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Disaggregating Orders of Water Scarcity - The Politics of Nexus in the Wami-Ruvu River Basin, Tanzania

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ABSTRACT: This article considers the dilemma of managing competing uses of surface water in ways that respond to social, ecological and economic needs. Current approaches to managing competing water use, such as Integrated Water Resources Management (IWRM) and the concept of the water-energy-food nexus do not adequately disaggregate the political nature of water allocations. This is analysed using Mehta's (2014) framework on orders of scarcity to disaggregate narratives of water scarcity in two ethnographic case studies in the Wami-Ruvu River Basin in Tanzania: one of a mountain river that provides water to urban Morogoro, and another of a large donor-supported irrigation scheme on the Wami River. These case studies allow us to explore different interfaces in the food-water-energy nexus. The article makes two points: that disaggregating water scarcity is essential for analysing the nexus; and that current institutional frameworks (such as IWRM) mask the political nature of the nexus, and therefore do not provide an adequate platform for adjudicating the interfaces of competing water use.

KEYWORDS: Nexus, politics, water scarcity, Tanzania, IWRM

INTRODUCTION

In human and economic development strategies water plays a critical role, but which uses of water should be prioritised over others? Is it better to use water resources to generate electricity that may enable small entrepreneurs to start businesses and children to see to do their homework in the evening; alternatively, is it better to prioritise domestic water supplies to the growing urban centres that are driving economic growth and experiencing rapid population growth; or is it using the water to irrigate agriculture that will make a greater contribution to reducing rural poverty (Kadigi et al., 2008; Cole et al., 2014)? Of course, competing uses for water are not mutually exclusive; however, they must be resolved and managed to prevent depletion of water sources and to prevent the marginalisation of those whose needs are weakly articulated, such as small-scale farmers. The process of making these decisions is political, given that it involves the interplay of both real and imagined scarcity and resource entitlements (Allouche, 2011; Mehta, 2014; Scoones et al., 2014).

These are the very real politics of the 'nexus', or the interdependence between water and food and energy systems. Attention to the nexus is gaining increasing policy attention at the international level (Allouche et al., 2015; Muller, 2015). This attention is often framed in technocratic and market-led narratives of natural resources scarcity, and the resultant need to ensure security of access to these, for example emerging from the World Economic Forum (Allouche et al., 2015). There are also some recent attempts to apply the conceptual ideas of nexus thinking to the assessment of river basins (e.g. De Strasser et al., 2016), but so far a nexus approach has not yet been distilled into policy packages for consumption by national governments.

In contrast, the ideas and frameworks of Integrated Water Resources Management (IWRM) continue to dominate at the policy level in many countries. The relationship between the nexus and IWRM is a

close one, but a point of debate (Allouche et al., 2015; Benson et al., 2015; Muller, 2015; De Strasser et al., 2016). The management of water scarcity and competing interests is central to both approaches, but it can be argued that scarcity has not been sufficiently disaggregated or delineated in either (Benson et al., 2015). Disaggregating different dimensions of water scarcity is essential in understanding the political nature of scarcity and how this can be used to assert the claims of one set of users over another (Mehta, 2014; Scoones et al., 2014).

This article is not about how water or land is 'grabbed' by one particular group or another (De Bont et al., 2015; Woodhouse, 2012) but it rather tries to untangle competing claims on surface water by analysing how different dimensions of scarcity are used and how these are linked to the interfaces of the nexus between food, water and energy systems. For institutions to manage the trade-offs required by the nexus they will need to be able to manage and adjudicate competing claims for water. By analysing water use in different hydrological positions in one river basin it aims to contribute to an understanding of how current IWRM institutions are important in both mandate and capacity to resolve these claims, and of how they therefore require reform to allow them to respond not only to the complexity of the water-food-energy nexus, but also to the politics of resource allocation.

Drawing on Mehta (2014) different orders of scarcity are analysed as a way of trying to map the nexus between food-water-energy systems. The settlements are situated at different hydrological points in the Wami-Ruvu River Basin in Tanzania. One is an upstream mountain village above the city of Morogoro, and the other is a large irrigation project on the Wami River on the plains 40 km from Morogoro.

This article investigates the following questions: what are the different orders of water scarcity at two points in one river basin and how do these relate to the nexus of water, energy and food systems; and how do the current institutional arrangements respond to these?

This article is divided into three sections. The first outlines a conceptual framework that draws on the idea of the nexus between food-water-energy, and links this to Integrated Water Resources Management (IWRM). The management of scarcity is critical in both of these frameworks and this article adopts Mehta's (2014) four orders of scarcity as a way of disaggregating water scarcity. The second part then presents an ethnographic description of the two settlements, outlining patterns of water use and disaggregating orders of scarcity. It also examines the management of water scarcity by the institutions tasked with managing the river basin. The following discussion then considers how the current institutional arrangements and limited framing of water scarcity prevent a deeper engagement with the nexus of competing demands on water. It concludes by analysing the implications of disaggregating orders of scarcity and how this analysis may contribute to reforming policy and institutional frameworks to resolve competing demands for water within the food-energy-water nexus.

CONCEPTUAL FRAMEWORK: DESCRIBING THE NEXUS, IWRM AND FOUR ORDERS OF SCARCITY

Dominant policy ideas are not necessarily informed by objective and supposedly scientific evidence but are rather shaped and promulgated as tools for powerful interests and dominant world views (Molle, 2008). Donors are particularly prone to adopting what Molle (2008) calls 'nirvana' concepts which offer simple solutions to complex problems. Integrated Water Resources Management (IWRM) was one such framework that offered the possibility of holistic management of water resources for social, economic and ecological optimisation (Lenton and Muller, 2009). The nexus analysis of food, water and energy systems takes this integration up to a certain level of complexity, given that it crosses more sectoral boundaries and scales (Allouche at al.; 2015; Muller, 2015).

