

## **Climate change and declining levels of green structures: Life in informal settlements of Dar es Salaam, Tanzania**

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**Abstract:** Impacts of climate change are often acute for those who live in informal settlements, the places where poverty, inequality and deprivation are concentrated in cities across the developing world. To broaden the strategies to address this issue, many cities are now embracing ecosystem-based adaptation and resilience. But, in Sub-Saharan Africa (SSA) the approach has yet to make much headway. This paper examines how climate change impacts on poor urban people via one component of urban ecosystem - urban green structures (UGS) - in Dar es Salaam, Tanzania. It examines: the UGS of importance to the city's informal dwellers and the range of derived services; changes over time to these UGS and derived services; and emerging adaptation practices. Using qualitative methods, the study has three key findings. First, cultural ecosystem services are of greatest importance to informal dwellers, although they do harness a range of other services. Second, the city's UGS have undergone dramatic changes due to both climatic and non-climatic factors. This has resulted in a gradual decline in the quantity and quality of UGS-derived services for the urban poor. Third, in responding to these changes, informal settlement dwellers have relied mostly on their personal, and sometimes on their collective, resources and capabilities. There are some innovative practices that draw on external institutions, but access to external support for informal communities has remained consistently low. City authorities should approach and plan greening 'for' (not 'in') informal settlements as a targeted environmental improvement endeavour - referred to here as 'creative urban planning'.

**Keywords:** Climate change; ecological infrastructure; informal settlements; slums; urban green structures; urban poverty

### **1. Introduction**

Concerns regarding increased climate change risks on urban ecosystems and on the urban poor continue to grow (IPCC, 2014). But there remains an important gap in knowledge: how climate change impacts on the services that poor people derive from urban ecosystems. Elmqvist et al. (2014), for example, observe how little researchers write about the ecological infrastructure of cities (parks, gardens, open spaces, water catchment areas) compared to a wealth of studies on the hardware of cities (transportation systems, housing, water works, sanitation). There is also an untested assumption that poor urban people are less dependent than the rural poor on the provision of ecosystem services (Slater & Twyman, 2003). Meanwhile, governments in most developing countries are advised to (Krishna, 2018), and continue to pay more attention to tackling rural than urban poverty (Banks, Roy & Hulme, 2011).

However the quality of life of a growing majority of the world's population - the urban dwellers - depends on the quality of city environments, including *both* ecological and hard infrastructure. In sub-Saharan Africa (SSA), where the numbers of informal settlement citizens is rapidly growing, the need for better quality city environments is particularly pressing. Over 50% of humanity already live in urban areas, a proportion due to reach 60% by 2030 and 70% by 2050 (UN, 2016). Nearly 90% of the increase is concentrated in Asia and Africa (UN, 2015) where cities are expanding much faster than the growth in urban population coupled with burgeoning informal settlements. By 2030, the urban population of developing countries is predicted to

double, while the area occupied by their cities triples (UN-Habitat, 2016a). These trends are strongest in SSA, where informal settlements have been growing in tandem with growth in urban populations. SSA alone accounts for 56% of the total increase in the number of informal dwellers among developing regions between 1990 and 2014.

Driven by a desire to promote adaptation and resilience many cities, including in SSA, are now embracing nature-based infrastructure provisioning (Roberts et al., 2012). But informal urbanisation continues to show a rapacious appetite to densify at the expense of ecological space (McPhearson et al., 2016). The reasons for this are deeply embedded in policies and practices: ‘... slums [and informal settlements] are a contiguous settlement that lacks one or more of the following five conditions: access to clean water; access to improved sanitation; sufficient living area that is not overcrowded; durable housing; and secure tenure... [they] are the product of failed [and/or inadequate implementation of] policies, poor governance, corruption, inappropriate regulation, dysfunctional land markets, unresponsive financial systems, and a lack of political will’ (UN-Habitat, 2016a:57).

The academic and policy community, however, remains somewhat divided on how to frame the linkages between urban poverty and ecosystem services. This is evident in the ways urban ecosystems are positioned both as a *concern* and an *opportunity* for addressing urban poverty. The concern highlights how low-income settlements lack access to urban green structures (UGS), ranging from a tree in a busy street, to an open playing field or a nature reserve (Bolund & Hunhammer, 1999). These settlements tend to locate in undesirable and environmentally problematic areas where shelter is cheaper or vacant land is available for informal occupancy (Simon, 2010). They often suffer from routine flooding and water-logging, and become receptors of diffuse pollution from the catchment/ drainage area. These factors can combine to make such settlements a ‘landscape of disasters’ (Gandy, 2008).

Yet, conversely, these landscapes are also *the* places of hope and aspirations for millions of poor people who ‘prefer urban squalor to rural hopelessness’ (The Economist, 2007). By viewing migration as a form of adaptation, most donor agencies now actively recommend policies to encourage migration from economically-lagging (e.g. rural areas) to leading areas (e.g. cities) (UN-Habitat 2016a). Most importantly, Target 11.1 of the UN Sustainable Development Goals (SDG 11) seeks to ensure by 2030, access for all to adequate, safe and sustainable housing and basic services and upgrading of slums (UN-Habitat, 2016b). Indeed, there is an expanding intellectual base that identifies the array of beneficial services that urban ecosystems can provide, arguing for ecosystem services to be regarded as part of the basic services package of SDG Target 11.1.

The Economics of Ecosystem Services and Biodiversity (TEEB, 2011), for example, identifies four types of ecosystem services: *provisioning*; *regulating*; *habitat or supporting*; and *cultural and amenity* services (see Gómez-Baggethun et al., 2014 for definitions). Diaz, Fargioneet, Chapin & Tilman (2006) also highlight many fundamental benefits for urban poor people of having access to ecosystem services: shelter, food, fresh water and biomass production, nutrient cycling and water cycling. Douglas (2012), however, argues that because of their very nature (e.g. low-lying and poorly drained) most informal settlements tend to be exposed to a variety of ecosystem disservices, particularly increased risk of water- and vector-borne diseases. Not only should the urban poor have access to ecosystem services of importance to them, their exposure to ecosystem risks must also be reduced.

Existing empirical work on how to address urban poor's access/exposure to ecosystem services/risks in an integrated way is limited in general and skewed toward a small number of countries (Mensah, 2014). This reflects a much broader trend that McPhearson et al. (2016: 166) recently observed: "most [urban] research is in the north; most need is in the south". To help fill this research lacuna, this paper presents findings from two projects (CLUVA<sup>1</sup> and EcoPoor<sup>2</sup>) on Dar es Salaam, Tanzania. It focuses on four key questions - the first three of which set-up the empirical scope, with the fourth analysing the city's urban planning practices against the empirical findings.

- *What services do Dar es Salaam's urban poor derive from the city's green structures?*
- *How vulnerable are the identified UGS and the dependant poor urban people?*
- *What are the emerging adaptation practices to address these vulnerabilities?*
- *What implications do these practices have for UGS governance and city planning?*

## **2. Urban Green Structures, Informal Settlements and Climate Change**

### **2.1 Characterising the Linkages**

The concept of 'urban green structures (UGS)' refers to all public and private open spaces and vegetation in urban areas that citizens use directly (e.g. active recreation) or experience indirectly via positive or negative impacts upon them (Mensah, 2014). Other commonly used terms associated with the concept are: green spaces; and green infrastructure. The former refers to all areas that are naturally or artificially covered with vegetation (Fratini & Marone, 2011); its origin is rooted in the European tradition of systematic green space planning, and is often used interchangeably with terms like open spaces (Mensah, 2014). The latter refers to *networks* of natural, semi-natural and artificial ecological systems within a given area (Tzoulas et al., 2007).

In this paper, the term UGS is preferred, as most of the ecological features found in informal settlements are not planned, nor constitute a well-connected ecological network. As Gopal & Nagendra (2014) report, informal settlements are typically characterised by densely packed shacks with narrow lanes and small courtyards, irregularly interspersed with trees, and with potted plants within homesteads. Following Douglas (2012), it is an informal settlement as a whole, not the individual UGS within it, which should be regarded as a 'patch' - the bottom level unit of what Ostrom (2007) defines as socio-ecological systems (SES). This allows informal settlements to be framed as a nested SES of the larger urban ecosystem.

