

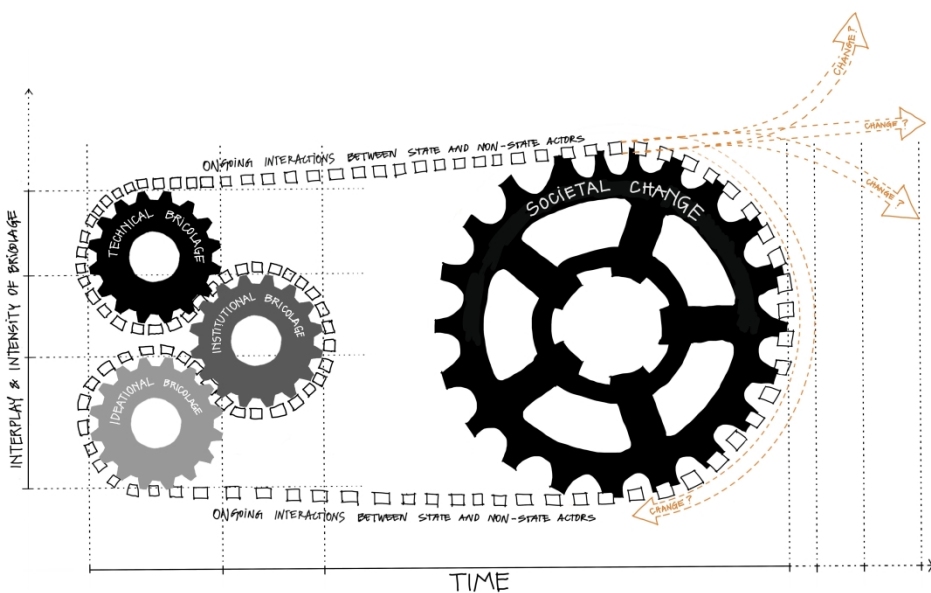
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Explaining societal change through bricolage: transformations in regimes of water governance

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Explaining societal change through bricolage

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Explaining societal change through bricolage: transformations in regimes of water governance

Abstract

This paper is motivated by the pressing need to understand how water use and irrigated agriculture can be transformed in the interests of both social and environmental sustainability. How does such change can come about? In particular, given the generally mixed results of simplified, state-initiated projects of social engineering, what is the potential for transformations in societal regimes of governance to be anchored in the everyday practices of farmers? In this paper we address these enduring questions in novel ways. We argue that the concept of bricolage, commonly applied to analysing community management of resources, can be developed and deployed to explain broad societal processes of change. To illustrate this, we draw on case studies of irrigated agriculture in Saharan areas of Algeria and in the occupied Golan Heights in Syria. Our case analysis offers insights into how processes of institutional, technological and ideational bricolage entwine, how the state becomes implicated in them and how multiple instances of bricolage accumulate over time to produce meaningful systemic change. In concluding, however, we reflect on the greater propensity of contemporary bricolage to rebalance power relations than to open the way to more ecological farming practices.

Keywords: institutional, ideational and technological bricolage, irrigated agriculture, societal change, sustainability

1. Introduction

The use of water for irrigated agriculture still holds much promise in terms of economic growth and development. The availability of surface and groundwater has allowed considerable expansion and intensification of agriculture, most notably in arid areas. However, governing water for agriculture is notoriously challenging - past and current models of management have often proved disappointing and ineffective (Molle, 2008). Tensions in the governance of irrigated agriculture have long been documented between individual and collective interests, short term gains and long-term sustainability. These tensions are currently heightened as the drive to extend and intensify agriculture in the interests of the economy, food security and development, is prompting widespread concerns about the depletion and degradation of water resources (Taylor, 2014) and the related marginalisation of vulnerable communities (Perreault, 2014). As the material conditions of society's reproduction are threatened in many locations (Rockström, 2015), there is a pressing need to find more sustainable ways of managing water –for facilitating transformations to social and ecological sustainability (Feola, 2015; Zwarteveen et al 2021).

This need to transform water use and management in irrigated agriculture raises a number of questions. Can such change be generated 'from above' – through science and policy initiatives that emphasise engineering, regulation and data as central to optimising water management? Or is meaningful change more likely to come 'from below' through the actions, initiatives and resistances of farmers and water users themselves? Expressed more broadly, can we explain how systemic change comes about (Scoones et al 2020)?

Our approach to addressing these questions is shaped by our work on the Transformations to Groundwater Sustainability (T2GS) research project. In T2GS, working with colleagues from around the world, we study promising grassroots initiatives of people managing ground and surface water in places where pressures on the resource are particularly acute. In this paper we draw on ~~two~~three contrasting cases where substantial change has taken place in water governance and in agricultural systems over the past decades. We use these cases - two from Algeria's Sahara and one from the occupied Golan Heights in Syria (oGH) - to explore how the everyday actions of water users have generated these transformations.

The starting point for our analysis is the concept of 'institutional bricolage' (Cleaver, 2002, 2012; De Koning 2011; Cleaver and Whaley 2018). Much of the institutional bricolage literature investigates how local communities adapt governance arrangements, often introduced by government and development agencies, to fit their circumstances and lifeworlds. The focus is on the creative blending of the rules and norms involved in management of natural resources like water, forests and grazing lands, the attribution of meaning and legitimacy to them and the ways in which power works through such hybridised arrangements. The orientation of institutional bricolage studies has generally been towards single case studies of community-level practices and arrangements (Liebrand 2015), though there are a growing number of cross-case and multi -case analyses (Sehring, 2009; Haapala et al., 2016; Gebara, 2019; Wang et al 2021).

We argue here that the concept of bricolage can explain societal or systemic change at scales beyond the water committee, community, or project. Building on, extending, and blending previous iterations of bricolage, our approach in this paper is novel in a number of ways. First, we show that bricolage is not practised merely over rules. Rather, institutional bricolage is

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3 constantly entwined with processes of *technological* and *ideational* bricolage. Being a three-
4 dimensional set of practices, with each dimension feeding back and transforming the others,
5 gives the overall process of bricolage a strong expansionist dynamic, as illustrated in figure 1.
6 We highlight just how these dimensions of bricolage interact to produce arrangements that are
7 *more than* pragmatic improvisations of rules, roles and norms, but which carry particular
8 meanings and (re)shape material artefacts, social relations and the environment. Our cases
9 illustrate how bricolage processes in combination can produce systemic change (Algeria) and
10 become implicated in broader movements of claiming political identity, land and citizenship
11 (oGH).
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15 Second, addressing the state as a key concern of political ecology (Harris, 2017; Loftus 2020)
16 and a gap in critical water studies (Mollinga, 2019), we show how bricolage is often a state-
17 society co-production. In line with the "State-in society" perspective *first* put forward by
18 Migdal (2002), we consider the State *neither* as a monolithic entity *nor* a fixed one, but rather
19 as a "field of power" shaped by "the actual practices of its multiple parts", even though these
20 parts are often able to construct "the image of a coherent, controlling organization in a territory"
21 (p. 16-17). In the cases that we analyse the action or inaction of a variety of state agencies and
22 representatives necessitates bricolage; State bureaucracies tolerate or become enrolled in
23 innovations, legitimising, formalising and materially supporting adapted arrangements. We
24 suggest how this enrolment of State actors, along with private sector actors (such as agricultural
25 supply companies) contributes to the reach of adapted arrangements well beyond the village or
26 water user community. These widely diffused arrangements have potentially significant effects
27 on the patterning of governance and the distribution of resources in society.
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31 Third, we highlight that bricolage is inherently a multi-scalar process. Rather than taking place
32 at the local level before being possibly 'scaled up', it is continuously the product of multiple
33 types of actors operating simultaneously in different, entwined, social domains. Our case
34 studies show how bricolage involves a variety of local, regional, national, and sometimes
35 international, actors. Thus, each particular instance of bricolage is already much wider in scope
36 than the focus on local creativity and adaptation would suggest.
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39 Fourth, we show that these defining features of bricolage (i.e. as a three-dimensional process,
40 a state-society coproduction and a multi-scalar set of practices) allow for transformative change
41 in agricultural systems and regimes of water governance. Whilst bricolage processes can
42 reproduce entrenched inequalities, our cases show they also have the potential to mitigate
43 structural power asymmetries and to pluralize governance arrangements. But this leads us to a
44 further critical question: how far can processes of bricolage facilitate transformations to
45 *ecological* sustainability? Institutional bricolage analyses often focus on the social implications
46 of adapted arrangements, and the implications for poor or excluded people. Here we re-focus
47 on environmental concerns, and reviewing our empirical material, we question how far
48 systemic changes wrought through bricolage are compatible with transformations to
49 sustainability.
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52 The paper proceeds as follows. In Section 2 we outline our conceptual framework, elaborate
53 the different elements of bricolage and relate these to issues of the state, society and scale. In
54 Section 3 we present our empirical material, focussing on tracing the interplay between
55 institutional, technological and ideational processes of bricolage. In Section 4 we work through
56 the cases to explain how transformative change in water governance and agrarian systems
57 happens. We then broaden the discussion to reflect on whether entwined processes of bricolage
58 can contribute transformations to socio-*ecological* sustainability. Section 5 concludes.
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2. Conceptual framework