IWRM emphasised stakeholder participation and environmental governance, whilst also emphasising water as an economic good to be paid for by cost sharing. IWRM was influenced by the neoliberal Washington consensus agenda and allowed considerable space for civil society and the

private sector, favouring decentralised and localised management at the river-basin level (Lankford and Hepworth, 2007; Muller, 2015). The role of the state in managing water was reduced and opportunities for private-sector investment were emphasised. The state was given the role of a 'facilitator' and therefore to set out an enabling policy environment that would allow a demand-led approach to the water supply. Management of water at the river-basin level assumes a significant role for local stakeholders in working out fair allocations of water resources through institutions such as Water User Associations (WUAs). The benefits of a participatory and bottom-up approach were assumed to be more likely to be sustainable and equitable (Cleaver and Toner, 2006).

The results of IWRM are now acknowledged to be limited in practice. Opportunities for the private sector were not attractive and the justification for management at the river-basin level was very weak (Muller, 2015). IWRM at the river-basin level was diagnosed, by some, as being top-down and enforcing certain prescribed principles and planning modes, particularly the creation of water users associations (WUAs) (Lankford and Hepworth, 2007; Molle, 2009). Conversely others have suggested that IWRM led to over-decentralisation and too much localised management, with a lack of strategic planning and opportunities for capture of the localised elite (Bartley et al., 2008; Brown, 2013; Cleaver and Toner, 2006; Madigele et al., 2015).

Muller argues that nexus analysis might help in moving beyond the failure of IWRM (Muller, 2015). He argues that frustration from business interests with the results of IWRM in resolving practical problems of water supply to critical sectors such as hydropower electricity generation and agriculture led to the 2008 World Economic Forum focus on the nexus between water, food and energy systems. The idea of a water-food-energy nexus has emerged from separate strands of analyses that sought to examine the connection between (a) food security and water scarcity and (b) water and energy. The nexus concept allows us to explore practical problems and to reveal competing demands. However, Bart points out that it is nothing new and is a tension that played out in early hydraulic civilisations and in state planning in Central Asia in the former Soviet Union (Bart, 2013). However, the nexus takes us back to the possibility of a state or regional role in planning the management of water resources (Soderbaum and Granit, 2014). Therefore, it is a pragmatic response to disappointing outcomes. However, it is not a complete response to the need to achieve water resources management that can balance social, economic and ecological requirements.

Others see the nexus of food-energy-water as framed in an international discourse on threats to water, food and energy security. This discourse is given urgency through concerns over climate change (Allouche et al., 2015). They note the World Economic Forum (WEF) interest in vulnerabilities in natural resources systems where WEF uses a formulation of the nexus that emphasises market mechanisms as a solution to resource scarcity. This perspective also enables the argument that water should be shifted away from low-value production in agriculture and reallocated to high-value production of energy and manufacturing. Alternatively, nexus thinking with the plasticity of all nirvana concepts (cf. good governance) can be adapted to suit other agendas and can also be called into service in meeting the Sustainable Development Goals and the efficiency-carbon reduction imperatives of green economy discourse (Hoff, 2011).

Allouche et al. (2015) argue there are four major shortcomings in nexus thinking: firstly, the illusion of newness (given the similarity to IWRM and historical attempts to integrate food, energy and water systems); secondly, that food, water and energy policy and institutions exist in silos and resist integration; thirdly, that the politics of knowledge in framing global scarcity results in a framing of scarcity as one of economics and technology rather than of inequality of access; and fourthly, a lack of consideration of the limits of optimisation (the food-energy-water nexus is not an equilibrium system – resource allocation cannot be easily quantified and balanced). The issue of how water scarcity is framed is critical to this article. Water scarcity can be framed by different agendas: the needs of a community of smallholder farmers using irrigation to increase agricultural production are not the same of an industry struggling with production problems from an expensive and unreliable energy supply. Water

scarcity has many dimensions. Scarcity can be created through many competing uses for the available resources; but the management of competing use is inherently political as it involves judgement on whose use is prioritised. Without understanding the politics of water scarcity, we risk marginalising those who are least likely to be able to articulate their needs.

Table 1 below shows a comparison of the nexus approach and IWRM. Two potentially important differences emerge: the issue of scale moving from a focus on the river-basin level to multiple scales; and also in relation to resource use with the noticeable loss of focus on equitable allocations under the nexus approach. In this regard Dupar and Oates (2012) warn that nexus thinking might lead to commodification of short-term gain and the marginalisation of those whose water use is judged as inefficient or harmful.

Table 1. Comparison of nexus and IWRM (taken from Benson et al., 2015: 762).

	Nexus	IWRM
Integration	Integrating water, energy and food policy objectives	Integrating water with other policy objectives
Optimal governance	Integrated policy solutions Multi-tiered institutions	'Good governance' principles
Scale	Multiple scales	River-basin scale
Participation	Public-private partnerships – multi-stakeholder platforms for increasing stakeholder collaboration	Stakeholder involvement in decision making Multiple actors, including women
Resource use	Economically rational decision-making Cost recovery	Efficient allocations Cost recovery Equitable access
Sustainable development	Securitisation of resources	Demand management

This table is somewhat limited as it does not fully illustrate the different scales of the two approaches. However, the Table suggests that neither the nexus approach nor IWRM deals satisfactorily with the contested politics of resource use. The nexus approach suggests 'economically rational decision-making', whilst IWRM prefers 'efficient allocations'. Both economic rationality and efficiency involve decisions of measurement and judgement. Who defines what is economically rational and efficient? A more political analysis is required to deconstruct narratives of scarcity and to analyse how decisions over efficient allocation, and economically rational decision-making are framed by assumptions already embedded in policy. Similarly, political influences on water pricing also influence how cost recovery is constructed. Deciding what is an 'efficient' allocation of water or what is 'economically rational' has a political dimension.

