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A relational framework for investigating nexus governance

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Abstract

Based on the assumption that the water, energy and food sectors are linked, the nexus concept drives research into the integration of governance systems. Nexus governance requires actors to engage across policy domains, governance levels and public, private and civic spheres. There is a need for a better understanding of how stakeholders navigate the inter-organisational networks constituting a given nexus. In this article, we present a three-dimensional relational framework and corresponding methods for investigating nexus governance. Drawing on mixed-methods network research with organisations implementing water, energy, agricultural and environmental policies in the Upper Blue Nile basin of Ethiopia, we demonstrate how our framework for investigating network structure, relations and narratives can inform a relational understanding of nexus governance.

Keywords

Nexus, governance, relational framework, Ethiopia, Social Network Analysis, mixed methods

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A relational framework for investigating nexus governance

1. INTRODUCTION

A growing recognition of the interdependence between policy domains and resource systems has given rise to more holistic approaches to natural resource management, including integrated water resources management and, more recently, the water–energy–food nexus (Benson et al., 2015; Leck et al., 2015). Nexus approaches aim at the integration and 'binding together' (Latin *nectare*) of governance systems across levels, sectors and scales (Hoff, 2011). The potential for synergies and reduced trade-offs make nexus approaches intuitively compelling but questions remain about how to realise the benefits of policy integration (Cairns & Krzywoszynska, 2016; McGrane et al., 2018; Rees, 2013; Weitz et al., 2017).

While scientists and policymakers recognise the complexity of sustainability challenges associated with the water–energy–food nexus, they often strive for a single optimal solution (Allouche et al., 2014; Stirling, 2015). This 'complexity paradox' of dynamic challenges and sweeping solutions (Leach et al., 2010; Voß et al., 2006) is rooted in a positivist understanding of how environmental change can be managed and an apolitical approach to the actors and institutions involved (Allouche et al., 2015; Verhoeven, 2015). Such an approach obscures the various challenges practitioners face when drafting and implementing policies and interventions involving multiple stakeholders (Leck et al., 2015; Mosse, 2004; Weitz et al., 2017).

Given the scope and scale of the water–energy–food nexus, no single actor has the knowledge, resources or authority required to govern it unilaterally (Koppenjan & Klijn, 2004). Governance challenges that call for a nexus approach have been found to be inherently 'wicked problems' (Allouche et al., 2015, p. 621). They comprise interrelated subsets of problems that make it difficult to develop a shared understanding of the challenge that is independent of one's approach to addressing it (Rittel & Webber, 1973; Weber & Khademian, 2008). This suggests that nexus governance is as much about shared problem construction as it is about collective solutions (Leach et al., 2010). It also highlights that nexus challenges are inseparable from people and their perceptions.

In this article, we put the actors involved and their relationships at the heart of nexus analysis and thinking. We argue that, in order to better understand the potential and implications of

nexus research and policies, we need to examine how nexus governance is approached, experienced and contested across different sectors (water, energy, food), at different levels of governance (local, regional, national) and at different scales, ranging from a village to an entire river basin. Existing research has largely focussed on prescriptive policy models (Hoff, 2011) or modelling the biophysical interconnections across the water–energy–food nexus to address nexus issues by optimising resource allocations (Bazilian et al., 2011). While such research has advanced our understanding of the nexus, it has fallen short of acknowledging more fully how nexus governance is shaped by inter-organisational relationships and networks, the wider socio-economic and political contexts in which they are embedded, and the meanings actors attach to networks, relationships and contexts.

We address this gap in the nexus literature by presenting a three-dimensional framework that combines the structural analysis of a wider governance *network* with an in-depth investigation of *patterns of relationships* through which key actors structure and navigate the network, and the underlying *narratives* they articulate and that promote, justify or reject the integration of governance systems across policy domains. Drawing on an empirical study of the water–energy–food–environment nexus in the Upper Blue Nile region of Ethiopia, we demonstrate the potential of the framework and corresponding methods for research into nexus governance. We show how each of the three dimensions opens up a different layer of insight into how the integration of governance systems may or may not be achieved, and how by triangulating these dimensions the framework bears significant potential for advancing research on nexus governance.

2. A RELATIONAL APPROACH TO NEXUS RESEARCH

The nexus approach may be seen as the latest terminology for the *interconnectivity* of resource systems and scales (Allouche et al., 2015; Verhoeven, 2015). It is an inherently relational concept: it starts with the assumption of interconnections between resource systems and a corresponding web of socio-economic and political entities (Lele et al., 2013; Scott, 2017). Nexus governance is widely seen as involving public, private and civil society organisations coordinating activities across policy domains, governance levels and geographical boundaries (Leck et al., 2015). From this perspective, the nexus appears as a relational space. However, this social dimension of nexus connections – illustrated by Figure 1 (a) as patterns of relationships between organisations within and between different policy domains – remains largely under-theorised (Foran, 2015; Lele et al., 2013; Weitz et al.,

2017). Figure 1 (b) presents an illustration of our three-dimensional framework for relational analysis of nexus governance. Questions remain as to the implications of nexus governance for a field of organisations concerned with plethora of issues, many of which are interpreted through the lens of a particular sector. What exactly should be integrated, across what boundaries, where, by whom, for whom and how?

