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Technical Veil, Hidden Politics: Interrogating the Power Linkages behind the Nexus

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ABSTRACT: The nexus is still very much an immature concept. Although it is difficult to disagree with a vision of integration between water, food and energy systems, there are fewer consensuses about what it means in reality. While some consider its framing to be too restrictive (excluding climate change and nature), particular actors see it as linked to green economy and poverty reduction, while others emphasise global scarcity and value chain management. The nexus debates, however, mask a bigger debate on resource inequality and access, contributing to social instability. Indeed, the market-technical framing of the nexus by the World Economic Forum, located in international business imperatives and global neoliberal policy hides political issues such as inequality, the manufacture of scarcity and international political economy and geopolitics. By addressing these, we then propose a new framing of the nexus.

KEYWORDS: Nexus, scarcity, politics, technology, systems approach

INTRODUCTION

Nexus is the 'new kid on the block' in the development discourse since 2008, and international and national agencies and academics are in a stage of adjustment. It is hard to disagree when the international business elites of the WEF community argue that there are important linkages between water, food, energy and climate change. Or when the German government argues that policy makers need to pay more careful consideration to the trade-offs between these different resources. Or when Jeffrey Sachs highlights the need for a policy convergence between climate change and development debates, flagging the importance of interlinkages between water and energy sectors in framing the post-2015 development agenda in a UN General Assembly thematic debate.[1]

The nexus debate has been articulated by the key actors as one about natural resource scarcity, with a tendency towards a managerial security framing that debates the technical and hides its politics. This discourse is often carried out against a general background of the failure to manage development of

[1] UN General Assembly thematic debate 'Sustainable Development and Climate Change: Practical Solutions in the Energy–Water Nexus', 16 May 2013.

resources effectively or equitably; politicised tensions exist between securing food, water and energy at the local versus national versus global scales, as revealed by studies in global political ecology (Peet et al., 2011). Meanwhile, as recent global crises in food, energy and finance have revealed, resource management has also failed to anticipate and be resilient to painful shocks that ensue every so often.

The concept of the nexus has gained salience as a new vocabulary to define sustainable development, with a proliferation of high-level workshops, seminars and conferences. The Bonn 2011 Conference, the Sixth World Water Forum in Marseilles in 2012, the Rio +20 negotiations in the same year, and the 2014 Stockholm Water Week, all had the nexus as a key topic. New policies and perspective papers from the World Economic Forum (WEF), the European Commission's Report on Development for 2011/12, the Global Water Partnership, and the World Bank amongst others are indicators of that growing interest in the nexus. Despite the buzz in global circles, however, the nexus and the debates around it have permeated relatively less to the level of national governments, as the 'nexus' bureaucracy has not been constructed and enforced yet. On the other hand, amongst the practices of local communities, the relationship between water, food and energy has often not become fragmented in the same way that experts have siloed the sectors in conceptual and policy debates.

Thus, the idea of 'the nexus' has been put forward by a range of proponents – each with his or her own perspectives and agendas – as a new framing of these interdependent problems, demanding new and innovative solutions (see Middleton et al., this issue). Water security remains central to the concept of nexus: food and energy security cannot be achieved without it. Climate change amplifies the significance and interdependence of this dynamic relationship, but is not seen within the nexus discourse as the primary driver for change (Bogardi, 2012). Given the centrality placed on water, debate has emerged within the water practitioners' community as to whether the nexus is replacing or complementing the IWRM paradigm (see Bird, 2014; Muller, this issue; Benson et al., this issue); nexus in these circles has been seen as an attempt to maintain, or at best rebrand, the integrative aspirations of IWRM across sectors, yet provide an entry point on equal footing for those whose primary focus is on food or energy rather than on privileging water as IWRM has been seen to do (Bach et al., 2012). Despite this, nexus is still seen as an initiative emerging principally from the water sector (Allouche et al., 2014).

This editorial argues that the emergence of the nexus needs to be understood according to a particular framing of global resource scarcity with implications for global economic growth. Water crisis is named the greatest global risk in terms of impact in the World Economic Forum's Global Risks 2015 report, with energy price shocks, food crisis and climate change also flagged as global risks (WEF, 2015). More broadly, debates around planetary boundaries and tipping points have implications for resource use and the nexus (Rockström et al., 2009). The emergent framing of the nexus leads to demand-led technological and market solutions that ignore the supply-side limits and political dimensions in terms of control over and access to resources.

