	0.54624	0.01384
Woburn	Shoulder	Soil-Sap Interface	36.2352	0.594846	0.59509	0.603	0.59765	0.00464
Woburn	Shoulder	Soil-Sap Interface	39.7777	0.653855	0.64554	0.64841	0.64927	0.00422
Woburn	Shoulder	Soil-Sap Interface	43.6665	0.701969	0.69778	0.69491	0.69822	0.00355
Woburn	Shoulder	Soil-Sap Interface	47.9356	0.740927	0.74946	0.74102	0.7438	0.0049
Woburn	Shoulder	Soil-Sap Interface	52.622	0.779168	0.79555	0.78271	0.78581	0.00862
Woburn	Shoulder	Soil-Sap Interface	57.7666	0.825443	0.82716	0.81183	0.82148	0.0084
Woburn	Shoulder	Soil-Sap Interface	63.4141	0.879361	0.8335	0.81761	0.84349	0.03207
Woburn	Shoulder	Soil-Sap Interface	69.6138	0.929073	0.80748	0.792	0.84285	0.07507
Woburn	Shoulder	Soil-Sap Interface	76.4196	0.968194	0.75474	0.73909	0.82067	0.128
Woburn	Shoulder	Soil-Sap Interface	83.8907	1.00674	0.70012	0.68223	0.79636	0.18241
Woburn	Shoulder	Soil-Sap Interface	92.0923	1.05293	0.6856	0.6627	0.80041	0.21899
Woburn	Shoulder	Soil-Sap Interface	101.096	1.10339	0.76359	0.73278	0.86659	0.20565
Woburn	Shoulder	Soil-Sap Interface	110.979	1.17545	0.99415	0.95302	1.04087	0.11835
Woburn	Shoulder	Soil-Sap Interface	121.829	1.34694	1.44385	1.39215	1.39431	0.04849
Woburn	Shoulder	Soil-Sap Interface	133.74	1.7522	2.1624	2.10414	2.00625	0.22193
Woburn	Shoulder	Soil-Sap Interface	146.815	2.52863	3.15283	3.09645	2.92597	0.34526
Woburn	Shoulder	Soil-Sap Interface	161.168	3.73267	4.34945	4.30512	4.12908	0.34402
Woburn	Shoulder	Soil-Sap Interface	176.925	5.27406	5.62509	5.60071	5.49995	0.19601
Woburn	Shoulder	Soil-Sap Interface	194.222	6.90228	6.81	6.8078	6.84003	0.05392
Woburn	Shoulder	Soil-Sap Interface	213.21	8.24877	7.72985	7.74478	7.9078	0.29538
Woburn	Shoulder	Soil-Sap Interface	234.054	8.9607	8.24417	8.2661	8.49032	0.40751
Woburn	Shoulder	Soil-Sap Interface	256.936	8.86409	8.27694	8.29454	8.47852	0.33403
Woburn	Shoulder	Soil-Sap Interface	282.056	8.02757	7.83295	7.8381	7.89954	0.11091
Woburn	Shoulder	Soil-Sap Interface	309.631	6.70984	6.99141	6.9817	6.89432	0.15984
Woburn	Shoulder	Soil-Sap Interface	339.902	5.25149	5.88784	5.86654	5.66862	0.36141
Woburn	Shoulder	Soil-Sap Interface	373.132	3.95193	4.68042	4.65408	4.42881	0.4132
Woburn	Shoulder	Soil-Sap Interface	409.611	2.9711	3.51553	3.49056	3.32573	0.30737
Woburn	Shoulder	Soil-Sap Interface	449.657	2.30506	2.49398	2.47518	2.42474	0.10407
Woburn	Shoulder	Soil-Sap Interface	493.617	1.83159	1.66392	1.65281	1.71611	0.10017
Woburn	Shoulder	Soil-Sap Interface	541.876	1.40514	1.02848	1.02424	1.15262	0.2187
Woburn	Shoulder	Soil-Sap Interface	594.852	0.961757	0.56232	0.5656	0.69656	0.22967
Woburn	Shoulder	Soil-Sap Interface	653.008	0.527041	0.24495	0.25059	0.34086	0.16126
Woburn	Shoulder	Soil-Sap Interface	716.849	0.159761	0.07329	0.07776	0.1036	0.04869
Woburn	Shoulder	Soil-Sap Interface	786.932	0.01148	0.0114	0.01257	0.01182	0.00065
Woburn	Shoulder	Soil-Sap Interface	863.866	0	0.00065	0.00079	0.00048	0.00042
Woburn	Shoulder	Soil-Sap Interface	948.322	0	0	0	0	0
Woburn	Shoulder	Soil-Sap Interface	1041.03	0	0	0	0	0
Woburn	Shoulder	Soil-Sap Interface	1142.81	0	0	0	0	0
Woburn	Shoulder	Soil-Sap Interface	1254.54	0	0	0	0	0
Woburn	Shoulder	Soil-Sap Interface	1377.19	0	0	0	0	0
Woburn	Shoulder	Soil-Sap Interface	1511.83	0	0	0	0	0
Woburn	Shoulder	Soil-Sap Interface	1659.63	0	0	0	0	0
Woburn	Shoulder	Soil-Sap Interface	1821.88	0	0	0	0	0

Woburn	Shoulder	~30 cm below interface	0.375124	0.00758	0.0069	0.00768	0.00739	0.00042
Woburn	Shoulder	~30 cm below interface	0.411798	0.014474	0.01241	0.0138	0.01356	0.00105
Woburn	Shoulder	~30 cm below interface	0.452057	0.024409	0.01852	0.02059	0.02117	0.00299
Woburn	Shoulder	~30 cm below interface	0.496252	0.033825	0.02668	0.02966	0.03005	0.00359
Woburn	Shoulder	~30 cm below interface	0.544768	0.042817	0.03345	0.03719	0.03782	0.00472
Woburn	Shoulder	~30 cm below interface	0.598027	0.051269	0.0398	0.04426	0.04511	0.00578
Woburn	Shoulder	~30 cm below interface	0.656493	0.059056	0.04592	0.05107	0.05201	0.00662
Woburn	Shoulder	~30 cm below interface	0.720675	0.066011	0.05219	0.05805	0.05875	0.00693
Woburn	Shoulder	~30 cm below interface	0.791132	0.071959	0.05746	0.06393	0.06445	0.00726
Woburn	Shoulder	~30 cm below interface	0.868477	0.076704	0.06213	0.06915	0.06933	0.00729
Woburn	Shoulder	~30 cm below interface	0.953383	0.08005	0.06624	0.07376	0.07335	0.00691
Woburn	Shoulder	~30 cm below interface	1.04659	0.081807	0.06994	0.0779	0.07655	0.00605
Woburn	Shoulder	~30 cm below interface	1.14891	0.081951	0.07282	0.08117	0.07864	0.00506
Woburn	Shoulder	~30 cm below interface	1.26123	0.080534	0.07499	0.08366	0.07973	0.00439
Woburn	Shoulder	~30 cm below interface	1.38454	0.077697	0.0766	0.08555	0.07995	0.00488
Woburn	Shoulder	~30 cm below interface	1.5199	0.073699	0.07781	0.08699	0.0795	0.00681
Woburn	Shoulder	~30 cm below interface	1.66849	0.068922	0.07868	0.0881	0.07857	0.00959
Woburn	Shoulder	~30 cm below interface	1.83161	0.063876	0.07923	0.08887	0.07732	0.0126
Woburn	Shoulder	~30 cm below interface	2.01068	0.059166	0.0796	0.08946	0.07608	0.01545
Woburn	Shoulder	~30 cm below interface	2.20725	0.055446	0.07996	0.09006	0.07515	0.0178
Woburn	Shoulder	~30 cm below interface	2.42304	0.053323	0.08055	0.09093	0.07494	0.01942
Woburn	Shoulder	~30 cm below interface	2.65993	0.053268	0.08138	0.09209	0.07558	0.02005
Woburn	Shoulder	~30 cm below interface	2.91998	0.055524	0.08254	0.09364	0.07724	0.01961
Woburn	Shoulder	~30 cm below interface	3.20545	0.060045	0.08412	0.09564	0.07994	0.01816
Woburn	Shoulder	~30 cm below interface	3.51883	0.066465	0.08625	0.09825	0.08366	0.01605
Woburn	Shoulder	~30 cm below interface	3.86284	0.074139	0.08892	0.10142	0.08816	0.01366
Woburn	Shoulder	~30 cm below interface	4.24049	0.082251	0.09213	0.10518	0.09319	0.0115
Woburn	Shoulder	~30 cm below interface	4.65506	0.089973	0.09587	0.10948	0.09844	0.01
Woburn	Shoulder	~30 cm below interface	5.11017	0.096636	0.10018	0.11434	0.10372	0.00937
Woburn	Shoulder	~30 cm below interface	5.60976	0.101846	0.10503	0.11974	0.10887	0.00955
Woburn	Shoulder	~30 cm below interface	6.1582	0.10555	0.11049	0.12574	0.11393	0.01053
Woburn	Shoulder	~30 cm below interface	6.76025	0.108018	0.11657	0.13238	0.11899	0.01236
Woburn	Shoulder	~30 cm below interface	7.42117	0.109746	0.1234	0.13975	0.1243	0.01502
Woburn	Shoulder	~30 cm below interface	8.14669	0.111497	0.13111	0.14802	0.13021	0.01828
Woburn	Shoulder	~30 cm below interface	8.94315	0.114324	0.14002	0.15753	0.13729	0.02173
Woburn	Shoulder	~30 cm below interface	9.81748	0.119516	0.15049	0.16866	0.14622	0.02485
Woburn	Shoulder	~30 cm below interface	10.7773	0.128533	0.16293	0.18187	0.15778	0.02704
Woburn	Shoulder	~30 cm below interface	11.8309	0.142732	0.17782	0.19767	0.17274	0.02782
Woburn	Shoulder	~30 cm below interface	12.9876	0.163	0.19567	0.21662	0.19176	0.02702
Woburn	Shoulder	~30 cm below interface	14.2573	0.189358	0.21711	0.23936	0.21528	0.02505
Woburn	Shoulder	~30 cm below interface	15.6512	0.220744	0.24267	0.26647	0.2433	0.02287
Woburn	Shoulder	~30 cm below interface	17.1813	0.255232	0.27291	0.29842	0.27552	0.02171
Woburn	Shoulder	~30 cm below interface	18.861	0.290801	0.30797	0.33523	0.31133	0.02241
Woburn	Shoulder	~30 cm below interface	20.705	0.326623	0.34784	0.37672	0.35039	0.02514
Woburn	Shoulder	~30 cm below interface	22.7292	0.363744	0.3922	0.42233	0.39276	0.0293
Woburn	Shoulder	~30 cm below interface	24.9513	0.404909	0.44072	0.4715	0.43904	0.03333
Woburn	Shoulder	~30 cm below interface	27.3906	0.453813	0.493	0.52354	0.49012	0.03495
Woburn	Shoulder	~30 cm below interface	30.0685	0.513222	0.54846	0.5776	0.54643	0.03224
Woburn	Shoulder	~30 cm below interface	33.0081	0.582229	0.60617	0.63249	0.60696	0.02514
Woburn	Shoulder	~30 cm below interface	36.2352	0.653916	0.66437	0.68635	0.66821	0.01655
Woburn	Shoulder	~30 cm below interface	39.7777	0.717189	0.7207	0.73711	0.725	0.01063
Woburn	Shoulder	~30 cm below interface	43.6665	0.764402	0.7724	0.78274	0.77318	0.00919
Woburn	Shoulder	~30 cm below interface	47.9356	0.797403	0.81631	0.82111	0.81161	0.01253
Woburn	Shoulder	~30 cm below interface	52.622	0.825706	0.84802	0.84885	0.84086	0.01313
Woburn	Shoulder	~30 cm below interface	57.7666	0.858701	0.86138	0.86034	0.86014	0.00135
Woburn	Shoulder	~30 cm below interface	63.4141	0.895448	0.85022	0.84912	0.86493	0.02643
Woburn	Shoulder	~30 cm below interface	69.6138	0.92402	0.81267	0.81218	0.84962	0.06443
Woburn	Shoulder	~30 cm below interface	76.4196	0.93962	0.7573	0.7566	0.81784	0.10547
Woburn	Shoulder	~30 cm below interface	83.8907	0.955166	0.70691	0.70412	0.78873	0.14414
Woburn	Shoulder	~30 cm below interface	92.0923	0.983291	0.69639	0.6895	0.78973	0.16767
Woburn	Shoulder	~30 cm below interface	101.096	1.02567	0.76813	0.75567	0.84982	0.15242
Woburn	Shoulder	~30 cm below interface	110.979	1.1004	0.96922	0.9508	1.00681	0.08158
Woburn	Shoulder	~30 cm below interface	121.829	1.27624	1.34962	1.32686	1.31757	0.03756
Woburn	Shoulder	~30 cm below interface	133.74	1.66566	1.94495	1.92247	1.84436	0.15517
Woburn	Shoulder	~30 cm below interface	146.815	2.37027	2.75656	2.74141	2.62275	0.21878
Woburn	Shoulder	~30 cm below interface	161.168	3.40578	3.73551	3.73469	3.62533	0.19013
Woburn	Shoulder	~30 cm below interface	176.925	4.66741	4.78855	4.80578	4.75391	0.07541
Woburn	Shoulder	~30 cm below interface	194.222	5.95379	5.79195	5.82542	5.85705	0.08543
Woburn	Shoulder	~30 cm below interface	213.21	7.0134	6.61842	6.66081	6.76421	0.21684
Woburn	Shoulder	~30 cm below interface	234.054	7.62868	7.16334	7.20447	7.33216	0.25761

Woburn	Shoulder	~30 cm below interface	256.936	7.71227	7.36446	7.39505	7.49059	0.19259
Woburn	Shoulder	~30 cm below interface	282.056	7.32611	7.21243	7.22735	7.2553	0.06178
Woburn	Shoulder	~30 cm below interface	309.631	6.62177	6.74591	6.74487	6.70418	0.07137
Woburn	Shoulder	~30 cm below interface	339.902	5.76867	6.04193	6.02813	5.94624	0.15394
Woburn	Shoulder	~30 cm below interface	373.132	4.90459	5.19571	5.1727	5.091	0.16185
Woburn	Shoulder	~30 cm below interface	409.611	4.11181	4.30167	4.27125	4.22824	0.10197
Woburn	Shoulder	~30 cm below interface	449.657	3.40899	3.43656	3.39795	3.4145	0.01989
Woburn	Shoulder	~30 cm below interface	493.617	2.75847	2.65148	2.60158	2.67051	0.08016
Woburn	Shoulder	~30 cm below interface	541.876	2.10781	1.97305	1.90554	1.99547	0.10298
Woburn	Shoulder	~30 cm below interface	594.852	1.45205	1.40805	1.31715	1.39242	0.0688
Woburn	Shoulder	~30 cm below interface	653.008	0.856358	0.95245	0.83811	0.8823	0.06143
Woburn	Shoulder	~30 cm below interface	716.849	0.413532	0.59809	0.46848	0.49337	0.09476
Woburn	Shoulder	~30 cm below interface	786.932	0.176161	0.33425	0.20734	0.23925	0.08374
Woburn	Shoulder	~30 cm below interface	863.866	0.110688	0.14977	0.0638	0.10809	0.04305
Woburn	Shoulder	~30 cm below interface	948.322	0.120573	0.04718	0.01021	0.05932	0.05618
Woburn	Shoulder	~30 cm below interface	1041.03	0.092429	0.00774	0.00063	0.0336	0.05107
Woburn	Shoulder	~30 cm below interface	1142.81	0.025828	0.0005	0	0.00878	0.01477
Woburn	Shoulder	~30 cm below interface	1254.54	0.001416	0	0	0.00047	0.00082
Woburn	Shoulder	~30 cm below interface	1377.19	0	0	0	0	0
Woburn	Shoulder	~30 cm below interface	1511.83	0	0	0	0	0
Woburn	Shoulder	~30 cm below interface	1659.63	0	0	0	0	0
Woburn	Shoulder	~30 cm below interface	1821.88	0	0	0	0	0
Woburn	Backslope	Soil-Sap Interface	0.375124	0.008129	0.00884	0.00957	0.00885	0.00072
Woburn	Backslope	Soil-Sap Interface	0.411798	0.015513	0.01688	0.01829	0.01689	0.00139
Woburn	Backslope	Soil-Sap Interface	0.452057	0.026128	0.02846	0.03085	0.02848	0.00236
Woburn	Backslope	Soil-Sap Interface	0.496252	0.036138	0.03943	0.04277	0.03945	0.00332
Woburn	Backslope	Soil-Sap Interface	0.544768	0.045628	0.04988	0.05419	0.0499	0.00428
Woburn	Backslope	Soil-Sap Interface	0.598027	0.054457	0.05969	0.06494	0.0597	0.00524
Woburn	Backslope	Soil-Sap Interface	0.656493	0.06248	0.06869	0.07489	0.06869	0.00621
Woburn	Backslope	Soil-Sap Interface	0.720675	0.069508	0.0767	0.08381	0.07667	0.00715
Woburn	Backslope	Soil-Sap Interface	0.791132	0.075353	0.0835	0.09148	0.08344	0.00806
Woburn	Backslope	Soil-Sap Interface	0.868477	0.079814	0.08887	0.09764	0.08877	0.00892
Woburn	Backslope	Soil-Sap Interface	0.953383	0.082696	0.09257	0.10204	0.09243	0.00967
Woburn	Backslope	Soil-Sap Interface	1.04659	0.083826	0.09439	0.10439	0.0942	0.01028
Woburn	Backslope	Soil-Sap Interface	1.14891	0.083218	0.09429	0.10466	0.09406	0.01072
Woburn	Backslope	Soil-Sap Interface	1.26123	0.080971	0.09236	0.10288	0.09207	0.01096
Woburn	Backslope	Soil-Sap Interface	1.38454	0.077273	0.08875	0.09922	0.08842	0.01098
Woburn	Backslope	Soil-Sap Interface	1.5199	0.072425	0.08377	0.09399	0.0834	0.01079
Woburn	Backslope	Soil-Sap Interface	1.66849	0.066837	0.07786	0.08768	0.07746	0.01043
Woburn	Backslope	Soil-Sap Interface	1.83161	0.061031	0.07161	0.08095	0.0712	0.00997
Woburn	Backslope	Soil-Sap Interface	2.01068	0.055598	0.06571	0.07458	0.0653	0.0095
Woburn	Backslope	Soil-Sap Interface	2.20725	0.051156	0.0609	0.06944	0.0605	0.00915
Woburn	Backslope	Soil-Sap Interface	2.42304	0.048261	0.05786	0.06632	0.05748	0.00904
Woburn	Backslope	Soil-Sap Interface	2.65993	0.047332	0.05711	0.06583	0.05676	0.00925
Woburn	Backslope	Soil-Sap Interface	2.91998	0.048575	0.05894	0.06828	0.0586	0.00986
Woburn	Backslope	Soil-Sap Interface	3.20545	0.051939	0.06328	0.07359	0.06294	0.01083
Woburn	Backslope	Soil-Sap Interface	3.51883	0.057105	0.06977	0.08128	0.06938	0.01209
Woburn	Backslope	Soil-Sap Interface	3.86284	0.063517	0.07769	0.09048	0.07723	0.01348
Woburn	Backslope	Soil-Sap Interface	4.24049	0.070478	0.08618	0.10012	0.08559	0.01483
Woburn	Backslope	Soil-Sap Interface	4.65506	0.077278	0.09434	0.10915	0.09359	0.01595
Woburn	Backslope	Soil-Sap Interface	5.11017	0.083337	0.10144	0.11671	0.1005	0.01671
Woburn	Backslope	Soil-Sap Interface	5.60976	0.0883	0.10703	0.12232	0.10588	0.01704
Woburn	Backslope	Soil-Sap Interface	6.1582	0.092095	0.11102	0.12595	0.10969	0.01697
Woburn	Backslope	Soil-Sap Interface	6.76025	0.094922	0.11368	0.12801	0.1122	0.01659
Woburn	Backslope	Soil-Sap Interface	7.42117	0.097199	0.11552	0.12919	0.11397	0.01605
Woburn	Backslope	Soil-Sap Interface	8.14669	0.099589	0.11736	0.13056	0.11584	0.01554
Woburn	Backslope	Soil-Sap Interface	8.94315	0.103033	0.12036	0.13352	0.11897	0.01529
Woburn	Backslope	Soil-Sap Interface	9.81748	0.108667	0.12589	0.13965	0.12474	0.01552
Woburn	Backslope	Soil-Sap Interface	10.7773	0.117743	0.13548	0.15057	0.1346	0.01643
Woburn	Backslope	Soil-Sap Interface	11.8309	0.131367	0.15039	0.16754	0.14976	0.01809
Woburn	Backslope	Soil-Sap Interface	12.9876	0.150222	0.17134	0.19108	0.17088	0.02043
Woburn	Backslope	Soil-Sap Interface	14.2573	0.17433	0.19815	0.22069	0.19772	0.02318
Woburn	Backslope	Soil-Sap Interface	15.6512	0.202878	0.22956	0.25466	0.22903	0.0259
Woburn	Backslope	Soil-Sap Interface	17.1813	0.234304	0.26329	0.29013	0.26258	0.02792
Woburn	Backslope	Soil-Sap Interface	18.861	0.266476	0.29641	0.32346	0.29545	0.02851
Woburn	Backslope	Soil-Sap Interface	20.705	0.297484	0.32643	0.35183	0.32525	0.02719
Woburn	Backslope	Soil-Sap Interface	22.7292	0.326513	0.35247	0.37489	0.35129	0.02421
Woburn	Backslope	Soil-Sap Interface	24.9513	0.354562	0.37616	0.39565	0.37546	0.02055
Woburn	Backslope	Soil-Sap Interface	27.3906	0.384728	0.40168	0.41964	0.40202	0.01746
Woburn	Backslope	Soil-Sap Interface	30.0685	0.420389	0.43324	0.45144	0.43502	0.0156