Such a framing raises two important points. First, the few UGS available in low-income settlements often consist of community spaces and culturally important medicinal, sacred and culinary plants (Cilliers, Cilliers, Lubbe & Siebert, 2012; Jaganmohan, Vailshery, Gopal & Nagendra, 2012). These UGS mainly offer cultural and amenity services, and for other types of services (provisioning, regulating and supporting) people must rely on UGS located *beyond* their settlements. Being poor, however, low-income people must practice commonage in accessing those external UGS (Davenport, Shackleton & Gambiza, 2012). But, as reported in Ostrom (2010), common pool resources are increasingly being converted into toll goods (i.e. when resources are managed by small scale public or private associations, such as pay-for-beaches or

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<sup>1</sup> See CLUVA (Climate Change and Urban Vulnerability in Africa) website: <http://www.cluva.eu/>

<sup>2</sup> See EcoPoor (Institutions for Urban Poor's Access to Ecosystem Services: A Case Study of Green and Water Structures in Bangladesh and Tanzania) website at: <http://www.espa.ac.uk/projects/ne-l001616-1>.

theme parks). In urban areas such conversion is often driven by gentrification, a process that invariably displaces poorer residents (López-Morales, 2015).

Second, a growing body of literature argues that low-income settlements tend to locate on hazardous landscapes (Douglas et al., 2008), exposing residents to an array of disservices. Douglas (2012) reports how poor sanitation, open waste water drainage and garbage disposal combined with low-lying and poorly drained landscapes promote diseases like diarrhoea and malaria to low-income dwellers. Increased climate variability, including higher temperatures and altered rainfall patterns is predicted to further aggravate these disservices (Dodman, Kibona & Kiluma, 2011). Additionally, informal dwellers are commonly excluded from access to formal risk reduction mechanisms (Christoplos et al. 2009) as they are regarded often as illegal occupiers by governments and political elites (McKean, 2009). This leads to risk accumulation, and can trigger a collapse in livelihood viability of the urban poor.

Informal dwellers are thus prone to experience, over time, a reduction in quantity, quality and diversity of UGS-derived services as well as an increase in exposure to environmental risks. Climate change is and will exacerbate these negative impacts. Indeed, in its Fifth Assessment Report (AR5), the Intergovernmental Panel on Climate Change (IPCC, 2014) notes that urban climate change risks are increasing on local and national economies and ecosystems. These risks are amplified for those living in informal settlements and hazardous areas, and who either lack essential infrastructure and services, or where there is inadequate provision for adaptation.

## **2.2 Vulnerability as Reduced Ecosystem Services and Increased Disservices**

Vulnerability is the physical, economic, social or political susceptibility of a system to damage (Birkmann, 2006). Vulnerability is often framed as part of the broader processes of development needs (e.g. more lands to accommodate urban growth), development challenges (e.g. limited financial, managerial and technical capacities to manage urban growth), specific social and ecological context (e.g. growing urban informality on hazardous lands), and climate variability and change (Roy, Hulme & Jahan, 2013). Thus, a range of dimensions makes-up the backdrop to specific challenges experienced by low-income people and the UGS of importance to them. Climate change is only one part of this ‘bundle’ of contributing factors.

In this paper we incorporate the multiple dimensions of vulnerability in two interconnected ways: whether they lead to *exposure or outcome*; and in terms of their domains of origin - *contextual, compositional, physical and politico-legal*. The exposure/outcome framing draws on Sumner & Mallett (2011) who distinguish between vulnerability *to* something and vulnerability *from* something. The former highlights exposure to risk, while the latter is about susceptibility to particular outcomes. In this paper, exposure captures how people and UGS are exposed to climatic and non-climatic shocks and perturbations. The outcome vulnerability is then taken to examine the consequences – e.g. reduced or increased services and disservices.

The ‘domains of origin’ framing draws on recent literature. Armah, Luginaah, Hambati, Chuenpagdee & Campbell (2015), for example, argue that differences in negative impacts of climate change between places have two possible explanations: contextual and compositional. The former highlights the role of place characteristics in determining how people experience shocks. The ecological vulnerability concept (Lange, Sala, Vighi & Faber’s, 2010) encapsulates these characteristics, referring to the ways an informal settlement (framed as an SES patch, see above) experiences climatic and non-climatic stressors. Compositional factors, in contrast, highlight that differential outcomes are a result of the differences in the socio-economic

characteristics of the resident populations (our second domain). In terms of vulnerability, therefore, we must expect similarities (because of similar economic profiles) as well as differences (because of subtle differences in social, cultural and demographic attributes) in how poor people, and the UGS of importance to them, experience vulnerability.

Several authors have also suggested that complex real life experiences in low-income settlements often require additional explanations. Chatterjee (2010), for example, examined vulnerability in terms of built environment quality (e.g. overcrowding, low-lying and poorly drained land). These physical, built environment aspects are captured by our physical vulnerability domain. Elsewhere Agrawal (2010) highlights how institutions and external actors (e.g. municipal governments, donors, civil society organisations, economic and political elites, and the private sector) construct and/or address vulnerability through governance rules and practices. We, therefore, define politico-legal as our fourth vulnerability domain.

### 2.3 Unpacking Adaptation to Climate Change by Linking Actors to Actions

As Moser & Ekstrom (2010) argue, adaptation involves changes in socio-ecological systems in response to actual and expected impacts of climate change in the context of interacting non-climatic changes. Adaptation strategies and actions can range from short-term coping to longer-term, deeper transformations, and may or may not succeed in moderating harm or exploiting beneficial opportunities.

Three analytical angles of relevance to this paper stand out from this definition. First, adaptation must not consider climate change alone and may be initiated or undertaken in the context of non-climatic factors. This resonates with Thorn, Thornton & Helfgott (2015) that people employ adaptation not only to reduce adverse effects of specific environmental change (e.g. urban land-cover changes), but also to enhance opportunities for well-being (e.g. migration to urban areas allows people to escape rural poverty). As such different forms of changes across the SES need to be considered – from patch, to city, to water basin, to global levels.

Second, we must acknowledge diverse outcomes. Some adaptive actions may prove to be more, less or ill-suited to a particular group of people. This provides an opportunity for people as well as authorities to learn from past mistakes, and revitalise, re-orientate or even abandon certain practices. Indeed, as Liana, Pietro, Silvia & Cerbara (2012) observe, in Dar es Salaam poor people whose livelihoods are dependent on natural resources chose to adjust or diversify their livelihood practices. In contrast, people who are less dependent on these resources tend to migrate to less vulnerable areas, thus practicing substitution. We therefore focus on three types of actions in our study: ***adjustment; diversification; and substitution***. They constitute a locally relevant sub-set of eight universal human adaptation processes, namely: mobility, exchange, rationing, pooling, diversification, intensification, innovation, and revitalisation (Thornton & Manasfi, 2010).

Thirdly, local adaptations of an individual, household or community can be supported, constrained or undermined by extra-local interventions (see Agrawal, 2010). This implies that examination of who acts is important to understand effective adaptation. When actors' strategies and processes combine, entailments and pathways develop towards a future alternative situation. This may also enable some further steps to be taken, and/or limit others. Co-incidental adaptations to other environmental stimuli might also occur. In short, linking actors to actions is important to understand and promote effective adaptation practices.

### 3. Study Context and Methods

Dar es Salaam is one of the fastest growing cities in SSA. Its current population of 4.4 million (URT, 2013) grew at 5.8 percent per annum during the last decade (Kiunsi, 2013a). UN-Habitat (2014) predicts the city population will grow at an even faster rate in the next decade, raising the prospect of Dar es Salaam becoming a mega city by 2034. Population growth will increase demand for hard infrastructure, but it will also create more pressure on, and demand for, soft infrastructure such as UGS (Kiunsi, 2013b). A massive land cover transformation is already underway (Kironde, 2006), without any plans for the provisioning of UGS. An evident trend is that informal settlements become progressively more densely populated as the availability of green structures declines. To Kyessi (2010), this is an inadvertent result of minimal self-provisioning of UGS during the informal urban development process.

Such unplanned and informal densification in the city *does not* happen in an institutional vacuum. The city's governance structure, in fact, reaches the household/ settlement level quite systematically. Previously a socialist state, Tanzania adopted a multi-party governance system in 1992. However, an important legacy of the socialist era - a system of 10-cell leaders (*Balozi* in *Kiswahili*) - remains deeply embedded in the post-socialist era (Kombe, 2005). In the urban setting, several 10-cell units together form the lowest (sub-ward) administrative level called Streets (*Mitaa* in *Kiswahili*) in the local government authority (LGA). The subsequent hierarchical levels of urban governance are: Ward, Division, Municipal Council and City Council. At the time when the study was conducted, the city was divided into three municipalities (Ilala, Kondononi and Temeke), 10 Divisions, 73 Wards and 449 Streets, with Dar es Salaam City Council as the overarching authority (DCC, IMC, KMC & TMC, 2010). All households in the city - whether living in informal or formal settlements - are, thus, part of a formal urban governance structure.