The theoretical underpinning of this paper is the concept of institutional bricolage, nested within a wider body of critical institutional scholarship and informed by political, cultural and social theory.¹ We complement this by drawing from two separate -but aligned- literatures that mobilise compatible concepts of bricolage. Recognising that these literatures have different intellectual origins, we nonetheless see promise in engaging with their deployment of the concept of bricolage. We thus weave into our analysis insights from science and technology studies showing how technologies are developed, adapted and widely diffused through bricolage (Ciborra, 1996; Garud and Karnoe, 2003; Naouri et al., 2020). Additionally, given our emphasis on state-society co-production, we draw from policy studies and political sociology literature concerned with how state actors also engage in bricolage and to what effect (Carstensen 2011; Allain & Madariaga, 2019; Hannah, 2020)

In this paper, we separate out institutional, ideational and technological processes of bricolage for analytical purposes, although they are, in fact, inextricably linked. For instance, ideational bricolage conveys meaning and authority to adapted institutional arrangements; irrigation technology and society are mutually constituted (Van der Kooij et al., 2015); while technological bricolage can at times be interpreted as subversive practice, challenging existing power relations and shifting water governance (Kuper et al., 2017a). In what follows we thus present the three different processes of bricolage, trace their interactions, and highlight the role of both state and non-state actors in enacting and facilitating bricolage.

2a Institutional bricolage

In developing the concept of institutional bricolage, Cleaver (2012) set out to show how institutions for the management of natural resources are formed, and how they function. Institutional bricolage is a process in which people consciously and non-consciously innovate by drawing on existing social material (styles of thinking, social norms, sanctioned roles and relationships, orders and arrangements), to piece together institutions which work in particular contexts. The resulting arrangements are often hybrids; a curious mix of the formal and informal, commonly serving multiple purposes and operating patchily, according to need.

Bricolage arises from the necessary improvisation of social practice; people must constantly adapt to changes in the social and natural world around them (Bourdieu 1977). Such practical improvisations are often incremental – the tweaking and blending of existing arrangements to better suit changed circumstances. But they may also involve innovations - the introduction of new elements borrowed from other contexts, or the radical recasting of roles, rules and mechanisms. Much of the institutional bricolage literature pays significant attention to the ways in which the agency of bricoleurs is creatively exercised in these ways (Liebrand 2015) Similarly, in the political science literature, analyses of policy change through bricolage have highlighted the role of “interpretive entrepreneurs” who select and communicate certain ideas from the many existing options, translating and accommodating them to the logic of specific policy fields (Campbell, 2010: 105).

¹ See Cleaver and Whaley 2018:49 for a schematic characterisation of the political, cultural and sociological roots of bricolage thinking, also Mollinga 2019:790 for a characterisation of different strands of critical water studies.

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3 However, innovation through bricolage is also constrained. First, in their creative
4 improvisations, bricoleurs can only draw on the institutional principles and practices at their
5 disposal, within particular contexts (Sehring 2009). Social structure thus shapes (as much as it
6 is shaped by) the creative agency of bricoleurs and numerous studies show the ‘capture’ of
7 local institutional arrangements by elites (Rusca et al, 2015). Second, in order to work,
8 bricolaged arrangements must appear legitimate, they must seem in some way natural, to
9 socially fit (Douglas, 1987). This fit is achieved in different ways: by invoking tradition; by
10 analogy to accepted ways of doing things and by calls on authoritative discourses and the
11 symbols and artefacts that represent these (Clever, 2000, 2012; Boelens, 2015). As an
12 example in the policy field, when key neo-liberal principles (e.g., use of markets to allocate
13 resources or competition) were introduced in Germany and Sweden, they had to be presented
14 as a renewal of traditional, social-democratic ideas, leading to hybrids of ‘corporatist-managed
15 liberalization’ in which ‘social partners’ are important participants with management in
16 ensuring firms’ international competitiveness (Jackson & Schnyder, 2013).
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20 In summary, bricolage is a creative and adaptive process but history, social structure, power
21 relations and meanings are all critical to how it works, and to the effects it produces. Processes
22 of institutional bricolage occur through everyday adaptations in social practice but are
23 distinguished by a number of key features. These include (1) the hybrid nature of arrangements
24 pieced together from different elements; (2) the importance of the meanings carried in the
25 component parts of these arrangements; (3) the ways which in bricolage is an authoritative
26 process, shaped by relations of power and the variable capacities of bricoleurs. The
27 combination of these factors mean that processes of institutional bricolage, whilst shaped by
28 history and social structure, are not entirely predictable or amenable to conscious design, but
29 are characterised by intermittence, diversity and unintended consequences².
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33 **2b Ideational bricolage**

34 From an institutional bricolage perspective, governance arrangements work partly because they
35 are imbued with meanings and values. Bricolage is therefore never a purely instrumental
36 endeavour, but is always a symbolic and imaginative process as well (Campbell, 2004: 70).
37 The attribution of meaning conveys authority and legitimacy and therefore helps to ensure the
38 acceptability and durability of new or adapted institutional arrangements.
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42 These meanings may be pieced together from various sources. Worldviews provide
43 explanations of phenomena, models of desirable social orders and the rationale for remedying
44 misfortunes and imbalances (Clever et al., 2021). As some of the idea-oriented political
45 science has long argued, dominant policy approaches draw on particular logics to frame
46 problems, deploy narratives which suggest solutions and promote visions of desirable futures
47 which justify particular allocations and arrangements (Blyth, 2013; Carstensen and Schmidt,
48 2016). Social and political movements also advance visions of desirable futures, based on
49 concepts of just allocations, rightful shares and meaningful citizenship (Snow et al., 1986;
50 Sanghera and Satybaldieva, 2021). All these sources provide the material for fashioning
51 arrangements through bricolage, and the means for investing them with legitimacy and
52 authority.
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58 ² For elaboration of key features of bricolage see Cleaver (2012: 33-52). For the location of institutional bricolage
59 as a school of thought within scholarship on environmental governance see Whaley (2022: 231); Nunan (2020:27-
60 30).