It is problematic to view water scarcity as just a physical problem of insufficient rainfall or capacity of river water. Water is inextricably linked to livelihoods and well-being. Volumetric and physical measurements of access to water inadequately value the social, productive and cultural values of water. Water scarcity and policy are both socially constructed to some degree, although this is not to deny that there are physical, economic and adaptive elements to scarcity. However, these can often be used to dismiss or hide politically constructed scarcity. Swyngedouw (2006) argues that constructed scarcity can be used to make markets seem inevitable. For example, Mena-Vasconez et al. (2016)

contrast community-embedded water rights with more individualised government granted permits. Their evidence from Ecuador argues that since the 1990s the government attempted to introduce market mechanisms for water allocation, but now in response to social movements which helped to get the current government elected there is a push to strengthen social and livelihoods-based rights. Popular protest in 2015 was a result of the belief that government was wrongly prioritising water for commercial growing of lowers rather than water for food production. Reallocation of scarce water from small farmers to agribusiness is also the theme of De Bont et al. (2015) in relation to agribusiness in Tanzania. This view of political scarcity shows how more powerful interests can use scarcity narratives to justify reallocations of water that favour their 'more efficient' activities and therefore potentially create a justification for reallocation (Scoones et al., 2014)

Mehta (2014) argues that water scarcity can be viewed in multiple ways and that these impact on the policy measures suggested for resolving competing uses of water. She suggests four ways that water scarcity can be viewed: first order/physical scarcity which focuses on volumetric quantities; second order/economic scarcity, which focuses on institutional and infrastructure arrangements through economic pricing and technological innovation; third order scarcity/adaptive capacity, which considers the social and economic context for water use and seeks to build a systemic adaptive capacity; and fourth order/sociopolitical scarcity which views scarcity as a discursive political process and therefore anticipates deliberative decision-making processes and assessments of entitlement as potential solutions. Table 1 highlights how nexus thinking and IWRM are rooted primarily in first (physical) and second (economic) order scarcity. IWRM might also constitute third order scarcity in its focus on adaptive capacity to balance economic, ecological and social needs. In this sense, it has a discursive element, but the application of the approach along a river basin misses wider political narratives. Neither approach explicitly integrates dimensions of sociopolitical scarcity; however, nexus thinking pushes us to think more closely about the political dimensions of competing uses for the same resource.

There have been significant difficulties in the implementation of IWRM in resource-poor contexts through river-basin offices. Lankford and Hepworth (2007) show that in Tanzania the river-basin offices have very little hard management data (on first order scarcity) and that this prevents the implementation of the IWRM regulatory model. Whilst they recommend adaptive dialogue-based systems as a solution to this, Allan and Curtis (2005) argue that adaptive management as a way to deal with complexity and uncertainty can be thwarted by social norms and rigid institutional frameworks. Natural resources management culture tends to value control and clarity over reflection, learning and embracing variability. The lack of physical data on river levels and on water use is an issue noted in different parts of Tanzania by Komakech et al. (2012), Kangalawe (2016), and in this paper. Therefore, managing and controlling first order (physical) scarcity is very difficult for river-basin authorities in this position. With no capacity to manage even first order physical scarcity, then setting appropriate economic costing to deal with second order scarcity, to build adaptive capacity to deal with third order scarcity or orchestrate deliberative and polycentric governance (as suggested by Lankford and Hepworth, 2007) solutions to deal with political fourth order scarcity are unlikely.

River basins are complex and nonequilibrium systems and therefore cannot be managed as if they were in a steady state. Rainfall and river levels vary and extractive demands change over time. Lankford and Beale (2006) make the case for basin-level management that can negotiate variable extraction levels, but that can also respond to the needs of local users. They note the need for the basin-level management to keep a view of intra-basin resource-sharing issues that may disadvantage the less powerful. This is where the nexus helps us to think through multiple scales and interfaces of competing claims for water use. Ultimately, there may be a case for higher-level political engagement over resource allocations (Madigele et al., 2015; Mena-Vasconez, 2016) with the state setting some priorities

as a framework for negotiating fourth order scarcity.[1] Responsibilities for managing aspects of first to third order scarcity could then be placed in the hands of appropriate institutions. As in the case of Ecuador, the state framework for water allocation priorities is influenced by the nature of the current political settlement. The point is that sociopolitical scarcity needs to be addressed before flexible and appropriate decisions on third, second and first order scarcity could be made.

DISAGGREGATING ORDERS OF WATER SCARCITY: TWO ETHNOGRAPHIC CASE STUDIES IN TANZANIA

Two ethnographic case studies allow us to explore different orders of water scarcity and positioning with the nexus through the analysis of public narratives around water access and scarcity. The idea of 'public narratives' captures what are collective framings of issues or experiences and what can and cannot be said (Lawler, 2002; De Bont et al., 2015). The type of narratives constructed reflect positions of power and positioning and are therefore helpful in trying to understand narratives of water scarcity framed by different actors. In addition, our fieldwork also took a historical perspective to nuance and contextualise current claims over water resources that extend over many decades (Walsh, 2012; Cliggett, 2014). The fieldwork also allowed us to explore the operation of existing water allocation and management process in the river basin.