Woburn	Backslope	Soil-Sap Interface	33.0081	0.462369	0.47145	0.49036	0.47473	0.01428
Woburn	Backslope	Soil-Sap Interface	36.2352	0.506253	0.51019	0.52749	0.51464	0.0113
Woburn	Backslope	Soil-Sap Interface	39.7777	0.543052	0.53806	0.54942	0.54351	0.0057
Woburn	Backslope	Soil-Sap Interface	43.6665	0.565832	0.54725	0.54946	0.55418	0.01015
Woburn	Backslope	Soil-Sap Interface	47.9356	0.574784	0.53954	0.53259	0.54897	0.02262
Woburn	Backslope	Soil-Sap Interface	52.622	0.57666	0.52469	0.5108	0.53738	0.03472
Woburn	Backslope	Soil-Sap Interface	57.7666	0.582268	0.5163	0.49816	0.53224	0.04426
Woburn	Backslope	Soil-Sap Interface	63.4141	0.599515	0.52316	0.50244	0.5417	0.05113
Woburn	Backslope	Soil-Sap Interface	69.6138	0.626887	0.54289	0.51975	0.56318	0.05637
Woburn	Backslope	Soil-Sap Interface	76.4196	0.658753	0.57101	0.54616	0.59198	0.05915
Woburn	Backslope	Soil-Sap Interface	83.8907	0.69263	0.60913	0.58649	0.62942	0.0559
Woburn	Backslope	Soil-Sap Interface	92.0923	0.728001	0.65765	0.64279	0.67614	0.04552
Woburn	Backslope	Soil-Sap Interface	101.096	0.778927	0.72333	0.71831	0.74019	0.03364
Woburn	Backslope	Soil-Sap Interface	110.979	0.910171	0.86033	0.86122	0.87724	0.02852
Woburn	Backslope	Soil-Sap Interface	121.829	1.26011	1.20258	1.20381	1.22217	0.03287
Woburn	Backslope	Soil-Sap Interface	133.74	2.01993	1.94647	1.94845	1.97162	0.04185
Woburn	Backslope	Soil-Sap Interface	146.815	3.33664	3.25141	3.26528	3.28444	0.04573
Woburn	Backslope	Soil-Sap Interface	161.168	5.16779	5.08498	5.12898	5.12725	0.04143
Woburn	Backslope	Soil-Sap Interface	176.925	7.22888	7.16169	7.25124	7.21394	0.04661
Woburn	Backslope	Soil-Sap Interface	194.222	9.06262	9.01225	9.14989	9.07492	0.06964
Woburn	Backslope	Soil-Sap Interface	213.21	10.183	10.1334	10.304	10.2068	0.08775
Woburn	Backslope	Soil-Sap Interface	234.054	10.2719	10.1987	10.3722	10.2809	0.0871
Woburn	Backslope	Soil-Sap Interface	256.936	9.32488	9.2185	9.36055	9.30131	0.0739
Woburn	Backslope	Soil-Sap Interface	282.056	7.64136	7.52142	7.609	7.59059	0.06205
Woburn	Backslope	Soil-Sap Interface	309.631	5.68402	5.59163	5.61691	5.63085	0.04775
Woburn	Backslope	Soil-Sap Interface	339.902	3.90732	3.88058	3.85073	3.87954	0.02831
Woburn	Backslope	Soil-Sap Interface	373.132	2.6152	2.65805	2.59436	2.62254	0.03247
Woburn	Backslope	Soil-Sap Interface	409.611	1.87423	1.95109	1.88077	1.90203	0.04261
Woburn	Backslope	Soil-Sap Interface	449.657	1.55122	1.60356	1.55846	1.57108	0.02836
Woburn	Backslope	Soil-Sap Interface	493.617	1.42596	1.39154	1.39846	1.40532	0.01821
Woburn	Backslope	Soil-Sap Interface	541.876	1.27673	1.13047	1.19329	1.20016	0.07337
Woburn	Backslope	Soil-Sap Interface	594.852	0.994812	0.77146	0.87408	0.88012	0.1118
Woburn	Backslope	Soil-Sap Interface	653.008	0.616645	0.41121	0.48924	0.5057	0.1037
Woburn	Backslope	Soil-Sap Interface	716.849	0.235471	0.18046	0.14417	0.1867	0.04597
Woburn	Backslope	Soil-Sap Interface	786.932	0.033602	0.11785	0.00985	0.05377	0.05675
Woburn	Backslope	Soil-Sap Interface	863.866	0.000771	0.18536	0	0.06204	0.1068
Woburn	Backslope	Soil-Sap Interface	948.322	0	0.30507	0	0.10169	0.17613
Woburn	Backslope	Soil-Sap Interface	1041.03	0	0.32297	0	0.10766	0.18646
Woburn	Backslope	Soil-Sap Interface	1142.81	0	0.23554	0	0.07851	0.13599
Woburn	Backslope	Soil-Sap Interface	1254.54	0	0.14458	0	0.04819	0.08347
Woburn	Backslope	Soil-Sap Interface	1377.19	0	0.07464	0	0.02488	0.0431
Woburn	Backslope	Soil-Sap Interface	1511.83	0	0.02102	0	0.00701	0.01214
Woburn	Backslope	Soil-Sap Interface	1659.63	0	0.00138	0	0.00046	0.00079
Woburn	Backslope	Soil-Sap Interface	1821.88	0	0	0	0	0
Woburn	Backslope	~30 cm below interface	0.375124	0	0.00576	0.00618	0.00398	0.00345
Woburn	Backslope	~30 cm below interface	0.411798	0	0.01099	0.01178	0.00759	0.00659
Woburn	Backslope	~30 cm below interface	0.452057	0	0.0185	0.01984	0.01278	0.01109
Woburn	Backslope	~30 cm below interface	0.496252	0.000356	0.02557	0.02744	0.01779	0.01513
Woburn	Backslope	~30 cm below interface	0.544768	0.004787	0.03226	0.03463	0.02389	0.01659
Woburn	Backslope	~30 cm below interface	0.598027	0.014707	0.03846	0.04132	0.0315	0.01461
Woburn	Backslope	~30 cm below interface	0.656493	0.02446	0.04408	0.04739	0.03864	0.0124
Woburn	Backslope	~30 cm below interface	0.720675	0.033179	0.04898	0.05271	0.04496	0.01037
Woburn	Backslope	~30 cm below interface	0.791132	0.040792	0.05304	0.05714	0.05032	0.0085
Woburn	Backslope	~30 cm below interface	0.868477	0.047032	0.05612	0.06054	0.05456	0.00689
Woburn	Backslope	~30 cm below interface	0.953383	0.051664	0.05811	0.06277	0.05751	0.00557
Woburn	Backslope	~30 cm below interface	1.04659	0.054473	0.05889	0.06372	0.05903	0.00462
Woburn	Backslope	~30 cm below interface	1.14891	0.055472	0.0585	0.06341	0.05913	0.00401
Woburn	Backslope	~30 cm below interface	1.26123	0.05477	0.05701	0.06193	0.0579	0.00366
Woburn	Backslope	~30 cm below interface	1.38454	0.052572	0.05457	0.05942	0.05552	0.00352
Woburn	Backslope	~30 cm below interface	1.5199	0.049175	0.05137	0.0561	0.05222	0.00354
Woburn	Backslope	~30 cm below interface	1.66849	0.044954	0.04769	0.05226	0.0483	0.00369
Woburn	Backslope	~30 cm below interface	1.83161	0.040334	0.04383	0.04825	0.04414	0.00397
Woburn	Backslope	~30 cm below interface	2.01068	0.035766	0.04017	0.04446	0.04013	0.00435
Woburn	Backslope	~30 cm below interface	2.20725	0.03168	0.03706	0.04129	0.03668	0.00482
Woburn	Backslope	~30 cm below interface	2.42304	0.028442	0.03482	0.0391	0.03412	0.00536
Woburn	Backslope	~30 cm below interface	2.65993	0.026318	0.0337	0.03815	0.03272	0.00598
Woburn	Backslope	~30 cm below interface	2.91998	0.025444	0.03382	0.03858	0.03261	0.00665
Woburn	Backslope	~30 cm below interface	3.20545	0.025822	0.03516	0.04034	0.03377	0.00736
Woburn	Backslope	~30 cm below interface	3.51883	0.027323	0.03756	0.04325	0.03605	0.00807
Woburn	Backslope	~30 cm below interface	3.86284	0.029712	0.04075	0.04697	0.03914	0.00874

Woburn	Backslope	~30 cm below interface	4.24049	0.032681	0.04435	0.05109	0.04271	0.00931
Woburn	Backslope	~30 cm below interface	4.65506	0.035907	0.04801	0.05517	0.04636	0.00974
Woburn	Backslope	~30 cm below interface	5.11017	0.039096	0.0514	0.05886	0.04978	0.00998
Woburn	Backslope	~30 cm below interface	5.60976	0.042031	0.05429	0.0619	0.05274	0.01002
Woburn	Backslope	~30 cm below interface	6.1582	0.04459	0.05658	0.0642	0.05512	0.00989
Woburn	Backslope	~30 cm below interface	6.76025	0.046751	0.05832	0.06583	0.05697	0.00961
Woburn	Backslope	~30 cm below interface	7.42117	0.048566	0.05962	0.06697	0.05839	0.00927
Woburn	Backslope	~30 cm below interface	8.14669	0.050175	0.06075	0.06793	0.05962	0.00893
Woburn	Backslope	~30 cm below interface	8.94315	0.051836	0.0621	0.06917	0.06104	0.00872
Woburn	Backslope	~30 cm below interface	9.81748	0.05391	0.06419	0.07128	0.06313	0.00873
Woburn	Backslope	~30 cm below interface	10.7773	0.056867	0.06762	0.07491	0.06647	0.00908
Woburn	Backslope	~30 cm below interface	11.8309	0.061203	0.07294	0.0806	0.07158	0.00977
Woburn	Backslope	~30 cm below interface	12.9876	0.067356	0.0805	0.08865	0.07884	0.01075
Woburn	Backslope	~30 cm below interface	14.2573	0.075579	0.09032	0.09896	0.08829	0.01182
Woburn	Backslope	~30 cm below interface	15.6512	0.085765	0.10191	0.11092	0.09953	0.01275
Woburn	Backslope	~30 cm below interface	17.1813	0.097374	0.11434	0.12353	0.11175	0.01327
Woburn	Backslope	~30 cm below interface	18.861	0.109409	0.12639	0.13547	0.12376	0.01323
Woburn	Backslope	~30 cm below interface	20.705	0.120791	0.13698	0.14568	0.13448	0.01263
Woburn	Backslope	~30 cm below interface	22.7292	0.130871	0.14564	0.15371	0.14341	0.01158
Woburn	Backslope	~30 cm below interface	24.9513	0.139833	0.15282	0.16018	0.15094	0.0103
Woburn	Backslope	~30 cm below interface	27.3906	0.148836	0.15998	0.16666	0.15849	0.00901
Woburn	Backslope	~30 cm below interface	30.0685	0.159244	0.16869	0.17476	0.16757	0.00782
Woburn	Backslope	~30 cm below interface	33.0081	0.17164	0.17942	0.18479	0.17862	0.00661
Woburn	Backslope	~30 cm below interface	36.2352	0.184881	0.19028	0.19464	0.18993	0.00489
Woburn	Backslope	~30 cm below interface	39.7777	0.196223	0.19745	0.20028	0.19799	0.00208
Woburn	Backslope	~30 cm below interface	43.6665	0.203752	0.19812	0.19901	0.20029	0.00303
Woburn	Backslope	~30 cm below interface	47.9356	0.208632	0.19321	0.19201	0.19795	0.00927
Woburn	Backslope	~30 cm below interface	52.622	0.21547	0.18802	0.18463	0.19604	0.01691
Woburn	Backslope	~30 cm below interface	57.7666	0.231278	0.19125	0.18551	0.20268	0.02493
Woburn	Backslope	~30 cm below interface	63.4141	0.261285	0.21049	0.2024	0.22472	0.03192
Woburn	Backslope	~30 cm below interface	69.6138	0.302966	0.2461	0.23626	0.26178	0.03601
Woburn	Backslope	~30 cm below interface	76.4196	0.344585	0.2894	0.27959	0.30453	0.03504
Woburn	Backslope	~30 cm below interface	83.8907	0.370184	0.32598	0.3191	0.33842	0.02772
Woburn	Backslope	~30 cm below interface	92.0923	0.37055	0.34371	0.34221	0.35216	0.01595
Woburn	Backslope	~30 cm below interface	101.096	0.3647	0.3535	0.35681	0.35834	0.00575
Woburn	Backslope	~30 cm below interface	110.979	0.420186	0.4149	0.41909	0.41806	0.00279
Woburn	Backslope	~30 cm below interface	121.829	0.656891	0.64513	0.64524	0.64909	0.00676
Woburn	Backslope	~30 cm below interface	133.74	1.24364	1.21606	1.20915	1.22295	0.01825
Woburn	Backslope	~30 cm below interface	146.815	2.32759	2.28739	2.27724	2.29741	0.02663
Woburn	Backslope	~30 cm below interface	161.168	3.91815	3.88509	3.8833	3.89551	0.01962
Woburn	Backslope	~30 cm below interface	176.925	5.83835	5.8405	5.86094	5.8466	0.01247
Woburn	Backslope	~30 cm below interface	194.222	7.75362	7.81197	7.8624	7.80933	0.05444
Woburn	Backslope	~30 cm below interface	213.21	9.26608	9.37833	9.45426	9.36622	0.09467
Woburn	Backslope	~30 cm below interface	234.054	10.051	10.1847	10.2699	10.1685	0.11034
Woburn	Backslope	~30 cm below interface	256.936	9.97222	10.0745	10.1489	10.0652	0.08871
Woburn	Backslope	~30 cm below interface	282.056	9.11715	9.1372	9.18689	9.14708	0.0359
Woburn	Backslope	~30 cm below interface	309.631	7.74787	7.6615	7.68258	7.69732	0.04503
Woburn	Backslope	~30 cm below interface	339.902	6.20246	6.02722	6.02471	6.0848	0.10191
Woburn	Backslope	~30 cm below interface	373.132	4.78091	4.57176	4.55551	4.63606	0.12571
Woburn	Backslope	~30 cm below interface	409.611	3.65643	3.481	3.46038	3.5326	0.10773
Woburn	Backslope	~30 cm below interface	449.657	2.85174	2.75898	2.73788	2.78287	0.06057
Woburn	Backslope	~30 cm below interface	493.617	2.28137	2.28389	2.25824	2.2745	0.01414
Woburn	Backslope	~30 cm below interface	541.876	1.82884	1.90496	1.86386	1.86589	0.0381
Woburn	Backslope	~30 cm below interface	594.852	1.41605	1.52464	1.45599	1.46556	0.05492
Woburn	Backslope	~30 cm below interface	653.008	1.02881	1.12955	1.03264	1.06367	0.05709
Woburn	Backslope	~30 cm below interface	716.849	0.693071	0.75695	0.64679	0.69894	0.05531
Woburn	Backslope	~30 cm below interface	786.932	0.438712	0.4507	0.35253	0.41398	0.05356
Woburn	Backslope	~30 cm below interface	863.866	0.278775	0.24851	0.18431	0.2372	0.04824
Woburn	Backslope	~30 cm below interface	948.322	0.183171	0.13348	0.1035	0.14005	0.04024
Woburn	Backslope	~30 cm below interface	1041.03	0.096914	0.04588	0.03794	0.06024	0.032
Woburn	Backslope	~30 cm below interface	1142.81	0.024542	0.00371	0.00315	0.01047	0.01219
Woburn	Backslope	~30 cm below interface	1254.54	0.001355	0	0	0.00045	0.00078
Woburn	Backslope	~30 cm below interface	1377.19	0	0	0	0	0
Woburn	Backslope	~30 cm below interface	1511.83	0	0	0	0	0
Woburn	Backslope	~30 cm below interface	1659.63	0	0	0	0	0
Woburn	Backslope	~30 cm below interface	1821.88	0	0	0	0	0
Woburn	Toeslope	Soil-Sap Interface	0.375124	0.02173	0.02249	0.02356	0.02259	0.00092
Woburn	Toeslope	Soil-Sap Interface	0.411798	0.038975	0.04034	0.04225	0.04052	0.00164
Woburn	Toeslope	Soil-Sap Interface	0.452057	0.05801	0.06004	0.06287	0.0603	0.00244
Woburn	Toeslope	Soil-Sap Interface	0.496252	0.083302	0.08621	0.09026	0.08659	0.0035