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3 These various ideational sources are unlikely to be complete systems of thought, but hybridised
4 assemblages of different logics, narratives and values. For example, worldviews combine
5 aspirations to the modern with assertion of the values of tradition (Cleaver et al., 2021); public
6 policies blend different agendas through translation, trade-offs and accommodation, amounting
7 to an ongoing process of “creative syncretism” (Berk and Galvan, 2013), while providing
8 sufficient polysemies to cater to different social groups (Parsons, 2016; Ennabih and Mayaux,
9 2020). Political movements often combine the pragmatic and the ideological, borrowing tactics
10 from aligned initiatives and building heterogenous alliances (Walter and Urkidi, 2015),
11 smoothing over value differences. Further complexity is provided by the location of resource
12 governance in the multiplex relations of everyday lives, where the principles shaping the
13 distributions of water, land, food, and social identity overlap (Schneegg, 2018). Of necessity,
14 bricoleurs (farmers, irrigation officials, policy makers) thus become adept at navigating social
15 interfaces and differences in values, interests, resources, knowledge and power (Landini et al.,
16 2014; Funder, 2020).
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21 A focus on ideational bricolage brings into scrutiny the ways in which power is exercised
22 through ideas. Like any exercise of power, ideational bricolage may be undertaken deliberately,
23 strategically drawing on particular narratives to justify or oppose allocations of resources. But
24 it may also work less consciously, quietly shaping people’s perceptions of their needs through
25 incremental changes, taken-for-granted rationales, orders and roles. Power works invisibly
26 through such processes to shape subjects and make certain arrangements seem like the right
27 way of doing things (Whaley 2018, Svarstad et al 2018). Political scientists also distinguish
28 between political ideas that are deliberately manipulated in the foreground of political debates
29 (strategic bricolage) from those underlying assumptions and core beliefs that invisibly shape
30 less conscious processes of bricolage, in the background (Campbell and Pedersen, 2014;
31 Hannah, 2020).
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35 We often think of meanings as purely ideational or discursive – the rationalities, representations
36 and types of knowledge that shape resource governance dynamics. But meanings are
37 inextricably linked with material things (Scott, 2008; Folch, 2019). In social structures,
38 material allocations (of money, labour, commodities, infrastructure) are shaped by the authority
39 of particular discourses and rationalities. And in the necessary improvisations of everyday life
40 in bio-physical environments, people’s ideas about desired orders, and imagined futures
41 manifest in their embodied interactions with the physical environment, infrastructure and
42 technology. This point now leads us to a consideration of the dynamics of technological
43 bricolage.
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47 **2c Technological bricolage**

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49 A key focus in critical perspectives on environmental governance concerns the ways in which
50 biophysical and social processes interact to shape the resource allocations in society (Whaley
51 and Cleaver, 2017). Here we define the bio-physical as relating to technologies (machinery,
52 equipment, and associated knowledges), infrastructure, and the broader physical landscape, as
53 well as the physiological (embodied) attributes of actors in the social situation (Whaley, 2018).
54 Our focus here is on the ways in which water users dynamically interact with technologies,
55 through their everyday practices. In this paper we focus on technologies for accessing,
56 distributing and storing water and the ways in which water users appropriate them, adapting
57 them to fit local circumstances and changing purposes. Social dynamics are inextricably bound
58 into technological bricolage. For example, the embodied knowledge and skills of the bricoleurs
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3 enable or constrain their technological tinkering. Thus, small-scale farmers in Morocco learned
4 about drip irrigation by working as labourers on large-scale farms and then invented a low-cost
5 drip irrigation system to make it work on their own farms (Benouniche et al., 2014). Their
6 socio-economic relationships, the time and labour required to adapt, produce and use
7 technologies, all offer various constraints and opportunities for innovation. Laws, rules and
8 norms are implicated in the operation of technologies, and the meanings associated with them
9 affect the extent to which they are adopted and by whom. Practices of technological bricolage
10 are therefore social as well as material, and have the potential to reinforce or reshape societal
11 arrangements.
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15 In regard to the technologies and infrastructure of irrigation, critical water scholars have
16 deployed terms such as ‘bricolage’, ‘socio-technical tinkering’ and ‘braconage’ (or poaching)
17 to capture what happens when designed systems or interventions are translated in everyday
18 realities ‘on the ground’ (e.g. Kuper et al., 2017a; Kemerink Seyoum et al., 2019). Common to
19 these approaches is a focus on the emergent nature of governance arrangements formed through
20 social practice. Such socio-technical arrangements are not fixed, finished or finite but
21 constantly in the process of coming into existence or prominence, and constantly being re-
22 made. From such perspectives, practices of technological bricolage have relevance beyond the
23 immediate situation in which they occur: they are implicated in reinforcing or shifting water
24 governance and societal orders more broadly (Benouniche et al., 2014; Venot et al., 2014).
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27 **2d A note about societal change and scale.**

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29 In order to understand how societal change happens we need to extend our focus beyond
30 discrete events and localised arrangements. This raises a question of how we conceptualise the
31 scalar dimensions of governance³. In this paper we understand governance interactions to take
32 place in intersecting social domains, not wholly captured by the notion of hierarchical local,
33 national, global levels of territory or organisation. We are aligned to ideas about scale as being
34 both materially *and* socially constructed, potentially *both* fixed and fluid, and inherently
35 relational (Brown and Purcell 2005; Norman et al., 2012). From our analytical perspective, the
36 adjustments that people make to arrangements in particular contexts, hold the potential to gain
37 reach across space and time (to become diffused, or upscaled). This happens through entwined
38 processes of institutional, technological and ideational bricolage. The social and material
39 resources that are drawn upon in these bricolaged arrangements are also the medium through
40 which societal structures are reproduced or transformed. These ‘emergent’ social structures are
41 typically unintended. The farmer, tinkering with irrigation technology does not *intend* to
42 transform society, and yet when that tinkering is repeated by many farmers and regularised in
43 new or hybrid configurations of governance, it may well contribute to that transformation (e.g.
44 Naouri et al., 2020). In this paper we use the term ‘upscaling’ to refer to such processes.
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49 **3 The empirical cases of Algeria’s Sahara and the occupied Golan Heights**

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51 Inspired by the theoretical and methodological developments in the T2GS project,
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54 For the purposes of this paper we compiled three contrasting case studies from material
55 previously collected in our respective research sites. This ~~exercise~~–cooperative analytical
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58 ³ [A concern with scale as elaborated here raises interesting questions about study design and method. Addressing](#)
59 [such questions is beyond the scope of this paper but they are beginning to be discussed in critical institutional](#)
60 [thinking - see for example Liebrand \(2015\) and Whaley \(2018\).](#)

exercise was in the spirit of the T2GS project in which we endeavour to learn across unlike cases, within an overarching concept framing which includes bricolage, along with the transformative potential of everyday “caring” and “sharing” practises. We thus designed a specific academic exercise with the aim of using a bricolage lens to re-analyse pre-existing data. We selected these three case studies because we already had an in-depth understanding of 1) the historical water dynamics in these contexts; and 2) how local practices were connected to wider changes in water governance and agricultural systems. We had studied and documented these cases in recent years using ethnographic methods (elaborated in Naouri et al., 2020, Dajani and Mason, 2018). In the cases of Biskra and Ghardaïa, we drew on our research on farmer-led open innovation processes related to drip irrigation systems drawing on the recent literature on technology translation (Naouri et al., 2020). In the occupied Golan Heights, we focussed on research which looked at small water infrastructure developed by communities challenging the infrastructural choices made by the occupying power to harness water for settlement agriculture (Dajani and Mason, 2018). To produce the analysis presented in this paper we first investigated, using the empirical data, the three different (but entwined) processes of bricolage and their interactions, while highlighting the role of different state and non-state actors. We then linked practices of bricolage to the larger societal dynamics at play by studying carefully how the different arrangements reach across space and time. Our aim in working through unlike cases was not primarily to demonstrate the uniqueness of each case (though they certainly *are* each unique), nor to claim that they are somehow representative of all instances of bricolaged governance arrangements. By bringing these unlike cases into engagement, with data that allows us to track the evolution of processes over several decades, we argue that we are able to make *generalizations to theory*. By that, we mean that we asked the same theoretical questions to all three cases, allowing us to guide and structure data analysis, thereby making systematic comparison and cumulation of the findings of the case possible (George & Bennett, 2005). In other words, we use our ~~three~~ context specific cases to experiment with an analysis that moves beyond tracking local practices to explain how societal change may come about through bricolage.

3a Algeria’s Sahara: the tale of two contrasting agricultural frontiers⁴

The importance of bricolage in the development of Saharan agriculture

Algeria’s Sahara has been the site of a tremendous development of irrigated agriculture over the past 30 years, based on abundant groundwater resources and favourable climatic conditions which enable off-season horticulture. This contributes to national food security and to supplying the cities in the North of the country with vegetables, fruits, cereals and livestock feed. Such agricultural development is often seen as the result of ambitious government programmes, providing access to land and capital. However, we argue that bricolage by farmers and artisans, interacting with state actors – the Agricultural Services, the Office of Agricultural Land, the Water Resources Directorate, and the District Prefecture of the Ministry of the Interior (Wilaya) and with (inter)national industries, has played a crucial role in this development (Kuper et al., 2017a). Our argument is based on the analysis of two distinct agricultural areas in the Sahara. Both areas have undergone major change, as a result of technical and institutional bricolage. In Biskra, 25,000 smallholders and artisans gained control over the design and deployment of innovative drip irrigation to develop greenhouse

⁴ Research and field work conducted by M. Naouri with the support of T. Hartani and M. Kuper, in Biskra between 2014-2019 and Ghardaia 2018-2019.