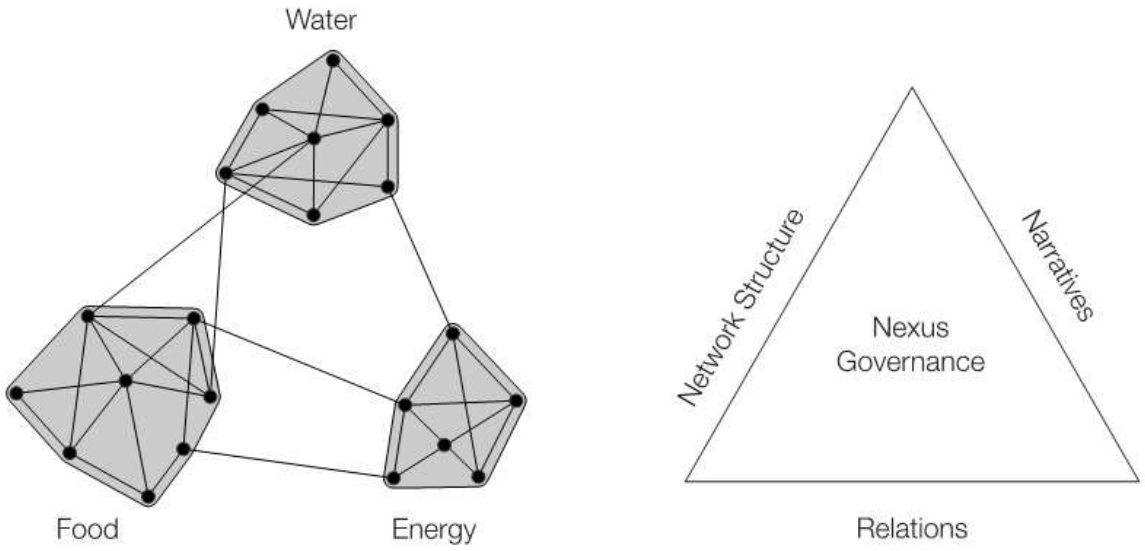

Figure 1. (a) The water–energy–food nexus as a clustered network of actors. (b) A framework for relational analysis of nexus governance.

Governance refers to the 'overall system of steering mechanisms […] in which traditional top-down government is only one among many' (Van Huijstee et al., 2007, p. 75). These mechanisms arise around notions of reciprocity, trust and legitimacy as well as collective sanctions and more formal arrangements including regulations, institutional procedures, and contracts (Newell et al., 2009; Provan & Kenis, 2007; Jones et al., 1997). Nexus governance approaches entail relationships among multiple actors across domains, societal sectors and governance levels (Pahl-Wostl, 2017; Scott, 2017; Stein et al., 2018). We define nexus governance as *the relational structures and processes that connect actors across sectors, governance levels, geographical boundaries and/or public, private and civic spheres, and that provide steering mechanisms for the integration of management and governance systems across different policy domains*. Nexus governance may involve participant-governed networks such as regional round tables and centralised governance characterised by an

asymmetrical power distribution, as well as governance through an administrative organisation set up for this purpose (Provan & Kenis, 2007).

We still know little about how integrative governance approaches can be realised by different stakeholders (Weitz et al., 2017) and whether governance challenges arise from the particularities of settings or are integral to such approaches themselves (Cairns & Krzywoszynska, 2016; Mosse, 2004). There is a lack of frameworks and tools that facilitate a 'grounding' of the nexus concept in local realities (Stirling, 2015), leaving the 'nexus concept disconnected from the decision-making and policy-making processes it ultimately seeks to influence' (Weitz et al., 2017, p. 165). Nexus governance is shaped by political-economic complexes – and the nexus concept itself can be instrumentalised in policy narratives driving political struggles (Verhoeven, 2015). While recent research has confirmed the importance of unpacking how policy narratives are used to justify sectoral and nexus policies (Lebel & Lebel, 2017; Middleton et al., 2015), most of this research has focussed on the structure and content of the narratives themselves without taking into consideration the relational embeddedness of those articulating, challenging and investing in these narratives.

We need a better understanding of the interlocking relationships between *nexus governance structures*, *relations* and *narratives* in order to appreciate more fully the potential and challenges of nexus governance. In this article, we propose a relational framework for investigating nexus governance. We build on three distinct yet interrelated strands of relational sociology and social network research: *structuralist network* research, which involves the analysis of complex and often hidden relational structures shaping governance processes and outcomes (Bodin & Prell, 2011; Hollstein et al., 2017); *relational* research, which attends to the characteristics of relationships and how actors navigate networks and engage with others (Crossley, 2010; Mische, 2003); and *narrative* research, which examines how actors make sense of relationships and networks through an analysis of narratives and stories about the nexus and its governance (Lejano et al., 2013; White, 2008). In the following paragraphs we explore each of the three relational dimensions in turn.

2.1 Structural dimension

Social network research involves the study of the structural patterns in aggregated data matrices that report the presence or absence of relationships amongst sets of actors (Wasserman & Faust, 1994). Scholars interested in natural resources management have

turned to Social Network Analysis (SNA) to study the underlying and mostly 'invisible' patterns of relations that form the structure of actor networks and how they influence governance processes and outcomes (Bodin & Crona, 2009; Lubell et al., 2014; Robins et al., 2011). While such research has yielded important insights into how a better understanding of social structures can guide policy interventions for improved coordination and enhanced environmental outcomes (Barnes et al., 2016; Sayles & Baggio, 2017), it is fraught with methodological challenges associated with boundary drawing (i.e. determining what actors are considered to be part of a nexus) and the sensitivity of many network models to missing data (Conway, 2014). Moreover, owing to its concern with 'hidden patterns', structuralist network research offers little insight into how actors perceive, make sense of and navigate the networks of which they are part. SNA also works on the implicit assumption that relationships can be standardised, which in the case of the nexus governance is not without problems – not least due to its potentially value-laden and highly political nature (Jaspersen & Stein, 2018). This said, an analysis of the structural configuration of any given governance network can indicate the degree of fragmentation and/or integration already achieved (Stein et al., 2018).

2.2 Relational dimension

As a formalist research programme, SNA by and large ignores context. However, in the case of nexus governance, we need to understand the often complex structure of large inter-organisational networks along with what flows across the relationships constituting these networks, 'who decides on those flows in the light of what interests, and what collective […] action flows from the organisation of links' (Stinchcombe et al., 1990, p. 381). Drawing on relational theory, such research combines an exploration of relevant patterns of *relationships* with an investigation of the meanings that actors attribute to them (Fuhse & Mützel, 2011; Molina et al., 2014). This usually involves an in-depth investigation of relationships using qualitative data, yielding detailed and situated accounts of how actors experience and engage with the network in which they are embedded (Desmond, 2014; Hollstein, 2011). As trajectories of shared experiences, relationships are 'storied' and give meaning to past interactions and prescribe rules for future engagements (Crossley, 2010; White, 2008). Relational narratives provide 'descriptions of relationships […] but more than this – they are the discursive processes through which relationships are formed and maintained in the first place' (Crossley et al., 2015, p. 125).