This article is divided into three sections. The first section deconstructs and reviews how the narrative of the nexus has emerged and has been framed around efficiency, storage and technology solutions. It critically examines the limits of the concept with respect to the politics of difference, the politics of knowledge and political economy. In the second section, this editorial builds on the articles in this special issue to reflect on a progressive agenda of furthering research on the nexus. Finally, in the third section, we will propose a new framing of the nexus around diverse and multiple food, water and energy designs that decentralise, democratise, and facilitate social and environmental justice.

DECONSTRUCTING THE NEXUS AND ITS POLICY DYNAMICS

The emergence of the new nexus policy paradigm was fuelled by fears linked to the 2007 and 2008 food and energy price shock (Allouche, 2011). The links between the food and energy crisis have been the subject of many debates as one can observe a strong correlation between the price of crude oil and the

UN FAO's Food Price Index. The 2007 global energy crisis, when oil prices increased dramatically, created fear among energy specialists as this oil crisis was demand-led, unlike previous oil shocks, which were caused by sudden interruptions in exports from the Middle East. Many of these specialists at the time predicted that prices would continue to trend upwards. The current collapse of the global oil price and the anticipation that oil prices will remain low for a couple of years have yet to impact on how the nexus debate is framed.

Besides these material shocks that created turbulence in the global economy and had severe consequences for the poor, calls for nexus-framed policy approaches were backed by alarmist scenarios about the relationship between food, energy, water and the climate. The nexus discourse is characterised by metaphors such as the 'perfect storm' to quote John Beddington, the Chief Scientific Adviser to the British Government in 2009. Concerns are linked to predictions which suggest that global demand for food and energy will grow by 50% and for freshwater by 30% by 2030 (Beddington, 2009). The problem is stated to be that the supply side will be considerably affected due to increasing uncertainties caused by climate change and its ecological consequences, and by fast changing socio-economic boundary conditions, including global redistributions of wealth and power, as well as changing flows of people, resources and knowledge (Schmidhuber and Tubiello, 2007; Hanjra and Qureshi, 2010). A global water-food-energy resource scarcity narrative is now becoming commonplace. Announcing a new report in 2011, the UN's Food and Agriculture Organization (FAO, 2011: paragraph 1) claimed: "Widespread degradation and deepening scarcity of land and water resources have placed a number of key food production systems around the globe at risk, posing a profound challenge to the task of feeding a world population expected to reach 9 billion people by 2050".

The 6th Edition of the 2011 Global Risks published by WEF (WEF, 2011b) made apparent that the 'land-grab' phenomenon is a response to a larger structural and correlated global risk to water, energy and food systems (see also Bizikova et al., 2013). Borras and Franco (2012: 37) describe this as a process through which "national governments in 'finance-rich, resource-poor' countries are looking to 'finance-poor, resource-rich' countries to help secure their own food and especially energy needs into the future" resulting in many large-scale land deals related to grains and biofuels, very often driven by transnational corporations and very often with the active collaboration of the host national governments. The ex-UN Special Rapporteur for Food, Olivier de Schutter, has highlighted the risks these investments run in creating food insecurity for the very poor. This could be the dangerous geopolitical consequences of a nexus framing if just looked at from a global perspective. In identifying a particular crisis at the nexus, a space for appropriation is opened up, often linked to a partial enclosure of previously shared, regional commons (a form of 'resource grabbing').