Many high profile attempts have been/ are being made to put this elaborate governance structure into practice to guide the city's urban development in an integrated way. The *Tanzanian Draft Urban Development and Management Policy* (awaiting ratification) is a case in point. It sets a key objective for LGA in Dar es Salaam: to address informal urbanization practices, coupled with managing environmental risks from growing climate related events (Shemdoe, Kassenga & Mbuligwe, 2015). Many doubt, however, that such policy changes will be enacted on the ground.

Against this context, four carefully-selected low-income settlements were investigated. The settlements were selected through a screening process involving all existing informal settlements in 2011 in the city. Initially, a GIS-based mapping was undertaken to list and locate all settlements across the city. A day-long workshop was then held with 15 local stakeholders and research partners. The workshop produced a short-list of six settlements as 'candidate sites' using five criteria: (i) located in flood-prone areas; (ii) occurrence of flooding incidents; (iii) existence of local institutions; (iv) existence of adaptation practices; and (v) level of housing and built-environment density (CLUVA, 2013). Field-visits then followed to double-check on the suitability of the short-listed sites, culminating in the selection of four settlements. All four case study settlements are located in Kinondoni municipality but, this is not surprising as Kinondoni has the greatest concentration of poorly serviced unplanned settlements in Dar es Salaam (CLUVA, 2013). The study sites are (Figure 1):

- **Suna** in *Magomeni* Ward: located 5km from the city centre, with approximately 2,500 people. It is bounded by two rivers - *Msimbazi* and *Ng'ombe*; most of the dwellings are

located on the encroached swamp at the confluence of these rivers. Over half of the dwellings are prone to flooding.

- **Bonde la Mpunga** (hereafter *Bonde*) in *Msasani* Ward: located 6 km from the city centre, with approximately 17,500 people. It is distant from rivers, yet severe waterlogging is routine. This is partly due to a rapid increase in bordering, high-class residential development which blocks natural and constructed drainage channels/structures to the Indian Ocean (about 1 km away).
- **Uzuri** in *Manzese* Ward: is the largest informal settlement in the city with 67,000 people (in 2009), located 7km from the city centre. Meandered by two rivers (*Sinza* and *Mbokomu*), flooding is also a major concern for houses built on encroached river banks.
- **Hanna Nassif** in *Hanna Nassif* Ward: 4km from the city centre, with a population of over 37,000 (URT, 2013). It comprises an upper (which has been regularised and is flood-free) and a lower part (which is extremely flood prone, on encroached swamp at the confluence of the *Ng'ombe* and *Msimbazi* rivers).

All four settlements are characterised by similar occupational patterns dominated by small and informal businesses including street vending. Urban agriculture is practised along the river valleys, where households cultivate vegetables for personal consumption or for sale in nearby shops. Income generation in every settlement is susceptible to fluctuations, due to flooding during the rainy seasons (March-May & November-December).

[Figure 1: The study context]

Data was collected in two stages. The first stage took place during June-August 2012 when Suna and Bonde were studied as part of the CLUVA project. The second stage took place during April-August 2015 when all four settlements were studied (Suna and Bonde revisited, and Hanna Nassif and Uzuri newly studied) as part of the EcoPoor project. We applied the same methodology in both stages, involving a combination of participatory appraisal and life history interview tools. Our initial findings obtained were cross-validated through: rapid visits to other settlements; key informant interviews with 10-cell leaders and LGA officials (at Mitaa, Ward and Municipal levels); and analysis of academic and 'grey' literatures. Researchers with extensive local contextual knowledge and relevant language skills conducted all fieldwork.

Our choice of participatory appraisal and life history interview tools were to capture perceptions of the case study population about which UGS are important to them, rather than an 'objective' economic and/or ecological evaluation of the UGS in question. We were particularly interested in capturing: the diversity of UGS that the respondents utilise; and the nature and extent of recent climatic and/or non-climatic changes to both the UGS and derived services. Although our units of analysis were households and communities, the UGS of importance to these local levels were located across the city. In effect, therefore, we sought to understand the micro (households and community) level benefits/disbenefits of UGS located at the meso (city) level, and the corresponding micro-to-macro (local, national, global) level factors.

A combination of participatory appraisals and life history interview tools emerged as the most appropriate approach for such a study. Participatory methodologies are rooted in appraisals of rural poverty (Chambers, 1994), but are increasingly applied in urban poverty and climate change studies. The urban adaptations of the methodology involve purposive sampling from a range of focus groups that are representative of community members (Moser & Stein, 2011).

Although the methods have rarely been applied to study urban poor's access to ecosystem services, the principle of allowing groups of low-income people to identify the ways they depend on or make use of the urban ecosystem and how climatic or other factors affect this informal dwelling-ecosystem relationship proved to be effective.

Yet, the findings of participatory appraisal are often criticised for amalgamating together from different pieces of information provided by different groups of poor people at different times (Hulme, 2003). They do not look in any detail at specific households - one of our two units of analysis. Even in low-income settlements, there are poor *and* non-poor households; participatory appraisals cannot effectively distinguish between households. In order to overcome this limitation and to obtain detailed household-level insights, we incorporated life history interviews with participatory appraisal. The life history approach has roots in oral history (Frisch, 1990), human geography (Miles & Crush, 1993), anthropology (Francis, 1993) and sociology (Bourdieu, 1999). It seeks to bring to light the respondent's representation of their situation by setting up a relationship of active and methodical listening (Bourdieu, 1999). The method can involve a full, a thematic or an occupational life (Goodson, 2008).

This study took the thematic life history approach with selected household heads about how they have been using the UGS in their day to day life and the changes they (themselves and UGS) have gone through over time. Particular attention was also given to capture if the respondent's household had experienced any 'critical incidents' involving important UGS. The critical incidents technique is a process of learning about 'what people do' in various situations, which need not be spectacular but should hold significance (Serrat, 2017). At the individual level such events or circumstances can make people stop and think, perhaps revisit their assumptions or even change (or adapt) the way they do things. At the collective level, such incidents can reveal strengths and weaknesses of existing institutional arrangements and if there are any systematic problems, including what Ostrom (2007) regards as collapse of the complex SES.

The methodology was implemented by conducting eight participatory appraisals (two appraisals per settlement - one involving only female and the other mixed gender participants) and 32 life history interviews. The participatory appraisals involved four exercises: (a) listing and ranking of everyday challenges facing the respondents; (b) community mapping of UGS of importance to them; (c) nature and timeline of critical UGS incidents that the participants had experienced; and (d) mapping of institutions that the respondents have access to. The information obtained from participatory exercises provided the basis for purposive sampling of life history interview respondents. We also held a concluding dialogue with the Tanzanian academic community to test and refine initial findings.

## **4. Urban Green Structures of Importance to Dar es Salaam's Informal Settlement Dwellers**

### **4.1 Types of UGS and Derived Services**

Findings presented in Table 1 and exemplified in Figures 2 & 3 indicate that the city's informal dwellers use a variety of UGS for multiple purposes. Our respondents reported collectively accessing 19 multi-functional UGS, many of which can be categorised into three ownership types: private (e.g. allotments, house gardens); common goods (e.g. sea, beaches); or club/toll goods (e.g. pay-for-beaches, mangroves). A few of these UGS, however, defy precise ownership-based categorisation because of the nature of their multi-functionality. A school playground, for instance, can be a private- or government-owned UGS. For schools located in the vicinity of case

study settlements, these playgrounds have become a common good in practice. Dwellers from the case study and neighbouring settlements regularly come to play football and/or conduct other recreational activities here.

Table 1: Types of UGS and derived services for the case study population

Figure 2: Potted plants within a micro plot in Bonde settlement

Figure 3: A family in Bonde settlement reliant on traditional fishing using fish trap and seaweeds

But the opportunity for informal dwellers to practice such commonage involving the UGS that they themselves do not own is not omnipresent. Indeed, of the 19 UGS, eight were unavailable for Bonde, seven Uzuri and Hanna Nassif each, and six Suna dwellers, indicating important variations in UGS availability for informal dwellers across the city. With Bonde being the most and Suna the least densely populated amongst the four case study settlements, a possible trend is evident: as the housing and built-environment density increases, UGS availability conversely decreases.

Notwithstanding this trend, there is strong evidence to suggest that having access to cultural services is of greatest importance to informal citizens. Based on the number of times respondents reported to have derived a type of service, the count decreases dramatically from cultural and amenities to other types of service. Cultural services have been associated with all but two UGS. Furthermore, although the vast majority of the UGS are located *outside* our case study settlements, UGS for everyday cultural activities tend to be located close to where people live. For less frequent/occasional festivity and livelihood-supporting services people tend to go further afield. It therefore matters for poorer people to have UGS provided cultural services in the vicinity of their residence. This is reinforced by the fact that poorer dwellers cannot themselves afford to have much UGS within their micro plots and indeed their settlement.