2.3 Narrative dimension

Nexus governance is not just about 'interacting *objective* systems – like energy, water and food infrastructures [but also] the *subjective* processes through which these systems are framed' (Stirling, 2015, p. 13 emphasis in original). The integration of governance systems depends on the emergence of *narratives* that call for such endeavour and interlock with existing governance arrangements (Leach et al., 2010; Roe, 1994; Rose, 1999). Narratives 'embody ideas concerning what forms of action and interactions are possible, feasible, desirable, and efficacious' (Tilly, 2002, pp. 8–9). They can motivate the coordination of diverse actions and shape the adoption, implementation and contestation of policy (Bevir, 2011; Lejano et al., 2013). The study of policy narratives can help explain the opportunities and challenges associated with coordination and collaboration across boundaries (Lebel & Lebel, 2017; Lejano et al., 2013). However, an analysis of policy narratives provides only limited insight into nexus governance if it is not complemented by an investigation into the underlying patterns of relationships among the actors involved. 'Narratives are inevitability constructed in a social and a political milieu by coalitions of actors with interests and positions' (Scoones et al., 2014, p. 8). Therefore, it is important to trace the relative position of actors who sign up to competing narratives, and to explore their interests and understanding of the nexus (Forsyth, 2003; Keeley & Scoones, 2003). Only in this way can we better understand the relationships that connect actors with each other and how actors use narratives to legitimise boundaries as well as boundary-spanning connections (Ingram et al., 2014).

2.4 Relational framework

Each of the three dimensions outlined above can open up important yet partial insights into nexus governance. *Structuralist network* research offers us an overview of the often complex structural configurations of the actor network(s) constituting a water–energy–food nexus and the extent to which integration has or has not been achieved. A *relational* approach is needed to examine how actors, and in particular those who occupy key positions, experience and navigate the network. Such research is likely to reveal relational patterns of collaboration and competition and strategies for boundary drawing and integration. These patterns have to be interpreted with a view as to how they (dis)connect with broader policy *narratives* around the water–energy–food nexus, and how they relate to the structure of the network as whole. Based on these considerations, we conceptualise nexus governance as a process driven by the recursive interplay of network structure, relations and narratives. We represent this as a

triangle (see Figure 1 b above) to illustrate that, for any investigation of network governance, all three dimensions need to be integrated, although their relative emphasis may vary according to context. Ultimately, this framework should bring into dialogue insights obtained from the analysis of each of the three dimensions. In the remainder of this article, we present a mixed-methods study that illustrates the application of this framework to nexus governance in the Blue Nile basin in Ethiopia, and the use of a set of corresponding methods for an investigation of each of its three dimensions.

3. NEXUS GOVERNANCE IN THE BLUE NILE

With a population of about 102 million inhabitants, Ethiopia is the second most populous country in Africa (World Bank, 2018). While Ethiopia's economy is growing fast, there is a need to improve sustainable access to water, energy and food (Calow et al., 2013; Tessema et al., 2014). Rain-fed agriculture is the main source of income and livelihoods in rural areas (Abro et al., 2014; Haileslassie et al., 2012). As a result, the livelihoods of the vast majority of Ethiopians are intricately linked to natural resources, and in particular water. The Tana and Upper Beles sub-basins, where this study was conducted (see Figure 2), form part of the Blue Nile river basin in north-western Ethiopia. It is a region undergoing rapid change in the water, energy and agriculture sectors. The implementation of the Growth and Transformation Plan (MoFED, 2010, 2015) has given rise to numerous development projects, including the construction of dams.

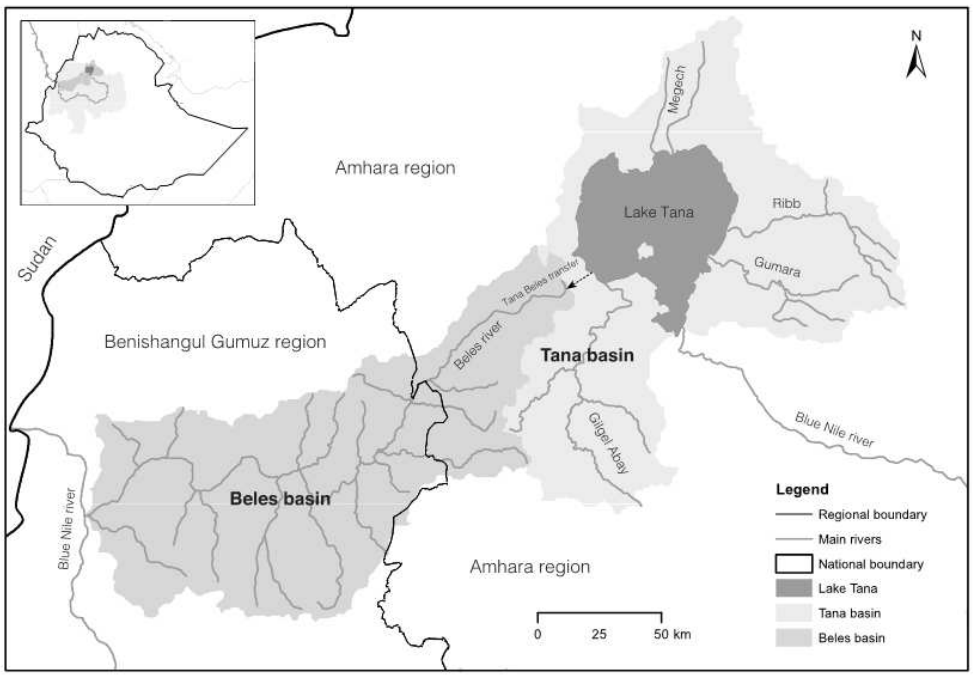

Figure 2. Map of the Tana and Beles sub-basins in the Upper Blue Nile basin.