Both the food and energy crises have fuelled a growing perception of scarcity among international businesses and food and energy experts that has inevitably been reinforced by climate change and environmental degradation narratives (e.g. Hartmann, 2014). Earth system scientists have now claimed to identify potential critical thresholds and tipping points in the Earth system (Steffen et al., 2004; Harden et al., 2014). They further argue that human activities drive multiple, interacting effects that cascade through the Earth system. Rockström et al. (2009) state and quantify nine interacting 'planetary boundaries' with possible threshold effects that manifest themselves at the planetary level, possibly in a non-linear way, namely: climate impacts, ozone depletion, atmospheric aerosol loading, ocean acidification, global freshwater use, chemical pollution, land system change, biodiversity, and biogeo-chemistry (an updated study by Steffen et al., 2015 identifies a hierarchy of boundaries with climate change and biosphere integrity as two core boundaries). These 'planetary boundaries' are however not fixed; they represent estimates of just how near the global human community can operate to an uncertainty zone around a potential threshold, without seriously challenging the continuation of the current state of the planet within which human settlements and cultures have flourished (Galaz et al., 2012). However, this implies drawing a 'safe operating space for humanity', which is bound to be a highly controversial project, as it echoes the earlier debates around 'limits to growth' and value

judgments that are intrinsic to such estimates, and the politics that ensue. Safe for whom? This is going to be a question that promises to haunt the policy debates – including those of the nexus – in the years ahead.

The current incarnation of the nexus idea emerged from the WEF at a time of various resource 'crises' in the sectors of food, energy and global finance. This was enhanced by further climate-related uncertainties including the failure to arrive at a global consensus at Copenhagen as well as subsequently. These crises have served to highlight the predicament of entwined relations between energy and food systems, together with that of water security, another concept that has received much attention in recent years (Cook and Bakker, 2012). Though water and energy are closely linked in the production phase, water security is prioritised in the nexus debates. Bazilian et al. (2011) reveal the complexity of this interconnectedness in identifying both analytical and policy-making entry points:

> If a water perspective is adopted, then food and energy systems are users of the resource (see e.g. Hellegers and Zilberman, 2008); from a food perspective energy and water are inputs (see e.g. Mushtaq et al., 2009; Khan and Hanjra, 2009; UN-DESA, 2011); from an energy perspective, water as well as bio-resources (e.g. biomass in form of energy crops) are generally an input or resource requirement and food is generally the output. Food and water supply as well as wastewater treatment require significant amounts of energy. Of course, areas such as food-as-fuels (i.e. biofuels) tend to blur these descriptions…

The language that has emerged since the WEF's discovery of the nexus in 2008 is significant in that it is the first time a wide and powerful business community came to realise the limits to growth, or perhaps more precisely protecting its resource base from possible vulnerabilities. It had earlier, when the Club of Rome's Limits to Growth was published, stood against the 'pessimism' of that point of view, arguing that substitutes that could replace the scarce item would always be invented, if only the market were left free to do so (see Nordhaus et al., 1992; Robbins et al., 2010: 11-45). While alarmism is often the forte of activist social and environmental movements, this time it is being sounded by the business community and the establishment. WEF currently sees water security as central, arguing that it is a key natural limit to economic growth, and suggesting for example that water is "the single constraint to expanding cities" (World Economic Forum, 2011b: xxi). In 2009, UN Secretary General, Ban Ki Moon also addressed the WEF meeting at Davos and underlined the imperative of private-sector participation to deal with these crises. This growing momentum led to a proliferation of special bodies within the WEF to deal with water issues, including the creation of a Global Compact CEO Water Mandate and the Water Security Global Agenda Council.

The WEF's formulation of the nexus has primarily been driven by international private actors, who see both the nexus – and subsequently also the concept of Green Economy – as an opportunity and a constraint to their business. The WEF approach to the nexus stresses the business imperative and the need to prepare for investment scenarios in the near future. They underline that the economics of water is both compelling and challenging and that water security, economic development and GDP are interlinked (World Economic Forum, 2009). They thus argue for recognition that future global investments will be significantly driven by the consideration of water, and will become a mainstream theme for investors; global financial regulators, therefore, will have to develop clear-cut rules to manage the flow of innovative water funds.

The WEF in particular emphasises market mechanisms as the solution to resource scarcity. Indeed, one of several explanations that the WEF gives for claims of a growing water scarcity and its risk to economic growth, is the under-pricing of water as a resource. This, for example, has led to some regional 'bubbles' of agricultural prosperity, that in the long term are not sustainable, as water resources become depleted beyond the rate of replenishment. The report also argues that a weak international trade regime, and a complex arrangement of tariffs and subsidies amplify the cost of food shortage (World Economic Forum, 2011b). In an earlier report, the WEF had referred to the bubble burst phenomenon as the concern that underpinned this nexus with the idea that, with resource

scarcity and water insecurity, a business-as-usual approach will burst the bubble of productivity and economic growth (World Economic Forum, 2009).