Woburn	Toeslope	Soil-Sap Interface	0.544768	0.104155	0.10779	0.11286	0.10827	0.00437
Woburn	Toeslope	Soil-Sap Interface	0.598027	0.123197	0.12749	0.13347	0.12805	0.00516
Woburn	Toeslope	Soil-Sap Interface	0.656493	0.141023	0.14592	0.15273	0.14656	0.00588
Woburn	Toeslope	Soil-Sap Interface	0.720675	0.158768	0.16425	0.17188	0.16497	0.00658
Woburn	Toeslope	Soil-Sap Interface	0.791132	0.173117	0.17908	0.18736	0.17985	0.00715
Woburn	Toeslope	Soil-Sap Interface	0.868477	0.184725	0.19105	0.19984	0.19187	0.00759
Woburn	Toeslope	Soil-Sap Interface	0.953383	0.19371	0.20029	0.20943	0.20114	0.00789
Woburn	Toeslope	Soil-Sap Interface	1.04659	0.200429	0.20717	0.21651	0.20804	0.00807
Woburn	Toeslope	Soil-Sap Interface	1.14891	0.204174	0.21097	0.22037	0.21184	0.00813
Woburn	Toeslope	Soil-Sap Interface	1.26123	0.204919	0.21166	0.22096	0.21251	0.00805
Woburn	Toeslope	Soil-Sap Interface	1.38454	0.203298	0.20988	0.21896	0.21072	0.00787
Woburn	Toeslope	Soil-Sap Interface	1.5199	0.199858	0.20622	0.21498	0.20702	0.00759
Woburn	Toeslope	Soil-Sap Interface	1.66849	0.1954	0.20151	0.2099	0.20227	0.00728
Woburn	Toeslope	Soil-Sap Interface	1.83161	0.189978	0.19581	0.20381	0.19653	0.00694
Woburn	Toeslope	Soil-Sap Interface	2.01068	0.184308	0.18988	0.1975	0.19056	0.00662
Woburn	Toeslope	Soil-Sap Interface	2.20725	0.179061	0.1844	0.1917	0.18505	0.00634
Woburn	Toeslope	Soil-Sap Interface	2.42304	0.175293	0.18048	0.18757	0.18111	0.00616
Woburn	Toeslope	Soil-Sap Interface	2.65993	0.173311	0.17844	0.18545	0.17907	0.00609
Woburn	Toeslope	Soil-Sap Interface	2.91998	0.173389	0.17857	0.18564	0.1792	0.00615
Woburn	Toeslope	Soil-Sap Interface	3.20545	0.17568	0.18102	0.1883	0.18166	0.00633
Woburn	Toeslope	Soil-Sap Interface	3.51883	0.180364	0.18596	0.19357	0.18663	0.00663
Woburn	Toeslope	Soil-Sap Interface	3.86284	0.187412	0.19334	0.20139	0.19405	0.00701
Woburn	Toeslope	Soil-Sap Interface	4.24049	0.196483	0.20281	0.21134	0.20354	0.00746
Woburn	Toeslope	Soil-Sap Interface	4.65506	0.207219	0.21397	0.22301	0.21473	0.00792
Woburn	Toeslope	Soil-Sap Interface	5.11017	0.219269	0.22644	0.23597	0.22723	0.00838
Woburn	Toeslope	Soil-Sap Interface	5.60976	0.232603	0.24018	0.25016	0.24098	0.00881
Woburn	Toeslope	Soil-Sap Interface	6.1582	0.247198	0.25514	0.26554	0.25596	0.0092
Woburn	Toeslope	Soil-Sap Interface	6.76025	0.263029	0.27129	0.28206	0.27213	0.00954
Woburn	Toeslope	Soil-Sap Interface	7.42117	0.280112	0.28864	0.29974	0.2895	0.00984
Woburn	Toeslope	Soil-Sap Interface	8.14669	0.29884	0.30759	0.31902	0.30848	0.01012
Woburn	Toeslope	Soil-Sap Interface	8.94315	0.32001	0.32893	0.34076	0.3299	0.01041
Woburn	Toeslope	Soil-Sap Interface	9.81748	0.344366	0.3534	0.36575	0.3545	0.01073
Woburn	Toeslope	Soil-Sap Interface	10.7773	0.372412	0.3815	0.39453	0.38281	0.01112
Woburn	Toeslope	Soil-Sap Interface	11.8309	0.404512	0.4136	0.42756	0.41522	0.01161
Woburn	Toeslope	Soil-Sap Interface	12.9876	0.44124	0.45033	0.46549	0.45235	0.01225
Woburn	Toeslope	Soil-Sap Interface	14.2573	0.483041	0.49213	0.50874	0.49464	0.01303
Woburn	Toeslope	Soil-Sap Interface	15.6512	0.529425	0.53842	0.55661	0.54149	0.01385
Woburn	Toeslope	Soil-Sap Interface	17.1813	0.57861	0.58733	0.60686	0.59093	0.01447
Woburn	Toeslope	Soil-Sap Interface	18.861	0.627982	0.63619	0.65644	0.64021	0.01465
Woburn	Toeslope	Soil-Sap Interface	20.705	0.675773	0.68328	0.70329	0.68745	0.01422
Woburn	Toeslope	Soil-Sap Interface	22.7292	0.721955	0.7286	0.74733	0.73263	0.01316
Woburn	Toeslope	Soil-Sap Interface	24.9513	0.767781	0.77324	0.78985	0.77696	0.0115
Woburn	Toeslope	Soil-Sap Interface	27.3906	0.813529	0.81713	0.83107	0.82058	0.00926
Woburn	Toeslope	Soil-Sap Interface	30.0685	0.856233	0.85675	0.86763	0.8602	0.00643
Woburn	Toeslope	Soil-Sap Interface	33.0081	0.889031	0.88479	0.89222	0.88868	0.00373
Woburn	Toeslope	Soil-Sap Interface	36.2352	0.902605	0.89176	0.89524	0.89653	0.00554
Woburn	Toeslope	Soil-Sap Interface	39.7777	0.889281	0.87041	0.86929	0.87633	0.01123
Woburn	Toeslope	Soil-Sap Interface	43.6665	0.847468	0.82003	0.81388	0.82713	0.01788
Woburn	Toeslope	Soil-Sap Interface	47.9356	0.783437	0.74812	0.73713	0.75623	0.02419
Woburn	Toeslope	Soil-Sap Interface	52.622	0.708642	0.6673	0.65261	0.67618	0.02905
Woburn	Toeslope	Soil-Sap Interface	57.7666	0.633686	0.58894	0.57259	0.5984	0.03163
Woburn	Toeslope	Soil-Sap Interface	63.4141	0.56375	0.51842	0.50287	0.52835	0.03163
Woburn	Toeslope	Soil-Sap Interface	69.6138	0.4979	0.45445	0.44201	0.46479	0.02934
Woburn	Toeslope	Soil-Sap Interface	76.4196	0.434045	0.39408	0.38618	0.40477	0.02566
Woburn	Toeslope	Soil-Sap Interface	83.8907	0.376507	0.34046	0.33708	0.35135	0.02185
Woburn	Toeslope	Soil-Sap Interface	92.0923	0.341412	0.30849	0.30816	0.31935	0.01911
Woburn	Toeslope	Soil-Sap Interface	101.096	0.356583	0.32489	0.3254	0.33563	0.01815
Woburn	Toeslope	Soil-Sap Interface	110.979	0.462314	0.42964	0.4286	0.44018	0.01917
Woburn	Toeslope	Soil-Sap Interface	121.829	0.719556	0.68483	0.67993	0.69477	0.0216
Woburn	Toeslope	Soil-Sap Interface	133.74	1.20043	1.16509	1.15519	1.17357	0.02378
Woburn	Toeslope	Soil-Sap Interface	146.815	1.95557	1.92356	1.91029	1.92981	0.02328
Woburn	Toeslope	Soil-Sap Interface	161.168	2.96974	2.9463	2.93393	2.94999	0.01819
Woburn	Toeslope	Soil-Sap Interface	176.925	4.14684	4.13669	4.12937	4.13763	0.00877
Woburn	Toeslope	Soil-Sap Interface	194.222	5.31985	5.32525	5.32369	5.32293	0.00278
Woburn	Toeslope	Soil-Sap Interface	213.21	6.2964	6.31572	6.31567	6.30926	0.01114
Woburn	Toeslope	Soil-Sap Interface	234.054	6.91668	6.94443	6.93826	6.93312	0.01457
Woburn	Toeslope	Soil-Sap Interface	256.936	7.09961	7.12782	7.10852	7.11198	0.01442
Woburn	Toeslope	Soil-Sap Interface	282.056	6.86152	6.88191	6.84738	6.8636	0.01736
Woburn	Toeslope	Soil-Sap Interface	309.631	6.29651	6.30293	6.25729	6.28558	0.02471
Woburn	Toeslope	Soil-Sap Interface	339.902	5.53962	5.53035	5.48167	5.51721	0.03113

Woburn	Toeslope	Soil-Sap Interface	373.132	4.72244	4.7013	4.65623	4.69332	0.03382
Woburn	Toeslope	Soil-Sap Interface	409.611	3.94181	3.91751	3.87679	3.91204	0.03285
Woburn	Toeslope	Soil-Sap Interface	449.657	3.24698	3.23041	3.18806	3.22182	0.03039
Woburn	Toeslope	Soil-Sap Interface	493.617	2.64541	2.64556	2.59311	2.62803	0.03024
Woburn	Toeslope	Soil-Sap Interface	541.876	2.12162	2.14173	2.07516	2.11284	0.03414
Woburn	Toeslope	Soil-Sap Interface	594.852	1.65656	1.69183	1.6179	1.65543	0.03698
Woburn	Toeslope	Soil-Sap Interface	653.008	1.24262	1.28155	1.21846	1.24754	0.03183
Woburn	Toeslope	Soil-Sap Interface	716.849	0.886526	0.9161	0.88601	0.89621	0.01723
Woburn	Toeslope	Soil-Sap Interface	786.932	0.602013	0.61464	0.62907	0.61524	0.01354
Woburn	Toeslope	Soil-Sap Interface	863.866	0.393488	0.38989	0.44212	0.4085	0.02917
Woburn	Toeslope	Soil-Sap Interface	948.322	0.251864	0.23933	0.30763	0.26627	0.03636
Woburn	Toeslope	Soil-Sap Interface	1041.03	0.157727	0.14523	0.20563	0.16953	0.03188
Woburn	Toeslope	Soil-Sap Interface	1142.81	0.086603	0.08464	0.12047	0.09724	0.02014
Woburn	Toeslope	Soil-Sap Interface	1254.54	0.036541	0.04874	0.06255	0.04928	0.01301
Woburn	Toeslope	Soil-Sap Interface	1377.19	0.008612	0.031	0.03281	0.02414	0.01348
Woburn	Toeslope	Soil-Sap Interface	1511.83	0.000965	0.02906	0.02463	0.01822	0.0151
Woburn	Toeslope	Soil-Sap Interface	1659.63	1.03E-05	0.03486	0.02621	0.02036	0.01814
Woburn	Toeslope	Soil-Sap Interface	1821.88	0	0.04285	0.0209	0.02125	0.02143
Woburn	Toeslope	~30 cm below interface	0.375124	0.012497	0.01378	0.01451	0.0136	0.00102
Woburn	Toeslope	~30 cm below interface	0.411798	0.023869	0.02634	0.02773	0.02598	0.00196
Woburn	Toeslope	~30 cm below interface	0.452057	0.040274	0.0445	0.04687	0.04388	0.00334
Woburn	Toeslope	~30 cm below interface	0.496252	0.055853	0.06183	0.06519	0.06096	0.00473
Woburn	Toeslope	~30 cm below interface	0.544768	0.070766	0.07852	0.08289	0.07739	0.00614
Woburn	Toeslope	~30 cm below interface	0.598027	0.084824	0.0944	0.09981	0.09301	0.00759
Woburn	Toeslope	~30 cm below interface	0.656493	0.097813	0.10923	0.11571	0.10758	0.00906
Woburn	Toeslope	~30 cm below interface	0.720675	0.109438	0.12271	0.13026	0.1208	0.01054
Woburn	Toeslope	~30 cm below interface	0.791132	0.119384	0.13446	0.14307	0.1323	0.01199
Woburn	Toeslope	~30 cm below interface	0.868477	0.127284	0.14406	0.15367	0.14167	0.01335
Woburn	Toeslope	~30 cm below interface	0.953383	0.132748	0.15103	0.16152	0.14843	0.01456
Woburn	Toeslope	~30 cm below interface	1.04659	0.135383	0.15486	0.16605	0.1521	0.01552
Woburn	Toeslope	~30 cm below interface	1.14891	0.135072	0.15534	0.16697	0.15246	0.01614
Woburn	Toeslope	~30 cm below interface	1.26123	0.131836	0.15239	0.16416	0.14946	0.01636
Woburn	Toeslope	~30 cm below interface	1.38454	0.125852	0.14614	0.15771	0.14323	0.01612
Woburn	Toeslope	~30 cm below interface	1.5199	0.117528	0.13699	0.14799	0.13417	0.01542
Woburn	Toeslope	~30 cm below interface	1.66849	0.107516	0.12565	0.13575	0.12297	0.01431
Woburn	Toeslope	~30 cm below interface	1.83161	0.096736	0.11319	0.12216	0.1107	0.01289
Woburn	Toeslope	~30 cm below interface	2.01068	0.086318	0.10097	0.1087	0.09866	0.01137
Woburn	Toeslope	~30 cm below interface	2.20725	0.077508	0.09052	0.09709	0.08837	0.00997
Woburn	Toeslope	~30 cm below interface	2.42304	0.071472	0.0833	0.089	0.08125	0.00894
Woburn	Toeslope	~30 cm below interface	2.65993	0.06911	0.08046	0.08573	0.07843	0.00849
Woburn	Toeslope	~30 cm below interface	2.91998	0.070863	0.08258	0.08797	0.08047	0.00875
Woburn	Toeslope	~30 cm below interface	3.20545	0.0766	0.08954	0.09561	0.08725	0.00971
Woburn	Toeslope	~30 cm below interface	3.51883	0.085566	0.10041	0.10763	0.09787	0.01125
Woburn	Toeslope	~30 cm below interface	3.86284	0.096448	0.11354	0.12218	0.11072	0.01309
Woburn	Toeslope	~30 cm below interface	4.24049	0.10761	0.12689	0.13694	0.12381	0.01491
Woburn	Toeslope	~30 cm below interface	4.65506	0.117439	0.13844	0.14962	0.13517	0.01634
Woburn	Toeslope	~30 cm below interface	5.11017	0.124701	0.14666	0.15849	0.14328	0.01714
Woburn	Toeslope	~30 cm below interface	5.60976	0.128787	0.15085	0.16275	0.14746	0.01723
Woburn	Toeslope	~30 cm below interface	6.1582	0.129818	0.15122	0.16266	0.1479	0.01667
Woburn	Toeslope	~30 cm below interface	6.76025	0.12857	0.14885	0.15942	0.14561	0.01568
Woburn	Toeslope	~30 cm below interface	7.42117	0.126249	0.14528	0.1548	0.14211	0.01454
Woburn	Toeslope	~30 cm below interface	8.14669	0.124503	0.14258	0.15107	0.13938	0.01357
Woburn	Toeslope	~30 cm below interface	8.94315	0.12531	0.14307	0.15079	0.13972	0.01306
Woburn	Toeslope	~30 cm below interface	9.81748	0.130698	0.14901	0.15641	0.14537	0.01323
Woburn	Toeslope	~30 cm below interface	10.7773	0.142461	0.16227	0.16992	0.15822	0.01417
Woburn	Toeslope	~30 cm below interface	11.8309	0.161563	0.18368	0.19219	0.17914	0.01581
Woburn	Toeslope	~30 cm below interface	12.9876	0.187672	0.21255	0.22244	0.20755	0.01791
Woburn	Toeslope	~30 cm below interface	14.2573	0.218836	0.2464	0.25793	0.24105	0.02009
Woburn	Toeslope	~30 cm below interface	15.6512	0.251665	0.28115	0.2942	0.27567	0.02179
Woburn	Toeslope	~30 cm below interface	17.1813	0.28159	0.31134	0.32523	0.30605	0.02229
Woburn	Toeslope	~30 cm below interface	18.861	0.303895	0.33146	0.34473	0.3267	0.02083
Woburn	Toeslope	~30 cm below interface	20.705	0.316231	0.33926	0.34987	0.33512	0.0172
Woburn	Toeslope	~30 cm below interface	22.7292	0.32048	0.33786	0.34371	0.33402	0.01208
Woburn	Toeslope	~30 cm below interface	24.9513	0.322862	0.33528	0.33498	0.33104	0.00708
Woburn	Toeslope	~30 cm below interface	27.3906	0.330984	0.34042	0.33394	0.33512	0.00483
Woburn	Toeslope	~30 cm below interface	30.0685	0.349662	0.35803	0.34693	0.35154	0.00578
Woburn	Toeslope	~30 cm below interface	33.0081	0.377412	0.38469	0.37174	0.37795	0.00649
Woburn	Toeslope	~30 cm below interface	36.2352	0.404423	0.4071	0.39467	0.40206	0.00654
Woburn	Toeslope	~30 cm below interface	39.7777	0.41833	0.41029	0.39838	0.409	0.01004
Woburn	Toeslope	~30 cm below interface	43.6665	0.416669	0.39298	0.37924	0.3963	0.01893