Lake Tana is not only a UNESCO Biosphere Reserve; it is also a natural water reservoir for agricultural production and hydropower downstream. An intra-basin water transfer diverts water from Lake Tana to a hydropower scheme in the Upper Beles, where there are plans to develop a large-scale sugar cane plantation. Environmental degradation and deforestation are increasing concerns, as soil erosion reduces agricultural productivity and sedimentation affects irrigation and hydropower infrastructure (Haileslassie et al., 2008). Dependence on biomass for fuel creates trade-offs between domestic energy use, environmental conversation and agricultural production (Mekonnen et al., 2017).

Interdependencies between the water, energy and agricultural systems require diverse sets of stakeholders to coordinate activities across sectors, governance levels and geographical boundaries. Notwithstanding a high level of policy consistency, at least on paper (Haileslassie et al., 2008), in practice coordination between sectors to realise integration remains difficult (Hagos et al., 2011). This makes the Blue Nile region a particularly suitable case study to explore issues around the water, agriculture, environment and energy nexus.

4. METHODOLOGY

The case study is guided by the relational framework and its three dimensions – network structure, relations and narratives. These dimensions are associated with distinctive sets of research questions, which are investigated through a mixed-methods approach.

Table 1 provides an overview of the three dimensions, the research questions that have guided our research, and the corresponding methods. The latter columns are illustrative rather than prescriptive, and there is scope to refine each of the three dimensions and to explore different approaches and methods for their investigation.

Dimension	Analytical focus	Methods	Questions
Network structure	Structural configuration of inter-organisational network constituting the nexus; identification of key actors based on	Network survey and Social Network Analysis	How does the structure of the nexus as a network of organisations give rise to opportunities and limitations for the integration of

	position in the network		domain-specific governance systems? Which are the key actors in the network?
Relational	Relational embeddedness of key actors; configuration of their organisational networks; content and quality of relationships	Network map interview	How do key actors from the water, agriculture, environment and energy sectors navigate the network and coordinate activities? How do they approach the integration of domain-specific governance systems?
Narrative	Policy narratives and associated visions and governance practices	Narrative analysis of expert and network map interviews, field notes, grey literature and responses to open-ended questions in the network survey	How do relational narratives and broader policy narratives inform the governance of the nexus?

Table 1. Framework dimensions, research questions and corresponding methods.

The framework's three dimensions correspond to distinct sets of methods for quantitative and qualitative network research and narrative analysis. In this section, we provide a brief overview of the methods used in the research; more details are provided in the Supporting Information. As in other mixed-methods studies, this research adopts a moderate subjectivist stance with a pragmatic epistemology assuming that both researchers and research participants are embedded in a social world, which is shaped by and shapes experiences (Cunliffe, 2011).

Firstly, in order to conduct a structural analysis of the governance network, its composition and boundaries had to be determined. For this purpose, a combination of expert interviews, site visits and document analysis were used to create a recall list, which is a complete list of all the organisations identified. A network survey was then conducted to establish how

organisations connected to each other. We used methods from the field of Social Network Analysis to analyse the structural configuration of the governance network and to identify key actors among a total of 85 organisations operating across both sectors and spatial scales. In the second, relational phase of the project, network map interviews were conducted with government agencies responsible for the implementation of sector-specific policies on water, energy, agriculture and the environment at the regional and local levels. Here, the aim was to understand how key actors navigate the network and coordinate activities. Then, thirdly, narratives employed in nexus governance were uncovered by extracting storylines from the transcribed interviews, field notes, grey literature, and survey data; this involved a coding process using the QDA software package Atlas.ti (see the Supporting Information). Narrative accounts were then analysed as devices through which participants make sense of the water–agriculture–environment–energy nexus of the Upper Blue Nile region.

5. FINDINGS

5.1 Network structure

The analysis of the structural characteristics of the governance network reveals that interactions across policy domains and corresponding sectoral boundaries are relatively common (Stein et al., 2018). This challenges the notion of actors operating in domain-specific silos, which features so prominently in the nexus literature. The structural analysis also shows that relationships are not primarily organised around policy domains but that they are also intertwined with hierarchical relationships between actors operating at different governance levels, as well as connections within and across jurisdictional and geographic boundaries, e.g. districts and the sub-basins (Stein et al., 2018).

Using weighted degree centrality, we then identified key actors with multiple relationships across policy domains that were likely to be of strategic importance for the integration of governance systems throughout the nexus. Actors with the highest weighted degree centrality included the regional government agencies, in particular the Bureau of Agriculture and Rural Development (‘Agricultural Bureau’), the Bureau of Water Resources Development (‘Water Bureau’) and the Environmental Protection, Land Administration and Use Authority (‘Environmental Bureau’), but also a number of organisations that are not part of the water, energy, agriculture or environment sectors, such as the regional Bureau of Finance and Economic Development and a small number of non-state actors such the World Bank. Figure 3 visualises the network of 85 organisations. The size of each node corresponds with the

organisation's weighted degree centrality. The seven organisations that were selected for the network map interview in the second phase of the research are highlighted with a circle around the node.