The WEF perspective has ushered in a new brand of resource realism (Wales and Winston, 2012). Large transnational corporations such as Coca Cola, Nestle and SABMiller are putting forward the private sector's "comprehensive value-chain viewpoint" to tackle nexus governance. The business logic is as follows: to grow, economies should shift their water allocations away from farming and toward uses that deliver higher economic value per litre, especially energy production, industry and manufacturing (see Allan, 2001). Within this logic, governments are encouraged to pursue high-value water uses with regard to the allocation of water between sectors. These shifts, at the same time, mean that they become more reliant on water use-efficient agriculture alongside food imports. To respond, the world system will need more trade flows in agriculture across more countries and virtual water flows (World Economic Forum, 2011b).

The nexus discourse has also been adopted by the mainstream sustainability discourse including within the Sustainable Development Goals. The German government picked up and in particular promoted its version of the nexus concept. It was shaped by a briefing coordinated by the Stockholm Environment Institute (Hoff, 2011), at Bonn 2011 and then Rio+20. In its essence, it was based on the belief that a better understanding of the interdependence of water, energy and climate resources with policy systems will catalyse an informed and transparent framework around determining trade-offs and synergies that meet demand, including of the poor, without compromising sustainability (German Federal Ministry for the Environment Nature Conservation and Nuclear Safety, 2011). Three guiding principles are proposed: investing to sustain ecosystem services; creating more with less; and accelerating access, integrating the poorest (Hoff, 2011).

The nexus is also very much linked to the concept of green economy, with human beings and social equity as two key pillars. As put by Hoff (2011: 6),

> The Green Economy, an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In Green Economy natural capital is valued as a critical economic asset as a provider for benefits for the poor. It is the nexus approach par excellence.

The green economy refers to a range of ideas including that of 'clean energy' and other ecological modernisation concepts. For example, the rising production of biofuel crops has been linked to deforestation and competing uses of land with agriculture, including smallholder agriculture (Borras et al., 2010). Not all endorse the concept of Green Economy; the World Social Forum has called it 'the Green Washington Consensus', stating "this latest phase of capitalist expansion seeks to exploit and profit by putting a price value on the essential life-giving capacities of nature" (Working Group on Green Economy, 2012).

Nexus language has thus sought to frame debates around acute pressures on the world's natural resources generated through a combination of factors, including climate change, global demographic trends of burgeoning population size and increased consumption levels. From a business perspective, crises in food and energy – and their relationship with water security – lay in that these resources are not given proper market value and clear ownership entitlements, which would enable nimble market reaction and adjustment to resource scarcity. From a public policy perspective, these crises have revealed the limits of existing institutional approaches that have hitherto sought to manage these resources by compartmentalising them into individual silos and using mainly market-based economic policy tools to address.

Like climate change, the nexus has also been securitised, with the US National Intelligence Council highlighting in its 2030 Global Trends report the important geopolitical consequences – for conflict, national security and global economy – if the nexus was not properly managed. This scarcity discourse

is used by the nexus promoters as a way to transform the nexus into a matter of emergency and an urgent matter of survival for all humanity (see Leese and Meisch, this issue).

One approach that is emerging from these policy dynamics has been the development of nexus assessments and toolkits to assess and prioritise different development options. As Hoff (2011: 12) points out, "there is a need for a coordinated and harmonised nexus knowledge-base and database indicators and metrics that cover all relevant spatial and temporal scales and planning horizons". These models are currently being developed by many international organisations from the FAO (Mohtar and Daher, 2012), to the Asian Development Bank (ADB, 2013) and initial nexus assessments have been undertaken in various case studies around the world, e.g. in Burkina Faso (Hermann et al., 2012), Mauritius (Welsch et al., 2014), and USA (DoE, 2014).

Nexus thinking becomes shorthand for this confluence of trends and the need for explicit trade-offs in policy-making (Dupar and Oates, 2012). Nexus thinking is through socio-ecological systems, analytical frameworks that seek to understand trade-offs and synergies, increase efficiency, and improve governance between food, water and energy systems (e.g. Hoff, 2011; Smajgl and Ward, 2013). The nexus narrative thus seeks to integrate sectors through making them visible and thereby aims to address externalities that link sectors together.