Table 2 illustrates another important finding – that, the respondents have good awareness of the changes regarding these UGS, the multi-level factors causing these changes, and the knock-on effects on derived services. The life history data, for example, revealed a gradual decline in the availability of trees within people’s home compounds as well as their settlements. Participants also reported of having to fell larger trees (e.g. Neem), as roots caused structural damage to adjacent dwellings. This also explains the exclusion of informal settlements from a city-wide initiative launched in 1995, when government directed that all business operators must plant a tree at their premises. Beyond these micro (household and community) and meso (neighbourhood) level factors, people also reported being affected by much larger macro/global factors such as tsunami, El Nino and sea level rise.

On the availability of ecosystem services, therefore, the implication is that as population and building density increased a gradual transformation of converting open, green spaces into built structures had followed. Trees are removed, coastal erosion spread, fish varieties declined, and many other changes occurred: a range of the derived services - from micro environment amelioration (e.g. shade) by individual trees to sea weeds supporting traditional fishing-based livelihoods - that had benefited the urban poor, are subsequently removed from their vicinity and wider landscapes.

[Table 2: Timeline and nature of critical incidents with implications on important UGS]

## 4.2 A Multitude of Vulnerability

Vulnerabilities of people and UGS of importance to them are presented in Table 3. In total 12 counts of vulnerability were identified, from which three key observations stand out. Firstly, all four vulnerability domains are strongly if not equally prevalent in every settlement. The variety of vulnerabilities identified include: contextual (e.g. unreliable rainfall and water hungry soils), compositional (e.g. constrained livelihoods), physical (e.g. highly concentrated land-use) and politico-legal (e.g. poor legal protection of community spaces). The concurrence of so many counts of vulnerability serves a key message: when entwined together, the natural and man-made factors contribute to reducing UGS-derived services and trigger disservices, resulting in a web of vulnerability for poor people. Amongst a range of adverse outcomes, is a gradual loss of neighbourhood vegetation and of air circulation blocked by new developments. As one respondent explained:

*“Now you can’t even find space to dry your clothes. Before the open spaces made our life easier and cheaper because we were able to grow food to supplement our diets, and reduce expenses on groceries. The beach increased the air circulated; now there is too much congestion and air cannot pass through.”*

[Table 3: Key vulnerabilities of people and UGS of importance to them]

Secondly, the vulnerability of people and UGS are intertwined. For example, the coastal ecosystems (e.g. the beach) are vulnerable to changes in ocean properties (e.g. sea currents); and an affected coastal ecosystem, in turn, is a source of vulnerability to the people who use the beach and sea for a variety of purposes. Perversely, people and tentacles of corruption perform various malpractices (e.g. disposal of raw sewage into the sea) and undermine their own access to UGS and directly contribute to pressures on the coastal ecosystem. This is a clear sign of the Driver-Pressure-State-Impact-Response (DPSIR) phenomenon (EEA, 1999). This inter-connectivity between dimensions of vulnerability was strongly evident in life history interviews. For example, regarding the causes of 2011 flooding in Suna, one respondent explained:

*“God made natural rivers and streams to drain the water, but people have bought this land and interfered with the natural flow of water. People have been filling and blocking the drainage channels, and construction projects next to the drains have also affected their ability to drain.”*

Thirdly, the outcomes of various exposures to vulnerability do not just lead to reduce services but create disservices. This distinction between a reduced service and a disservice arrives at the fault line between when the utility of a service is greatly reduced, and when a disservice is established. For example, within the contextual vulnerability domain, outcomes such as a fall in seaweed quality/quantity and the subsequent dip in harvest and fish catch may be seen as service reductions. Conversely outcomes such as waterborne/parasitic are *disservices*, resulting from poor sanitation/drainage practices. However, the distinction between reduced services and disservices is often extremely subtle, and can be transitional - disservices may eventually arise from reduced services. An example could be that, government-supported ecotourism development elsewhere in Tanzania is believed to lead to falling tourist numbers in Dar es Salaam. This loss of trade leads to redundancies, a reduction in employment for wood carvers, and the potential disappearance of wood carving skills - as such this is a *reduction* in services. If lack of employment opportunities leads to an increase in drug dealing, petty crime and other unsociable activities (as some respondents report), then service reduction leads to disservice.

### 4.3 The ‘Actor v/s Action’ Adaptation Matrix

The identified adaptation practices are presented in an ‘Actor X Action’ matrix in Table 4. Whilst as many as 25 individual practices have been identified, the accrued benefits to people are mostly indirect. This is hardly surprising, as the data gathered shows that climate change is not the primary concern of Dar es Salaam’s poor. Another overall observation is that a greater number of practices have been developed by households (thirteen practices) than community-based organisations (CBOs, six practices) or external bodies (six practices).

[Table 4: Emerging adaptation practices involving important UGS]

In terms of nature of practices, households are more concerned with adjustment (six practices) and diversification (five practices) than substitution (two practices). Given the low economic status of informal dwellers, it is unsurprising that adjustment and diversification are the most available options to them to alleviate vulnerability. To initiate and maintain these practices, households commonly draw on their own limited resource-bases and know-how. The scanty household resources, in turn, transform these practices into mere acquiescence (meaning they simply absorb the impact) or at best coping (meaning they make some adaptations that partially offset the impacts) (Hulme, Roy, Hordijk & Cawood, 2016). Aspects of progressive or transformative adaptation (Pelling, 2011) are largely absent in these practices, although there are encouraging signs as detailed later in this section.

In terms of action by CBOs, the data revealed six emerging practices - adjustment (three practices), diversification (two practices), and substitution (one practice). Adjustment practices revolved around the issue of ecosystem-based livelihoods (provisioning services - harvesting, farming etc.). Diversification practices sought to secure diverse *group* benefits and knowledge acquisition/ sharing. Substitution practice involved a form of informal insurance to tackle the potential collapse in the supply of specific timber used for wood carving.

The practices employed by CBOs usually concern issues that affect at least a few households involved in similar livelihood activities such as fishing or urban farming. For resources and ideas, CBOs tend to rely mostly on their community-based network, although we found some evidence of CBOs accessing a limited number of external institutions. Acting at the interface between poorer communities and formal institutions, CBOs have emerged as a crucial agency to reduce vulnerability within Dar es Salaam’s informal settlements. Unfortunately, however, this study finds that most CBOs involved in mediating UGS derived ecosystem services in the city are episodic in nature.

As a sign of encouragement, the study also reveals six counts of adaptive actions involving external actors. These practices showcase interesting partnerships between public and private organisations, and CBOs. The six practises were split evenly between adjustment, diversification, and substitution. CBOs are involved in two adaptive adjustment practices: one with the Ministry of Natural Resources and Tourism (MNRT), the other with the Ministry of Livestock and Fisheries Development (MLFD). The municipal authority has also instigated two diversifying initiatives: to promote city beautification by planting diverse trees (in 1995, every business was advised to plant a tree in their premises), as well as the creation of an environmental officer post at the local authority level as part of the 2004 Environmental Act. Two interesting substitution practices have also emerged. The first one is a public-private partnership to manage city parks; already two parks have been restored and are managed by the National Bank of Commerce (NBC) and Vodafone. The second one required the central

government taking action to find a suitable relocation site for the 2011 flood victims. Whilst the decision to relocate flood victims to a remote location over 30km away from Dar es Salaam is open to debate, the involvement of the central government was unusually rapid.

In sum, whilst adaptation practices employed by informal dwellers show determination, ingenuity and capacity for collective action, it is evident that diversification and substitution practices involving access to extra-local UGS require institutional pluralism and political acquiescence or willingness (through CBOs and external actors). The data shows that the political support of external actors is the principal reason why some adaptation practices occurred at the meso-level. For example, the promotion of city beautification and park management, the creation of posts at the local authority level and relocation of flood victims are examples of initiatives that are an outcome of broader political processes. The further up the pyramid of influential actors one goes from the base household level, the greater the influence of the realm of politics.

## **5. UGS for Informal Settlement Dwellers: Role of Creative Urban Planning**

This study has revealed the ways in which everyday challenges facing Dar es Salaam's urban poor relate to the city's green structures. Unsurprisingly, the narratives emerging indicate that environmental concerns underpin many issues facing Dar es Salaam's informal settlement dwellers, including: improper waste disposal; bad drainage; and poor sanitation. The respondents remain acutely aware of the role of green structures in their lives. They identified green structures that ranged from the obvious (parks, cemeteries, rivers and beaches) to the less obvious (quarries, orchards and roadside plantations). They also reported that the availability of these UGS, and the quantity and quality of the derived ecosystem services were declining, which aggravated their vulnerability and reduced their capacity to adapt to change.