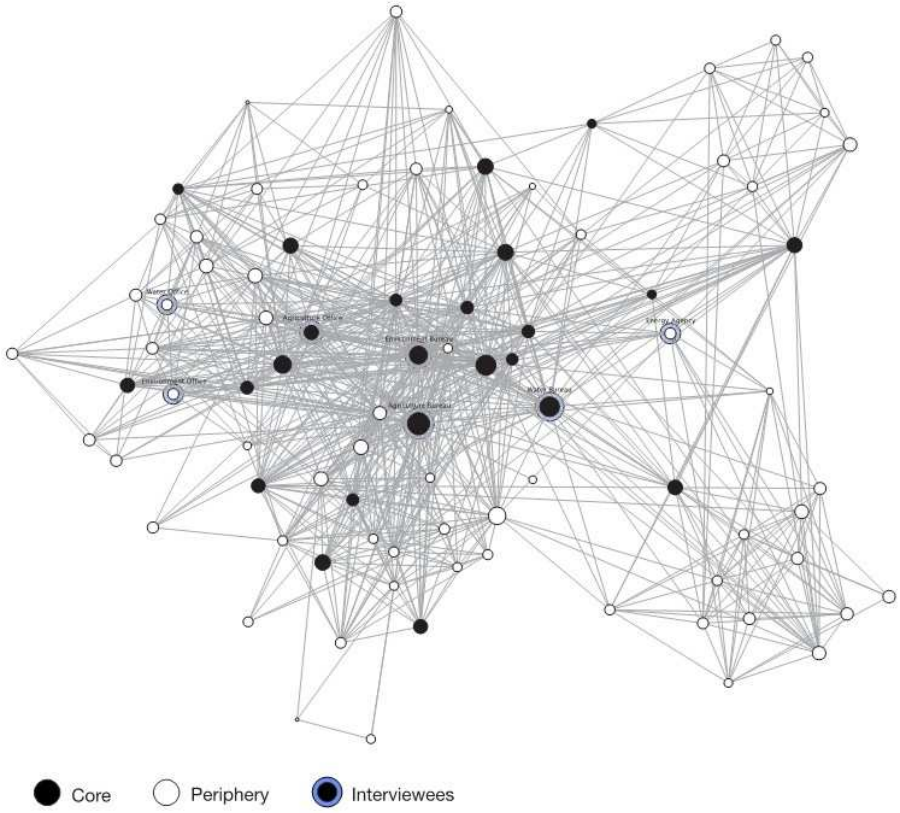

Figure 3. Visualisation of the nexus governance network.

The distribution of degree centrality scores suggests the presence of an underlying core–periphery structure, where actors situated at the core maintain a large number of relationships to other actors in the core and in the periphery, whereas those situated at the periphery mainly relate to core actors. Figure 3 illustrates the result of our analysis based on a core–periphery model implemented in UCINET, which identifies a centre and periphery in the network and partitions actors accordingly. Organisations that are closer to the centre are represented by a black node and those that are closer to the periphery are illustrated by a white node. While the governance network does not fit an ideal core–periphery model in that some peripheral actors are connected to others in the periphery, most of the peripheral relationships are among organisations that are based in the same jurisdiction. The clusters of organisations illustrated at the right-hand side of the figure illustrate this. They represent peripheral organisations operating in different policy domains but within the same district. Their connections to other

districts are by and large mediated by organisations that are situated at a higher governance level (e.g. agencies at the zone level, which is a subdivision between districts and regions).

With a view to the first research question (see Table 1), our findings point to inherent limitations arising from the network's structure for the integration of domain-specific governance systems. They show that the actual potential for governance integration across domains is largely restricted to connections mediated by key actors, and that the overall network is subject to a relatively centralised governance system. With a view to the second research question, about key actors, our analysis points to the importance of regional agencies as mediators of relationships between policy domains and governance levels. Based on the structural analysis alone, we had no insight into the nature of the boundary-spanning relationships and the kind of opportunities they generated for the integration of governance systems. We therefore selected four regional agencies (bureaux) and corresponding local offices to conduct network map interviews. Our sampling was guided by considerations relating to an organisation's position in the network, its principal policy domain and the level of governance at which it operates. For the energy domain, we could only interview one organisation as the responsibility of energy issues at the local level was with the Water Resources Development Office ('Water Office').

5.2 Relations

In this section, we present the results of our analysis of the network map interviews, which we conducted with the Water Bureau, Energy Agency, Agricultural Bureau and Environment Bureau at the regional level and the Water Office, Agriculture Office and Environment Office at the local level. Figure 4 provides an overview of the composition of the seven networks and also highlights the collaborative relationships maintained by each of the organisations (illustrated by connecting lines). We first conducted a comparative analysis of the network maps and then examined more closely how actors described relationships, in particular those that were perceived to be in need of improvement (illustrated by dotted lines in Figure 4). Our analysis focussed on how key actors navigate the network, how they coordinate activities and how they approach the integration of domain-specific governance systems (the second set of research questions). All quotations included in this article are based on detailed field notes created by the first author. For reasons of confidentiality, we do not further specify the roles and positions of our interviewees.

Figure 4. Ego-centric network maps of key governmental actors at the local and regional levels.

All of the network maps confirm a general tendency of actors to engage with organisations working in the same sector (see Figure 4). Patterns of cross-sectoral collaboration vary depending on policy domain. For example, the energy sector appears as a largely domain-specific governance system. Most contacts of the regional Energy Agency are in the energy domain, and the otherwise very heterogeneous networks of the regional Agricultural Bureau and the Environment Bureau both lack collaboration with organisations in the energy sector. Given competing demands for irrigation, hydroelectricity and conservation, this lack of engagement is surprising and also extends to the Water Office, which, despite being formally responsible for energy issues at the local level, maintains only a small number of collaborative ties with other organisations in this domain.

In contrast to the regional Water Bureau, the local Water Office also lacks collaborative ties with agricultural organisations. This is one of several examples where patterns of cross-sector collaboration vary according to the governance level. An analysis of the corresponding interview data reveals that this divergent pattern arises from the division of responsibilities across governance levels and policy domains. Unlike its local counterpart, the Water Bureau

is involved in the planning of irrigation systems, which requires coordination with agricultural organisations. However, the responsibilities for developing and managing irrigation systems could lie with organisations situated at different levels and in different domains. 'There is a gap between development and management […] Development is accelerating, while management is lagging behind' (Interview 13). This makes it difficult even for key actors to navigate the network and coordinate activities.

Where responsibilities overlap, it often remains unclear how 'how political boundaries could be reconciled with geographical (in this instance hydrological) boundaries' (respondent from the Water Bureau). For example, the creation of a River Basin Organisation has added another layer of complexity. Water management is now undertaken by organisations that are 'planning to the district, to the region, and to the basin' (Interview 41). An analysis of the relationships between these water organisations shows that they are accessing each other's networks in a hierarchical way (e.g. for the River Basin Organisation, the Water Bureau provides a point of entry to the offices at the district level). While the strategic importance of the networks of peripheral actors was acknowledged by those at the core (i.e. the bureaux), 'without these offices this bureau is nothing' (Interview 7). Respondents from the periphery often considered their relationships with core organisations to be challenging owing to a perceived lack of political support for local priorities in the face of problems arising from ambitious development targets. 'The government understands these kind of problems, but it is a political decision' (Interview 23). The potential of peripheral actors for achieving integration across domains appears to be constrained by a system that favours centralised decision-making and top-down policy implementation.