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3 horticulture, producing one third of the nation's tomatoes, along with bell pepper, aubergines,
4 melons and watermelons (Naouri et al., 2020). In Ghardaïa, farmers have enrolled the state in
5 developing collective arrangements for accessing groundwater through a combination of
6 technical and institutional bricolage. In both cases the bricolaged institutions and technologies,
7 produced by the actions of smallholders, became 'upscaled' and shaped systemic
8 transformations resource access, water use and agricultural intensification.
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10 11 **Smallholder-led drip irrigation in Biskra** 12 13

14 Around Biskra, sometimes called the "Eldorado of Sands", the availability of land and water
15 resources attracted thousands of young farmers with experience in greenhouse farming on
16 Algeria's northern coast, to develop a new agricultural frontier (Amichi et al., 2020).
17 Vegetables have always been cultivated in the oasis, but in very small quantities, on tiny plots,
18 for self-consumption. What is new is the orientation towards the market-oriented intensive
19 production of early vegetables under greenhouses. Before the smallholder revolution, the
20 landowner - very present on his farm - would move the greenhouses across the farm,
21 integrating them into a rotation including other crops such as barley. The main objective of
22 local landowners was to plant palm trees, the lucrative *deglet nour* variety, and greenhouse
23 farming remained marginal. In this system the landowner owned the land, greenhouses and
24 water access. For expertise and labour, young farmers were called as labourers or sharecroppers
25 with little scope for advancement. Limiting factors included their lack of access to land, water
26 and capital and the restricted number of greenhouses on each farm.
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30 To overcome these constraints landowners and young farmers engaged, first, in institutional
31 bricolage by devising organizational arrangements enabling them to obtain access to land,
32 water and commercial inputs through resource pooling⁵ (Amichi et al., 2015). Most landowners
33 did not have enough financial capital and practical knowledge to invest in the emerging
34 greenhouse farming system. Moreover, these landowners were more interested in the less-
35 labour intensive and lucrative palm trees. However, creating a palm grove is a very costly
36 enterprise and palm trees only start producing after five years. The basic but brilliant idea here
37 was to combine two distinct but complementary farming systems on the same plot: the
38 progressive planting of perennial palm trees by landowners, financed by the ephemeral
39 greenhouses cultivated by young sharecroppers, who would move on to 'virgin' plots once the
40 existing plot was fully planted with palm trees. This prompted negotiations between
41 landowners and landless young farmers to ensure each could secure access to production
42 factors. The landowners invested only in clearing the land and installing tube-wells which
43 enabled them to rent out the land to young farmers who mobilized their greenhouses and know-
44 how. Based on their experiences, these young farmers agreed to pay rent to landowners for
45 each greenhouse installed with access to water for at least three hours, twice a week. The
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51 ⁵ Landowners provide land and water, lessees provide greenhouses and financial capital, sharecroppers provide
52 know-how and work force (in some cases, they hire labourers). Income sharing rules are generally as follows:
53 Sharecroppers get 25% of the gross revenue (and pays the labourer), landowners 10%, and lessees get 65% (pays
54 the rent of the land and water, the greenhouses and inputs). The risks are carefully distributed across the different
55 actors. The sharecropper does not invest (although he pays the labourer) and the risk he takes is to have no or little
56 revenues at the end of the season in case of plant diseases or volatility of market prices. The lessee encounters
57 two distinct risks. First, and like the sharecropper, the risk of having little or no revenues, but second, he also
58 cannot pay back his investment in greenhouses and drip irrigation if the season is not good. Finally, the landowner
59 is paid by the lessee at the beginning of the season, independently of the success of the season. His risk is related
60 to the investment (borehole, pump and water distribution network) as there may be breakdowns, in particular with
the pump.

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3 greenhouse farming system proved lucrative, enabling the young sharecroppers to build
4 financial capital, and it started to attract more attention. Some sharecroppers were able to leave
5 the hard work in the greenhouses by becoming lessees, renting in the land and the access to
6 water from landowners, and engaging (younger) sharecroppers to do the physical work. In this
7 way, an agricultural ladder was gradually established and regularised, ensuring upward socio-
8 professional mobility. Young farmers were able to move, within a few years, from the status
9 of labourer to sharecropper or even lessee employing several sharecroppers (Naouri et al.,
10 2015).
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14 Second, as an effect of the institutional bricolage, these emerging smallholder farmers engaged
15 in technological bricolage by developing low-cost and functional drip irrigation infrastructure
16 (see Naouri et al., 2017 and Naouri et al., 2020), thereby challenging the drip kits provided by
17 (inter)national companies, despite the fact that they were subsidized by the Ministry of
18 Agriculture through different programs managed by the District Agricultural Services and the
19 General Office for Agricultural Concessions. The new farm structure needed a more
20 decentralized irrigation management to accommodate the variation in irrigation and fertigation
21 ⁶ schedules between greenhouses. In this new organisation, each smallholder (lessee) was
22 making his own choices about which crops to cultivate and agricultural practices to adopt. The
23 smallholders started incrementally adapting the drip irrigation system by eliminating some
24 parts and redesigning others, to create more flexibility and agility in the system. The
25 distribution companies, which had provided the standardized drip irrigation systems,
26 eventually responded to these local innovations and supplied the equipment required by the
27 smallholders. Smallholders were proud of the drip irrigation system they had designed and thus
28 forced the multinational manufacturers and distribution companies to adapt the supply of
29 equipment to their requirements. In this way, processes of bricolage, initiated by smallholders,
30 reshaped the system of greenhouse horticulture. Today, Biskra has more than 150,000
31 greenhouses operated by more than 25,000 young farmers. Throughout this process, the
32 interactions with the state were indirect but decisive. First, the technical state services related
33 to agriculture and water resources demonstrated the presence of water resources and the
34 possibility of engaging with market crops (Amichi et al., 2020), despite the fact that a lot of
35 the state-sponsored agricultural initiatives were considered failures (Otmame and Kouzmine,
36 2013). Second, various State services enabled the pioneering Eldorado we described by
37 developing the necessary local infrastructure: agricultural services for rural roads, farms
38 electrification and subsidies for agricultural equipment; municipalities and districts for larger
39 roads and markets; the relevant ministries for health and education. Third, agricultural services,
40 the Agricultural Land Office and the Water Resources Directorate all tolerated the use of land,
41 water and agrochemical products with minimum control. In return, these dynamic farming
42 systems turned out to be very helpful in feeding the main cities in the north. This co-production
43 of bricolage by state and non-state actors is even more evident in another Saharan location,
44 Ghardaïa.
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51 **Ghardaïa: State-society coproduction of a bricolaged access to groundwater**

52 In the El-Ateuf irrigation scheme in Ghardaïa, farmers have been able to individually and
53 collectively access and manage groundwater, in quantities and quality necessary to develop
54 their agricultural activities. This has happened over the past 45 years through several stages of
55 mutually reinforcing technical and institutional bricolage, enacted between water users and
56 with state actors. It started in 1974 when a group of local farmers were attracted to the area,
57 thought to be situated in an ancient river bed, which the farmers associated with a relatively
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60 ⁶ Fertigation is irrigation combined with the application of (soluble) fertiliser.