Fieldwork was conducted in two sites in the Wami-Ruvu River Basin over a period of nine months from June 2013 to March 2014. The two sites are Choma in the Uluguru Mountains above the urban Morogoro Municipality, and Dakawa on the lowland plains and the site of a former state rice farm. The sites were chosen to reflect different hydrological positions in the river basin but both demonstrated tensions over water extraction between different user groups. In both sites, interviewees were selected from identified stakeholder groups (farmers of both genders, small-scale farmers, commercial farmers, WUA staff, local politicians and bureaucrats, river-basin office staff, NGO staff and donor staff working on related interventions). A total number of 75 key informants were interviewed over several repeat visits. A small survey of 100 farmers was also conducted in each location (total 200) which covered basic descriptive information on landholdings, water access and agricultural activities. A number of small group discussions were conducted with farmers in relation to the financial aspects of their agricultural activities. At the district levels, interviews were also conducted with Morogoro Municipality Council, Morogoro Urban Water and Sewage Authority (MORUWASA), Mvomero District Council, Sokoine University of Agriculture (SUA) and the Wami-Ruvu River Basin Office (WRRBO).

As much as possible semi-structured interviews were combined with direct observation as well as more unstructured discussions. The majority of interviews and other interactions were conducted in Swahili and translated into English.

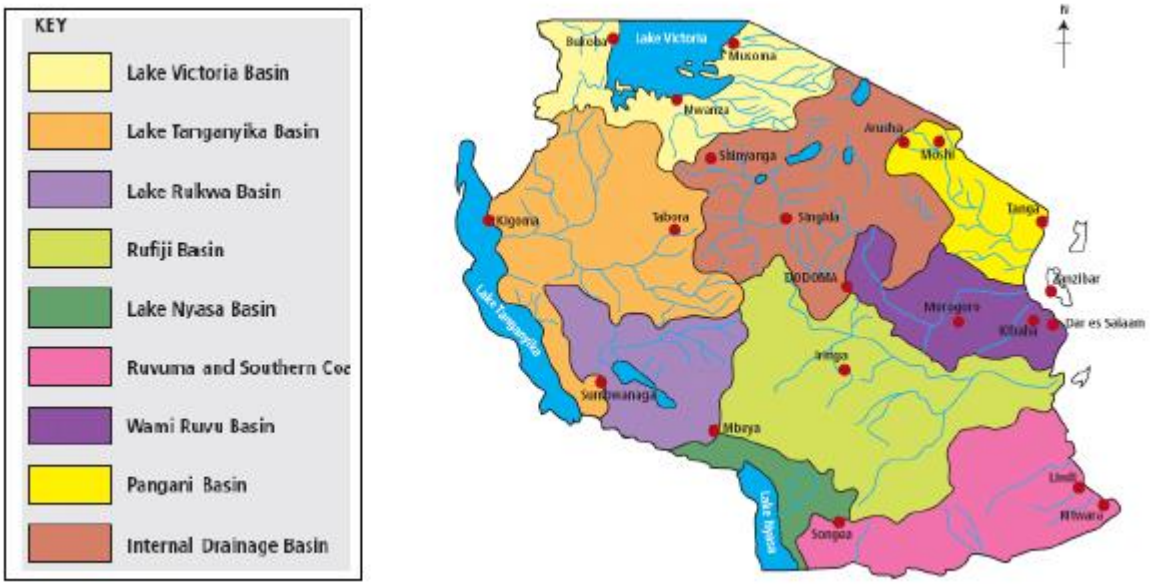
TWO INTERFACES IN THE WATER-ENERGY-FOOD NEXUS IN THE WAMI-RUVU RIVER BASIN

The 2002 Tanzanian Water Policy fully adopted the principles of IWRM (URT, 2002; Lein and Tagseth, 2009). This policy is now underpinned by the 2009 Water Resources Act and sets out procedures for the allocation and protection of water resources. A recent assessment of IWRM in Tanzania suggests that the main beneficiaries of its adoption have been large commercial and private interests, whilst smallholder farmers have lost out (van Koppen et al., 2016). The Wami-Ruvu River Basin is one of nine river basins in Tanzania, as shown in Figure 1 below. It was formally established in 2002. A River Basin Board has the responsibility of protecting and allocating water resources within the river basin (Maganga, 2003; Komakech, 2013). The River Basin Board has statutory responsibility for awarding

[1] This paper does not explicitly cover water rights but a number of countries have set volumetric rights to water allocations – these include South Africa and Tanzania.

water rights for extraction through the issuing of permits to individuals, companies and water user associations (URT, 2009a). The process of creating and registering WUAs has been the main operational challenge and is far from complete (Komakech, 2013). The Act does accommodate customary institutions and informal water use but not without application for a water use permit. The 2009 Irrigation Policy makes it clear that customary arrangements are to be 'modernised' (URT, 2009b) through formalisation. When a permit is issued, a payment is made for the water based on an estimated volumetric extraction from the source. Assessments of the Wami-Ruvu River Basin Board and Office suggest that its activities have been severely constrained by a lack of resources, and this has led to a situation where more powerful interests can easily manipulate official processes to access water, whereas the water use of less-powerful and customary water users has been rendered illegal (van Eeden et al., 2016; van Koppen et al., 2016)

Figure 1. Map of the nine River Basin Offices in Tanzania.