A change in the approach from the municipal authorities and those who are tasked with city development policies is needed to avert the build-up of vulnerability and accumulation of risks to the livelihoods of the urban poor in the city. This, as argued in Shemdoe et al. (2015), needs to start with capacity building of local government officials and technical cadre enabling them to understand the importance of ecosystem services in adaptation to climate change. Urban planning has always been central within the concept of creating and conserving green structures. But, the process of urban planning in Dar es Salaam (and indeed across the developing world) appears to almost totally ignore UGS for poorer people. The sheer volume of informal development in Dar es Salaam's informal districts means that communal land is parcelled off for sale and/or to build more housing units, meaning that the very properties that enable many UGS to provide ecosystem services are compromised through a gradual reduction in their size and break-up of their link functions. Such crowding out and fragmentation presents a worrying trend for informal dwellers looking to use these services.

Strategic planning initiatives which often prioritise investment in big/hard infrastructure mean that UGS dotted in and around informal settlements are often overlooked, and worst, these are destroyed. This raises the question of whether more *creative urban planning* might seek a greater inclusion of UGS within their remits, enabling a greater harnessing of the derived services by the urban poor. The idea of creative urban development is closely related to the emerging political concept of 'development coalitions' (DLP, 2012). These arise when local-level partnerships of political, bureaucratic and civil society actors devise and implement 'institutional fixes' to provide or maintain service for poorer people. Our evidence shows that low-income people

greatly value having access to UGS (e.g. cemetery, playgrounds) within the vicinity of their settlements. A pro-poor urban planning approach would be to revitalise/conservate UGS which are accessible to low-income populations across the city.

Such an approach would promote targeted greenspace improvement technique over systemic greenspace planning (Yong & Longcore, 2000). As a technique, targeted greenspace improvement involves acquisition of specific sites and their management as greenspace or changing management of properties already in public ownership. In contrast, systemic greenspace planning includes public policy mechanisms such as landscaping, building and lot design and parking lots.

Whilst some targeted green structure revitalisation and conservation does occur in Dar es Salaam, it can be best described as *ad hoc*. Take the example of the partnership between Dar es Salaam City Council (DCC) and the National Bank of Commerce (NBC) to manage a city centre park. This was a public-private partnership in which NBC received advertising space within the park as a reward for taking the responsibility of gentrification of the park. In such *creative* arrangements there is then the potential to not only improve UGS within the city, but external institutions (e.g. NBC) would also receive rewards from their involvement, in the form of advertising space.

To be truly effective, however, the role of CBOs must be considered of critical importance in such targeted initiatives. This study indicates that CBOs in Dar es Salaam are ready to collaborate, but they need recognition and incentives. Examples include the CBO-MNRT partnership in addressing coastal erosion through the plantation of mangroves. Such initiatives are clear examples of community awareness and a desire to conserve and revitalise UGS within the city. But, the episodic nature of the initiative means that people's/CBOs' enthusiasm has dampened, and the prospects of CBOs federating to create a political voice for poor urban dwellers is reduced.

It is imperative that these objectives are ingrained into development schemes and seek to foster creative engagement of diverse institutions. Doing so would increase the likelihood that this form of development would not continue to function merely *ad hoc*, or as a sub-directive to other initiatives. Until then, in spite of their rich potential for goods/service provision, UGS will continue to be carved up and privatised which decreases their availability for poorer populations. Low income dwellers cannot be expected to continually source and maintain their own green structures without a significant shift in planning practices, and assistance from official duty bearers, including but not limited to, the government and regional authorities. Through a more considered and inclusive form of urban planning, green structures in and around low-income settlements can find a place in development initiatives. Poor communities must be included in such processes, so that their local knowledge, enthusiasm and expertise can be efficiently harnessed. We have called this *creative urban planning*.

## 6. Conclusion

This study has four main conclusions. Firstly, low-income urban dwellers in developing cities like Dar es Salaam remain heavily dependent on the presence of UGS and are affected by a decline in quantity and quality of the derived services. Their dependence is evident in the range of supporting, provisioning, regulating and cultural services that the dwellers of four case study settlements of Dar es Salaam draw from the 19 identified types of UGS. Relatedly, evidence of negative impacts on the city's low-income people include the loss of critical services (e.g.

livelihoods, food production, provisioning of clean air and water, recreation, and hazard regulation) as a result of the degradation of ecosystems within their settlements and further afield.

Secondly, UGS accessible to low-income dwellers undergo changes due to a combination of global, national and local processes and factors. Global environmental processes such as El Nino and tsunamis have had serious implications for the ecosystem functions on which Dar es Salaam's informal residents are dependent. These, and the country's national development that promotes tourism industry away from the city, have impacted negatively on the wood carving-based employment market in Dar es Salaam. Locally, the city's urban development process that favours the expansion of high class residential development along the beach has irreparably altered the local environment in and around informal settlements. Many link functions have been cut off, and waterlogging and blocked line drains have become routine. Continued densification has resulted in a chronic absence of UGS within these settlements. Even for regular recreational activities people have to go to places much further afield.

Thirdly, while the study identifies a range of innovative adaptation practices being developed by individuals and community groups, there is a limit to what these people and groups can do by themselves. Many of the changes, and the associated drivers, are beyond their control. Their adaptation practices are commonly acquiescence and coping, not progressive or transformative. Nevertheless, the study has identified some positive deviance: CBO-MNRT partnership in mangroves plantation; and CBO-MLFD partnership in Beach Management Units (BMUs). Creative urban planning is needed to turn these incidences of positive deviance into a social norm.

Finally, to be creative, the city authority should conceive greening for (rather than in) informal settlements as a targeted improvement endeavour. Such an approach allows the city authority to promote development coalitions with political, bureaucratic and civil society actors. A few examples of targeted greenspace improvements in Dar es Salaam have already proven successful (e.g. the DCC-NBC partnership). In countries where informal urbanisation is common rather than an exception, approaches like these need to be mainstreamed and expanded in scope. However, in SSA cities are also rapidly expanding, so only targeted improvement initiatives are not enough. Other strategic measures must also be taken, such as setting aside land for green space in areas where the city is expanding to or encroaching.

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## Bibliography

1. Agrawal, A. (2010). Local institutions and adaptation to climate change. In R. Mearns, & A. Norton (eds.), *Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World* (pp. 173-197). Washington DC, USA: The World Bank.
2. Armah, F. A., Luginaah, I., Hambati, H., Chuenpagdee, R., & Campbell, G. (2015). Assessing barriers to adaptation to climate change in coastal Tanzania: Does where you live matter? *Population and Environment*, 37(2), 231-263.
3. Banks, N., Roy, M., & Hulme, D. (2011). Neglecting the urban poor in Bangladesh: research, policy and action in the context of climate change. *Environment and Urbanization*, 23(2), 487-502.
4. Birkmann, J. (2006). Measuring vulnerability to promote disaster-resilient societies: conceptual framework and definitions. In J. Birkmann (ed.), *Measuring Vulnerability to Natural Hazards* (pp. 9-54). Tokyo, Japan: United Nations University Press.
5. Bolund, P., & Hunhammar, S. (1999). Ecosystem services in urban areas. *Ecological Economics*, 29, 293-301.
6. Bourdieu, P. (2000). *The weight of the world: Social suffering in contemporary society*. Stanford, USA: Stanford University Press.
7. Chambers, R. (1994). The origins and practice of participatory rural appraisal, *World Development*, 22(7), 953-969.
8. Chatterjee, M. (2010). Slum dwellers response to flooding events in the megacities of India. *Mitigation and Adaptation Strategies for Global Change*, 15(4), 337-353.
9. Christoplos, I., Anderson, S., Arnold, M., Galaz, V., Hedger, M., Klein, R.J.T., & Goulven, K.L. (2009). *The human dimension of climate adaptation: the importance of local and institutional issues*. Stockholm, Sweden: Commission on Climate Change and Development.
10. Cilliers, S., Cilliers, J., Lubbe, R., & Siebert, S. (2013). Ecosystem services of urban green spaces in African countries - perspectives and challenges. *Urban Ecosystems*, 16(4), 681-702.
11. CLUVA (Climate Change and Urban Vulnerability in Africa). (2013). *A GIS based assessment of the urban green structure of selected case study areas and their ecosystem services* (Report D2.8, EU Seventh Framework Programme Theme ENV.2010.2.1.5-1). The University of Manchester, UK. Retrieved 25 September 2017 from - [http://www.cluva.eu/deliverables/CLUVA\\_D2.8.pdf](http://www.cluva.eu/deliverables/CLUVA_D2.8.pdf)
12. Davenport, N. A., Shackleton, C. M. & Gambiza, J. (2012). The direct use value of municipal commonage goods and services to urban households in the Eastern Cape, South Africa. *Land Use Policy*, 29, 548-557.
13. DCC (Dar es Salaam City Council), IMC (Ilala Municipal Council), KMC (Kinondoni Municipal Council) & TMC (Temeke Municipal Council). (2010). *Dar es Salaam Infrastructure Development Programme*. Dar es Salaam, Tanzania. Retrieved September 25, 2017 from - [http://www.citiesalliance.org/sites/citiesalliance.org/files/CAFiles/Projects/Dar\\_es\\_Salaam\\_Infrastructure\\_Development\\_Programme.pdf](http://www.citiesalliance.org/sites/citiesalliance.org/files/CAFiles/Projects/Dar_es_Salaam_Infrastructure_Development_Programme.pdf).