Woburn	Toeslope	~30 cm below interface	47.9356	0.410032	0.36971	0.35187	0.37721	0.02979
Woburn	Toeslope	~30 cm below interface	52.622	0.412498	0.35799	0.33679	0.36909	0.03906
Woburn	Toeslope	~30 cm below interface	57.7666	0.431984	0.36718	0.34742	0.38219	0.04424
Woburn	Toeslope	~30 cm below interface	63.4141	0.461739	0.38978	0.37669	0.4094	0.04579
Woburn	Toeslope	~30 cm below interface	69.6138	0.482807	0.4046	0.39725	0.42822	0.04742
Woburn	Toeslope	~30 cm below interface	76.4196	0.49332	0.41127	0.40273	0.43577	0.05002
Woburn	Toeslope	~30 cm below interface	83.8907	0.520985	0.44461	0.43063	0.46541	0.04863
Woburn	Toeslope	~30 cm below interface	92.0923	0.583415	0.52728	0.51014	0.54028	0.03833
Woburn	Toeslope	~30 cm below interface	101.096	0.658601	0.63055	0.61595	0.63503	0.02168
Woburn	Toeslope	~30 cm below interface	110.979	0.728121	0.71778	0.70959	0.7185	0.00929
Woburn	Toeslope	~30 cm below interface	121.829	0.860153	0.84665	0.8441	0.8503	0.00863
Woburn	Toeslope	~30 cm below interface	133.74	1.22398	1.19476	1.19285	1.20386	0.01745
Woburn	Toeslope	~30 cm below interface	146.815	2.02199	1.98673	1.97796	1.99556	0.02331
Woburn	Toeslope	~30 cm below interface	161.168	3.36674	3.36421	3.34402	3.35832	0.01245
Woburn	Toeslope	~30 cm below interface	176.925	5.17647	5.26202	5.2355	5.22466	0.04379
Woburn	Toeslope	~30 cm below interface	194.222	7.15153	7.36583	7.34425	7.2872	0.11799
Woburn	Toeslope	~30 cm below interface	213.21	8.80455	9.13223	9.1211	9.01929	0.18606
Woburn	Toeslope	~30 cm below interface	234.054	9.63907	9.99175	9.9849	9.87191	0.20167
Woburn	Toeslope	~30 cm below interface	256.936	9.4142	9.6747	9.65857	9.58249	0.14597
Woburn	Toeslope	~30 cm below interface	282.056	8.2585	8.35512	8.31611	8.30991	0.04861
Woburn	Toeslope	~30 cm below interface	309.631	6.58759	6.52483	6.45745	6.52329	0.06508
Woburn	Toeslope	~30 cm below interface	339.902	4.91434	4.74325	4.65613	4.77124	0.13136
Woburn	Toeslope	~30 cm below interface	373.132	3.62415	3.40395	3.31203	3.44671	0.16039
Woburn	Toeslope	~30 cm below interface	409.611	2.82793	2.61569	2.52541	2.65634	0.1553
Woburn	Toeslope	~30 cm below interface	449.657	2.39152	2.24397	2.14984	2.26178	0.12182
Woburn	Toeslope	~30 cm below interface	493.617	2.08445	2.04292	1.93659	2.02132	0.07626
Woburn	Toeslope	~30 cm below interface	541.876	1.73561	1.78895	1.6758	1.73345	0.05661
Woburn	Toeslope	~30 cm below interface	594.852	1.32086	1.39026	1.30329	1.33814	0.04599
Woburn	Toeslope	~30 cm below interface	653.008	0.918101	0.90792	0.89056	0.90553	0.01393
Woburn	Toeslope	~30 cm below interface	716.849	0.602632	0.4805	0.54847	0.54387	0.0612
Woburn	Toeslope	~30 cm below interface	786.932	0.404445	0.25003	0.37313	0.34254	0.08163
Woburn	Toeslope	~30 cm below interface	863.866	0.310507	0.23901	0.38464	0.31138	0.07282
Woburn	Toeslope	~30 cm below interface	948.322	0.261363	0.36804	0.48181	0.3704	0.11024
Woburn	Toeslope	~30 cm below interface	1041.03	0.200803	0.47068	0.47178	0.38109	0.15613
Woburn	Toeslope	~30 cm below interface	1142.81	0.169655	0.47426	0.36744	0.33712	0.15455
Woburn	Toeslope	~30 cm below interface	1254.54	0.222308	0.43667	0.31231	0.32376	0.10764
Woburn	Toeslope	~30 cm below interface	1377.19	0.327433	0.34596	0.29808	0.32382	0.02414
Woburn	Toeslope	~30 cm below interface	1511.83	0.442678	0.21292	0.29559	0.31706	0.11638
Woburn	Toeslope	~30 cm below interface	1659.63	0.553177	0.07484	0.29517	0.30773	0.23942
Woburn	Toeslope	~30 cm below interface	1821.88	0.592768	0.00628	0.26712	0.28872	0.29384
Hilton	Summit	Soil-Sap Interface	0.375124	0	0	0	0	0
Hilton	Summit	Soil-Sap Interface	0.411798	0	0	0	0	0
Hilton	Summit	Soil-Sap Interface	0.452057	0	0	0	0	0
Hilton	Summit	Soil-Sap Interface	0.496252	0.000291	0.00031	0.00033	0.00031	2.1E-05
Hilton	Summit	Soil-Sap Interface	0.544768	0.003907	0.00414	0.00446	0.00417	0.00028
Hilton	Summit	Soil-Sap Interface	0.598027	0.011997	0.01272	0.01371	0.01281	0.00086
Hilton	Summit	Soil-Sap Interface	0.656493	0.019926	0.02113	0.0228	0.02129	0.00144
Hilton	Summit	Soil-Sap Interface	0.720675	0.026975	0.02864	0.03092	0.02884	0.00198
Hilton	Summit	Soil-Sap Interface	0.791132	0.033081	0.03517	0.03799	0.03541	0.00246
Hilton	Summit	Soil-Sap Interface	0.868477	0.038024	0.0405	0.04378	0.04077	0.00289
Hilton	Summit	Soil-Sap Interface	0.953383	0.041621	0.04442	0.04807	0.0447	0.00323
Hilton	Summit	Soil-Sap Interface	1.04659	0.043719	0.04677	0.05067	0.04706	0.00349
Hilton	Summit	Soil-Sap Interface	1.14891	0.044369	0.0476	0.05164	0.04787	0.00364
Hilton	Summit	Soil-Sap Interface	1.26123	0.043709	0.04703	0.0511	0.04728	0.0037
Hilton	Summit	Soil-Sap Interface	1.38454	0.041973	0.04531	0.0493	0.04553	0.00367
Hilton	Summit	Soil-Sap Interface	1.5199	0.039477	0.04275	0.04659	0.04294	0.00356
Hilton	Summit	Soil-Sap Interface	1.66849	0.03661	0.03976	0.0434	0.03993	0.0034
Hilton	Summit	Soil-Sap Interface	1.83161	0.033808	0.03681	0.04024	0.03695	0.00322
Hilton	Summit	Soil-Sap Interface	2.01068	0.031515	0.03436	0.03763	0.0345	0.00306
Hilton	Summit	Soil-Sap Interface	2.20725	0.030142	0.03288	0.03606	0.03303	0.00296
Hilton	Summit	Soil-Sap Interface	2.42304	0.030019	0.03274	0.03596	0.03291	0.00297
Hilton	Summit	Soil-Sap Interface	2.65993	0.03136	0.03418	0.03759	0.03438	0.00312
Hilton	Summit	Soil-Sap Interface	2.91998	0.034221	0.03728	0.04104	0.03751	0.00341
Hilton	Summit	Soil-Sap Interface	3.20545	0.038486	0.04193	0.04617	0.04219	0.00385
Hilton	Summit	Soil-Sap Interface	3.51883	0.043854	0.04779	0.05262	0.04809	0.00439
Hilton	Summit	Soil-Sap Interface	3.86284	0.049878	0.05438	0.05981	0.05469	0.00497
Hilton	Summit	Soil-Sap Interface	4.24049	0.056037	0.0611	0.06709	0.06141	0.00553
Hilton	Summit	Soil-Sap Interface	4.65506	0.061825	0.06738	0.0738	0.06767	0.00599
Hilton	Summit	Soil-Sap Interface	5.11017	0.066845	0.07278	0.07946	0.07303	0.00631
Hilton	Summit	Soil-Sap Interface	5.60976	0.070868	0.07702	0.08378	0.07722	0.00646

Hilton	Summit	Soil-Sap Interface	6.1582	0.073873	0.08009	0.08676	0.08024	0.00645
Hilton	Summit	Soil-Sap Interface	6.76025	0.076036	0.08219	0.08867	0.0823	0.00632
Hilton	Summit	Soil-Sap Interface	7.42117	0.077685	0.08368	0.08995	0.08377	0.00613
Hilton	Summit	Soil-Sap Interface	8.14669	0.079329	0.08515	0.09128	0.08525	0.00598
Hilton	Summit	Soil-Sap Interface	8.94315	0.081677	0.08739	0.09357	0.08755	0.00595
Hilton	Summit	Soil-Sap Interface	9.81748	0.085572	0.09135	0.09788	0.0916	0.00616
Hilton	Summit	Soil-Sap Interface	10.7773	0.091881	0.09802	0.10525	0.09838	0.00669
Hilton	Summit	Soil-Sap Interface	11.8309	0.101284	0.10815	0.11644	0.10862	0.00759
Hilton	Summit	Soil-Sap Interface	12.9876	0.114003	0.12194	0.13159	0.12251	0.00881
Hilton	Summit	Soil-Sap Interface	14.2573	0.12961	0.13884	0.14995	0.13947	0.01019
Hilton	Summit	Soil-Sap Interface	15.6512	0.146952	0.15739	0.16985	0.15806	0.01147
Hilton	Summit	Soil-Sap Interface	17.1813	0.164364	0.17549	0.18888	0.17625	0.01228
Hilton	Summit	Soil-Sap Interface	18.861	0.1802	0.19111	0.20461	0.19197	0.01223
Hilton	Summit	Soil-Sap Interface	20.705	0.193691	0.2033	0.21591	0.2043	0.01114
Hilton	Summit	Soil-Sap Interface	22.7292	0.205662	0.21315	0.22416	0.21432	0.0093
Hilton	Summit	Soil-Sap Interface	24.9513	0.218414	0.22364	0.23312	0.22506	0.00745
Hilton	Summit	Soil-Sap Interface	27.3906	0.234785	0.23836	0.24723	0.24013	0.00641
Hilton	Summit	Soil-Sap Interface	30.0685	0.256394	0.25922	0.2687	0.26144	0.00645
Hilton	Summit	Soil-Sap Interface	33.0081	0.281991	0.28434	0.29501	0.28711	0.00694
Hilton	Summit	Soil-Sap Interface	36.2352	0.307245	0.30793	0.31876	0.31131	0.00646
Hilton	Summit	Soil-Sap Interface	39.7777	0.326813	0.32313	0.33158	0.32718	0.00423
Hilton	Summit	Soil-Sap Interface	43.6665	0.338303	0.3272	0.33056	0.33202	0.0057
Hilton	Summit	Soil-Sap Interface	47.9356	0.344144	0.32356	0.32041	0.32937	0.01289
Hilton	Summit	Soil-Sap Interface	52.622	0.349048	0.31856	0.30909	0.32557	0.02088
Hilton	Summit	Soil-Sap Interface	57.7666	0.355859	0.31656	0.30229	0.3249	0.02774
Hilton	Summit	Soil-Sap Interface	63.4141	0.36221	0.31568	0.29839	0.32543	0.03301
Hilton	Summit	Soil-Sap Interface	69.6138	0.362786	0.30969	0.28989	0.32079	0.03769
Hilton	Summit	Soil-Sap Interface	76.4196	0.359376	0.2998	0.27688	0.31202	0.04258
Hilton	Summit	Soil-Sap Interface	83.8907	0.364026	0.29929	0.27327	0.3122	0.04673
Hilton	Summit	Soil-Sap Interface	92.0923	0.386552	0.31971	0.29172	0.33266	0.04872
Hilton	Summit	Soil-Sap Interface	101.096	0.425698	0.36027	0.33177	0.37258	0.04816
Hilton	Summit	Soil-Sap Interface	110.979	0.479196	0.4173	0.38997	0.42882	0.04572
Hilton	Summit	Soil-Sap Interface	121.829	0.558937	0.50029	0.47674	0.51199	0.04233
Hilton	Summit	Soil-Sap Interface	133.74	0.687204	0.62932	0.61275	0.64309	0.03909
Hilton	Summit	Soil-Sap Interface	146.815	0.876669	0.81581	0.8078	0.83343	0.03766
Hilton	Summit	Soil-Sap Interface	161.168	1.12333	1.05708	1.05547	1.07863	0.03872
Hilton	Summit	Soil-Sap Interface	176.925	1.42803	1.35815	1.35791	1.38136	0.04041
Hilton	Summit	Soil-Sap Interface	194.222	1.81546	1.74693	1.74327	1.76855	0.04066
Hilton	Summit	Soil-Sap Interface	213.21	2.32318	2.25883	2.24954	2.27718	0.0401
Hilton	Summit	Soil-Sap Interface	234.054	2.98546	2.92094	2.908	2.93813	0.04149
Hilton	Summit	Soil-Sap Interface	256.936	3.82246	3.7464	3.73672	3.76853	0.04696
Hilton	Summit	Soil-Sap Interface	282.056	4.81477	4.7145	4.7184	4.74922	0.0568
Hilton	Summit	Soil-Sap Interface	309.631	5.87723	5.74772	5.77504	5.8	0.06827
Hilton	Summit	Soil-Sap Interface	339.902	6.86596	6.71669	6.77247	6.78504	0.07542
Hilton	Summit	Soil-Sap Interface	373.132	7.61506	7.4692	7.55208	7.54545	0.07316
Hilton	Summit	Soil-Sap Interface	409.611	7.98008	7.86472	7.97221	7.939	0.06445
Hilton	Summit	Soil-Sap Interface	449.657	7.87494	7.81024	7.945	7.87673	0.0674
Hilton	Summit	Soil-Sap Interface	493.617	7.29603	7.28857	7.45446	7.34635	0.0937
Hilton	Summit	Soil-Sap Interface	541.876	6.32636	6.36974	6.55858	6.41823	0.12347
Hilton	Summit	Soil-Sap Interface	594.852	5.12461	5.20306	5.38388	5.23718	0.13296
Hilton	Summit	Soil-Sap Interface	653.008	3.88678	3.97988	4.10307	3.98991	0.10849
Hilton	Summit	Soil-Sap Interface	716.849	2.79138	2.88698	2.90609	2.86148	0.06146
Hilton	Summit	Soil-Sap Interface	786.932	1.95182	2.05522	1.95438	1.98714	0.05897
Hilton	Summit	Soil-Sap Interface	863.866	1.39022	1.51822	1.32588	1.41144	0.09791
Hilton	Summit	Soil-Sap Interface	948.322	1.05255	1.22089	0.99439	1.08928	0.11763
Hilton	Summit	Soil-Sap Interface	1041.03	0.859136	1.0626	0.85947	0.92707	0.11737
Hilton	Summit	Soil-Sap Interface	1142.81	0.757011	0.97407	0.83289	0.85465	0.11015
Hilton	Summit	Soil-Sap Interface	1254.54	0.715156	0.92343	0.8484	0.829	0.10548
Hilton	Summit	Soil-Sap Interface	1377.19	0.687148	0.8545	0.81442	0.78536	0.08738
Hilton	Summit	Soil-Sap Interface	1511.83	0.669975	0.78353	0.74909	0.7342	0.05822
Hilton	Summit	Soil-Sap Interface	1659.63	0.660151	0.69884	0.65798	0.67233	0.02299
Hilton	Summit	Soil-Sap Interface	1821.88	0.623716	0.57534	0.52421	0.57442	0.04976
Hilton	Summit	~30 cm below interface	0.375124	0.00548	0.0057	0.00459	0.00525	0.00059
Hilton	Summit	~30 cm below interface	0.411798	0.010456	0.01087	0.00825	0.00986	0.00141
Hilton	Summit	~30 cm below interface	0.452057	0.017606	0.01832	0.01233	0.01608	0.00327
Hilton	Summit	~30 cm below interface	0.496252	0.024344	0.02535	0.01778	0.02249	0.00411
Hilton	Summit	~30 cm below interface	0.544768	0.030725	0.03203	0.02233	0.02836	0.00527
Hilton	Summit	~30 cm below interface	0.598027	0.036658	0.03828	0.02665	0.03386	0.0063
Hilton	Summit	~30 cm below interface	0.656493	0.042045	0.04399	0.03085	0.03896	0.00709
Hilton	Summit	~30 cm below interface	0.720675	0.046766	0.04904	0.03522	0.04368	0.00741