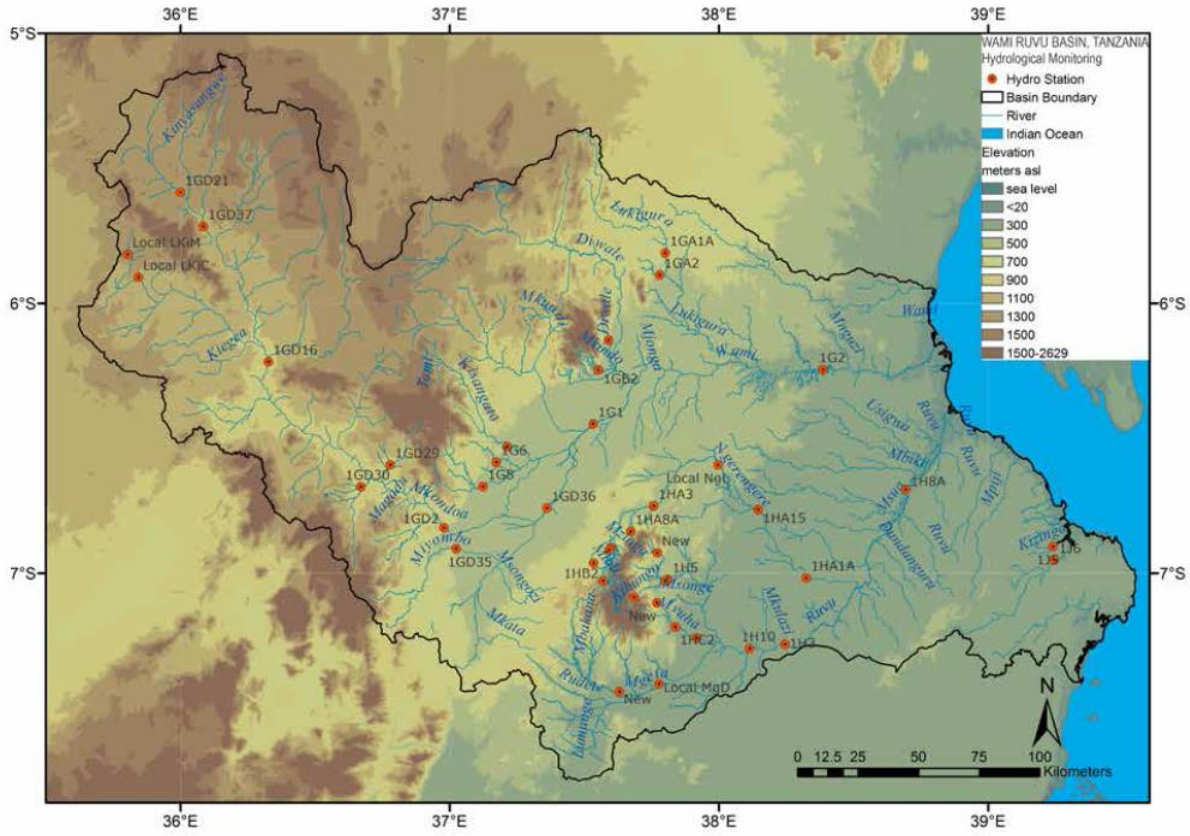
Source: WWF, 2007.

Although Tanzanian water policy is based on an IWRM approach, a brief consideration of the nexus between food, water and energy systems at a national level is necessary for framing patterns of water demand. Tanzania has experienced rapid economic growth over the last decade, and the hub for much of this growth is the coastal port of Dar-es-Salaam (Kessy et al., 2013). Hot, humid and coastal, the rapidly growing city is thirsty, not only for cooking and washing for the expanding population but also indirectly for water to generate electricity and to grow the food to keep the populations fed (Smiley, 2016). It is where the politicians, business leaders and the donors live, and there are lawns to be watered and swimming pools that must be filled, and homes and offices demanding that the lights stay on. Secondary cities of Dodoma (the capital but secondary in terms of size) and Morogoro also expose the same tensions in the nexus. They are also growing and demands (both physical and political) for water are growing. The Ruvu River Basin, starting in the Uluguru Mountains above Morogoro, is expected to contribute much of the multiple water needs of Morogoro and Dar-es-Salaam (personal comments, Professors Hella and Tarimo-Sokoine University of Agriculture).

The Southern Agriculture Growth Corridor in Tanzania (SAGCOT) is a major government-donor initiative, launched by former President Jakaya Kikwete at the World Economic Forum in Davos in 2011. Framed by a model of agricultural modernisation, it sees transformation potential by agribusiness that will contract small-scale farmers as producers (Cooksey, 2012; van Eeden et al., 2016). It encompasses much of the Wami-Ruvu River Basin and will demand water for food production and potentially electricity to drive extraction of water from rivers and below ground. There is therefore clearly a gap in analysis of the nexus between water and food in the Wami-Ruvu River Basin. The cases in this research allow us to illuminate this further. One is the Dakawa Rice Farm, an irrigated rice farm of 2000 hectares (ha), and the other a mountain village of smallholder famers using gravity-fed hosepipes for horticultural production. Both cases reveal the value of applying a sociopolitical analysis to how the narratives of scarcity are constructed. This analysis further reveals problems in how the current institutional frameworks to respond to socialpolitical questions.

The Dakawa Rice Farm (point 1G1 on figure 2) is a former state rice farm, built by the North Koreans in 1981 (Chachage and Mbunda, 2009). The parastatal owner NAFCO collapsed in 1996 but Dakawa Rice Farm was unused for the decade from 1986 to 1996. From 1999, the Parastatal Sector Reform Commission ordered that the farm be handed over to Dakawa village council. It was then taken over by the 'group of 6' – regional figures from Army and Police in collaboration with the Village Council. There were no limits on individual landownership but there were lots of reported manipulation over water access. "Some big shot could just call up from Dar and demand that their plot be watered first" (Farmer Interview – Dakawa, November 2013).