As put by Leese and Meisch (this issue), "all nexus conceptions share general perceptions of present and future crises and offer solutions for more efficient resource management within a green economy, thereby specifically calling for integrated solutions with regard to water, energy and food". Currently, the framing of the nexus is very top-down, often North to South linked to external interests, and outsider-generated managerial solutions.

We have identified four shortcomings in nexus thinking:

1. The questionable novelty of the solutions proposed.
2. The lack of engagement with market logic within sub-nexuses and difficulty of integration.
3. Disregard of the politics of knowledge in framing it as a global scarcity issue.
4. The limits of optimisation.

The first problem with the nexus is that the proposed types of solutions are an illusion of newness. The presentation of hard statistics about water consumption in food and energy and the proposal for nexus approaches, may give a veneer of newness to global policy makers. Yet looking in more detail at the discourse of the nexus to date, there is far less clarity on what a new common integrative approach might look like, beyond the existing water-centric paradigm of Integrated Water Resources Management (IWRM). The idea of an underlying nexus between natural resource sectors is not new (Gleick, 1994; Mueller, this issue). It has been the staple of environmental movements ranging from 'deep ecology' and Gaia proponents to more mainstream 'service delivery' NGOs. Previous concepts such as IWRM were also promoting integrated approaches and water as an economic good. The idea of integration at the river-basin level is a very old idea (Molle, 2009). The nexus may be seen as a repetition of the debate of the early nineties with the Dublin principles and the emergence of IWRM. The following quote by the WEF shows this continuity by emphasising how water is an economic and social good.

> Water lies at the heart of a nexus of social, economic and political issues – agriculture, energy, cities, trade, finance, national security and human lives, rich and poor; water is not only an indispensable ingredient for human life, seen by many as a right, but also indisputably an economic and social good unlike any other. It is a commodity in its own right… but it is also a crucial connector between humans, our environment and all aspects of our economic system (World Economic Forum, 2011b: 3).

In this special issue, Benson et al. (2015) argue that the nexus presents some novel elements compared to the IWRM paradigm, particularly in terms of holistically integrating different policy sectors,

encouraging business involvement, promoting economically rational decision-making and privileging water securitisation in the pursuit of sustainable development. According to Bach et al. (2012), the critical difference is that the nexus is a multi-centric concept that treats the different sectors – water, energy, food, and climate security – as equally important as opposed to IWRM, which is water-centric (although the WEF framing of the nexus is also water centric as explained in the previous section). In fact, this is nothing new; modellers, farming households, and civil engineers have known about these interrelationships for a long time. This begs the question whether nexus is merely a new development buzz word (Dupar and Oates, 2012), and what to date is new about nexus that did not exist in earlier resource management knowledge?

The second issue is that the nexus as a system approach fails to engage with the international political economy of food and energy. Given that food, water and energy sectors often exist in silos, the idea of integration may be challenging to put into practice. The different governing regimes of water, land and energy will make nexus governance even more difficult. In fact, one can see the emergence of parallel concepts, which rather emphasise the two subnexuses, the water-food-trade sub-nexus and the energy-climate change sub-nexus (Allan, forthcoming). These two sub-nexus are separate and very different in character and operate in very different global regimes. This means that any change needs to come from an international political economy perspective, a point we will come back to later, rather than a 'prescribed optimal scientifically rational' one.