14. Diaz, S., Fargione, J., Chapin III, F. S. & Tilman, D. (2006). Biodiversity loss threatens human well-being. *PLoS Biology*, 4(8), 1300-1305. DOI: 10.1371/journal.pbio.0040277.
15. DLP (Developmental Leadership Programme). 2012. *Coalitions in the politics of development* (Findings, Insights and Guidance from the DLP Coalitions Workshop, Sydney, 15-16 February 2012). Retrieved October 20, 2017 from - <http://publications.dlprog.org/Coalitions%20in%20the%20Politics%20of%20Development.pdf>
16. Dodman, D., Kibona, E. & Kiluma, L. (2011). *Tomorrow is too late: Responding to social and climate vulnerability in Dar es Salaam, Tanzania* (Case study prepared for Cities and Climate Change: Global Report on Human Settlements 2011). Retrieved October 20, 2017 from - [http://mirror.unhabitat.org/downloads/docs/GRHS2011/GRHS2011CaseStudyChapter06Dar es Salaam.pdf](http://mirror.unhabitat.org/downloads/docs/GRHS2011/GRHS2011CaseStudyChapter06Dar%20es%20Salaam.pdf).
17. Douglas, I. (2012). Urban ecology and urban ecosystems: understanding the links to human health and well-being. *Current Opinion in Environmental Sustainability*, 4, 385–392.
18. Douglas, I., Alam, K., Maghendra, M., McDonnell, Y., McLean, L. & Campbell, J. (2008). Unjust waters: climate change, flooding and the urban poor in Africa. *Environment and Urbanization*, 20(1), 187-205.
19. EEA (European Environment Agency). 1999. *Environmental indicators: Typology and overview* (Technical Report No. 25). Copenhagen, Denmark: EEA.
20. Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P. J., McDonald, R., I., Parnell, S. Schewenius, M., Sendstad, M., Seto, K. C. & Wilkinson, C. (eds.). (2014). *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*. London, UK: Springer.
21. Frances, E. (1993). Qualitative research: Collecting life histories. In S. Devereux & J. Hoddinott (eds.) *Fieldwork in Developing Countries* (pp. 86-101). London, UK: Lynne Rienner Publishers.
22. Fratini, R. & Marone, E. (2011). Green-space in urban area: Evaluation of the efficiency of public spending for management of green urban areas. *International Journal of E-business Development*, 1(1), 9-14.
23. Frisch, M. (1990). *A shared authority: Essays on the craft and meaning of oral public history*. Albany, USA: University of New York Press.
24. Gandy, M. (2008). Landscapes of disaster: water, modernity, and urban fragmentation in Mumbai. *Environment and Planning A*, 40, 108-130.
25. Goodson, I. (2008). *Investigating the teacher's life and work*. Rotterdam, The Netherlands: Sense Publishers.
26. Gómez-Baggethun, E., Gren, A., Barton, D. N., Langemeyer, J., McPhearson, T., O'Farrell, P., Andersson, E., Hamstead, Z. & Kremer, P. (2014). Urban ecosystem services. In T. Elmqvist, M. Fragkias, J. Goodness, B. Güneralp, P. J. Marcotullio, R. I. McDonald, S. Parnell, M. Schewenius, M. Sendstad, K. C. Seto, & C. Wilkinson (eds.), *Urbanization*,

- Biodiversity and Ecosystem Services: Challenges and Opportunities*. London, UK: Springer (pp. 175-251).
27. Gopal, D. & Nagendra, H. (2014). Vegetation in Bangalore's slums: boosting livelihoods, well-being and social capital. *Sustainability*, 6, 2459-2473.
  28. Hulme, D. (2003). *Thinking 'small' and the understanding of poverty: Maymana and Mofizul's story* (Working Paper 22, Chronic Poverty Research Centre). The University of Manchester, UK. Retrieved 25 September 2017 from - <https://assets.publishing.service.gov.uk/media/57a08cf9ed915d622c0016d3/22Hulme.pdf>.
  29. Hulme, D., Roy, M., Hordijk, M. & Cawood, S. (2016). Re-Conceptualising Adaptation and Comparing Experiences. In M. Roy, S. Cawood, M. Hordijk & D. Hulme (eds.) *Urban Poverty and Climate Change: Life in the Slums of Asia, Africa and Latin America* (pp. 257-265). London, UK and New York, USA: Routledge.
  30. IPCC (Intergovernmental Panel on Climate Change). (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability* (Part A: Global and Sectoral Aspects). Cambridge, UK and New York, USA: Cambridge University Press. Retrieved September 20, 2017 from - <http://ipcc.ch/report/ar5/wg2/>
  31. Jaganmohan, M., Vailshery, L., Gopal, D. & Nagendra, H. (2012). Plant diversity and distribution in urban domestic gardens and apartments in Bangalore, India. *Urban Ecosystems*, 15(4), 911–925.
  32. Kombe, W. J. (2005). Land use dynamics in peri-urban areas and their implications on the urban growth and form: The case of Dar es Salaam, Tanzania. *Habitat International*, 29, 113-135.
  33. Kironde, J. M. L. (2006). The regulatory framework, unplanned development and urban poverty: Findings from Dar es Salaam, Tanzania. *Land Use Policy*, 23, 460-472.
  34. Kiunsi, R. B. (2013a). A review of traffic congestion in Dar es Salaam city from the physical planning perspective. *Journal of Sustainable Development*, 6(2), 94-103.
  35. Kiunsi, R. B. (2013b). The constraints on climate change adaptation in a city with large development deficits: The case of Dar es Salaam city. *Environment and Urbanization*, 25(2), 321–337.
  36. Krishna, A. (2018). Rural-urban inequality and poverty. In G. Antonelli & B. Rehbein (eds.), *Inequality in Economics and Sociology: New Perspectives*. London, UK and New York, USA: Routledge (pp.162-173).
  37. Kyessi, A. (2010). Enhancing security of land tenure in informal settlements: The case of WAT-Human Settlements Trust in Hanna Nassif Settlement, Dar es Salaam, Tanzania. *Utafiti Journal*, 8(1), 87-104.
  38. Lange, H. J. D., Sala, S., Vighi, M., & Faber, J. H. (2010). "Ecological vulnerability in risk assessment: review and perspectives." *Science of the Total Environment*, 408, 3871–3879.
  39. Liana, R., Pietro, D., Silvia, M., & Cerbara, L. (2012). *Investigating the Livelihoods of the Population Dependent on Natural Resources and their Concerns* (Working Paper, Adapting to Climate Change in Coastal Dar es Salaam Project). Rome, Italy: Sapienza University.