Figure 2. Map of hydrological monitoring stations and topography of the Wami-Ruvu River Basin.



Source: FIU-GLOWS, 2014: 83. In this Figure, there's a scale but not a directional symbol showing North.

In 2003, the Regional Commissioner ordered that the farm be divided between the then Village Council, Government Officers (including the Chollima Rice Research Institute based in Dakawa) and the organisation led by the group of 6 (DAKOP). This led to the collapse of DAKOP and the emergence of UWAWAKUDA (Swahili acronym meaning the Association of small irrigators in Dakawa). Throughout the period from 2003 to 2012 there continued to be political disputes over leadership and control of UWAWAKUDA, continuing allegations of political interference in land allocations and access to water. In 2012, the Director of Chollima Rice Institute who is also a state employee was installed as Chairman and the USAID NAFAKA project started operations supporting productivity improvements. Landownership was limited to 12 acres per individual. Twelve acre blocks could also be leased by groups of small farmers who have their own internal sharing arrangements (these can be problematic if sharers want water at different times). In practice, richer absentee farmers registered multiple blocks in the names of family members.

Dakawa Rice Farm is an 'aid hot spot' and has been the site of renewal by a succession of donors over the decades, with the latest phase funded by USAID under the Feed the Future initiative. Its canal irrigated land of 2000 ha is currently farmed by an association of almost 1000 farmers, with water extracted by pumps from the Wami River. The flow of the river has never been sufficient to operate the scheme at full capacity, and the pumps only operate in the rainy season (March-May); otherwise, they become clogged with sand and cannot operate at other times of the year. The leaders of the irrigators association (UWAWAKUDA) blame upstream extraction by other large-scale landowners and demand that the WRRBO do something to control this. A neighbour of the rice farm is a Chinese agricultural research and teaching station of 60 ha. Built in 2010 it is home to several Chinese agricultural scientists and has the aim of sharing knowledge on production techniques and testing Chinese varieties of maize, rice and vegetables in Tanzania. Pictures of a smiling President Kikwete opening the centre adorn the walls. The Head of the station is frustrated: two Ministers who promised that the Government of Tanzania would provide water from the Wami River have come and gone without delivering. In frustration he has sunk two small boreholes and they farm a fraction of the land, selling their produce to the growing number of Chinese restaurants in Dar-es-Salaam.

Choma (at about 1000 m elevation above point 1HABA in figure 2) is a small settlement on the steep slopes of the Uluguru Mountains. Administratively this is a street (mtaa) of Morogoro Municipality, but the local government officials do not like to venture up here, as it is difficult to reach (without a vehicle) and they fear witchcraft. It is only accessible on foot, although the villagers are building a track for motorbikes so that they can more easily move their horticultural produce to the markets in Morogoro. The WaLuguru people have lived on the Ulugurus since at least the 17th century, and since the creation of the Uluguru Nature Reserve under German Occupation have lived in a state of tension with the local authorities, accused of deforesting and eroding the steep slopes (Ulvila, 1995). They are now accused additionally of extracting too much water. The Morogoro Water and Sewage Authority (MORUWASA) has less water than it needs to supply its customers and water rationing is common from October to March. This led to an attempt in 2006/7 to evict the Choma residents (and others from surrounding areas) and settle them in the lowlands. The attempt to resettle farmers failed due to political pressure and a lack of funds to pay compensation. Residents were told that they could stay as long as they adopt 'environmentally friendly' production including no farming within 60 m of the river (Kusulika et al., 2011). The WaLuguru like other mountain dwellers in Tanzania use irrigation furrows managed customarily through social relationships, kinship and land allocations. This has evolved in the last decade through the use of hosepipes spread like spaghetti around the edges of the steep slopes. These hosepipes feed low pressure sprinklers in small plots and enable the production of a wider range of high-value horticultural produce. Particularly notable is strawberry production with the fruits being sold in Morogoro, Dar-es-Salaam and Arusha using the interregional network of buses.

Since 2010 a local NGO has been working with the farmers to promote an agroecological approach to agriculture and to provide market access. Farmers see the benefits of terracing high-value

horticultural production and started more actively building terraces and practising organic agricultural techniques (Wostry, 2014). There have also been less successful donor-funded projects attempting the introduction of payment for environmental services (PES) with the farmers (Lopa et al., 2012). This research suggests that such schemes were not sustained and were not valued by farmers in Choma.

Table 2 attempts to disaggregate orders of water scarcity that are at play in these two locations. Data used in the construction of the Table 2 is drawn from the survey data and key informant interviews in both locations. Points of interface with food and energy systems are also highlighted. This Table is not exhaustive but is used as illustrative of how such analyses may help to describe the interfaces of the nexus, as well as providing a more nuanced framing of water resource scarcity and the limitations of current IWRM policies and institutions.

Table 2. Disaggregating scarcity in Choma and Dakawa.