Thirdly, the framing of the nexus as a global scarcity issue is not only important both for creating this sense of alarm and urgency but also in terms of how it can be managed. Many studies have highlighted that limits on economic growth due to water is place-specific and may not be the general case (Barbier, 2004). Brown and Lall (2006) suggest that it is rainfall variability, in particular, that is a significant factor shaping economic growth, rather than a generalised water scarcity. Pointing out the constructed and political nature of global resource scarcity is not a call to relativism – 'real', material scarcities clearly exist – but an acceptance that meanings and interpretations are co-constructed in particular policy settings, in arenas of power and contestation. What could be seen as an international political economy issue linked to unequal access has been framed as having an economic and technological solution. One can see that nexus policy documents tend to provide a narrative to manage economic structures through technological solutions, rather than question the inequalities within the system. Leese and Meisch (this issue) argue that the current framing of the nexus does not question the structured inequalities in the economy but rather confirms them. They view the nexus as a constructed security problem and a means for sustainability to be securitised. The nexus logic according to their view is plain and simple: we have to produce security through the economy and as such the survival of the economy must no longer be questioned. The literature on the politics of scarcity shows how the nexus framing obliterates inequalities of access as the root of resource crises. Increased resource productivity by using waste or economic incentives for efficient usage combined with technological 'advances' such as Genetically modified crops, transgenic technologies, automation of agriculture or micro-irrigation technologies are put forward as solutions to nexus challenges (see for example Gregory et al., 2005). These solutions rely heavily on a simplistic availability assumption, namely that increased food supply will automatically reduce hunger or that increased supply of water will improve general access to water. The crucial issue for food or energy security, however, is not whether food or energy is 'available' in the 'average' or 'aggregate' but whether the monetary and/or non-monetary resources at peoples' disposal, as well as distribution networks, are sufficient and without bottle-neck choke points controlled by trading concerns, to allow everyone access to adequate quantities of food (Millstone, 2010). Key to this approach is the idea of efficiency, but it skips the next challenging question: who benefits primarily from these improvements and who is marginalised? Without judicious re-distributive mechanisms, it is often the poor as well as those in the non-business class who will continue to pay for their needs but with increased profits from efficiency accumulating in private hands.

Finally, this logic of optimisation has clear limits. It treats the trade-offs between human needs for water, energy and food as a perfect equilibrium model, in which resource allocation can be decided. This can encourage the commodification of resources, downplaying environmental externalities, such as biodiversity and climate change, as well as poverty alleviation needs, ignoring day-to-day realities, local priorities and needs. Dupar and Oates (2012) warn that nexus thinking, in its simplistic form, might lead to the commodification of resources most readily or profitably monetised (perhaps for short-term gain), underplaying other long-term environmental externalities, such as biodiversity protection, pollution or climate change. They argue for a nexus approach that is sensitive to political economy issues, including open, inclusive and transparent negotiation and rights-based approaches.

HOW TO TAKE THE NEXUS AGENDA FORWARD

As put by Foran (this issue), the nexus is an immature concept in need of more critical conceptualisation. Middleton et al. (this issue) show how framings of the nexus differ across a range of organisations, including investment-type organisations, sustainability-type organisations and research institutes, and conservation organisations, including with regard to concepts such as sustainability, the green economy, and scarcity and trade-offs. In this section, we highlight how authors in this special issue have adopted a range of approaches adopted towards researching and operationalising the nexus, including system analysis and value-chain analysis.

Kalberg et al. (this issue) explore how systems analysis can take into account different stakeholder perspectives and preferences with a case study at Lake Tana in Ethiopia. Recognising the inherent subjectivities that shape policy formulation, their approach is based on participatory scenario modelling to account for different stakeholder views and preferences. Their nexus modelling toolkit helps to illustrate via a scenarios approach system-wide and cross-sectoral outcomes of potential development trajectories, and identifies both potential synergies and dilemmas to be deliberated by stakeholders. In this particular case, the framing of the nexus incorporates both agricultural transformation and energy transition considered in the context of lake water level and the environment. The research process of Kalberg et al. (this issue) facilitates mutual learning amongst stakeholders and is designed to render visible stakeholders' assumptions and expectations; the authors argue in favour of a 'stakeholder-driven nexus approach' that combines quantitative modelling with participatory scenarios planning to help resolve 'nexused' development dilemmas.