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3 easy access to water. In a first step, farmers manually (and informally) dug individual shallow
4 wells of around 35 m depth in the phreatic aquifer⁷. In less than 10 years, the District technical
5 services had formalized the individual water access, so regularising the shallow wells.
6 However, the quality of water from the phreatic aquifer was not good enough for some crops
7 and for animals.
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10 In a second step, the farmers requested state support for access to the deeper Albian aquifer⁸.
11 In the beginning of the 1990s, the District technical services installed a deep tube-well and
12 implemented an irrigation scheme project based on the collective use of the resource. The
13 project was initially designed to serve 25 farmers with a distribution system to the farm level.
14 Most farmers kept their shallow wells as a safety measure. The Water Ressources Directorate
15 managed the system and farmers were supposed to share total energy costs on an equal basis,
16 regardless of volumes consumed by each user. However, the tube-well and equipment
17 maintenance operations were neglected. State management turned out to be not operational and
18 ended up with a broken pumping system and unpaid energy bills.
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22 In a third step, in the face of management problems with no clear water consumption rules, the
23 idea of creating a water users' organization was suggested but a legal framework was missing.
24 A 'farmers group' was created by the users, which has a formal existence but is not supposed
25 to manage water. The users agreed amongst themselves to pay for volumetric consumption
26 measured through water meters. They elected a president and put an accounting system in
27 place. To show their engagement, members contributed to a common fund to finance repairs
28 needed to restart, and henceforward maintain, the pumping and distribution systems. In
29 parallel, the farmers' group negotiated with the District services with the support of the
30 Agricultural Services to take on management co-responsibility of the irrigation scheme,
31 implicitly inviting the state to engage with institutional bricolage. Seeking to operate under the
32 state's umbrella was seen by farmers as crucial for further investment. Inside the group, rules
33 were established to make the rights and duties transparent and open for negotiations. The
34 informal rules were perceived as adaptive and thus more legitimate.
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38 The new mode of management attracted more farmers who wanted access to the Albian aquifer.
39 To respond to the increasing demand, some more technological bricolage was needed. In a
40 fourth step, secondary connections were thus added to the network to serve new farmers. At
41 some point, the distribution system was serving more users than it was designed for. Farmers
42 far away from the source were having pressure issues which pushed them to use small pumps
43 to boost the pressure. A victim of its success, the number of users of the system increased to
44 more than 180 farmers. The pressure on the system was too high and communication among
45 members became complicated. In a fifth step, the board of the farmers' group agreed with the
46 members to split the scheme in two parts. The adaptive and negotiating capacity of the farmers
47 led to the division of the perimeter in two and the creation of a new irrigation scheme around
48 an existing state-financed (relief) tube-well. Users in this new irrigation scheme developed
49 their own rules adapted to the new conditions, by increasing the fixed charges and reducing the
50 variable charges (price per cubic meter) compared to the first group.
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54 **The dynamics of multi-scalar bricolage**

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58 ⁷ Phreatic aquifer is the first water table encountered in a permeable subsoil.

59 ⁸ Albian aquifer is a little renewable deep groundwater layer where the pressure is higher than atmospheric
60 pressure.

In addition to the farmers/water users, processes of bricolage involve other actors active in different social domains and levels of organisation. In Biskra, the negotiations, dialogues, technical and institutional adjustments involved smallholders, international manufacturers of irrigation equipment, multinational companies and the state, which financed the first development of drip irrigation. Similarly, communities in Ghardaia were able to enroll the agricultural administration in institutional bricolage around the collective management of groundwater resources, and the administration also tolerated the development of individual wells to secure agricultural production. In both cases, the state was, at the very least, “tolerant” of technical-institutional bricolage but also generally “supportive” through heavy investments in infrastructure.

As knowledge of these bricolaged arrangements circulated, they inspired other groups of farmers. For example, in Biskra, the technological bricolage of the fertigation⁹ systems of smallholders enabled their adaptation and transfer to the Canarian¹⁰ greenhouses of large-scale farmers. Technological bricolage also provided meaning to a functional, low-cost, and in-house developed drip irrigation system. Institutional bricolage led to a similar adaptation and transfer of the rules of income sharing between the different actors active in greenhouses, to these large-scale farms. The institutional bricolage around the organization of collective tube-wells in Ghardaia is also transferable to irrigation schemes, which are facing problems in the access of groundwater, and where negotiations over collective access are ongoing. In these irrigation schemes, there is a high demand for successful experiences in technical-institutional bricolage for the sharing of rights/duties and the governance of tube-wells. Bricolage is giving water users the flexibility to implement rules and technologies adapted to their own situations. In other words, bricolage allows for the development and translation of technologies and rules in a context of incremental adaptation, allowing for more organizational sustainability. In the Algerian Sahara, the co-production of bricolaged arrangements took place in a series of negotiations and power struggles with (inter)national drip irrigation manufacturers and the state (see Naouri et al., 2020, for more details on these negotiations and power struggles) while upholding a relatively stable political order (the Algerian “black decade¹¹” of the 1990s affected Saharan regions less than other areas). In this respect, the occupied Golan Heights provides a contrasting case, which illustrates how entwined processes of bricolage may also unfold in situations of military occupation and contested citizenship, where farmers’ access to water is embedded in a broader political conflict.

3b The occupied Golan Heights¹², Syria: from counter-infrastructure to embedded resistance

New meanings of water governance forged through bricolage

In the past five decades the occupied Golan Heights (oGH) have witnessed a tremendous shift in political, cultural and economic realities under military occupation by Israel. A formerly thriving population of Syrians, engaged in agriculture, were dislocated from their homeland and forced to construct new arrangements with an occupying power which controlled their means of production, marketing and everyday livelihood practices. The remaining Jawlanis¹³

⁹ Fertigation is irrigation combined with the application of (soluble) fertiliser.

¹⁰ Large scale greenhouses similar to the multi-span greenhouses

¹¹ Civil war in Algeria fought between the Algerian government and various Islamist rebel groups (1991-2002)

¹² Research and field work conducted by Muna Dajani in Majdal Shams village in occupied Syrian Golan between 2015-2019

¹³ Jawlani is a vernacular term referring to the Syrians of the occupied Golan Heights.

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3 engaged in acts to reclaim rights to their presence on the land and to reaffirm their worldview
4 and way of life. Since the occupation of 1967, the Jawlanis have engaged in multi-sited
5 processes of technological and institutional bricolage, changing the land and water governance
6 within their communities and linking issues of identity and belonging with those of natural
7 resource management. In tracing these multi-faceted processes, we explore how bricolaged
8 arrangements transformed Jawlanis' relationship with the state from one of outright opposition
9 (the building of counter-infrastructure), to one of resistance-through-incorporation (via
10 formalised water cooperatives and related infrastructure). We show how ideational bricolage
11 plays a crucial role in ensuring that adapted institutional and technological arrangements are
12 seen as justified and necessary ways of continuing to resist the occupying state.
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15 16 **From resistance infrastructure to co-option** 17

18 In May 2019, representatives of agricultural cooperatives in the oGH¹⁴ issued a statement to
19 the local Jawlani community. This related to an incident whereby the Israeli government water
20 company (Mekorot)¹⁵ had uprooted 7-year-old cherry trees from land belonging to a Jawlani
21 farmer in al-Musheirfeh area. The statement was intended to counter misunderstandings that
22 this action was a state encroachment on farmers land, explaining that it was actually prompted
23 by the cooperatives themselves, in negotiation with Mekorot. The joint aim was to increase the
24 water quota made to local farmers by rehabilitating the company's well. That well is located
25 next to the farmer's land, and the company sought to rent a plot from him in order expand its
26 works and place its machinery. This al-Musheirfeh well symbolises the complex but
27 synergetic relationship that has developed between the Jawlani farmers and the Israeli state
28 officials over five decades of military occupation. Woven through this relationship are
29 entwined processes of technological, institutional and ideational bricolage.
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33 To grasp the symbolism of the al-Musheirfeh well, a historical reflection is required. In the
34 1970s, the water company confiscated Jawlani lands in the area as part of its exploration of
35 water sources for the benefit of Israeli-Jewish settlements. Five wells were dug in the heart of
36 the Jawlani land and their waters pumped exclusively to Jewish settlements in the region. The
37 Jawlani farmers, who relied solely on al-Musheirfeh spring and another two local springs to
38 irrigate their lands, protested against the development of these wells, correctly claiming that
39 their water sources would dry up. Simultaneously, the community was denied access to another
40 water source, a volcanic lake called *Briket Ram*, which Mekorot also claimed as state property
41 and made available to Israeli settlements only. Surface and groundwater abstraction, and
42 related infrastructure, became an exclusively Israeli (state) activity, and one that the local
43 community was excluded from. In reaction, the Jawlani population began devising tools to
44 reconfigure their agricultural practices and to centre them around reclaiming rights to water
45 and land. To protect their land from state confiscation and to secure a modicum of economic
46 stability, their agricultural activity had to be multiplied and expanded¹⁶. This required an
47 extensive reconfiguration of landscapes (turning hilly terrain into terraced plots for apple
48 cultivation) and waterscapes (devising methods to capture surface water and increase its
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54 ¹⁴ The occupied Golan Heights is a region south-west of Syria that has been illegally occupied by Israel since
55 1967. Today, around 25,000 Syrians (mostly of the Druze sect) live in 5 remaining villages on 7% of the occupied
56 land and practice agriculture in order to remain on the land.