Hilton	Summit	~30 cm below interface	0.791132	0.050703	0.05332	0.03897	0.04766	0.00764
Hilton	Summit	~30 cm below interface	0.868477	0.053735	0.05668	0.04241	0.05094	0.00754
Hilton	Summit	~30 cm below interface	0.953383	0.055752	0.05901	0.04556	0.05344	0.00702
Hilton	Summit	~30 cm below interface	1.04659	0.056663	0.06021	0.04855	0.05514	0.00598
Hilton	Summit	~30 cm below interface	1.14891	0.056508	0.0603	0.05108	0.05596	0.00463
Hilton	Summit	~30 cm below interface	1.26123	0.055382	0.05937	0.05326	0.056	0.0031
Hilton	Summit	~30 cm below interface	1.38454	0.053445	0.05758	0.05517	0.0554	0.00208
Hilton	Summit	~30 cm below interface	1.5199	0.050928	0.05516	0.0569	0.05433	0.00307
Hilton	Summit	~30 cm below interface	1.66849	0.048132	0.05243	0.0585	0.05302	0.00521
Hilton	Summit	~30 cm below interface	1.83161	0.045425	0.04978	0.05995	0.05172	0.00746
Hilton	Summit	~30 cm below interface	2.01068	0.043208	0.04765	0.06137	0.05074	0.00947
Hilton	Summit	~30 cm below interface	2.20725	0.041883	0.04648	0.06283	0.0504	0.01101
Hilton	Summit	~30 cm below interface	2.42304	0.041799	0.04667	0.0645	0.05099	0.01195
Hilton	Summit	~30 cm below interface	2.65993	0.043202	0.0485	0.06634	0.05268	0.01212
Hilton	Summit	~30 cm below interface	2.91998	0.046179	0.05205	0.06844	0.05556	0.01154
Hilton	Summit	~30 cm below interface	3.20545	0.050632	0.0572	0.07082	0.05955	0.0103
Hilton	Summit	~30 cm below interface	3.51883	0.056263	0.06361	0.07359	0.06449	0.0087
Hilton	Summit	~30 cm below interface	3.86284	0.062612	0.07075	0.07671	0.07003	0.00708
Hilton	Summit	~30 cm below interface	4.24049	0.069129	0.07799	0.0802	0.07577	0.00586
Hilton	Summit	~30 cm below interface	4.65506	0.07527	0.08471	0.08404	0.08134	0.00527
Hilton	Summit	~30 cm below interface	5.11017	0.080596	0.09043	0.08827	0.08643	0.00517
Hilton	Summit	~30 cm below interface	5.60976	0.084841	0.09488	0.09285	0.09086	0.00531
Hilton	Summit	~30 cm below interface	6.1582	0.087963	0.09804	0.09783	0.09461	0.00576
Hilton	Summit	~30 cm below interface	6.76025	0.090126	0.10017	0.10322	0.09784	0.00685
Hilton	Summit	~30 cm below interface	7.42117	0.091662	0.10166	0.10907	0.1008	0.00874
Hilton	Summit	~30 cm below interface	8.14669	0.093105	0.10318	0.11545	0.10391	0.01119
Hilton	Summit	~30 cm below interface	8.94315	0.095229	0.10558	0.12255	0.10778	0.01379
Hilton	Summit	~30 cm below interface	9.81748	0.098988	0.10988	0.13053	0.11313	0.01602
Hilton	Summit	~30 cm below interface	10.7773	0.10541	0.11713	0.13958	0.12071	0.01737
Hilton	Summit	~30 cm below interface	11.8309	0.11538	0.12813	0.14987	0.13113	0.01744
Hilton	Summit	~30 cm below interface	12.9876	0.129315	0.14317	0.16155	0.14468	0.01617
Hilton	Summit	~30 cm below interface	14.2573	0.146938	0.16178	0.17479	0.16117	0.01394
Hilton	Summit	~30 cm below interface	15.6512	0.16705	0.18261	0.18965	0.17977	0.01156
Hilton	Summit	~30 cm below interface	17.1813	0.187674	0.2035	0.20617	0.19911	0.01
Hilton	Summit	~30 cm below interface	18.861	0.206534	0.22201	0.22408	0.21754	0.00959
Hilton	Summit	~30 cm below interface	20.705	0.222076	0.23661	0.24312	0.23394	0.01077
Hilton	Summit	~30 cm below interface	22.7292	0.234685	0.24803	0.26291	0.24854	0.01412
Hilton	Summit	~30 cm below interface	24.9513	0.247008	0.25938	0.28331	0.26323	0.01845
Hilton	Summit	~30 cm below interface	27.3906	0.26342	0.27516	0.30424	0.28094	0.02101
Hilton	Summit	~30 cm below interface	30.0685	0.287662	0.29857	0.32554	0.30392	0.0195
Hilton	Summit	~30 cm below interface	33.0081	0.319718	0.32831	0.3466	0.33154	0.01373
Hilton	Summit	~30 cm below interface	36.2352	0.354471	0.35759	0.366	0.35935	0.00596
Hilton	Summit	~30 cm below interface	39.7777	0.383968	0.37752	0.38184	0.38111	0.00329
Hilton	Summit	~30 cm below interface	43.6665	0.403777	0.38445	0.39228	0.3935	0.00972
Hilton	Summit	~30 cm below interface	47.9356	0.416574	0.38303	0.39628	0.39863	0.01689
Hilton	Summit	~30 cm below interface	52.622	0.429339	0.38189	0.39387	0.4017	0.02467
Hilton	Summit	~30 cm below interface	57.7666	0.449667	0.38929	0.38654	0.4085	0.03568
Hilton	Summit	~30 cm below interface	63.4141	0.481567	0.40931	0.3785	0.42312	0.05291
Hilton	Summit	~30 cm below interface	69.6138	0.524089	0.44136	0.37789	0.44778	0.07331
Hilton	Summit	~30 cm below interface	76.4196	0.579841	0.48936	0.39787	0.48902	0.09099
Hilton	Summit	~30 cm below interface	83.8907	0.661821	0.56796	0.45662	0.56213	0.10273
Hilton	Summit	~30 cm below interface	92.0923	0.786422	0.69373	0.57717	0.68577	0.10485
Hilton	Summit	~30 cm below interface	101.096	0.967713	0.87807	0.78684	0.87754	0.09044
Hilton	Summit	~30 cm below interface	110.979	1.22571	1.13674	1.11196	1.15814	0.05982
Hilton	Summit	~30 cm below interface	121.829	1.59549	1.50276	1.57178	1.55668	0.04817
Hilton	Summit	~30 cm below interface	133.74	2.118	2.01875	2.16951	2.10209	0.07663
Hilton	Summit	~30 cm below interface	146.815	2.81178	2.70652	2.89048	2.80293	0.0923
Hilton	Summit	~30 cm below interface	161.168	3.65031	3.54231	3.69847	3.63036	0.07997
Hilton	Summit	~30 cm below interface	176.925	4.56711	4.46228	4.54024	4.52321	0.05445
Hilton	Summit	~30 cm below interface	194.222	5.46744	5.37334	5.34928	5.39669	0.06244
Hilton	Summit	~30 cm below interface	213.21	6.23486	6.15569	6.05625	6.14893	0.0895
Hilton	Summit	~30 cm below interface	234.054	6.76466	6.69807	6.5989	6.68721	0.08341
Hilton	Summit	~30 cm below interface	256.936	7.01012	6.94829	6.92998	6.9628	0.04199
Hilton	Summit	~30 cm below interface	282.056	6.9874	6.92037	7.02474	6.9775	0.05288
Hilton	Summit	~30 cm below interface	309.631	6.74614	6.66665	6.8805	6.76443	0.10809
Hilton	Summit	~30 cm below interface	339.902	6.34179	6.25159	6.51706	6.37015	0.13499
Hilton	Summit	~30 cm below interface	373.132	5.81948	5.72825	5.9705	5.83941	0.12235
Hilton	Summit	~30 cm below interface	409.611	5.2055	5.12223	5.2873	5.20501	0.08254
Hilton	Summit	~30 cm below interface	449.657	4.50977	4.43544	4.51773	4.48765	0.04539
Hilton	Summit	~30 cm below interface	493.617	3.74156	3.66832	3.71274	3.70754	0.0369

Hilton	Summit	~30 cm below interface	541.876	2.92769	2.8449	2.92175	2.89811	0.04618
Hilton	Summit	~30 cm below interface	594.852	2.12896	2.02939	2.18789	2.11541	0.08011
Hilton	Summit	~30 cm below interface	653.008	1.42167	1.31168	1.54341	1.42559	0.11591
Hilton	Summit	~30 cm below interface	716.849	0.864173	0.76936	1.00837	0.88063	0.12035
Hilton	Summit	~30 cm below interface	786.932	0.479997	0.43246	0.58813	0.5002	0.07978
Hilton	Summit	~30 cm below interface	863.866	0.237151	0.2594	0.27529	0.25728	0.01916
Hilton	Summit	~30 cm below interface	948.322	0.072263	0.16498	0.09107	0.10944	0.04901
Hilton	Summit	~30 cm below interface	1041.03	0.005431	0.11013	0.01557	0.04371	0.05774
Hilton	Summit	~30 cm below interface	1142.81	0	0.10211	0.00107	0.03439	0.05865
Hilton	Summit	~30 cm below interface	1254.54	0	0.14449	0	0.04816	0.08342
Hilton	Summit	~30 cm below interface	1377.19	0	0.23773	0	0.07924	0.13725
Hilton	Summit	~30 cm below interface	1511.83	0	0.37512	0	0.12504	0.21657
Hilton	Summit	~30 cm below interface	1659.63	0	0.52234	0	0.17411	0.30157
Hilton	Summit	~30 cm below interface	1821.88	0	0.61355	0	0.20452	0.35423
Hilton	Shoulder	Soil-Sap Interface	0.375124	0	0.00493	0.00511	0.00335	0.0029
Hilton	Shoulder	Soil-Sap Interface	0.411798	0	0.00943	0.00978	0.0064	0.00555
Hilton	Shoulder	Soil-Sap Interface	0.452057	0	0.01593	0.01655	0.01083	0.00938
Hilton	Shoulder	Soil-Sap Interface	0.496252	0.000366	0.02214	0.02305	0.01518	0.01284
Hilton	Shoulder	Soil-Sap Interface	0.544768	0.004915	0.02813	0.02936	0.0208	0.01377
Hilton	Shoulder	Soil-Sap Interface	0.598027	0.015091	0.03384	0.03543	0.02812	0.01131
Hilton	Shoulder	Soil-Sap Interface	0.656493	0.02506	0.0392	0.04118	0.03514	0.00879
Hilton	Shoulder	Soil-Sap Interface	0.720675	0.03391	0.04408	0.0465	0.0415	0.00668
Hilton	Shoulder	Soil-Sap Interface	0.791132	0.041547	0.04837	0.05126	0.04706	0.00499
Hilton	Shoulder	Soil-Sap Interface	0.868477	0.047681	0.05191	0.0553	0.05163	0.00382
Hilton	Shoulder	Soil-Sap Interface	0.953383	0.05206	0.05454	0.05842	0.055	0.0032
Hilton	Shoulder	Soil-Sap Interface	1.04659	0.054465	0.05608	0.06041	0.05698	0.00307
Hilton	Shoulder	Soil-Sap Interface	1.14891	0.054933	0.05647	0.06118	0.05753	0.00326
Hilton	Shoulder	Soil-Sap Interface	1.26123	0.05362	0.0557	0.06069	0.05667	0.00363
Hilton	Shoulder	Soil-Sap Interface	1.38454	0.050802	0.05383	0.05897	0.05454	0.00413
Hilton	Shoulder	Soil-Sap Interface	1.5199	0.046876	0.05105	0.0562	0.05138	0.00467
Hilton	Shoulder	Soil-Sap Interface	1.66849	0.042344	0.04766	0.05269	0.04756	0.00517
Hilton	Shoulder	Soil-Sap Interface	1.83161	0.037785	0.04409	0.0489	0.04359	0.00558
Hilton	Shoulder	Soil-Sap Interface	2.01068	0.033818	0.0409	0.04546	0.04006	0.00587
Hilton	Shoulder	Soil-Sap Interface	2.20725	0.031034	0.0387	0.04306	0.0376	0.00609
Hilton	Shoulder	Soil-Sap Interface	2.42304	0.029929	0.03809	0.04239	0.0368	0.00633
Hilton	Shoulder	Soil-Sap Interface	2.65993	0.030851	0.03953	0.04401	0.03813	0.00669
Hilton	Shoulder	Soil-Sap Interface	2.91998	0.033943	0.0433	0.04822	0.04182	0.00725
Hilton	Shoulder	Soil-Sap Interface	3.20545	0.039108	0.04935	0.05501	0.04782	0.00806
Hilton	Shoulder	Soil-Sap Interface	3.51883	0.045975	0.05733	0.06398	0.05576	0.0091
Hilton	Shoulder	Soil-Sap Interface	3.86284	0.053937	0.06656	0.07435	0.06495	0.0103
Hilton	Shoulder	Soil-Sap Interface	4.24049	0.062251	0.07618	0.08512	0.07452	0.01152
Hilton	Shoulder	Soil-Sap Interface	4.65506	0.070172	0.08528	0.09527	0.08357	0.01263
Hilton	Shoulder	Soil-Sap Interface	5.11017	0.077095	0.09315	0.10394	0.0914	0.01351
Hilton	Shoulder	Soil-Sap Interface	5.60976	0.082644	0.09934	0.11064	0.09754	0.01408
Hilton	Shoulder	Soil-Sap Interface	6.1582	0.086729	0.10375	0.11528	0.10192	0.01436
Hilton	Shoulder	Soil-Sap Interface	6.76025	0.089527	0.10666	0.11817	0.10478	0.01441
Hilton	Shoulder	Soil-Sap Interface	7.42117	0.091395	0.10853	0.11988	0.1066	0.01434
Hilton	Shoulder	Soil-Sap Interface	8.14669	0.092901	0.11012	0.12128	0.1081	0.0143
Hilton	Shoulder	Soil-Sap Interface	8.94315	0.094853	0.11241	0.12351	0.11026	0.01445
Hilton	Shoulder	Soil-Sap Interface	9.81748	0.098217	0.11653	0.12786	0.1142	0.01496
Hilton	Shoulder	Soil-Sap Interface	10.7773	0.104004	0.12361	0.13557	0.12106	0.01593
Hilton	Shoulder	Soil-Sap Interface	11.8309	0.112991	0.13441	0.14746	0.13162	0.0174
Hilton	Shoulder	Soil-Sap Interface	12.9876	0.1254	0.14905	0.16354	0.146	0.01925
Hilton	Shoulder	Soil-Sap Interface	14.2573	0.140615	0.16672	0.18273	0.16336	0.02126
Hilton	Shoulder	Soil-Sap Interface	15.6512	0.157085	0.18556	0.20278	0.18181	0.02308
Hilton	Shoulder	Soil-Sap Interface	17.1813	0.172499	0.20273	0.22038	0.19854	0.02422
Hilton	Shoulder	Soil-Sap Interface	18.861	0.184429	0.21506	0.23201	0.2105	0.02412
Hilton	Shoulder	Soil-Sap Interface	20.705	0.191601	0.22071	0.23598	0.2161	0.02254
Hilton	Shoulder	Soil-Sap Interface	22.7292	0.195013	0.221	0.23426	0.21676	0.01996
Hilton	Shoulder	Soil-Sap Interface	24.9513	0.198283	0.22075	0.2326	0.21721	0.01743
Hilton	Shoulder	Soil-Sap Interface	27.3906	0.20666	0.22663	0.23819	0.22383	0.01595
Hilton	Shoulder	Soil-Sap Interface	30.0685	0.224518	0.24382	0.25597	0.24144	0.01586
Hilton	Shoulder	Soil-Sap Interface	33.0081	0.252577	0.27238	0.28507	0.27001	0.01638
Hilton	Shoulder	Soil-Sap Interface	36.2352	0.286487	0.30536	0.31741	0.30309	0.01559
Hilton	Shoulder	Soil-Sap Interface	39.7777	0.319843	0.33337	0.34299	0.33207	0.01163
Hilton	Shoulder	Soil-Sap Interface	43.6665	0.35128	0.3546	0.36053	0.35547	0.00469
Hilton	Shoulder	Soil-Sap Interface	47.9356	0.386933	0.37796	0.38022	0.38171	0.00467
Hilton	Shoulder	Soil-Sap Interface	52.622	0.435333	0.4159	0.41594	0.42239	0.01121
Hilton	Shoulder	Soil-Sap Interface	57.7666	0.500941	0.47556	0.47572	0.48408	0.01461
Hilton	Shoulder	Soil-Sap Interface	63.4141	0.578427	0.55054	0.55212	0.56036	0.01567