40. López-Morales, E. (2015). Gentrification in the global South. *City*, 19(4), 564-573.
41. McKean, B. (2009). Invisible lives: stories of innovation and transition. *Intersections*, 10(2), 1-57.
42. McPhearson, T., Parnell, S., Simon, D., Gaffney, O., Elmqvist, T., Bai, X., Roberts, D., Revi, A. (2016). Scientists must have a say in the future of cities. *Nature*, 538, 165-166.
43. Mensah, C. A. (2014). Urban green spaces in Africa: nature and challenges. *International Journal of Ecosystem*, 4(1), 1-11.
44. Miles, M. & Crush, J. (1993). Personal narratives as interactive texts: collecting and interpreting migrant life histories. *Professional Geographer*, 45(1), 95-129.
45. Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, 107(51), 22026–22031.
46. Moser, C. & Stein, A. (2011). Implementing urban participatory climate change adaptation appraisals: A methodological guideline. *Environment & urbanization*, 23(2), 463-485.
47. Ostrom, E. (2010). Beyond markets and states: Polycentric governance of complex economic systems. *American Economic Review*, 100, 641-672.
48. Ostrom, E. (2007). A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*, 104(39), 15181-15187.
49. Pelling, M. (2011). *Adaptation to Climate Change: From Resilience to Transformation*. London, UK : Routledge
50. Roberts, D., Boon, R., Diederichs, N., Douwes, E., Govender, N., Mcinnes, A., Mclean, C., O'Donoghue, S. & Spires, M. (2012). Exploring ecosystem-based adaptation in Durban, South Africa: “learning-by-doing” at the local government coal face. *Environment and Urbanization*, 24(1), 167–195.
51. Roy, M., Hulme, D. & Jahan, F. (2013). Contrasting adaptation responses by squatters and low income tenants in Khulna, Bangladesh. *Environment and Urbanization*, 25(1), 157-176.
52. Serrat, O. (2017). *Knowledge Solutions: Tools, Methods, and Approaches to Drive Organizational Performance*. Mandaluyong, Philippines: Asian Development Bank and Springer.
53. Shemdoe, R., Kassenga G. & Mbuligwe, S. (2015). Implementing climate change adaptation and mitigation interventions at the local government levels in Tanzania: where do we start? *Current Opinion in Environmental Sustainability*, 13, 32-41.
54. Simon, D. (2010). The challenges of global environmental change for urban Africa. *Urban Forum*, 21(3), 235-248.
55. Slater, R. & Twyman, C. (2003). *Hidden livelihoods? Natural resource-dependent livelihoods and urban development policy* (Working Paper No. 225). London, UK: Overseas Development Institute (ODI). Retrieved September 20, 2017 from - <https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/2462.pdf>

56. Summer, A. & Mallett, R. (2011). *Snakes and ladders, buffers and passports: rethinking poverty, vulnerability and wellbeing* (IDS Working Paper 83). Brighton: Institute of Development Studies. Retrieved September 20, 2017 from - <http://www.ipc-undp.org/pub/IPCWorkingPaper83.pdf>
57. TEEB (The Economics of Ecosystems and Biodiversity). (2011). *TEEB manual for cities: Ecosystem services in urban management*. Retrieved September 20, 2017 from - <http://www.teebweb.org/publication/teeb-manual-for-cities-ecosystem-services-in-urban-management/>.
58. The Economist. (2007). *The strange allure of the slums*. 3<sup>rd</sup> May. Retrieved September 20, 2017 from <http://www.economist.com/node/9070714>.
59. Thorn, J., Thornton, T. F. & Helfgott, A. (2015). Autonomous adaptation to global environmental change in peri-urban settlements: Evidence of a growing culture of innovation and revitalisation in Mathare Valley Slums, Nairobi. *Global Environmental Change*, 31, 121-131.
60. Thornton, T., & Manasfi, N. (2010). Adaptation - genuine and spurious: demystifying adaptation processes in relation to climate change. *Environment and Society: Advances in Research*, 1(1), 132–155.
61. Tzoulas, K. K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kazmierczak, A., Niemelä, J. & James, P. (2007). Promoting ecosystem and human health in urban areas using green infrastructure: A literature review. *Landscape Urban Planning*, 81(3), 167–178.
62. UN (United Nations). (2016). *The World Cities in 2016 – Data Booklet* (ST/ESA/SER.A/392). New York, USA: UN Department of Economic and Social Affairs, Population Division.
63. UN-Habitat (United Nations Human Settlements Programme). (2016a). *Urbanization and Development: Emerging Future* (World Cities Report 2016). Nairobi, Kenya: UN-Habitat.
64. UN-Habitat (United Nations Human Settlements Programme). (2016b). *Sustainable Cities and Communities: SDG Goal 11 Monitoring Framework*. UN-Habitat Research and Capacity Development Branch. Retrieved September 20, 2017 from - <https://unhabitat.org/sdg-goal-11-monitoring-framework/>.
65. URT (The United Republic of Tanzania). (2013). *2012 population and housing census: Population distribution by administrative areas*. Dar es Salaam, Tanzania: National Bureau of Statistics.
66. Yong, T. & Longcore, T. (2000). *Creating community greenspace: A handbook for developing sustainable open space in central cities*. California League of Conservation Voters-Education Fund, USA. Retrieved 25 September 2017 from - [http://www.cpp.edu/~tgyoung/Creating\\_Community\\_Greenspace.pdf](http://www.cpp.edu/~tgyoung/Creating_Community_Greenspace.pdf)

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**Table 1: Types of UGS and derived ecosystem services for the case study population**

UGS type	Use*				Availability**			
	S	R	P	C	Bonde	Suna	Uzuri	Hanasif
Public parks, gardens, playgrounds		3, 4		1, 2, 4, 6, 8	•	X	X	X
Educational institution grounds		4		1, 4	•	X	•••	•
Communal semi-public grounds				1, 2, 8	•	••	••	••
Beaches		4		1, 3, 4, 8	•••	X	X	X
Rivers		4, 6	5	4	X	••	••	X
Trenches		6	5		••	•••	••	•••
Natural fountains			4	6	X	•	X	•
Roadside plantations		3		1, 3, 4, 8	•	••	•	•
Mangroves		2	2	5, 6, 8	•	•	X	•
Nurseries				5, 8	•	•	•	•
Cemeteries		3	2	2, 4	•••	X	•••	X
Open fields		4		1	X	•••	X	•••
Allotments			1, 7	5, 6, 8	•	•	•••	•••
House gardens			1, 7	3, 4, 6, 8	X	•	•	X
Sea	1	5	1	2, 3, 4, 5, 7, 8	•••	X	X	X
Quarries			6	8	X	••	••	••
Woodland				8	X	•	X	X
Orchards			1	8	X	X	•	•
Natural vegetation		1	1		X	•	•	•

**\*Key for UGS services****S = Supporting**

1. Nutrient cycling for sea weeds used as bait

**P = Provisioning**

1. Food & fodder
2. Wood
3. Fuel
4. Fresh water
5. Water
6. Minerals
7. Medical resources

**R = Regulating**

1. Erosion regulation (non-coastal)
2. Coastal erosion regulation
3. Temperature control – shade
4. Temperature control - provision of cool/fresh air corridors
5. Waste treatment
6. Flood – river

**C = Cultural**

1. Outdoor recreation
2. Spiritual and religious value
3. Aesthetics and inspiration
4. Psychological comfort
5. Educational
6. Other social meeting
7. Tourism
8. Livelihood

**\*\* Key for availability of UGS services (indicative)**

- = High  
 •• = Medium  
 • = Low  
 X = None

**Table 2: Timeline and nature of critical incidents with implications on important UGS**

<b>Year people started to notice changes</b>	<b>Nature of change</b>	<b>Impact on ecosystem services</b>
1990s (people used imprecise terms like 15-20 years ago)	Sea level rise	Coastal erosion and inundation Change in shallow water currents, resulting in uprooting of sea weeds; stronger current also drove fish away from the shore leading to a reduction in species variety Difficulty to clean beaches Rise in groundwater salinity
1995	Govt. issued a directive that all business operators must plant a tree at their premises	An increase in tree plantation (mainly Neem and Coconut), although people reported to have later cut down Neem trees, which caused structural damage to adjacent buildings
1999	El Nino effect	Stronger sea waves Coastal flooding Abnormally strong wind
2002	Rise in illegal dynamite fishing Increased construction activities near the beach Altered rainfall pattern: extended dry season, late arrival of rainy season, and an overall fall in rainfall in the region as a whole	Gradual decline in fish varieties; some species (e.g. Tuna) disappeared completely, while for others stocks are gradually declining Disruption of link function between land and the sea - e.g. blocked drainage channels caused waterlogging and inland flooding Drop in rice plantation in the up/highland Rain is needed to cool the water to support the fish stock
2004	Tsunami	Increased tremors in the Indian Ocean
2007	Land-use intensification; houses built too close to each other; no room to plant trees	Reduction of neighbourhood level green structures Rise in conflicts between neighbours
2005 & 2011	Intense and frequent flooding	Forced displacement, both short-term (e.g. for a month in 2006) and long-term (e.g. govt. relocating in 2011) Rise in malaria and foot skin diseases Vegetation decay in courtyard