Villamayor-Tomas et al. (this issue) highlight that nexus approaches are yet to seriously engage with the institutions that mediate environmental outcomes, proposing that the combination of an Institutional Analysis and Development framework with a value chain analysis could contribute towards filling this gap (Ostrom, 1994). Villamayor-Tomas et al. (this issue) question the usefulness of system approaches for studying the nexus as these rely on rational knowledge-based assumptions that there are potentially optimisable ways of allocating and managing water and energy. Nexus frameworks are process-based approaches to resource use, and show a preference for systems analysis and modelling over other empirical strategies. This can be useful to study water-food-energy interlinkages, but neglect the very important role of institutionally mediated human agency. In their view, system approaches do not reflect the institutional realities as it is the private-sector supply chains, which largely determine energy and climate-change policies. The question then is how these can operate at the nexus level between water, food and energy. Using a value-chain analysis, they show in various case studies how food and energy market systems do not integrate these linkages. These include, for example, the economic and environmental risks in food supply chains, and of consuming vast volumes of unaccounted water associated with inadequately costed embedded energy incurred in pumping water. Other examples discussed in the paper are about the consequences of wasteful allocation and management of water and energy in the production, conveyance and wasteful consumption of goods and services in which the real, but unaccounted costs of water and energy are substantial. Villamayor-

Tomas et al. (this issue) furthermore argue that profits have not proved to be a sound metric to incentivise reliable stewardship of natural ecosystems, but it is the main incentive for the market players who deliver water-intensive food and energy services. Strong regulations and adequate institutions are therefore needed to create these incentives. However, vested interests and norms may prevent such adaptation and reflect institutional path dependencies. Previously independent institutions need to adapt to take into account cross-sector linkages.

Foran (this issue), reflecting on the CSIRO Delphi-method regional assessment, sketches out the limits to the current predominance of integrated assessment/complex systems methodologies approaches to the nexus, arguing that the "social dimensions of resource [nexus] linkages remain thinly described and under-theorized". According to Foran, researchers engaged in nexus research need to pay closer attention to how current social formations on energy, food and water systems have been produced historically, adding that circumstantial premises need to be taken into account if uncertainty and complexity are to be taken seriously. Foran proposes a critical social science approach with an emphasis on political economy and discursive elements to understand social interactions that occur within the nexus, in particular at critical 'nodes' where politics over resource use are most intense.

These various sets of articles in this special issue show how a different framing of the nexus is required: one which recognises that global priorities may not reflect local concerns; and that resource allocations are political decisions, which need to be decided through more open and transparent decision-making, and recognising uncertainties.

One would expect radical solutions to be proposed given how the emergency of the crisis has been framed by the nexus promoters, which, purportedly, has reached irreversible tipping points, limits and planetary boundaries. As pointed out by Leese and Meisch (this issue), the proposed measures in the nexus reports reveal that the nexus is in fact conceived of as something that is very much manageable, even if planetary boundaries have already been crossed (2030 WRG, 2009: 6; Hoff, 2011: 4). As put by Foran (this issue), commentators were already in 2012 (Hoff, 2012) referring to the need to 'manage' the nexus as if it had become a relatively well-defined class of problems, one that could be quantified using integrated assessment tools, and addressed via capacity building and other improved managerial and governance responses. In fact, for nexus advocates, the present and future crisis can be potentially resolved, with proposed policy measures linked to a neoliberal understanding of resource scarcity, processes of rationalisation, risk analysis, and management in a global (green) economy. While there may be biophysical limits, the nexus promoters follow a cornucopian optimists' view as put by Scoones (2014) where these limits can be overcome through investment, innovation and ingenuity, driven by ever-more-sophisticated technologies (Scoones et al., 2014: 5).

A NEW APPROACH TO AND FRAMING OF THE NEXUS

The preceding discussion reveals that, to date, nexus debates in global policy arenas have advocated an ecological modernisation approach towards resolving food-water-energy contradictions, emphasising innovation in technology, efficiency, market, and societal institutions aiming at broadly defined goals of sustainability and poverty reduction (Hoff, 2011). Whilst implicit in much of the discussion, politics largely remain hidden and principles of justice are not explicitly addressed (Middleton et al., this issue).

Yet, research into socio-technical systems has revealed how the transformation of large socio-technical regimes – including food, energy and water regimes – involves the co-evolution and innovation of technologies, infrastructures, institutions, governance and people (Grin et al., 2010). Such innovations are relational; the emergence and adoption of a particular technology or institution, for example, reflect existing societal structure and power relations, and often (re)produce dominant interests, inevitably raising issues of justice. Therefore, a productive and necessary approach to research on 'the nexus' (or food/energy/water interdependencies) needs to ask does a (proposed) technology or institutional innovation for production, storage, distribution, or consumption reduce

poverty or exacerbate it; does it centralise or decentralise control and decision-making; does it reduce or increase income inequality, and the three 'securities' – water, food and energy?