Hilton	Shoulder	Soil-Sap Interface	69.6138	0.654154	0.62248	0.62384	0.63349	0.01791
Hilton	Shoulder	Soil-Sap Interface	76.4196	0.721868	0.68342	0.68142	0.69557	0.0228
Hilton	Shoulder	Soil-Sap Interface	83.8907	0.790393	0.74731	0.74154	0.75975	0.0267
Hilton	Shoulder	Soil-Sap Interface	92.0923	0.865688	0.82511	0.81878	0.83652	0.02545
Hilton	Shoulder	Soil-Sap Interface	101.096	0.937086	0.90342	0.89963	0.91338	0.02062
Hilton	Shoulder	Soil-Sap Interface	110.979	0.993794	0.96462	0.96291	0.97378	0.01736
Hilton	Shoulder	Soil-Sap Interface	121.829	1.04925	1.02102	1.01922	1.02983	0.01684
Hilton	Shoulder	Soil-Sap Interface	133.74	1.13534	1.10925	1.10693	1.11717	0.01578
Hilton	Shoulder	Soil-Sap Interface	146.815	1.27012	1.249	1.24609	1.25507	0.01311
Hilton	Shoulder	Soil-Sap Interface	161.168	1.44262	1.4255	1.41948	1.4292	0.01201
Hilton	Shoulder	Soil-Sap Interface	176.925	1.63436	1.61841	1.60757	1.62011	0.01348
Hilton	Shoulder	Soil-Sap Interface	194.222	1.83808	1.82241	1.81147	1.82399	0.01337
Hilton	Shoulder	Soil-Sap Interface	213.21	2.05177	2.03358	2.03118	2.03884	0.01126
Hilton	Shoulder	Soil-Sap Interface	234.054	2.29384	2.26423	2.27541	2.27783	0.01495
Hilton	Shoulder	Soil-Sap Interface	256.936	2.63419	2.58542	2.60927	2.60963	0.02439
Hilton	Shoulder	Soil-Sap Interface	282.056	3.17648	3.1136	3.14277	3.14428	0.03147
Hilton	Shoulder	Soil-Sap Interface	309.631	3.99615	3.93905	3.95779	3.96433	0.02911
Hilton	Shoulder	Soil-Sap Interface	339.902	5.08597	5.0616	5.05096	5.06618	0.01795
Hilton	Shoulder	Soil-Sap Interface	373.132	6.33037	6.36219	6.31374	6.33543	0.02462
Hilton	Shoulder	Soil-Sap Interface	409.611	7.51218	7.60775	7.53342	7.55112	0.05018
Hilton	Shoulder	Soil-Sap Interface	449.657	8.36002	8.50176	8.42779	8.42986	0.07089
Hilton	Shoulder	Soil-Sap Interface	493.617	8.63583	8.78009	8.72646	8.71413	0.07292
Hilton	Shoulder	Soil-Sap Interface	541.876	8.2224	8.3087	8.27206	8.26772	0.04331
Hilton	Shoulder	Soil-Sap Interface	594.852	7.18134	7.16261	7.11555	7.15317	0.0339
Hilton	Shoulder	Soil-Sap Interface	653.008	5.73349	5.61047	5.52697	5.62364	0.10389
Hilton	Shoulder	Soil-Sap Interface	716.849	4.13966	3.96059	3.85516	3.98514	0.14383
Hilton	Shoulder	Soil-Sap Interface	786.932	2.63312	2.47729	2.393	2.50114	0.12182
Hilton	Shoulder	Soil-Sap Interface	863.866	1.38929	1.30534	1.28841	1.32768	0.05402
Hilton	Shoulder	Soil-Sap Interface	948.322	0.428291	0.40463	0.51517	0.44936	0.0582
Hilton	Shoulder	Soil-Sap Interface	1041.03	0.032084	0.03035	0.10158	0.05467	0.04063
Hilton	Shoulder	Soil-Sap Interface	1142.81	0	0	0.00456	0.00152	0.00263
Hilton	Shoulder	Soil-Sap Interface	1254.54	0	0	0	0	0
Hilton	Shoulder	Soil-Sap Interface	1377.19	0	0	0	0	0
Hilton	Shoulder	Soil-Sap Interface	1511.83	0	0	0	0	0
Hilton	Shoulder	Soil-Sap Interface	1659.63	0	0	0	0	0
Hilton	Shoulder	Soil-Sap Interface	1821.88	0	0	0	0	0
Hilton	Shoulder	~30 cm below interface	0.375124	0.011611	0.0134	0.01438	0.01313	0.0014
Hilton	Shoulder	~30 cm below interface	0.411798	0.02082	0.02401	0.02576	0.02353	0.0025
Hilton	Shoulder	~30 cm below interface	0.452057	0.031023	0.03577	0.03836	0.03505	0.00372
Hilton	Shoulder	~30 cm below interface	0.496252	0.044619	0.05144	0.05517	0.05041	0.00535
Hilton	Shoulder	~30 cm below interface	0.544768	0.055978	0.06459	0.06928	0.06328	0.00675
Hilton	Shoulder	~30 cm below interface	0.598027	0.066512	0.07677	0.08237	0.07522	0.00804
Hilton	Shoulder	~30 cm below interface	0.656493	0.0766	0.08845	0.0949	0.08665	0.00928
Hilton	Shoulder	~30 cm below interface	0.720675	0.086835	0.1003	0.10763	0.09826	0.01055
Hilton	Shoulder	~30 cm below interface	0.791132	0.095545	0.11047	0.11859	0.1082	0.01169
Hilton	Shoulder	~30 cm below interface	0.868477	0.103133	0.11936	0.12817	0.11689	0.0127
Hilton	Shoulder	~30 cm below interface	0.953383	0.109766	0.12717	0.13661	0.12451	0.01362
Hilton	Shoulder	~30 cm below interface	1.04659	0.115639	0.13413	0.14415	0.1313	0.01446
Hilton	Shoulder	~30 cm below interface	1.14891	0.120427	0.13992	0.15047	0.13694	0.01524
Hilton	Shoulder	~30 cm below interface	1.26123	0.124155	0.14454	0.15557	0.14142	0.01594
Hilton	Shoulder	~30 cm below interface	1.38454	0.127186	0.14841	0.15989	0.14516	0.01659
Hilton	Shoulder	~30 cm below interface	1.5199	0.129779	0.15182	0.16374	0.14845	0.01723
Hilton	Shoulder	~30 cm below interface	1.66849	0.132343	0.15529	0.16772	0.15178	0.01795
Hilton	Shoulder	~30 cm below interface	1.83161	0.134923	0.15887	0.17187	0.15522	0.01874
Hilton	Shoulder	~30 cm below interface	2.01068	0.13786	0.16298	0.17666	0.15917	0.01968
Hilton	Shoulder	~30 cm below interface	2.20725	0.14149	0.16799	0.18249	0.16399	0.02079
Hilton	Shoulder	~30 cm below interface	2.42304	0.146271	0.17446	0.18993	0.17022	0.02214
Hilton	Shoulder	~30 cm below interface	2.65993	0.152347	0.18255	0.19919	0.17803	0.02375
Hilton	Shoulder	~30 cm below interface	2.91998	0.15979	0.19231	0.21031	0.18747	0.0256
Hilton	Shoulder	~30 cm below interface	3.20545	0.16873	0.20388	0.22338	0.19866	0.0277
Hilton	Shoulder	~30 cm below interface	3.51883	0.179171	0.21717	0.2383	0.21155	0.02996
Hilton	Shoulder	~30 cm below interface	3.86284	0.191064	0.2321	0.25493	0.22603	0.03236
Hilton	Shoulder	~30 cm below interface	4.24049	0.204199	0.24831	0.27283	0.24178	0.03478
Hilton	Shoulder	~30 cm below interface	4.65506	0.218453	0.26562	0.29178	0.25862	0.03716
Hilton	Shoulder	~30 cm below interface	5.11017	0.233779	0.28389	0.3116	0.27642	0.03944
Hilton	Shoulder	~30 cm below interface	5.60976	0.25015	0.30312	0.33229	0.29518	0.04164
Hilton	Shoulder	~30 cm below interface	6.1582	0.267753	0.3235	0.35404	0.3151	0.04375
Hilton	Shoulder	~30 cm below interface	6.76025	0.286553	0.34504	0.37688	0.33616	0.04581
Hilton	Shoulder	~30 cm below interface	7.42117	0.307196	0.36848	0.40163	0.3591	0.04791
Hilton	Shoulder	~30 cm below interface	8.14669	0.330154	0.39448	0.42904	0.38456	0.05019

Hilton	Shoulder	~30 cm below interface	8.94315	0.356727	0.42466	0.46089	0.41409	0.05288
Hilton	Shoulder	~30 cm below interface	9.81748	0.387682	0.46006	0.49828	0.44867	0.05617
Hilton	Shoulder	~30 cm below interface	10.7773	0.4247	0.50264	0.5433	0.49021	0.06027
Hilton	Shoulder	~30 cm below interface	11.8309	0.469022	0.55392	0.59752	0.54015	0.06534
Hilton	Shoulder	~30 cm below interface	12.9876	0.522181	0.61577	0.66289	0.60028	0.07162
Hilton	Shoulder	~30 cm below interface	14.2573	0.585005	0.68908	0.74022	0.67143	0.0791
Hilton	Shoulder	~30 cm below interface	15.6512	0.657253	0.77311	0.82846	0.75294	0.08737
Hilton	Shoulder	~30 cm below interface	17.1813	0.738018	0.8658	0.92505	0.84296	0.09559
Hilton	Shoulder	~30 cm below interface	18.861	0.824571	0.96291	1.02522	0.93757	0.1027
Hilton	Shoulder	~30 cm below interface	20.705	0.914869	1.06139	1.12572	1.03399	0.10806
Hilton	Shoulder	~30 cm below interface	22.7292	1.00669	1.15881	1.22427	1.12992	0.11163
Hilton	Shoulder	~30 cm below interface	24.9513	1.09999	1.25567	1.32167	1.22578	0.11382
Hilton	Shoulder	~30 cm below interface	27.3906	1.1961	1.35375	1.41989	1.32325	0.11497
Hilton	Shoulder	~30 cm below interface	30.0685	1.29774	1.45531	1.52097	1.42467	0.11473
Hilton	Shoulder	~30 cm below interface	33.0081	1.40926	1.56335	1.62737	1.53333	0.11211
Hilton	Shoulder	~30 cm below interface	36.2352	1.53618	1.68169	1.74234	1.6534	0.10595
Hilton	Shoulder	~30 cm below interface	39.7777	1.6868	1.81778	1.8731	1.79256	0.09568
Hilton	Shoulder	~30 cm below interface	43.6665	1.87073	1.98201	2.03057	1.9611	0.08195
Hilton	Shoulder	~30 cm below interface	47.9356	2.09654	2.1855	2.22675	2.1696	0.06655
Hilton	Shoulder	~30 cm below interface	52.622	2.36652	2.43415	2.46886	2.42318	0.05204
Hilton	Shoulder	~30 cm below interface	57.7666	2.67134	2.72203	2.75189	2.71509	0.04072
Hilton	Shoulder	~30 cm below interface	63.4141	2.9885	3.02874	3.05557	3.02427	0.03376
Hilton	Shoulder	~30 cm below interface	69.6138	3.28591	3.32219	3.34677	3.31829	0.03062
Hilton	Shoulder	~30 cm below interface	76.4196	3.53145	3.56829	3.58934	3.56303	0.0293
Hilton	Shoulder	~30 cm below interface	83.8907	3.70368	3.74271	3.75652	3.7343	0.0274
Hilton	Shoulder	~30 cm below interface	92.0923	3.79962	3.83952	3.84069	3.82661	0.02338
Hilton	Shoulder	~30 cm below interface	101.096	3.83645	3.87353	3.85701	3.85566	0.01858
Hilton	Shoulder	~30 cm below interface	110.979	3.84534	3.87495	3.83854	3.85294	0.01936
Hilton	Shoulder	~30 cm below interface	121.829	3.86106	3.87915	3.82553	3.85525	0.02728
Hilton	Shoulder	~30 cm below interface	133.74	3.90527	3.90998	3.84674	3.88733	0.03523
Hilton	Shoulder	~30 cm below interface	146.815	3.97552	3.96742	3.90455	3.94916	0.03885
Hilton	Shoulder	~30 cm below interface	161.168	4.03752	4.01747	3.96325	4.00608	0.03842
Hilton	Shoulder	~30 cm below interface	176.925	4.03533	4.00011	3.9568	3.99741	0.03933
Hilton	Shoulder	~30 cm below interface	194.222	3.91139	3.84876	3.81065	3.85693	0.05086
Hilton	Shoulder	~30 cm below interface	213.21	3.63434	3.52154	3.47685	3.54424	0.08116
Hilton	Shoulder	~30 cm below interface	234.054	3.21843	3.02718	2.96295	3.06952	0.1329
Hilton	Shoulder	~30 cm below interface	256.936	2.721	2.42891	2.33673	2.49555	0.20061
Hilton	Shoulder	~30 cm below interface	282.056	2.2235	1.82834	1.7077	1.91985	0.2698
Hilton	Shoulder	~30 cm below interface	309.631	1.79837	1.32575	1.18459	1.43624	0.32146
Hilton	Shoulder	~30 cm below interface	339.902	1.48574	0.98122	0.83164	1.09954	0.34272
Hilton	Shoulder	~30 cm below interface	373.132	1.28565	0.79839	0.65003	0.91136	0.33253
Hilton	Shoulder	~30 cm below interface	409.611	1.16694	0.73979	0.59857	0.8351	0.29593
Hilton	Shoulder	~30 cm below interface	449.657	1.08311	0.74855	0.6202	0.81728	0.23899
Hilton	Shoulder	~30 cm below interface	493.617	0.988951	0.76053	0.65168	0.80039	0.17213
Hilton	Shoulder	~30 cm below interface	541.876	0.857837	0.72568	0.64144	0.74165	0.10908
Hilton	Shoulder	~30 cm below interface	594.852	0.687552	0.62784	0.56999	0.62846	0.05879
Hilton	Shoulder	~30 cm below interface	653.008	0.49893	0.48698	0.45354	0.47982	0.02353
Hilton	Shoulder	~30 cm below interface	716.849	0.319353	0.33936	0.32445	0.32772	0.0104
Hilton	Shoulder	~30 cm below interface	786.932	0.162577	0.20922	0.20487	0.19222	0.02576
Hilton	Shoulder	~30 cm below interface	863.866	0.059098	0.10424	0.10386	0.08906	0.02595
Hilton	Shoulder	~30 cm below interface	948.322	0.010957	0.03663	0.03673	0.02811	0.01485
Hilton	Shoulder	~30 cm below interface	1041.03	0.000853	0.00663	0.00665	0.00471	0.00334
Hilton	Shoulder	~30 cm below interface	1142.81	0	0.00047	0.00046	0.00031	0.00027
Hilton	Shoulder	~30 cm below interface	1254.54	0	0	0	0	0
Hilton	Shoulder	~30 cm below interface	1377.19	0	0	0	0	0
Hilton	Shoulder	~30 cm below interface	1511.83	0	0	0	0	0
Hilton	Shoulder	~30 cm below interface	1659.63	0	0	0	0	0
Hilton	Shoulder	~30 cm below interface	1821.88	0	0	0	0	0
Hilton	Backslope	Soil-Sap Interface	0.375124	0	0.00543	0.0058	0.00374	0.00325
Hilton	Backslope	Soil-Sap Interface	0.411798	0	0.01037	0.01107	0.00714	0.0062
Hilton	Backslope	Soil-Sap Interface	0.452057	0	0.01747	0.01867	0.01205	0.01045
Hilton	Backslope	Soil-Sap Interface	0.496252	0.000341	0.02419	0.02587	0.0168	0.01428
Hilton	Backslope	Soil-Sap Interface	0.544768	0.004581	0.03058	0.03276	0.02264	0.01568
Hilton	Backslope	Soil-Sap Interface	0.598027	0.014067	0.03657	0.03925	0.02996	0.01383
Hilton	Backslope	Soil-Sap Interface	0.656493	0.023375	0.04207	0.04526	0.0369	0.01182
Hilton	Backslope	Soil-Sap Interface	0.720675	0.031673	0.04696	0.05067	0.0431	0.01007
Hilton	Backslope	Soil-Sap Interface	0.791132	0.038891	0.05115	0.05536	0.04847	0.00856
Hilton	Backslope	Soil-Sap Interface	0.868477	0.044786	0.05452	0.05923	0.05285	0.00737
Hilton	Backslope	Soil-Sap Interface	0.953383	0.049156	0.05697	0.06215	0.05609	0.00654
Hilton	Backslope	Soil-Sap Interface	1.04659	0.051834	0.05842	0.06404	0.0581	0.00611

Hilton	Backslope	Soil-Sap Interface	1.14891	0.052884	0.05891	0.06491	0.0589	0.00601
Hilton	Backslope	Soil-Sap Interface	1.26123	0.052472	0.05853	0.06485	0.05862	0.00619
Hilton	Backslope	Soil-Sap Interface	1.38454	0.050868	0.05744	0.06404	0.05745	0.00658
Hilton	Backslope	Soil-Sap Interface	1.5199	0.04843	0.05589	0.0627	0.05567	0.00714
Hilton	Backslope	Soil-Sap Interface	1.66849	0.045596	0.05418	0.06118	0.05365	0.0078
Hilton	Backslope	Soil-Sap Interface	1.83161	0.042844	0.05269	0.05988	0.05181	0.00855
Hilton	Backslope	Soil-Sap Interface	2.01068	0.040657	0.05185	0.05928	0.05059	0.00937
Hilton	Backslope	Soil-Sap Interface	2.20725	0.039474	0.05208	0.05985	0.05047	0.01028
Hilton	Backslope	Soil-Sap Interface	2.42304	0.039645	0.05375	0.06201	0.0518	0.01131
Hilton	Backslope	Soil-Sap Interface	2.65993	0.041388	0.05711	0.06605	0.05485	0.01249
Hilton	Backslope	Soil-Sap Interface	2.91998	0.044759	0.06224	0.07206	0.05969	0.01383
Hilton	Backslope	Soil-Sap Interface	3.20545	0.04963	0.069	0.07985	0.06616	0.01531
Hilton	Backslope	Soil-Sap Interface	3.51883	0.055689	0.077	0.08898	0.07389	0.01686
Hilton	Backslope	Soil-Sap Interface	3.86284	0.062484	0.08568	0.09879	0.08232	0.01838
Hilton	Backslope	Soil-Sap Interface	4.24049	0.069488	0.09436	0.10848	0.09078	0.01974
Hilton	Backslope	Soil-Sap Interface	4.65506	0.076188	0.10241	0.1173	0.09863	0.02082
Hilton	Backslope	Soil-Sap Interface	5.11017	0.08217	0.10929	0.12467	0.10538	0.02152
Hilton	Backslope	Soil-Sap Interface	5.60976	0.087179	0.11472	0.13025	0.11072	0.02181
Hilton	Backslope	Soil-Sap Interface	6.1582	0.091148	0.11867	0.13405	0.11462	0.02174
Hilton	Backslope	Soil-Sap Interface	6.76025	0.094209	0.12138	0.1364	0.11733	0.02138
Hilton	Backslope	Soil-Sap Interface	7.42117	0.096624	0.12328	0.13781	0.11924	0.02089
Hilton	Backslope	Soil-Sap Interface	8.14669	0.098838	0.12502	0.13909	0.12098	0.02043
Hilton	Backslope	Soil-Sap Interface	8.94315	0.101496	0.12752	0.1413	0.12344	0.02021
Hilton	Backslope	Soil-Sap Interface	9.81748	0.105385	0.13182	0.14563	0.12761	0.02045
Hilton	Backslope	Soil-Sap Interface	10.7773	0.111329	0.13894	0.15321	0.13449	0.02129
Hilton	Backslope	Soil-Sap Interface	11.8309	0.119943	0.14958	0.16475	0.14476	0.02279
Hilton	Backslope	Soil-Sap Interface	12.9876	0.131382	0.16374	0.18013	0.15842	0.02481
Hilton	Backslope	Soil-Sap Interface	14.2573	0.145041	0.18044	0.19809	0.17452	0.02701
Hilton	Backslope	Soil-Sap Interface	15.6512	0.159498	0.19759	0.2161	0.19106	0.02886
Hilton	Backslope	Soil-Sap Interface	17.1813	0.172641	0.2122	0.23062	0.20515	0.02962
Hilton	Backslope	Soil-Sap Interface	18.861	0.182315	0.22123	0.23826	0.21394	0.02868
Hilton	Backslope	Soil-Sap Interface	20.705	0.187405	0.22328	0.23779	0.21616	0.02593
Hilton	Backslope	Soil-Sap Interface	22.7292	0.188751	0.22002	0.23176	0.21351	0.02223
Hilton	Backslope	Soil-Sap Interface	24.9513	0.189478	0.21644	0.22624	0.21072	0.01904
Hilton	Backslope	Soil-Sap Interface	27.3906	0.19379	0.21853	0.22791	0.21341	0.01763
Hilton	Backslope	Soil-Sap Interface	30.0685	0.204938	0.23018	0.24045	0.22519	0.01827
Hilton	Backslope	Soil-Sap Interface	33.0081	0.223036	0.25021	0.26159	0.24494	0.01981
Hilton	Backslope	Soil-Sap Interface	36.2352	0.2441	0.27159	0.28301	0.26623	0.02
Hilton	Backslope	Soil-Sap Interface	39.7777	0.262185	0.28563	0.29518	0.281	0.01698
Hilton	Backslope	Soil-Sap Interface	43.6665	0.273725	0.2888	0.29468	0.28574	0.01081
Hilton	Backslope	Soil-Sap Interface	47.9356	0.280697	0.2861	0.28762	0.2848	0.00364
Hilton	Backslope	Soil-Sap Interface	52.622	0.288945	0.28673	0.28487	0.28685	0.00204
Hilton	Backslope	Soil-Sap Interface	57.7666	0.303444	0.29699	0.29374	0.29806	0.00494
Hilton	Backslope	Soil-Sap Interface	63.4141	0.324516	0.31532	0.3118	0.31721	0.00657
Hilton	Backslope	Soil-Sap Interface	69.6138	0.349004	0.33464	0.32975	0.3378	0.01001
Hilton	Backslope	Soil-Sap Interface	76.4196	0.378401	0.35577	0.3475	0.36056	0.016
Hilton	Backslope	Soil-Sap Interface	83.8907	0.420613	0.39219	0.38038	0.39773	0.02068
Hilton	Backslope	Soil-Sap Interface	92.0923	0.476145	0.45105	0.43807	0.45509	0.01936
Hilton	Backslope	Soil-Sap Interface	101.096	0.528602	0.5172	0.506	0.51727	0.0113
Hilton	Backslope	Soil-Sap Interface	110.979	0.561283	0.56933	0.56143	0.56401	0.0046
Hilton	Backslope	Soil-Sap Interface	121.829	0.590838	0.61857	0.61412	0.60784	0.01489
Hilton	Backslope	Soil-Sap Interface	133.74	0.68615	0.73082	0.72924	0.7154	0.02535
Hilton	Backslope	Soil-Sap Interface	146.815	0.963119	1.02126	1.02143	1.00194	0.03362
Hilton	Backslope	Soil-Sap Interface	161.168	1.57175	1.64081	1.64384	1.6188	0.04077
Hilton	Backslope	Soil-Sap Interface	176.925	2.65291	2.73802	2.75223	2.71439	0.05371
Hilton	Backslope	Soil-Sap Interface	194.222	4.24801	4.36754	4.40977	4.34177	0.0839
Hilton	Backslope	Soil-Sap Interface	213.21	6.21168	6.38333	6.46996	6.35499	0.13145
Hilton	Backslope	Soil-Sap Interface	234.054	8.21025	8.42734	8.55753	8.39837	0.17544
Hilton	Backslope	Soil-Sap Interface	256.936	9.82557	10.0476	10.1976	10.0236	0.18717
Hilton	Backslope	Soil-Sap Interface	282.056	10.6932	10.8544	10.9849	10.8442	0.14612
Hilton	Backslope	Soil-Sap Interface	309.631	10.6222	10.6533	10.7257	10.6671	0.05311
Hilton	Backslope	Soil-Sap Interface	339.902	9.65811	9.51593	9.51542	9.56315	0.08224
Hilton	Backslope	Soil-Sap Interface	373.132	8.06008	7.75373	7.69334	7.83572	0.19664
Hilton	Backslope	Soil-Sap Interface	409.611	6.19735	5.78917	5.70114	5.89589	0.26476
Hilton	Backslope	Soil-Sap Interface	449.657	4.41257	3.99509	3.90728	4.10498	0.26997
Hilton	Backslope	Soil-Sap Interface	493.617	2.92734	2.58722	2.48821	2.66759	0.23033
Hilton	Backslope	Soil-Sap Interface	541.876	1.81297	1.58817	1.45774	1.61963	0.17969
Hilton	Backslope	Soil-Sap Interface	594.852	1.04023	0.92003	0.73062	0.89696	0.15609
Hilton	Backslope	Soil-Sap Interface	653.008	0.540283	0.47995	0.2143	0.41151	0.17344
Hilton	Backslope	Soil-Sap Interface	716.849	0.237752	0.15283	0.01527	0.13528	0.11228