**Table 3: Key vulnerabilities of people and UGS of importance to them**

<b>Domain</b>	<b>Type</b>	<b>Exposure</b>	<b>Outcome</b> (Reduced service/increased disservice)
<b>Contextual</b>	Unreliable rainfall Changes to ocean properties & rise in sea water temperature Water-hungry soil	Variable land-to-ocean nutrient cycling Stronger ocean current & waves, increased near-coast turbulence Rain-dependent urban agriculture	Fall in quality and quantity of seaweeds used as a bait Coastal erosion & retreats, uprooting of seaweeds, damaged habitat for small fish, difficulty in traditional fishing practices Seasonal dip in harvest, financial hardship
<b>Compositional</b>	Constrained livelihood options Preferential development along the coastline Poor waste management	Dependence of ecosystem-based livelihood Gated development with inaccessible green space Siltation of channels and rivers, soil and air pollution	Unregulated harvesting, seasonal dip in earnings, financial hardship Community breakups, social unrest, disruption of link functions Slow recovery from flooding and waterlogging, poor hygiene & parasitic diseases
<b>Physical</b>	Proximity to coasts & rivers, shallow ground water table Poor drainage  Poor sanitation & dirty environment Highly concentrated land-use	Salinity, poor water quality, contamination of ground water Flooding & waterlogging Raw sewage spillage, insects & pests Loss of neighbourhood vegetation, blocked air circulation	Hypertension & related illness, waterborne diseases Crop failure, plant decay, mud & filth, damaged hut, displacement Poor hygiene & parasitic diseases, damaged coastal ecosystem Heat stress, rapid spread of vector borne disease, poor ventilation & light, social conflicts, fire incidents
<b>Politico-legal</b>	Rise in regional ecotourism Tenure insecurity  Lack of a socio-political platform  Lack of catchment-level pollution policy Poor legal protection of community-owned open space	Falling tourists' numbers in Dar Political and market-driven displacement Patronage democracy & corruption  Downstream waterborne transfer of pollutants Land grabbing and illegal construction	Collapse of wood carving industry in Dar, redundancy & loss of skills Community breakups, dereliction of land, psychological distress Moral hazard & erosion of trust on representative democracy, illegal logging & fishing practices Soil and water contamination, abandonment of urban gardening, financial hardship Loss of community space, social conflicts, political patronage

**Table 4: Emerging adaptation practices involving important UGS**

<i>Action</i> ↓ <i>Actor</i>	→	<b>Adjusting</b>	<b>Diversifying</b>	<b>Substituting</b>
<b>Households</b>		Changes to ecosystem-based livelihood practices Promote low-cost soil enrichment Creative use of trees for shaded outdoor workplace/ food stall Creative use of back garden as social and cultural space Practice urban farming to support human development Water-proofing of dwellings	Multiple ecosystem-based livelihoods Household labour mobilisation Invest in farming land on the city outskirts Maintain seasonal calendar agro products and diversify suppliers Diverse use of land	Abandon practices that face a collapse of market Share neighbourhood open spaces for recreation
<b>Community-based organisations (CBO)</b>		Develop group fishing practices to enable long-distance fishing trips Develop rotational farming practices to ensure a steady supply of products and reduce internal competition harvesting of seaweeds to minimise cost and share risks	Work as a pressure group to claim diverse benefits for members Acquire and share knowledge to develop organic farming and alternative marketing strategies	Group purchase of woodland to ensure supply of the needed raw material, if the supply market collapses
<b>External actors</b>		CBO- MNRT partnership in the plantation of mangroves to prevent address coastal erosion CBO-MLFD participation in forming the Beach Management Units (BMUs).	Promotion of city greening as a mitigation agenda by the municipal authority Creation of an environment officer post at the local authority level	Develop public-private partnerships to manage city parks Involving the state government to bypass inter-municipality conflicts on relocation of flood victims

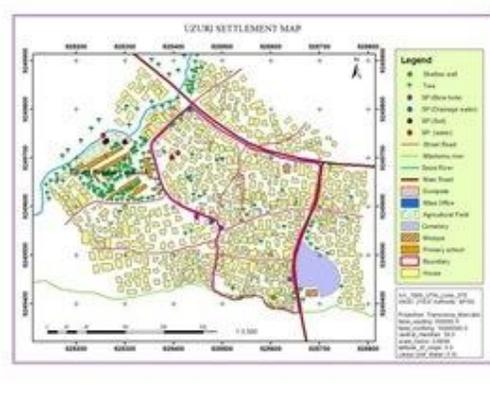
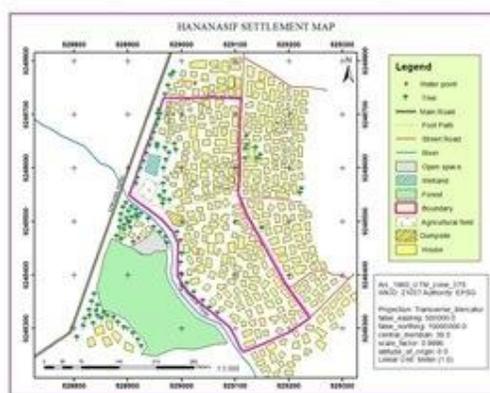
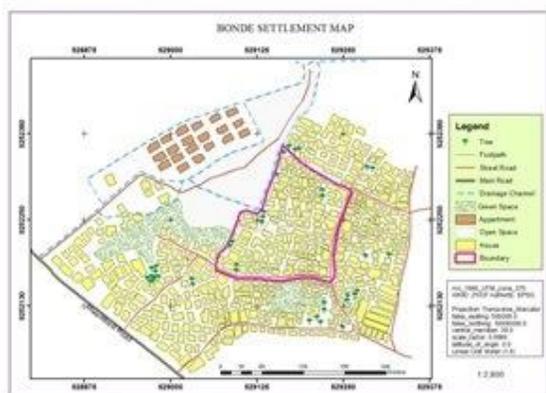
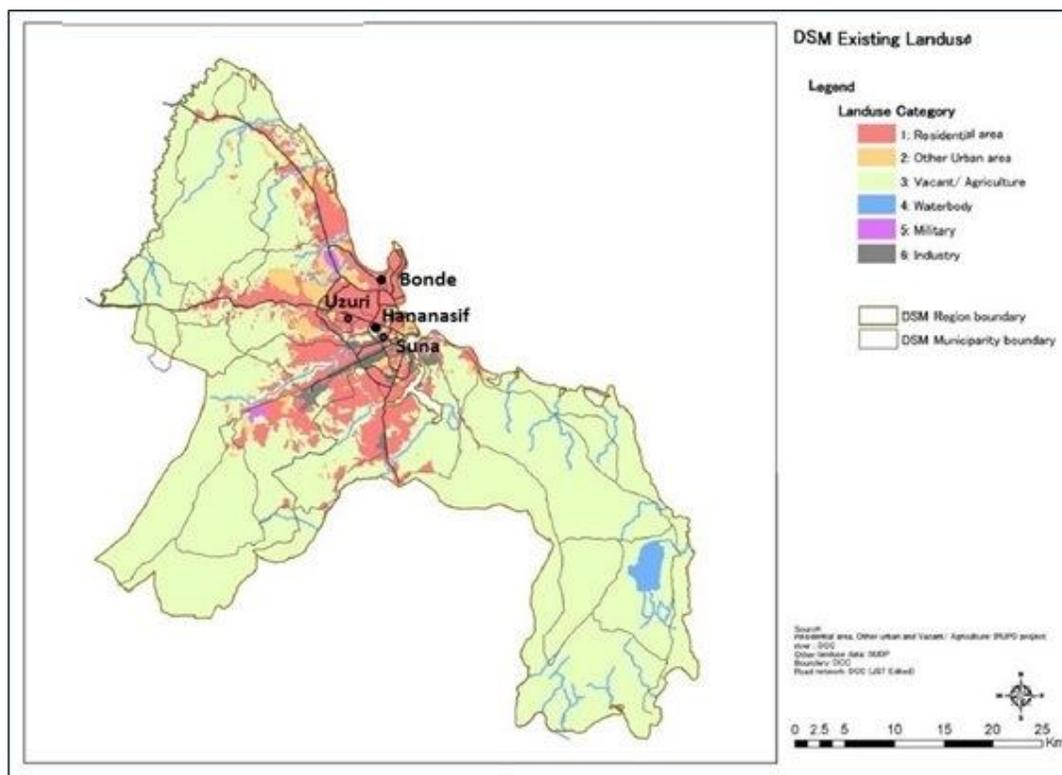
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Figure 1: The study context



**Figure 2: Potted plants within a micro plot in Bonde settlement**



Credit: Manoj Roy

**Figure 3: A family in Bonde settlement reliant on traditional fishing using fish trap and seaweeds**



Credit: Manoj Roy