Turning to the quality of relationships, we find that relationships crossing domains and governance levels are the ones most likely to be perceived as in need of improvement. This suggests that boundary-spanning relationships are more common than previously thought but also that these relationships are often seen as too weak to enable the effective integration of domain-specific governance systems. Relationships concerning the environment in particular are reported as being in need of improvement. Despite the Environment Bureau's efforts to maintain a large number of collaborative ties across all domains, in a situation where economic development is prioritised over conservation these collaborations do not translate into a mainstreaming of environmental concerns. The Environment Office is also perceived to be of 'little importance' compared to the Agriculture Office as the latter has to deliver on

ambitious targets derived from the government's Growth and Transformation Plan. This and related observations speak to the importance of enquiring into the third dimension of the relational framework – the narrative dimension – to better understand how different policy narratives and corresponding political priorities shape strategic engagement across domains and governance levels (the last research question).

5.3 Narratives

Our analysis of interviews, network map interviews, documents and open-ended questions from the network survey focussed on storylines around governance problems and solutions and corresponding relational patterns. Based on our findings, and drawing on related work on policy narratives in Ethiopia (Keeley & Scoones, 2003; Verhoeven, 2013), we identify two dominant narratives, which open up a third and complementary analytical point of entry to examine what relationships and actions are considered desirable and effective in enhancing the governance of the water–energy–food–environment nexus in the Upper Blue Nile region.

Transformative change through economic development

The first narrative focusses on economic development as a means for alleviating poverty. With the national Growth and Transformation Plan as its most visible expression, this narrative calls for agricultural productivity to be increased within the multi-sectoral strategy for Ethiopia to achieve the status of a middle-income country by 2025 (MoFED, 2010, 2015). The narrative prescribes the effective use of natural resources, an expansion of irrigation areas and an increase in hydropower production. However, as noted before, there are power asymmetries between those actors directly contributing to economic development (e.g. agriculture) and those working on environmental conservation. As the Upper Nile is a region of great potential for agriculture and hydropower development, but one that also faces persistent challenges with food and energy security, many actors involved in this research referred to elements of the transformative change narrative, albeit in different ways. Findings of our relational analysis testify to the relative dominance of this narrative, which legitimises centralised steering by the state. For example, the regional Bureau of Finance and Economic Development, as the main executive body of the Growth and Transformation Plan, is the only organisation that features on all seven network maps. These findings align well with accounts of how actors at higher levels mobilise the centralised structure of the network. 'Targets are very ambitious at the national level and then will be pushed down to the districts and regions' (Interview 11). Problems associated with the realisation of the transformative change

narrative were largely framed as 'problems with implementation, from the regional level down' (Interview 17), rather than a matter of policy: 'You cannot blame the Growth and Transformation Plan, it is an implementation problem' (Interview 28).

Integration through collaboration

A second and contrasting narrative focusses on a need for more inclusive approaches to address the complex interconnections between the water, energy, agriculture and environment systems. Acknowledging the limitations of top-down governance approaches, the narrative promotes multi-stakeholder collaboration and community participation. International donor organisations and NGOs, but also the government, have invested in programmes for achieving integration through collaboration, with the Tana and Beles Integrated Water Resources Development Project being just one of many examples. So far, most of these initiatives have involved platforms and forums. Findings from our analysis of the network structure and the relational embeddedness of key actors suggest that these initiatives have given rise to boundary-spanning relationships, but also that these relationships would require strengthening in order to achieve lasting impact. As one interviewee pointed out, 'After meeting it will still remain difficult for the offices to work together […] After a planning session, our partners will be engaged in different activities […] It's a matter of prioritisation, people prioritise issues on what they will be evaluated on, not working together with other organisations' (Interview 4). For collaborative approaches involving diverse stakeholders to become effective in influencing decision-making processes, 'political back up is very critical' (Interview 6). Another informant commented, 'You need to have a big fish that shares the platform' (Interview 24). This again speaks to the reality of a governance system characterised by a centralised decision-making structure.

Silent spots

Our analysis also reveals the existence of 'silent spots' in the public discourse, which we constructed by tracing minor storylines and comments that did not connect to a full narrative, yet hinted the existence of marginalised views on how nexus governance impacts – or, rather, does not impact – on the lives of the many Ethiopians experiencing water, energy and food insecurity. While about 90% of the rural population in the region rely on rain-fed agriculture and the use of traditional biomass energy, some of the immediate concerns of this large share of the population appeared to remain unaddressed. The transformative change narrative envisages a future where large-scale infrastructure development will transform agricultural

practices and provide energy access for all. However, gaps in the current institutional infrastructure for addressing energy needs at the local level can be seen as one of many examples of problems that remain invisible to a governance system that is concerned with large-scale transformative change. 'Most people in the country don't have access to electricity, even so the power lines go over their heads. Instead electricity is exported to Sudan' (Interview 15). Our analysis of the configuration of the energy sector further speaks to the ways in which narratives lead to the creation of certain linkages and organisational structures – and not others.

The narratives we present here are somewhat generic and not conclusive, yet they reflect broader discursive contexts in which actor networks pertaining to nexus governance are situated and from which relationships between actors derive their meaning. The ways in which they are used to inform the governance of the nexus have important implications for which actors get involved, how they relate to one another and what issues are prioritised. Against this background, questions arise about the actual impact of the 'integration through collaboration' narrative as it does not seem to enable a discourse that allows for 'putting the last first' (Chambers, 1984).

6. DISCUSSION

6.1 Nexus governance in the Upper Blue Nile region

Taken together, our findings offer multifaceted insights into the opportunities and limitations of nexus governance in the Upper Blue Nile region. On the one hand, they testify to the power of a centralised governance system that interlocks with a dominant narrative promoting top-down transformative change through economic growth. On the other hand, our findings also reveal relationships within and across domains, governance levels and jurisdictional and geographic boundaries that operate in the shadow of more hierarchical governance structures. Through our three-dimensional analysis, we have identified tensions between attempts at achieving integration through centralised decision-making (for example through the use of an encompassing development plan or the creation of higher-level agencies such as the River Basin Organisation) and initiatives seeking to promote integration through collaboration (for example through the creation of platforms and forums).