Hilton	Backslope	Soil-Sap Interface	786.932	0.085353	0.01177	0	0.03237	0.04626
Hilton	Backslope	Soil-Sap Interface	863.866	0.021237	0	0	0.00708	0.01226
Hilton	Backslope	Soil-Sap Interface	948.322	0.001578	0	0	0.00053	0.00091
Hilton	Backslope	Soil-Sap Interface	1041.03	0	0	0	0	0
Hilton	Backslope	Soil-Sap Interface	1142.81	0	0	0	0	0
Hilton	Backslope	Soil-Sap Interface	1254.54	0	0	0	0	0
Hilton	Backslope	Soil-Sap Interface	1377.19	0	0	0	0	0
Hilton	Backslope	Soil-Sap Interface	1511.83	0	0	0	0	0
Hilton	Backslope	Soil-Sap Interface	1659.63	0	0	0	0	0
Hilton	Backslope	Soil-Sap Interface	1821.88	0	0	0	0	0
Hilton	Backslope	~30 cm below interface	0.375124	0.006163	0.0064	0.0066	0.00639	0.00022
Hilton	Backslope	~30 cm below interface	0.411798	0.011763	0.01222	0.01261	0.0122	0.00042
Hilton	Backslope	~30 cm below interface	0.452057	0.019821	0.02062	0.02131	0.02058	0.00075
Hilton	Backslope	~30 cm below interface	0.496252	0.027435	0.02861	0.02962	0.02855	0.00109
Hilton	Backslope	~30 cm below interface	0.544768	0.034673	0.03628	0.03764	0.0362	0.00149
Hilton	Backslope	~30 cm below interface	0.598027	0.041436	0.04354	0.0453	0.04342	0.00193
Hilton	Backslope	~30 cm below interface	0.656493	0.04762	0.05029	0.05249	0.05013	0.00244
Hilton	Backslope	~30 cm below interface	0.720675	0.053091	0.05639	0.0591	0.05619	0.00301
Hilton	Backslope	~30 cm below interface	0.791132	0.057713	0.06172	0.06496	0.06146	0.00363
Hilton	Backslope	~30 cm below interface	0.868477	0.061344	0.06609	0.06991	0.06578	0.00429
Hilton	Backslope	~30 cm below interface	0.953383	0.06385	0.06937	0.07377	0.06899	0.00497
Hilton	Backslope	~30 cm below interface	1.04659	0.065115	0.07138	0.07634	0.07095	0.00562
Hilton	Backslope	~30 cm below interface	1.14891	0.065167	0.07212	0.07758	0.07162	0.00622
Hilton	Backslope	~30 cm below interface	1.26123	0.0641	0.07163	0.07751	0.07108	0.00672
Hilton	Backslope	~30 cm below interface	1.38454	0.06209	0.07007	0.07625	0.06947	0.0071
Hilton	Backslope	~30 cm below interface	1.5199	0.059407	0.0677	0.07407	0.06706	0.00735
Hilton	Backslope	~30 cm below interface	1.66849	0.056418	0.06491	0.07135	0.06423	0.00749
Hilton	Backslope	~30 cm below interface	1.83161	0.053588	0.06223	0.06866	0.06149	0.00756
Hilton	Backslope	~30 cm below interface	2.01068	0.051447	0.06028	0.06669	0.05947	0.00765
Hilton	Backslope	~30 cm below interface	2.20725	0.05055	0.05974	0.0662	0.05883	0.00786
Hilton	Backslope	~30 cm below interface	2.42304	0.051403	0.06125	0.06792	0.06019	0.00831
Hilton	Backslope	~30 cm below interface	2.65993	0.054394	0.0653	0.07244	0.06405	0.00909
Hilton	Backslope	~30 cm below interface	2.91998	0.059716	0.07215	0.08006	0.07064	0.01026
Hilton	Backslope	~30 cm below interface	3.20545	0.067302	0.08172	0.09072	0.07991	0.01181
Hilton	Backslope	~30 cm below interface	3.51883	0.076803	0.09354	0.10389	0.09141	0.01367
Hilton	Backslope	~30 cm below interface	3.86284	0.087611	0.10681	0.11866	0.10436	0.01567
Hilton	Backslope	~30 cm below interface	4.24049	0.098956	0.1205	0.13387	0.11777	0.01761
Hilton	Backslope	~30 cm below interface	4.65506	0.110035	0.13354	0.14825	0.13061	0.01928
Hilton	Backslope	~30 cm below interface	5.11017	0.120157	0.14502	0.16076	0.14198	0.02047
Hilton	Backslope	~30 cm below interface	5.60976	0.128848	0.15433	0.17067	0.15128	0.02108
Hilton	Backslope	~30 cm below interface	6.1582	0.135919	0.16125	0.17772	0.15829	0.02105
Hilton	Backslope	~30 cm below interface	6.76025	0.141467	0.16598	0.18212	0.16319	0.02047
Hilton	Backslope	~30 cm below interface	7.42117	0.145796	0.16902	0.18442	0.16641	0.01944
Hilton	Backslope	~30 cm below interface	8.14669	0.149466	0.17124	0.18561	0.16877	0.0182
Hilton	Backslope	~30 cm below interface	8.94315	0.153361	0.17397	0.18719	0.17151	0.01705
Hilton	Backslope	~30 cm below interface	9.81748	0.15862	0.17888	0.19107	0.17619	0.01639
Hilton	Backslope	~30 cm below interface	10.7773	0.166519	0.18771	0.19931	0.18451	0.01663
Hilton	Backslope	~30 cm below interface	11.8309	0.178124	0.20174	0.21355	0.19781	0.01804
Hilton	Backslope	~30 cm below interface	12.9876	0.193862	0.22116	0.23426	0.21643	0.02061
Hilton	Backslope	~30 cm below interface	14.2573	0.21301	0.24444	0.25995	0.23913	0.02391
Hilton	Backslope	~30 cm below interface	15.6512	0.233417	0.26819	0.2869	0.26284	0.02714
Hilton	Backslope	~30 cm below interface	17.1813	0.251652	0.28776	0.30963	0.28301	0.02928
Hilton	Backslope	~30 cm below interface	18.861	0.264123	0.29897	0.32265	0.29525	0.02944
Hilton	Backslope	~30 cm below interface	20.705	0.269231	0.30062	0.32346	0.29777	0.02723
Hilton	Backslope	~30 cm below interface	22.7292	0.269092	0.2959	0.31464	0.29321	0.02289
Hilton	Backslope	~30 cm below interface	24.9513	0.269385	0.29166	0.30384	0.2883	0.01747
Hilton	Backslope	~30 cm below interface	27.3906	0.276918	0.29545	0.30099	0.29112	0.0126
Hilton	Backslope	~30 cm below interface	30.0685	0.295984	0.3116	0.31342	0.307	0.00959
Hilton	Backslope	~30 cm below interface	33.0081	0.325145	0.33744	0.34018	0.33426	0.00801
Hilton	Backslope	~30 cm below interface	36.2352	0.357207	0.36268	0.36942	0.3631	0.00612
Hilton	Backslope	~30 cm below interface	39.7777	0.384318	0.37596	0.38503	0.38177	0.00504
Hilton	Backslope	~30 cm below interface	43.6665	0.405724	0.37554	0.38133	0.38753	0.01602
Hilton	Backslope	~30 cm below interface	47.9356	0.43171	0.37483	0.3732	0.39325	0.03332
Hilton	Backslope	~30 cm below interface	52.622	0.479816	0.39745	0.38966	0.42231	0.04996
Hilton	Backslope	~30 cm below interface	57.7666	0.567446	0.46691	0.45762	0.49733	0.0609
Hilton	Backslope	~30 cm below interface	63.4141	0.703116	0.59517	0.58724	0.62851	0.06474
Hilton	Backslope	~30 cm below interface	69.6138	0.883016	0.77762	0.76937	0.81	0.06337
Hilton	Backslope	~30 cm below interface	76.4196	1.10452	1.00958	0.99774	1.03728	0.05853
Hilton	Backslope	~30 cm below interface	83.8907	1.37485	1.29901	1.28376	1.31921	0.04879
Hilton	Backslope	~30 cm below interface	92.0923	1.68964	1.64134	1.62718	1.65272	0.03275

Hilton	Backslope	~30 cm below interface	101.096	2.01768	1.99849	1.99023	2.00213	0.01408
Hilton	Backslope	~30 cm below interface	110.979	2.32841	2.32969	2.32941	2.32917	0.00067
Hilton	Backslope	~30 cm below interface	121.829	2.63222	2.64157	2.64942	2.64107	0.00861
Hilton	Backslope	~30 cm below interface	133.74	2.9865	2.99752	3.01275	2.99892	0.01318
Hilton	Backslope	~30 cm below interface	146.815	3.46227	3.47694	3.49691	3.47871	0.01739
Hilton	Backslope	~30 cm below interface	161.168	4.10515	4.13025	4.15039	4.1286	0.02267
Hilton	Backslope	~30 cm below interface	176.925	4.91736	4.96411	4.98186	4.95444	0.03332
Hilton	Backslope	~30 cm below interface	194.222	5.83835	5.9213	5.94117	5.90027	0.05454
Hilton	Backslope	~30 cm below interface	213.21	6.72163	6.8466	6.87616	6.8148	0.08203
Hilton	Backslope	~30 cm below interface	234.054	7.37236	7.52186	7.56065	7.48496	0.09942
Hilton	Backslope	~30 cm below interface	256.936	7.63508	7.7691	7.80755	7.73724	0.09054
Hilton	Backslope	~30 cm below interface	282.056	7.44196	7.51154	7.53913	7.49754	0.05007
Hilton	Backslope	~30 cm below interface	309.631	6.82329	6.78451	6.79516	6.80099	0.02004
Hilton	Backslope	~30 cm below interface	339.902	5.90083	5.73219	5.72964	5.78755	0.09811
Hilton	Backslope	~30 cm below interface	373.132	4.8411	4.55688	4.55581	4.65126	0.1644
Hilton	Backslope	~30 cm below interface	409.611	3.79328	3.43696	3.45246	3.5609	0.2014
Hilton	Backslope	~30 cm below interface	449.657	2.84052	2.47865	2.5116	2.61026	0.20009
Hilton	Backslope	~30 cm below interface	493.617	1.99873	1.70786	1.73702	1.81454	0.16018
Hilton	Backslope	~30 cm below interface	541.876	1.25758	1.09905	1.08912	1.14858	0.09452
Hilton	Backslope	~30 cm below interface	594.852	0.624748	0.63889	0.56192	0.60852	0.04097
Hilton	Backslope	~30 cm below interface	653.008	0.169407	0.34624	0.19878	0.23814	0.09476
Hilton	Backslope	~30 cm below interface	716.849	0.011069	0.20932	0.04346	0.08795	0.10635
Hilton	Backslope	~30 cm below interface	786.932	0	0.17681	0.02623	0.06768	0.09542
Hilton	Backslope	~30 cm below interface	863.866	0	0.18705	0.07371	0.08692	0.09422
Hilton	Backslope	~30 cm below interface	948.322	0	0.15318	0.10836	0.08718	0.07875
Hilton	Backslope	~30 cm below interface	1041.03	0	0.05473	0.04941	0.03471	0.03018
Hilton	Backslope	~30 cm below interface	1142.81	0	0.00395	0.00408	0.00268	0.00232
Hilton	Backslope	~30 cm below interface	1254.54	0	0	0	0	0
Hilton	Backslope	~30 cm below interface	1377.19	0	0	0	0	0
Hilton	Backslope	~30 cm below interface	1511.83	0	0	0	0	0
Hilton	Backslope	~30 cm below interface	1659.63	0	0	0	0	0
Hilton	Backslope	~30 cm below interface	1821.88	0	0	0	0	0
Hilton	Toeslope	Soil-Sap Interface	0.375124	0.005527	0.00669	0.00777	0.00666	0.00112
Hilton	Toeslope	Soil-Sap Interface	0.411798	0.009913	0.01199	0.01393	0.01194	0.00201
Hilton	Toeslope	Soil-Sap Interface	0.452057	0.014773	0.01786	0.02074	0.01779	0.00298
Hilton	Toeslope	Soil-Sap Interface	0.496252	0.021255	0.02569	0.02982	0.02559	0.00428
Hilton	Toeslope	Soil-Sap Interface	0.544768	0.026668	0.03225	0.03743	0.03212	0.00538
Hilton	Toeslope	Soil-Sap Interface	0.598027	0.0317	0.03834	0.04448	0.03817	0.00639
Hilton	Toeslope	Soil-Sap Interface	0.656493	0.036525	0.04417	0.05122	0.04397	0.00735
Hilton	Toeslope	Soil-Sap Interface	0.720675	0.041448	0.05012	0.05808	0.04988	0.00832
Hilton	Toeslope	Soil-Sap Interface	0.791132	0.045646	0.05523	0.06395	0.05494	0.00916
Hilton	Toeslope	Soil-Sap Interface	0.868477	0.049339	0.05972	0.0691	0.05939	0.00988
Hilton	Toeslope	Soil-Sap Interface	0.953383	0.052601	0.0637	0.07362	0.06331	0.01051
Hilton	Toeslope	Soil-Sap Interface	1.04659	0.055559	0.06732	0.07769	0.06686	0.01108
Hilton	Toeslope	Soil-Sap Interface	1.14891	0.058037	0.0704	0.08116	0.06986	0.01157
Hilton	Toeslope	Soil-Sap Interface	1.26123	0.060063	0.07296	0.084	0.07234	0.01198
Hilton	Toeslope	Soil-Sap Interface	1.38454	0.061799	0.0752	0.08649	0.07449	0.01236
Hilton	Toeslope	Soil-Sap Interface	1.5199	0.063393	0.0773	0.08881	0.0765	0.01273
Hilton	Toeslope	Soil-Sap Interface	1.66849	0.06503	0.07951	0.0913	0.07861	0.01316
Hilton	Toeslope	Soil-Sap Interface	1.83161	0.066722	0.08185	0.09399	0.08085	0.01366
Hilton	Toeslope	Soil-Sap Interface	2.01068	0.068611	0.0845	0.0971	0.0834	0.01428
Hilton	Toeslope	Soil-Sap Interface	2.20725	0.07083	0.08762	0.10084	0.08643	0.01504
Hilton	Toeslope	Soil-Sap Interface	2.42304	0.073595	0.09147	0.1055	0.09019	0.01599
Hilton	Toeslope	Soil-Sap Interface	2.65993	0.076935	0.09609	0.11115	0.09473	0.01715
Hilton	Toeslope	Soil-Sap Interface	2.91998	0.080852	0.10146	0.11776	0.10003	0.0185
Hilton	Toeslope	Soil-Sap Interface	3.20545	0.085329	0.10755	0.12526	0.10604	0.02001
Hilton	Toeslope	Soil-Sap Interface	3.51883	0.09035	0.11428	0.13354	0.11272	0.02164
Hilton	Toeslope	Soil-Sap Interface	3.86284	0.095854	0.12156	0.14246	0.11996	0.02335
Hilton	Toeslope	Soil-Sap Interface	4.24049	0.10172	0.12919	0.15173	0.12755	0.02504
Hilton	Toeslope	Soil-Sap Interface	4.65506	0.107815	0.13698	0.16107	0.13529	0.02667
Hilton	Toeslope	Soil-Sap Interface	5.11017	0.114043	0.14478	0.1703	0.14304	0.02817
Hilton	Toeslope	Soil-Sap Interface	5.60976	0.12036	0.15256	0.17936	0.15076	0.02954
Hilton	Toeslope	Soil-Sap Interface	6.1582	0.126816	0.16037	0.18829	0.15849	0.03078
Hilton	Toeslope	Soil-Sap Interface	6.76025	0.13338	0.1682	0.19707	0.16622	0.03189
Hilton	Toeslope	Soil-Sap Interface	7.42117	0.140168	0.17618	0.20587	0.17407	0.0329
Hilton	Toeslope	Soil-Sap Interface	8.14669	0.147247	0.18447	0.21491	0.18221	0.03389
Hilton	Toeslope	Soil-Sap Interface	8.94315	0.154971	0.19355	0.22477	0.1911	0.03497
Hilton	Toeslope	Soil-Sap Interface	9.81748	0.163605	0.20379	0.2359	0.2011	0.03622
Hilton	Toeslope	Soil-Sap Interface	10.7773	0.173617	0.21571	0.2489	0.21274	0.03773
Hilton	Toeslope	Soil-Sap Interface	11.8309	0.185289	0.22964	0.26418	0.22637	0.03955