57 ¹⁵ Mekorot is a wholly owned water company under the Ministry of Energy and Water and the Ministry of
58 Finance.

59 ¹⁶ Legislation authorises the Israeli Ministry of Agriculture to declare lands as 'waste' lands and to take control
60 over 'uncultivated' lands (Cohre and Badil, 2005)

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3 availability for the newly rehabilitated lands). To these ends a number of bricolaged
4 arrangements, technologies and practices were initiated.
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8 **Synergies between institutional, technological and ideational bricolage** 9

10 In the 1970's and 1980's the Jawlani farmers began to improvise with trial-and- error processes
11 of capturing water. Technological bricolage was deployed to increase collective water
12 availability. This was facilitated by the Jawlani's expertise in local water management and their
13 ability to access heavy machinery, due to their incorporation into the Israeli economy, primarily
14 as construction workers. The Jawlani farmers started their 'trials' by pumping water from the
15 lake at night and using mobile tankers to transport it to their land to irrigate their newly-planted
16 crops. When those trials failed to secure sufficient water, the farmers dug small ponds to
17 capture rainwater. These proved to be extremely costly, labour intensive and ultimately unable
18 to meet the demand for water. The culmination of their technological bricolage' efforts was the
19 crafting of a circular metal tank, with a volume between 300 and 1,000 cubic metres. The tank
20 was seen by farmers as a triumph against the state and, with the first prototype successfully
21 holding onto water, there was a 'mushroom effect'. These metal tanks started dotting the
22 landscape, and hundreds of farmers began constructing them, empowered by a sense of
23 collective action and solidarity. This was done in defiance of the Israeli Water Law of 1959,
24 which prohibited the harvesting of rainwater for private use and treated all water as state
25 property. All of these improvised attempts to deploy water technologies were punished by the
26 state, which issued a series of fines, demolition orders and other punitive measures to curb their
27 spread. Significantly, the technological bricolage took place at a time when Jawlanis were
28 engaged in protests against the imposition of Israeli citizenship, and in issuing a collective
29 statement identifying land and water rights as central to their struggle.
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34 Faced with increasingly hostile state pressure, unfavourable conditions for marketing
35 agricultural produce and fierce competition from the Israeli settlements, the farmers decided to
36 demand water allocations directly from the Israeli water company Mekorot. Negotiations with
37 Mekorot began in the 1990s enabled by the establishment of formal water cooperatives
38 (drawing on earlier collective arrangements for the management of water). The cooperatives
39 created channels of negotiation and lobbying for water rights and quotas. The farmers were
40 required to develop their own water supply network in order to purchase water from Mekorot.
41 Here, an upscaling of arrangements occurred, which strengthened and further interconnected
42 technological and institutional bricolage. This involved large investments from the farmers in
43 designing and developing a network of pipes and pumps to reach their plots, in addition to
44 establishing financial mechanisms and organisational structures to ensure its realisation and
45 maintenance. Whilst these 'incorporation' arrangements seem like a change of strategy, they
46 are still underpinned by, and actually reinforce, the underlying logics of the counter
47 infrastructure initiatives – asserting identity, belonging, and claiming rights. They illustrate
48 how adapted arrangements are layered onto the previous ones, with meaning leaking from one
49 to another. Under such arrangements, ideational bricolage is articulated when institutional
50 arrangements are adapted to engage with the state whilst maintaining the meanings and values
51 associated with challenging unjust relationships of power with the occupying authorities.
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57 **Complex yet synergetic relations between state and non-state actors** 58 59 60

In the statement issued in May 2019, the cooperatives express their gratitude for the farmer (Mr. A.) whose land has been utilised by Mekorot:

“As cooperatives, we thank Mr. A. for his cooperation with us by granting Mekorot access to his land so that we can provide additional water which will strengthen our attachment to the land and turn it into a green haven throughout the year¹⁷”

What this quote illustrates is the uneasy, complex and evolving realities of the relationship of between the farmers and the state, and how processes of bricolage subtly change and alter this, creating new forms of patterning and meaning in existing structures. Before the 1990s, farmers were engaged in direct confrontation with the Israeli state, and even after the establishment of the cooperatives, these wells remained a site of farmer-state confrontation. In 2004, an emergency meeting was called by the Jawlani community upon being notified of the Water Authority’s plan to pump water from Al Musheirfeh spring. At the meeting it was declared “we will protect our water with our bodies”.¹⁸

Simultaneously the state/farmer relationship was also transactional and managerial, with the aim of increasing water quota for farmers. This required a level of ‘negotiated incorporation’ and compromise, as farmers were placed with the responsibility for developing their own network, which they have collectively fundraised for and pieced together themselves. Eighteen water cooperatives were established, and an assemblage of pipes, pumps and filters were constructed to channel the water sold to them by Mekorot. Through their collective lobbying efforts the cooperative succeeded over a number of decades in securing substantially increased quotas of water from the company. However, underlying these transactions is the ongoing contestation with the state and continued opposition to the Israeli presence on their land.

In these dynamics, the mundane and banal standardisation mechanisms of the state are not void of meaning and value. Registering the water associations with the Israeli state required complying with regulations and norms of the occupying power, and a deep knowledge and embeddedness in a socio-cultural system which relies on a foreign language, Hebrew. From the contracts signed with cooperatives, to water distribution and crop maps, and even the computer software they must use, the farmers had to adapt to Israeli methods, logic and lexicon. Thus, the farmers use Hebrew terms consistently to describe crops, infrastructures, equipment and procedures. The cooperatives became a channel through which the occupying state made the oGH farming practices legible, controlled and monitored, with the farmers’ acquiescence. The transformation of all agricultural land in the village to monocrop orchards exemplifies how the farmers not only had to speak the language of the state, but also to adopt its logics. However, the planting of apple trees has taken on a different meaning and become the material expression of a land-based political belonging, in opposition to the state (Mason and Dajani, 2019). Jawlani Apples have become a symbol of the identity of the occupied Golan Heights and its people and provide the roots for their physical existence on the land. Today, apple cultivation is a part-time job for many farmers, and indeed a costly and unprofitable one. Many of the Jawlanis comment that they became ‘amateur farmers’, growing apple trees, as a rite of passage to remain on the land. Under the unequal conditions of production and marketing, apple growing has become an economic burden on many growers, and most depend

¹⁷ [Jawlany.com](https://jawlany.com) (2019) *The agricultural cooperatives in the Golan: clarification and explanation for the public on irrigation projects*. Last accessed October 2022: <https://jawlany.com/الجمعيات-الزراعية-في-الجولان-شرح-وتوض/>

¹⁸ Ashtarr news (2004). The Golan opposes a plan to loot the waters of Al musheirfeh.