	CHOMA (above 1 HABA on Figure 2)	DAKAWA (1G1 on Figure 2)
Location: key features	Settlement in a hillside location on the slopes of the Uluguru Mountains, above Morogoro. Steep river valleys with fast flowing mountain rivers.	40 km from Morogoro, on the lowlands. Dakawa is both a settlement on the Wami River and the site of a 2000 ha rice farm drawing people from this settlement and further afield to cultivate rice.
Irrigation practices and livelihoods	Hosepipes and gravity-fed sprinklers to grow vegetables and fruit; water from streams that feed the Morogoro River. Male and female farmers with land in proximity to rivers can produce high-value crops such as strawberries. A polycropping system exists that uses the produce for home consumption and for sale to urban centres. There is a positive impact on livelihoods from adoption of agroecological techniques (Wostry 2014)	Canal irrigation to grow rice, with water pumped from the Wami River. Due to USAID intervention under the NAFAKA programme rice production has doubled or even tripled in some cases. However, between 2012 and 2013 the farmer-reported price of rice on the local market halved. The farm has problems in marketing and selling rice and the management is looking for further donor investment in this.
Reported dimensions of scarcity from fieldwork	First order (physical) scarcity – Rainfall to Ulugurus increasing (FIU-GLOWS, 2014). Farmers report enough water throughout the year. MORUWASA estimates a shortfall of 4000 m^3 per day to meet needs of customers in urban Morogoro (Wostry 2014). Farmers' use of water is unmeasured but assumed to be contributing to the shortfall in supply. MORUWASA is benefiting from Millennium Challenge Funding to build technical capacity and water infrastructure www.mca-t.go.tz/en/about-us-v15-70/vision/projects-v15-96/the-water-sector.html	First order (physical) scarcity – all actors agree there is insufficient water in the Wami River for year-round production, which is attributed to two reasons: declining lowland rainfall (confirmed by FIU-GLOWS 2014) and increasing upstream extraction – agribusiness, large individual landowners (national and regional politicians, civil servants and business people).
	Second order scarcity (economic) – no cost water access to farmers (they see it as their water). Farmers are actively resisting incorporation into a WUA. WRRBO has a mandate but no resources to form WUAs. Sources in WRRBO stated that the 2009 Water Resources Act mandates the issue of a permit to one intake. They argued this could not be	Second order (economic) scarcity – issue of permits by WRRBO to official users and WUAs. Payment based on estimate of volumetric use but is not monitored in practice as there is no capacity to do so. Within the Dakawa rice farm each farmer in DRO pays Tsh60,000 (£20) per acre per year (2013) for access to water. This is inadequate to cover cost of

	done for multiple tiny intakes from hosepipe irrigation.	electricity to run the pumps, which is subsidised by donor inputs to UWAWAKUDA. Farmers fear if the cost is pushed higher then production will no longer be profitable.
	Third order scarcity (adaptive capacity) – Since 2006/7 Farmers have been told to adopt environmentally friendly agriculture (no production within 60 m of rivers and building of terraces). Since 2003 farmers have been adopting hosepipes as more efficient and labour-saving than furrows. Farmers practise customary water-sharing arrangements and report no internal conflict.	Third order (adaptive capacity) scarcity – minor attempts to improve efficiency of water use through canal cleaning. Project to replace existing pumps with more energy-efficient ones (failed for contract reasons). No interactions with other water users but blame upstream users for over-extraction. Deliberative river-basin management does not appear to be in operation. Management of the scheme has a troubled history. Now managed by a water user association water-sharing arrangements have improved but conflict is still present.
	Fourth order scarcity (sociopolitical) – WaLuguru Farmers believe that the name of their ethnic group comes from the sound that water makes in rushing down the mountainside. They believe that they cooperate harmoniously to manage water, and in recent years have seen improvements in their livelihoods through greater opportunities to market their produce to urban consumers. They recognise the value of agroecological production and many are adopting low-input organic production. Due to the nature of the terrain it is very difficult to practise irrigated production without infringing the 60-m rule.	Fourth order scarcity (sociopolitical) – Donors and Government are interested in the commercialisation of agriculture under the SAGCOT initiative (aims to bring in private capital and stimulate contract farming) and USAID's Feed the Future (increasing the productivity of small-scale farmers). Reported land acquisitions by political and business class occurring along the Wami River and increasing extractions are seen to be impacting the river level. There is no monitoring of actual water use. WRRBO admits to lacking capacity to monitor water use and to be unable to resolve issues around competing demands for extraction.
	Urban areas demand water. Morogoro and Dar-es-Salaam have greater domestic demand and supply for both water and electricity generation and consumption. Small farmers are identified as problematic and causing environmental damage to water sources. Resettlement identified as 'best' solution but not implemented due to lack of funds for compensation and political pressure. Large dwellings on lower slopes and large institutions such as universities (SUA and Mzumbe) and the army (Mzinga base) identified as problematic but WRRBO lacking resources and political capital to challenge their water use.	*"We just sell water" WRRBO official.* The National government appears to have no strategic plan to adjudicate on water extraction or consider limits, e.g. in the encouragement of the Chinese Agricultural Research station to be located in Dakawa but without consideration of water availability. Cost of electricity to run pumps to extract water from the Wami River for the Dakawa Rice Farm is prohibitive and cannot be covered by farmer contributions. Although farmer productivity has doubled or tripled the illegal importing of rice (Therkildsen, 2011) is supressing the price of local rice and production profits have stagnated or declined.

DISCUSSION

Table 2 shows the complexity of starting to disaggregate orders of scarcity to map the interfaces of the food-water-energy nexus. The examples given highlight the degree to which water, food and energy

systems interact with each other. The cases shown here are for illustrative purposes. They show how water scarcity is differentially constructed according to the lens through which we choose to examine it.