Hilton	Toeslope	Soil-Sap Interface	12.9876	0.199003	0.24606	0.28236	0.24247	0.04179
Hilton	Toeslope	Soil-Sap Interface	14.2573	0.21511	0.26533	0.3038	0.26141	0.04448
Hilton	Toeslope	Soil-Sap Interface	15.6512	0.233745	0.28733	0.32823	0.2831	0.04738
Hilton	Toeslope	Soil-Sap Interface	17.1813	0.254878	0.31153	0.35469	0.30703	0.05006
Hilton	Toeslope	Soil-Sap Interface	18.861	0.277953	0.33679	0.38163	0.33212	0.052
Hilton	Toeslope	Soil-Sap Interface	20.705	0.302847	0.36274	0.40856	0.35805	0.05301
Hilton	Toeslope	Soil-Sap Interface	22.7292	0.329882	0.3899	0.43631	0.38537	0.05336
Hilton	Toeslope	Soil-Sap Interface	24.9513	0.360533	0.42022	0.46731	0.41602	0.05351
Hilton	Toeslope	Soil-Sap Interface	27.3906	0.396811	0.45587	0.50402	0.45223	0.0537
Hilton	Toeslope	Soil-Sap Interface	30.0685	0.440385	0.49796	0.5473	0.49522	0.05351
Hilton	Toeslope	Soil-Sap Interface	33.0081	0.491883	0.54585	0.59569	0.54447	0.05192
Hilton	Toeslope	Soil-Sap Interface	36.2352	0.550232	0.59681	0.64539	0.59748	0.04758
Hilton	Toeslope	Soil-Sap Interface	39.7777	0.613274	0.64745	0.69216	0.65096	0.03956
Hilton	Toeslope	Soil-Sap Interface	43.6665	0.678216	0.69478	0.73273	0.70191	0.02795
Hilton	Toeslope	Soil-Sap Interface	47.9356	0.742318	0.73706	0.76582	0.7484	0.01531
Hilton	Toeslope	Soil-Sap Interface	52.622	0.803257	0.7739	0.79188	0.78968	0.0148
Hilton	Toeslope	Soil-Sap Interface	57.7666	0.859178	0.80554	0.81204	0.82559	0.02927
Hilton	Toeslope	Soil-Sap Interface	63.4141	0.909306	0.8328	0.82783	0.85664	0.04567
Hilton	Toeslope	Soil-Sap Interface	69.6138	0.954441	0.85731	0.84136	0.88437	0.06121
Hilton	Toeslope	Soil-Sap Interface	76.4196	0.9973	0.88196	0.85591	0.91172	0.07525
Hilton	Toeslope	Soil-Sap Interface	83.8907	1.042	0.91087	0.87613	0.943	0.08748
Hilton	Toeslope	Soil-Sap Interface	92.0923	1.09265	0.94856	0.90712	0.98277	0.09739
Hilton	Toeslope	Soil-Sap Interface	101.096	1.15246	0.99936	0.95402	1.03528	0.10398
Hilton	Toeslope	Soil-Sap Interface	110.979	1.22224	1.06607	1.02072	1.10301	0.10572
Hilton	Toeslope	Soil-Sap Interface	121.829	1.29973	1.14874	1.10849	1.18565	0.10082
Hilton	Toeslope	Soil-Sap Interface	133.74	1.37796	1.24188	1.21253	1.27746	0.08827
Hilton	Toeslope	Soil-Sap Interface	146.815	1.44683	1.33451	1.32082	1.36739	0.06914
Hilton	Toeslope	Soil-Sap Interface	161.168	1.49755	1.41351	1.41627	1.44244	0.04774
Hilton	Toeslope	Soil-Sap Interface	176.925	1.53236	1.4738	1.48746	1.49787	0.03064
Hilton	Toeslope	Soil-Sap Interface	194.222	1.57257	1.52908	1.54207	1.54791	0.02232
Hilton	Toeslope	Soil-Sap Interface	213.21	1.66035	1.61692	1.61559	1.63095	0.02547
Hilton	Toeslope	Soil-Sap Interface	234.054	1.85182	1.79348	1.76742	1.80424	0.04322
Hilton	Toeslope	Soil-Sap Interface	256.936	2.20416	2.12057	2.06636	2.13036	0.06942
Hilton	Toeslope	Soil-Sap Interface	282.056	2.75995	2.64965	2.57271	2.66077	0.09411
Hilton	Toeslope	Soil-Sap Interface	309.631	3.52475	3.39862	3.31225	3.41187	0.10687
Hilton	Toeslope	Soil-Sap Interface	339.902	4.44885	4.3301	4.25024	4.34306	0.09994
Hilton	Toeslope	Soil-Sap Interface	373.132	5.42295	5.34147	5.27822	5.34755	0.07256
Hilton	Toeslope	Soil-Sap Interface	409.611	6.29648	6.27928	6.23067	6.26881	0.03413
Hilton	Toeslope	Soil-Sap Interface	449.657	6.91256	6.97348	6.92605	6.93736	0.032
Hilton	Toeslope	Soil-Sap Interface	493.617	7.14731	7.28076	7.21674	7.21494	0.06674
Hilton	Toeslope	Soil-Sap Interface	541.876	6.94334	7.12456	7.03231	7.0334	0.09061
Hilton	Toeslope	Soil-Sap Interface	594.852	6.32857	6.51952	6.40179	6.41663	0.09634
Hilton	Toeslope	Soil-Sap Interface	653.008	5.40772	5.5691	5.44404	5.47362	0.08466
Hilton	Toeslope	Soil-Sap Interface	716.849	4.32959	4.43203	4.32588	4.3625	0.06024
Hilton	Toeslope	Soil-Sap Interface	786.932	3.23515	3.26944	3.20271	3.23577	0.03337
Hilton	Toeslope	Soil-Sap Interface	863.866	2.23363	2.21197	2.19037	2.21199	0.02163
Hilton	Toeslope	Soil-Sap Interface	948.322	1.38482	1.33413	1.3465	1.35515	0.02643
Hilton	Toeslope	Soil-Sap Interface	1041.03	0.690504	0.64606	0.6675	0.66802	0.02223
Hilton	Toeslope	Soil-Sap Interface	1142.81	0.245357	0.22274	0.23635	0.23481	0.01139
Hilton	Toeslope	Soil-Sap Interface	1254.54	0.044564	0.03952	0.04288	0.04232	0.00257
Hilton	Toeslope	Soil-Sap Interface	1377.19	0.003336	0.00287	0.00321	0.00314	0.00024
Hilton	Toeslope	Soil-Sap Interface	1511.83	0	0	0	0	0
Hilton	Toeslope	Soil-Sap Interface	1659.63	0	0	0	0	0
Hilton	Toeslope	Soil-Sap Interface	1821.88	0	0	0	0	0
Hilton	Toeslope	~30 cm below interface	0.375124	0.005472	0.00632	0.00679	0.00619	0.00067
Hilton	Toeslope	~30 cm below interface	0.411798	0.009824	0.01134	0.01217	0.01111	0.00119
Hilton	Toeslope	~30 cm below interface	0.452057	0.014656	0.01691	0.01815	0.01657	0.00177
Hilton	Toeslope	~30 cm below interface	0.496252	0.021113	0.02437	0.02615	0.02388	0.00255
Hilton	Toeslope	~30 cm below interface	0.544768	0.026514	0.03063	0.03286	0.03	0.00322
Hilton	Toeslope	~30 cm below interface	0.598027	0.031587	0.0365	0.03917	0.03575	0.00384
Hilton	Toeslope	~30 cm below interface	0.656493	0.036496	0.04219	0.04527	0.04132	0.00445
Hilton	Toeslope	~30 cm below interface	0.720675	0.041561	0.04807	0.05158	0.04707	0.00508
Hilton	Toeslope	~30 cm below interface	0.791132	0.045917	0.05317	0.05706	0.05205	0.00566
Hilton	Toeslope	~30 cm below interface	0.868477	0.049854	0.0578	0.06203	0.05656	0.00618
Hilton	Toeslope	~30 cm below interface	0.953383	0.053433	0.06203	0.06658	0.06068	0.00668
Hilton	Toeslope	~30 cm below interface	1.04659	0.056798	0.06604	0.07089	0.06457	0.00716
Hilton	Toeslope	~30 cm below interface	1.14891	0.059702	0.06957	0.0747	0.06799	0.00762
Hilton	Toeslope	~30 cm below interface	1.26123	0.062222	0.07268	0.07808	0.07099	0.00806
Hilton	Toeslope	~30 cm below interface	1.38454	0.064495	0.07555	0.08119	0.07375	0.00849
Hilton	Toeslope	~30 cm below interface	1.5199	0.066668	0.07833	0.08423	0.07641	0.00894

Hilton	Toeslope	~30 cm below interface	1.66849	0.068872	0.0812	0.08739	0.07916	0.00943
Hilton	Toeslope	~30 cm below interface	1.83161	0.071121	0.08417	0.09068	0.08199	0.00996
Hilton	Toeslope	~30 cm below interface	2.01068	0.073552	0.0874	0.09426	0.08507	0.01055
Hilton	Toeslope	~30 cm below interface	2.20725	0.076294	0.09101	0.09828	0.08853	0.0112
Hilton	Toeslope	~30 cm below interface	2.42304	0.079568	0.09528	0.10303	0.09263	0.01195
Hilton	Toeslope	~30 cm below interface	2.65993	0.08339	0.10022	0.10851	0.09737	0.0128
Hilton	Toeslope	~30 cm below interface	2.91998	0.087809	0.10586	0.11476	0.10281	0.01373
Hilton	Toeslope	~30 cm below interface	3.20545	0.092834	0.1122	0.12175	0.10893	0.01473
Hilton	Toeslope	~30 cm below interface	3.51883	0.09853	0.11928	0.12952	0.11578	0.01579
Hilton	Toeslope	~30 cm below interface	3.86284	0.104853	0.12704	0.13801	0.1233	0.01689
Hilton	Toeslope	~30 cm below interface	4.24049	0.111756	0.13541	0.14709	0.13142	0.018
Hilton	Toeslope	~30 cm below interface	4.65506	0.119146	0.14425	0.15663	0.14001	0.0191
Hilton	Toeslope	~30 cm below interface	5.11017	0.126988	0.1535	0.16652	0.149	0.02015
Hilton	Toeslope	~30 cm below interface	5.60976	0.135234	0.16312	0.17673	0.15836	0.02115
Hilton	Toeslope	~30 cm below interface	6.1582	0.143927	0.17314	0.1873	0.16812	0.02212
Hilton	Toeslope	~30 cm below interface	6.76025	0.153037	0.18355	0.1982	0.17826	0.02304
Hilton	Toeslope	~30 cm below interface	7.42117	0.162633	0.19441	0.20949	0.18884	0.02392
Hilton	Toeslope	~30 cm below interface	8.14669	0.17278	0.20581	0.22125	0.19995	0.02476
Hilton	Toeslope	~30 cm below interface	8.94315	0.183749	0.21807	0.23386	0.21189	0.02562
Hilton	Toeslope	~30 cm below interface	9.81748	0.19576	0.23148	0.24759	0.22494	0.02653
Hilton	Toeslope	~30 cm below interface	10.7773	0.209085	0.24632	0.26276	0.23939	0.0275
Hilton	Toeslope	~30 cm below interface	11.8309	0.223896	0.26277	0.27953	0.2554	0.02854
Hilton	Toeslope	~30 cm below interface	12.9876	0.240404	0.28105	0.29814	0.2732	0.02966
Hilton	Toeslope	~30 cm below interface	14.2573	0.258822	0.30137	0.31879	0.293	0.03085
Hilton	Toeslope	~30 cm below interface	15.6512	0.279186	0.32364	0.34132	0.31472	0.03202
Hilton	Toeslope	~30 cm below interface	17.1813	0.301381	0.34745	0.36517	0.338	0.03293
Hilton	Toeslope	~30 cm below interface	18.861	0.324897	0.37191	0.38922	0.36201	0.03328
Hilton	Toeslope	~30 cm below interface	20.705	0.349433	0.39642	0.41268	0.38618	0.03284
Hilton	Toeslope	~30 cm below interface	22.7292	0.374933	0.42079	0.43526	0.41033	0.03149
Hilton	Toeslope	~30 cm below interface	24.9513	0.40198	0.44559	0.45743	0.435	0.0292
Hilton	Toeslope	~30 cm below interface	27.3906	0.431334	0.4714	0.47974	0.46082	0.02588
Hilton	Toeslope	~30 cm below interface	30.0685	0.463359	0.49811	0.50192	0.48779	0.02125
Hilton	Toeslope	~30 cm below interface	33.0081	0.497606	0.52446	0.52257	0.51488	0.01499
Hilton	Toeslope	~30 cm below interface	36.2352	0.532544	0.54809	0.53923	0.53996	0.0078
Hilton	Toeslope	~30 cm below interface	39.7777	0.566341	0.56671	0.54981	0.56096	0.00965
Hilton	Toeslope	~30 cm below interface	43.6665	0.597464	0.57915	0.55366	0.57676	0.022
Hilton	Toeslope	~30 cm below interface	47.9356	0.625237	0.58597	0.55217	0.58779	0.03657
Hilton	Toeslope	~30 cm below interface	52.622	0.649568	0.58905	0.54816	0.59559	0.05102
Hilton	Toeslope	~30 cm below interface	57.7666	0.670413	0.59058	0.54457	0.60186	0.06367
Hilton	Toeslope	~30 cm below interface	63.4141	0.688246	0.59302	0.54432	0.60853	0.07321
Hilton	Toeslope	~30 cm below interface	69.6138	0.704972	0.59972	0.5508	0.6185	0.07878
Hilton	Toeslope	~30 cm below interface	76.4196	0.725689	0.61641	0.56943	0.63718	0.08017
Hilton	Toeslope	~30 cm below interface	83.8907	0.759312	0.65195	0.60855	0.67327	0.07761
Hilton	Toeslope	~30 cm below interface	92.0923	0.818213	0.71823	0.67945	0.73863	0.07159
Hilton	Toeslope	~30 cm below interface	101.096	0.917281	0.82969	0.796	0.84766	0.0626
Hilton	Toeslope	~30 cm below interface	110.979	1.0715	1.00116	0.97243	1.01503	0.05097
Hilton	Toeslope	~30 cm below interface	121.829	1.29443	1.24614	1.22136	1.25398	0.03716
Hilton	Toeslope	~30 cm below interface	133.74	1.59422	1.57191	1.5491	1.57174	0.02256
Hilton	Toeslope	~30 cm below interface	146.815	1.97316	1.97848	1.95488	1.96884	0.01238
Hilton	Toeslope	~30 cm below interface	161.168	2.42574	2.45658	2.42939	2.43724	0.01685
Hilton	Toeslope	~30 cm below interface	176.925	2.94232	2.99218	2.95974	2.96475	0.0253
Hilton	Toeslope	~30 cm below interface	194.222	3.50987	3.56899	3.53189	3.53692	0.02988
Hilton	Toeslope	~30 cm below interface	213.21	4.11417	4.17194	4.13378	4.13996	0.02938
Hilton	Toeslope	~30 cm below interface	234.054	4.73726	4.78501	4.7522	4.75816	0.02443
Hilton	Toeslope	~30 cm below interface	256.936	5.35163	5.38434	5.36515	5.36704	0.01644
Hilton	Toeslope	~30 cm below interface	282.056	5.91608	5.93227	5.93515	5.92783	0.01028
Hilton	Toeslope	~30 cm below interface	309.631	6.37138	6.37192	6.40296	6.38209	0.01808
Hilton	Toeslope	~30 cm below interface	339.902	6.64864	6.63467	6.69549	6.6596	0.03186
Hilton	Toeslope	~30 cm below interface	373.132	6.68212	6.65372	6.73969	6.69184	0.0438
Hilton	Toeslope	~30 cm below interface	409.611	6.43	6.386	6.48628	6.43409	0.05027
Hilton	Toeslope	~30 cm below interface	449.657	5.8929	5.83062	5.93078	5.88477	0.05057
Hilton	Toeslope	~30 cm below interface	493.617	5.1192	5.03687	5.12206	5.09271	0.04838
Hilton	Toeslope	~30 cm below interface	541.876	4.19945	4.0975	4.15703	4.15133	0.05121
Hilton	Toeslope	~30 cm below interface	594.852	3.22728	3.11878	3.14307	3.16304	0.05694
Hilton	Toeslope	~30 cm below interface	653.008	2.29433	2.19962	2.18654	2.22683	0.05882
Hilton	Toeslope	~30 cm below interface	716.849	1.46755	1.41109	1.36373	1.41412	0.05198
Hilton	Toeslope	~30 cm below interface	786.932	0.769394	0.78687	0.69949	0.75192	0.04624
Hilton	Toeslope	~30 cm below interface	863.866	0.296428	0.34519	0.26537	0.30233	0.04023
Hilton	Toeslope	~30 cm below interface	948.322	0.064522	0.10339	0.05789	0.07527	0.02458
Hilton	Toeslope	~30 cm below interface	1041.03	0.006611	0.01607	0.00602	0.00957	0.00564

Hilton	Toeslope	~30 cm below interface	1142.81	7.46E-05	0.00092	8.07E-05	0.00036	0.00049
Hilton	Toeslope	~30 cm below interface	1254.54	0	0	0	0	0
Hilton	Toeslope	~30 cm below interface	1377.19	0	0	0	0	0
Hilton	Toeslope	~30 cm below interface	1511.83	0	0	0	0	0
Hilton	Toeslope	~30 cm below interface	1659.63	0	0	0	0	0
Hilton	Toeslope	~30 cm below interface	1821.88	0	0	0	0	0