While our structural analysis identifies an impressive number of boundary-spanning ties in what we knew to be a political system of strong hierarchies, a closer analysis of the relational

dimension has added nuance to this finding. Many of the relationships created by initiatives in the context of the 'integration through collaboration' narrative were described as weak. Our research has also identified 'silent spots' around nexus challenges relating to small-scale agricultural practices and energy access that despite being of vital importance to those living in rural areas remain largely addressed.

The recent evaluation of the Tana and Beles Integrated Water Resources Development Project confirms our finding that 'the institutional capacity for implementation [of a large-scale integrated approach] was limited' (World Bank, 2017, p. 7). Any attempt to move towards a more integrated governance system would have to be built on what is already in place. Opening up avenues for multi-stakeholder collaboration in a hierarchical system is inherently difficult. A high-level government official summarised his experience in the following way: 'if you involve everybody, it may not work' (Interview 42). While our findings suggest that a strengthening of organisational capacity and existing boundary crossing relationships at the local level would be necessary to overcome some of the inherent contradictions and shortcomings of the current state of overlapping governance systems, such a move would require political commitment, resources and time, which are all in short supply.

It is difficult to predict whether the growing complexity associated with the introduction of nexus approaches will 'open up' new opportunities for nexus governance and participation or instead perpetuate the centralisation of decision-making as incumbent actors seek to affirm their positions and promote sweeping solutions. Tensions between different modes of governance, i.e. centralised steering versus polycentric coordination, are not unique to Ethiopia (Scott, 2017). There is no single optimal solution for dealing with the interdependence between policy domains, resource systems and political structures. Our research confirms empirically there is not one 'but multiple, socially constructed and politically consequential nexuses' (Verhoeven, 2015, p. 361).

6.2 Relational framework

In order to better understand nexus governance and inspire approaches that further prosperity but also protect those who are most vulnerable, we need come to terms with both the complexity and the plurality of relationships that are constitutive of any given nexus. The framework presented in this article is intended to assist in this process. The investigation of

each of its three dimensions opens up a more nuanced perspective on nexus governance. The analysis of *network structure* provides us with an overview of the often complex structural configurations of the actor network(s) constituting a nexus. These structures may be seen as a function of path dependency, as they represent the crystallised outcome of past and ongoing governance processes and related political struggles. Our case study demonstrates the potential of examining the network structure with a view to sectoral as well as political and geographical boundaries, and illustrates how such an analysis can be useful to identify actors of strategic importance. The *relational* dimension enhances our understanding of how key actors perceive and navigate their network. It sheds light on what relationships are perceived to be of value and illuminates how relationships give meaning to past interactions and prescribe rules for future engagements. This takes us to the third dimension, where we examine these meanings in relation to broader policy *narratives* 'through which actors interpret policy problems [but] also situate actors relative to one another' (Turnbull, 2016, p. 384). The ways in which narratives, network structure and relationships interlock may be more or less dynamic but they are not coincidental. 'Networks can gradually change narratives as well as reinforce them – as they bring people together who exchange ideas and strategize' (Leach et al., 2010, p. 131).

7. CONCLUSION

It is one of the challenges of our times to overcome the complexity paradox in nexus research by attending to the diverse, at times fluid but always political understandings that stakeholders have of a given nexus and the relationships that are constitutive of it. Networks arise from interactions that enable or constrain action, but they may be interpreted differently by different stakeholders. Depending on the perspective one adopts, different governance approaches may appear possible or desirable. By proposing a multidimensional framework for investigating the water–energy–food sector as a relational space, we hope that this paper will go some way in enabling research that takes us 'beyond the dichotomy of synergies and trade-offs to understand the nature of [nexus] interactions in more depth' (Weitz et al., 2017, p. 172). The initial findings we have presented in this article mainly for illustrative purposes provide some indication as to how the application of the framework may assist researchers and policymakers in evaluating the relative strengths and weaknesses of specific policies and interventions. In the face of growing demands for water, energy and food, we need to identify solutions for the integration of domain-specific governance systems that are not sweeping but

appropriate. We hope that the framework and methods we have illustrated provide a means of contributing to such solutions.

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Supporting Information: Methodology

In this section we present detailed accounts of the methods used in this research. We have structured this section in accordance with the three dimensions of our relational framework – network structure, relations and narratives.

1. Structural network research: Social Network Analysis

In order to conduct a structural analysis of a governance network, its composition and boundaries need to be determined. In this study, 47 expert interviews, site visits and document analysis were used to devise an initial recall list of 100 organisations from multiple sectors, levels of governance and jurisdictions. A conventional network survey was then conducted to establish how each of the organisations was connected to all other organisations on the list. We also sought to identify relevant organisations that were missing from the initial list. In this way, we relied on the research participants' own knowledge and perceptions to determine the boundaries of the network of organisations involved in the governance of the water–energy–agriculture–environment nexus in the Upper Blue Nile region. This is considered a pragmatic yet robust approach for reconstructing an inter-organisational network (Doreian & Woodard, 1992; Hanneman & Riddle, 2005; Marsden, 1990). Our survey of a total of 85 organisations further collected data on the sectors an organisation was involved in (water, energy, agriculture, environment) and at what level of governance (national, regional, local) the organisation operated, along with information about where in the study area the organisation was active (indicating administrative and/or hydrological areas on a map). The last section of the survey included open-ended questions about the perception of governance problems and how relationships would need to change for improving the governance of the nexus.

The social network survey enabled us to reconstruct the inter-organisational network of each of the four sectors. We then coded the data into a single matrix to identify relationships spanning multiple nexus domains. This dataset of the whole nexus governance network was then visualised using Visone (Brandes & Wagner, 2004) and analysed using the software package UCINET (Borgatti et al., 2002). Our analysis focussed in particular on centrality measures, which allow for the identification of actors in positions of power and influence, and processes of intermediation (Brass & Krackhardt, 2012; Freeman, 1979; Friedkin, 1991), and which assisted us in the identification of seven key actors in the network. A detailed

account of our analysis of betweenness centrality has been published in Stein et al. (2018). In this paper, we present findings of an analysis of weighted degree centrality (Borgatti et al., 2013), which we conducted to identify actors that are influential with regard to multiple nexus domains. Weighted degree centrality takes into account that actors may share more than one relationship with each other. Furthermore, network centralisation was used to assess the extent to which the whole network has a centralised structure (Freeman, 1979). A core–periphery model was then used to investigate the structural characteristics of the governance network as a whole, and how different types of actors are embedded in those structures (Borgatti & Everett, 1999).