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3 on other jobs (as lawyers, dentists, medical doctors, and construction contractors and workers)
4 to earn a livelihood.
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8 **4. Discussion**

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10 **4a/ Mutually reinforcing processes of bricolage**

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12 In general, studies have recognized that bricolage is a process unfolding over multiple,
13 intimately connected dimensions. The literature on institutional bricolage, in particular, sees
14 ideational bricolage as proceeding alongside, and directly supporting, the bricolage of rules
15 (Cleaver, 2012; Carstensen, 2011). Similarly, other studies have shown how technological
16 bricolage can generate institutional bricolage (Whaley and Cleaver 2017; Naouri et al., 2020).
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19 Our case studies build on these insights to show that it is possible for entwined processes of
20 bricolage to recursively shape each other over long periods of time. Thus, bricolage is a process
21 that can be sustained and reinforced endogenously, as each round changes the relative position
22 of the actors and the circumstances they face, and thus provides them with renewed incentives
23 and opportunities to adapt to these changed circumstances through additional rounds of
24 bricolage. The point, here, is not that each sequence of bricolage mechanistically triggers
25 subsequent ones, but that it paves the way for its own creative expansion as resourceful actors
26 build on it in unforeseen ways. The cumulative effects of these interconnected processes of
27 bricolage can be much more transformational than is suggested by more segmented and short-
28 term analyses.
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31 Thus, in Biskra, processes of technical and institutional bricolage have prompted and
32 reinforced each other over time. Because young farmers from the north had set up
33 organizational arrangements that enabled them to access land, water and commercial inputs,
34 this prompted considerable interest in the development of low-cost drip irrigation infrastructure
35 better tailored to their skills and resources. In turn, the success of low-cost drip irrigation meant
36 smallholders could extend the number of greenhouses cropped, which generated more
37 resources to be pooled, further expanding these organizational arrangements and attracting yet
38 more farmers from the north. Then, over time, institutional and technological bricolage had the
39 joint effect of nurturing ideational bricolage, with the formation of a young Saharan farmer
40 identity, pieced together from ideas of resourceful northern entrepreneurship blended with a
41 broader frontier imaginary inspired by the American West (Amichi et al., 2020). In turn, this
42 emerging identity favoured the establishment of institutional arrangements allowing for rapid
43 upward social mobility.
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48 In the occupied Golan Heights, Jawlani farmers first engaged in technical experimentation to
49 resist Israeli occupation, covertly pumping and transporting water from the lake, digging small
50 ponds, and fashioning metal tanks to capture rainwater. Over time, this technological bricolage
51 put them in a better bargaining position to engage in institutional bricolage. Having developed
52 their own water networks, they could negotiate to purchase water directly from Mekorot.
53 Crucially, both technological and institutional arrangements were developed from historical
54 and traditional practices employed by the Jawlanis in their long experience of seeking
55 autonomy in natural resource management. However, the re-configured processes were
56 developed in response to a drastic reconfiguration when the Israeli occupation transformed
57 their geographical connection to their homeland. Under such abrupt change, both institutional
58 and technical adaptations reinforced, and were reinforced by, a bricolaged identity of
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3 "embedded resistance". In this identity, pride and belonging are derived from frontal opposition
4 to Israeli authorities, *and* from the ability to extract meaningful concessions from them. This
5 defiant land-based identification, in turn, gives more impetus to their technological and
6 institutional bricolage.
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9 To capture these various linkages across multiple domains of social practices, we can see how
10 a long-term analysis spanning several decades is required. Social change through bricolage,
11 when considered over decades and across multiple terrains, appears more unintended and
12 unexpected than when the analysis is restricted to shorter historical sequences. It is the
13 accumulation of multiple, disparate actions of bricolage that creates the systemic change – the
14 bricoleurs did not set out with the purpose of upscaling their adaptations to societal level. And
15 it is by analysing the interdependent processes of institutional, ideological and technical
16 bricolage over time that we can see how both planned changes and unanticipated consequences
17 unfold.
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20 21 22 **4b/ The co-production of bricolage by State and non-State actors**

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24 In her work on institutional bricolage Jessica De Koning considers three different ways in
25 which communities respond to governance arrangements introduced by the state and other
26 agencies (De Koning 2011, 2014). These relate to the degree to which imposed or introduced
27 arrangements are absorbed into the social milieu of the community (aggregation); adapted and
28 tweaked to fit better (alteration) or resisted through assertion of alternative values, claims and
29 distributions (articulation). Our cases illustrate that a combination of these processes occurs,
30 producing varying outcomes in different sets of circumstances.
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33 Our approach also emphasizes the capacities of state actors to pragmatically adjust their own
34 actions to initiatives from non-state actors (Funder, 2020). State actors do not merely coerce,
35 ignore, or passively stand by as social processes of bricolage unfold. Rather, they often “seek
36 to reproduce order through creative adjustments to rules and routines that channel action into
37 predictable and controllable behaviour” (Jabko and Sheingate, 2018: 312). They seek do this
38 in two major ways, with varying degrees of success. First, they may choose to practice
39 ‘forbearance’, knowingly tolerating informal creativity as long as its distributional
40 consequences are deemed acceptable or even desirable (Tendler, 2002; Holland, 2016).
41 Second, they may choose to formalise, materially support and legitimize adapted arrangements
42 (Gallien, 2020). Thus, adapted arrangements are generally a site of “hybrid governance”
43 (Titeca and Flynn, 2014), one decisively shaped by state actors’ endeavours to stabilize a social
44 order.
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48 Viewed in this light, frontal antagonism between state and non-state actors appears more as a
49 temporary exception than the rule. The case of the oGH illustrates well the gradual shift from
50 radical estrangement to ambivalent negotiations between the Jawlanis and the Israeli State.
51 Broadening De Konings’s conception of articulation - to apply it to technological and
52 ideational and well as institutional bricolage - the first historical sequence can be described as
53 the construction of a “counter-infrastructure” (Dajani and Mason 2018). This oppositional
54 infrastructure articulated material artefacts such as pipes, pumps and storage; formal and
55 informal regulations; and meanings of belonging and defiance. However, these counter-
56 infrastructures gradually morphed into “joint ventures” as the Jawlanis entered into
57 negotiations with Mekorot. Today, this relationship remains extraordinarily ambivalent, as
58 resistance to assimilation proceeds alongside everyday transactions and acculturation.
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4 Likewise, in Ghardaïa, when the Algerian state introduced its own arrangements for the
5 collective use of groundwater in the Sahara, its programs were first countered, and in some
6 cases simply discarded, by local farmers. Then a dialogue emerged that led to complex forms
7 of groundwater co-management. Likewise, in Biskra, existing arrangements prohibited young
8 farmers, deprived of land, from accessing water. By re-engineering the drip irrigation systems
9 and adapting the institutions to their fragmented farm structures, landowners and sharecroppers
10 found a working formula for these intensive greenhouse farming systems. At first, Algerian
11 authorities merely tolerated these informal arrangements, but as Biskra became the main
12 supplier of vegetables off-season to the cities, they then helped these farmers by developing
13 roads, electricity networks, markets, etc.
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17 These observations show the productive potential for an articulation between research on state
18 bricolage and research on bricolage outside the state. Indeed, bricolage might just be a typical
19 illustration of “how states and societies transform and constitute one another” (Migdal, 2001).
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22 **4c/ Beyond local tinkering: Scale, society and change**

23
24 Both case studies show that while bricolage is often initiated by local actors to experimentally
25 adapt infrastructure or collectively organise livelihood practices, these processes may
26 aggregate and leak across social domains to shape broader patterns of societal organisation.
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29 Our analysis thus extends beyond understanding bricolage only as a locally situated process. It
30 is true that bricoleurs take stock of existing ideas, institutions and technological know-how,
31 and reinterpret them in the light of particular and changing circumstances. This might appear
32 to suggest that bricolage is characterized above all by contextual diversity, and that it cannot
33 be generalised beyond the local (Carstensen, 2011). However, our cases show that the
34 apparently limited character of bricolage is precisely what makes it such an effective vehicle
35 for diffusion of arrangements across space and time. By virtue of its familiarity, change through
36 bricolage can appear more feasible (technological bricolage), legitimate (institutional
37 bricolage) and meaningful (ideational bricolage) to all actors faced with comparable ecological
38 conditions and sharing proximate cultural scripts. By appearing more natural and less
39 intimidating than more ambitious changes, bricolaged arrangements resonate and can be
40 appropriated more easily. Such apparently incremental adjustments, grounded in social context
41 and meanings, can invisibly “enable more radical changes than would otherwise be possible”
42 (McAdam and Scott, 2005:28)
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46 Thus, in Biskra, the low-cost drip irrigation system spread rapidly across the region as it
47 corresponded closely to the infrastructure already in place in the north, was less expensive to
48 install than the high technology model, and appeared to fit better with a collective identity
49 based on a sense of astuteness, flexibility and practical know how. Similarly, in the occupied
50 Golan Heights, the creation of counter infrastructure through technological bricolage was
51 possible because of the availability of local materials, machinery and manpower. Institutional
52 bricolage was made possible by drawing on traditional arrangements of collectively managing
53 and distributing water. What these entwined processes produced was a heightened sense of
54 political subjectivity— strengthening farmers motivations to enact them as a way of continuing
55 to resist oppression. Through these negotiations the *apparently* unchanged imaginary of
56 defiance and resistance made possible the development of closer ties with the occupier.
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60 **4d/ The scope for socio-ecological transformations through bricolage**

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4 We have demonstrated that processes of bricolage can produce substantial changes to water
5 access in a region or country. But how far can these changes be seen as *environmentally*
6 sustainable? Can processes of bricolage facilitate the radical re-framing of the relationship
7 between nature and society that is needed to further transformations to sustainability? In short,
8 can we bricolage our way to a broader socio-ecological sustainability?