The Tanzanian state has set out priorities for water use, in that domestic consumption is to be prioritised over other productive uses such as agriculture and this has already led to smallholders' water use being rendered 'uneconomic' (van Koppen et al., 2016). Komakech et al. (2012) show how agriculture is assumed to be a low productivity use of water and water for urban centres is prioritised. Water is therefore drawn to the cities. Their observations of this relate to the Pangani River Basin and the city of Arusha, but we can also see this situation playing out in Choma. It also applies more broadly to the pressure for the Uluguru Mountains to provide the water for Dar-es-Salaam (for power generation and domestic consumption) but with a potential cost for the farmers who currently live on the mountains. Should these farmers be moved in the name of progress? Yet the farmers in Choma are also effective small producers of high-value horticultural crops, and have shown a willingness to adopt agroecological practices (Wostry, 2014). They risk impoverishment if they are forcibly moved. The institutions of the state operate under IWRM principles, but the WRRBO claims that it does not have a mechanism to even talk to the farmers in Choma. It can only recognise them if they organise themselves to become a WUA. The farmers on the other hand see no benefit in doing so; they will then have to pay fees for water extraction and will only be allowed one intake from the river rather than many. The WRRBO suspects that first order water scarcity is not only the fault of the small farmers, but is also due to large institutional users (e.g. the Mzinga Army Base extracts water for large irrigated production of rice and tomatoes), but it finds these other stakeholders problematic to engage.

In Dakawa, we see a different interface of the nexus. There are an increasing number of agricultural operations and large-scale farmers who want to use the water from the Wami River (van Eeden et al., 2016). The Tanzanian government wants to encourage production of staple crops for the urban markets and for export (Therkildsen, 2011; Manjengwa et al., 2014). Donors are supporting this through investments in schemes such as Dakawa, through which they also hope to benefit small-scale farmers through collective farming ventures. The Wami has insufficient water to satisfy the needs of all those who currently want to use it, as is evidenced by the frustration of the Head of the Chinese Agricultural Research Station. Dakawa Rice Farm cannot run at full capacity as the level of the river is only sufficient to extract water in peak flow (March-May). With USAID investment, production at Dakawa has at least doubled for many farmers and yet as a model the farm may not be viable or sustainable. The cost of electricity to run the pumps that extract the Wami is prohibitive and is not covered by the fees paid by members of the Dakawa Rice Farm, and in 2013 the price of rice halved, leaving farmers no better-off than before the increase in production.

Both of these cases also show the limitations of IWRM in practice and the scale of the institutional reconfiguration that will be required to resolve different tensions in the nexus between food, energy and water. WRRBO has very limited capacity or institutional mechanism to resolve these issues in practice. In the case of Dakawa and the Wami River, they have issued permits to users of many scales but have no capacity to monitor their actual extractions of water. All they can do is sell water permits, and fine those who are extracting water without one. In Choma, WRRBO has no mechanism to engage with informal and customary water users. It cannot sell them a permit without formalisation and it does not have the capacity to support the formalisation process. As a technocratic institution charged with protecting and allocating water resources it has no language or mandate with which to even consider different orders of water scarcity and how they relate to interfaces of the nexus.

It is very clear that the IWRM institutions (the River Basin Office) lack the capacity and remit to be able to make these choices, as they link issues from the micro to the macro levels. To reduce poverty, different orders of scarcity must be disaggregated and taken into account. Water for domestic consumption, and also for irrigation for small-scale farmers must be priorities. However, for rural households, water for domestic use and water for consumption may come from the same water source. The urban areas cannot expect to extract more than a fair share without considering what that urban

water is being used for: does filling a hotel swimming pool or watering an office lawn take priority over subsistence farmers who are lucky enough to have land close to a water source? Should irrigated large-scale agriculture be given permits to consume large volumes of water if the crops they produce are being subsidised by donors due to the prohibitive costs of electricity to extract the water?

CONCLUSION

This article argues that IWRM and current nexus thinking is insufficiently political, and may result in the masking of the political construction of narratives of water scarcity, efficiency and rational decision-making. Our analysis used Mehta's (2014) four dimensions of water scarcity to work through two case studies at different hydrological points of a river basin. This illustrates several issues:

The institutions of IWRM operating at the river-basin level are unable to resolve the sociopolitical dimensions of policy. These issues go beyond the river-basin level and link directly to national policy dialogues and implementation. There is a clear variance between the content of policy frameworks and how such frameworks are implemented in practice. This is not necessarily a wilful subversion of policy but reflects a lack of resources and capacity within the organisations tasked with river-basin management. These institutions cannot deal with issues of wider hydropolitics as they have no jurisdiction to do so.

Disaggregating water scarcity illuminates competing demands in the water-energy-food nexus. This reveals different interfaces of the nexus and highlights the complexity of the challenge of managing these competing demands. In a sense the nexus analysis reveals the issues that IWRM institutions face. Therefore, one potential step is for IWRM to more explicitly integrate a nexus analysis. However, as our approach shows an explicit disaggregation of water scarcity (with emphasis on sociopolitical framings) has value in resolving some of the criticism of both IWRM and nexus.

As Allouche at al. (2015) note, to treat nexus as only a technocratic and efficiency optimisation problem risks that political framings of water, food and energy scarcity will be downplayed.

Who will make these choices? They involve fundamental questions of resource allocation and prioritisation. These choices are both technocratic and political; and there are no easy answers. Negotiating the nexus will demand deliberative and reflexive actions that can respond to the complexity of the nexus interfaces. The interfaces of the nexus will also shift, for example as new sources of energy generation are adopted.

Adopting a disaggregated approach to water scarcity will therefore necessitate a change in the institutional framework. IWRM and nexus are not so significantly different that they could not be integrated and extended to incorporate a more sociopolitical analysis. This will also require greater strategic leadership at the national and international levels.

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