2. Relational research: network map interviews

In the second phase of the project, *network map interviews* were conducted with a sample of seven government agencies implementing sector-specific policies at the regional and local levels. The selection of these organisations was guided by the structural analysis conducted in the first phase as well as theoretical considerations, in that we aimed to select actors from different policy domains and governance levels. Groups of three to four high-level representatives of the same agency co-created network maps based on a network map template. The template illustrated their organisation as a small circle at the centre of three concentric circles indicative of the relative importance of an organisation, i.e. the closer to the respondents' organisation, the more important an organisation was perceived to be. The template map was also divided into subsectors representing four policy domains (water, energy, agriculture and environment). Figure SI1 below shows the mapping process and the template map with its four subsectors.

The network map interviews proceeded in three steps. Firstly, interviewees were invited to write on sticky notes the names of organisations in their organisation's network, and to place these notes on the template, while taking into consideration the main policy domain of the organisation and its importance to the ego organisation. Secondly, the interviewees were asked to indicate whether, and in which ways, their organisation was connected to each of the named organisations, through flows of funding, information exchange and collaboration. Interviewees were also asked to identify relationships they considered to be in need of improvement. Thirdly, in the last phase of the interview, the finalised maps were used to explore the quality, content and implications of some relationships in greater detail, followed

by a discussion of how the embeddedness of the organisation affected its operation and ability to coordinate activities with others. The interviews lasted between 1.5 and 2.5 hours.

The semi-structured interview process and template map facilitated comparisons between relationships. As 'boundary objects', the network maps assisted research participants in articulating, reflecting on and verifying responses to questions about their relationships with the different organisations in their network. The narratives elicited during the drawing process provided insights into the meanings attached to both relationships and networks (Jaspersen & Stein, 2018). After the interview, the multiplex network maps were digitised and disaggregated. Figure SI1 illustrates the mapping process on paper along with the network map template. Network maps were analysed in conjunction with associated interview records, facilitating an investigation of the content of different kinds of relationships along with their structural configuration in networks and the meanings attached to both relationships and networks.

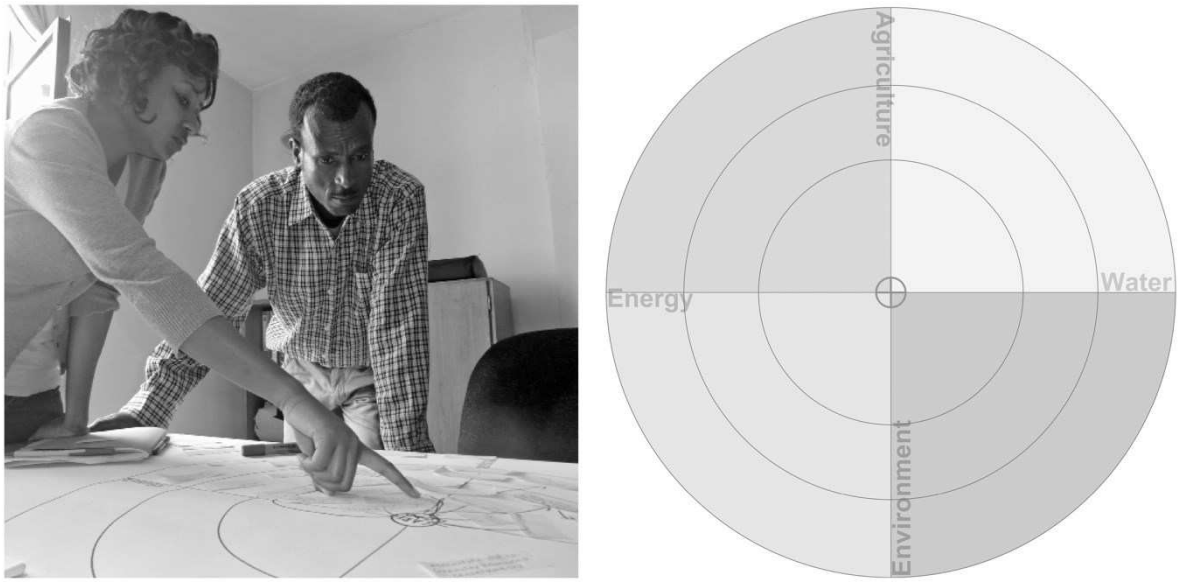

Figure SI1. Discussion during a network map interview (left) and the network map template (right).

3. Narrative research

To identify narratives, and in particular policy narratives, we analysed our initial key informant interviews, network map interviews, fieldnotes, grey literature and the responses to our open-ended questions in the network survey. The material was coded using the QDA

software package Atlas.ti. Codes and initial themes were derived from the research questions and focussed in particular on storylines describing governance problems and solutions as well as actor constellations and relationships. As our analysis progressed and the codes became more refined, memos were created summarising recurring storylines that could be seen as linking up to broader narratives (Saldaña, 2009). Display matrices were used to compare different storylines and narratives (Miles et al., 2014).

In a second step, we then examined more closely which actors articulated, supported or rejected which narratives. The network map interviews in particular provided us with a useful source of data as they allowed us to connect certain storylines and narratives to specific actors and relationships, by jointly analysing the digitised network maps alongside the narrative data in Atlas.ti. Coalitions of organisations appeared as 'collective storytelling system[s] in which the performance of stories is a key part of members' sense-making' (Boje, 2003, p. 43). By triangulating the interview records obtained during the network map interviews with key informant interviews conducted throughout the study and document analysis, it was possible to reconstruct both dominant and incumbent policy narratives through the application of narrative analysis. Narrative accounts were then analysed as devices through which participants make sense of the water–agriculture–environment–energy nexus of the Upper Blue Nile region.

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