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10 Much of the bricolage literature, concerned with how institutions channel power, process and
11 meaning, has relatively little to say on environmental outcomes (Cleaver and Whaley, 2018).
12 And yet, we have seen in our case studies that bricolage engages material as well as social
13 processes, and is enacted in bio-physical environments.
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16 Viewed in this light, the processes of bricolage that we track in our cases have not entailed, so
17 far, any shift away from ecologically damaging modernist imaginaries and practices. Rather,
18 they mostly show an appropriation of such imaginaries from below. This is especially true for
19 two core features of modernism: first, a faith in technological control over nature, according to
20 which even the most seemingly hostile, arid environment, can be productively harnessed
21 through science, (irrigation) technology and infrastructure (Worster, 1992). Second, a resource
22 optimism, anchored in the belief in the availability of an unlimited supply of land and water to
23 increase production (Hamilton et al., 2015). This twofold “anthropocenic illusion” (Hörl, 2015)
24 puts these bricolaged arrangements at great risk in the medium term, as the material conditions
25 of their reproduction may very well disappear.
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29 Thus, in Biskra, the intensive greenhouse horticulture cannot, in any way, be qualified as
30 environmentally sustainable. Smallholders exploit little-renewable water resources, are
31 exposed to toxic pesticides, degrade soil fertility and apply large quantities of fertilizers to the
32 land. These smallholders do not see this entrepreneurial farming as a vocation, but rather as a
33 way to obtain the means to lead a better life elsewhere (Naouri et al., 2017). Farmers are
34 “reasoning” their lives (and livelihoods) rather than reasoning their farming systems, especially
35 in environmental terms. They do so by limiting the time they stay inside very toxic farming
36 systems (typically 5-10 years)¹⁹. With the money made, they then get out and “start” their lives
37 for good (i.e. get married, build a house, diversify into less dangerous activities) elsewhere.
38 Meanwhile, these toxic farming systems produce fresh off-season vegetables for the cities,
39 where consumers are supplied at a relatively low cost which partly explains why they enjoy
40 strong support from the state (Kuper et al., 2017b). The entwined processes of bricolage
41 enacted by farmers and supported by the state and agricultural supply companies thus
42 perpetuates unsustainable resource use.
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46 In Ghardaïa, the way ongoing practices and imaginaries relate to modernism is more nuanced
47 and quite different from Biskra. New agricultural extensions were first stimulated by the State
48 to promote modern, intensive agriculture, as opposed to the traditional subsistence agriculture
49 in oases. However, local communities invested in these extensions, bringing in their secular
50 know-how of living and producing in the desert, leading to hybridized forms of agriculture that
51 borrow from the oasis lexicon (for example, the practices of layered agriculture; the association
52 of livestock and crop production; or the circularity of water), while introducing new crops (such
53 as saffron) and technologies (especially irrigation equipment). Taken together, these practices
54 constitute an emerging “Saharan farmer” identity, priding itself on being enterprising and
55 independent vis-a-vis the Algerian State, but also having a strong sense of belonging and caring
56 for the environment. This distinguishes these farmers from those in Biskra, who come from the
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¹⁹ See also Okali and Sumberg (2012) on a similar story on tomato production in Ghana.

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3 north of the country. The latter group identity is also strong, as these young farmers are proud
4 of their technical know-how in irrigation and greenhouse farming. They think they know better
5 than the multinational corporations what sort of drip irrigation “works” in Saharan conditions,
6 and they designed for themselves the system they consider most appropriate. However, they
7 do not identify as Saharan farmers, but as merely passing by (Kuper et al., 2017).
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10 In the Israeli case, the promotion of sustainability in groundwater exploitation cannot be
11 viewed uncritically as it occurs under conditions of inequality. While Israel promotes itself as
12 a leader in wastewater treatment and reuse schemes in agriculture, it continues to exploit
13 groundwater for the benefit of its illegal settlements expansion in the occupied Palestinian
14 territories and the oGH. Thus, groundwater sustainability must be analysed through its settler
15 colonial lens and not just its techno-managerial advancement to expose social and political
16 injustices embedded in those practices claiming sustainability.
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19 In the oGH, the bricolaged technologies and institutions, and the meanings and values that they
20 shape, normalise unequal resource extraction. They do this by framing current arrangements
21 as necessary for strengthening rootedness and attachment to the land. This is further
22 complicated by the menace to the community’s presence on the land of state-sanctioned
23 projects of wind energy production threatening the Jawlani agriculture and way of life
24 (Southlea and Brik, 2020;).
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27 The cooperatives, however, can still be seen as a site of resistance to forced cooperation. Since
28 the water allocations are given only during the dry seasons (mid-April to October), the pumping
29 rates needed each month always exceed the allocation agreed. This is when the Nator (guard
30 for each cooperative) pumps beyond the agreed quota. This is seen as a way to secure of the
31 water that the farmers view as their rightful share. The logic behind this over-pumping relates
32 to another claim that the farmers make to water rights, under the requirement in international
33 law that an occupying power provides basic level of services to the population it controls. It
34 can be claimed that development and diffusion of bricolaged arrangements which took place
35 following threats to the community’s existence on the land has developed a sense of belonging
36 that is centred around water, land and crops. However, the contribution of such processes to
37 environmental sustainability remains highly questionable.
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41 In sum, the different cases show that interdependent processes of ideological, institutional, and
42 technological bricolage can bring about profound social and political transformations. One can
43 also see, however, the limitations of the improvised character of bricolage. The pragmatic
44 recombinations to which its gives rise may substantially alter power relations within a given
45 development paradigm. However, the very nature of this paradigm, at least in our cases,
46 continues to be largely derived from previous ways of thinking and doing things. Former
47 contextual differences are thus merely renewed and maintained, without any fundamental
48 bifurcation of the mode of development. In addition to its short-term orientation, which might
49 prevent it from challenging particularly deep social structures, another limiting factor may be
50 the fact that, being a negotiated process, bricolage has to be at least tolerated, however reluctantly,
51 by powerful actors. This can pave the way for more equitable - at least temporarily - modes of
52 development, but it also sets strong limits to any possibility of shifting towards a post-
53 modernist development, less tied to capitalist growth. These reflections, nevertheless, can only
54 be preliminary, and the potential effects of bricolage on ecological transformation should
55 provide important avenues for future research.
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5. Conclusions

We have identified in this paper three defining features of bricolage that have not received sufficient attention: first, institutional, technological and ideational processes are entwined and mutually reinforcing; second, bricolage is coproduced by the State and society; and third, it is always a multi-scalar process with multiple actors intervening continuously at different, connected levels. These features explain the transformative capacity of bricolage, its potential for bringing about societal change, and for opening avenues towards ecological sustainability.

In so doing, mobilising a bricolage lens to analyse the potential for social-ecological transformations raises some productive questions. In particular, it avoids considering separately different ways forward to address fundamental socio-ecological problems, whether it is through cultural change, innovative institutional arrangements or technological disruptions. Instead, it invites us to explore to what extent processes of bricolage, operating over time on the three interdependent dimensions of institutions, worldviews and technology, can foster genuine socio-ecological transformation. This also suggests that meaningful systemic change to societal regimes of resource governance can be anchored in the everyday actions of farmers and water users rather than coming from simplified recipes implemented from above (Zwarteveen et al., 2021). The cases of the Algerian Sahara and the occupied Golan Heights, however, suggest that bricolage may more easily rebalance power relations within a productivist mode of development than transform irrigation practices towards greater sustainability. More research is therefore needed to examine if, and under what conditions, bricolage can open the way to something other than extractivism from below.

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