In the study of water, food and energy systems as discrete systems to date, there has been much consideration of how preferred development pathways have emerged, and how alternative pathways have been dismissed.[2] Development pathways are historically contingent and often become 'locked-in' for many reasons including due to past decisions and sunk investment, institutional path-dependency alongside technological, social and political inflexibility.

We propose that for nexus thinking to create alternative development pathways that are sustainable, address poverty and redress inequality and social injustice, an approach must be adopted that:

- explores the interaction of ecological, social and technological systems across scales;
- considers the role of science and technology, and technological choices;
- highlights the importance of local context and diversity of ways of knowing;
- acknowledges the value of plural ways of understanding problems and solutions, and defining development and its objectives;
- recognises the highly political nature of associated decision-making.

The case of (the technology of) water storage can be taken as an example. There is little doubt that reliable access to water is vital to smallholder farmers to ensure food security and well-being. Beyond smallholder agriculture, however, as the nexus highlights, water is used for a range of purposes including electricity generation, large-scale agriculture, and water supply for domestic and industrial users, with some uses more consumptive than others.

To address water scarcity and ensure water security, it is often the case that there is a perceived need for more water storage, and that this is interpreted as the need to build additional large-scale dams. McCartney and Smakhtin (2010) point out, however, that a 'continuum' of water storage options exists that include: natural wetlands; enhanced soil moisture; groundwater aquifers; ponds and tanks; and large or small dams/reservoirs. These are to name but a few. Farmers may also, for example, store virtual water in crops that they select to harvest depending on whether the year was wet or dry.

Whilst not all storage types fit all purposes, McCartney and Smakhtin (2010: 4) argue that "[e]ach has an important role to play and, under the right circumstances, can contribute to food security and poverty reduction". They go on to argue that "[a]ll [water storage options] have strengths and weaknesses which depend, in part, on the inherent characteristics of the storage but are also affected by site-specific conditions and the way the storage is planned and managed. Consequently, each storage type needs to be considered carefully within the context of its geographic, cultural and political location".

Within the nexus debate, there have likewise been a range of positions on water storage solutions. Organisations such as IUCN have argued the importance of 'natural infrastructure' (Krchnak et al., 2011). Others, such as the International Hydropower Association, have highlighted the role that large dams should play.[3] At present, however, not all water storage options are considered equally within planning and assessment processes. Indeed, McCartney and Smakhtin (2010) suggest that with the exception of large dams, which are typically conceived and led by the state and large businesses, the

[2] A development pathway is defined as "the particular directions in which interacting social, technological and environmental systems co-evolve over time" (Leach et al, 2010: xiv).

[3] www.water-energy-food.org/en/calendar/view__1592/adressing-the-water-energy-nexus-the-role-and-sustainability-of-hydropower-tokyo-japan.html

development of alternative storage options has largely been ad-hoc in nature and left to local communities, NGOs or local businesses. Alternative storage options are therefore developed with limited planning, for example in relation to other nearby water uses and management arrangements. At a minimum, this lack of coordination may result in sub-optimal gain of benefits whilst, at worst, outcomes may negatively affect people's well-being.

In addition, some water storage technologies like large irrigation and hydropower dams have a tendency to centralise control over water storage, whilst others have a tendency to decentralise control and decision-making (McCully, 2001). There have been intense debates over the relationship between large versus small-scale technologies and poverty reduction and community empowerment. This is perhaps epitomised by the large dams debate; the World Commission on Dams (2000) concluded that whilst (see also Moore et al., 2010):

> [d]ams have made an important and significant contribution to human development, and the benefits derived from them have been considerable … in too many cases an unacceptable and often unnecessary price has been paid to secure those benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers and by the natural environment.

Various studies, meanwhile, demonstrate the contribution that small-scale technologies can play in ensuring water security, in particular for smallholder farmers (McCully, 2006; FAO, 2008; Wisser et al., 2010; Hagos et al., 2012).

McCartney and Smakhtin (2010) propose that for water storage to be more reliable and resilient – and to allow for greater uncertainty in the context of climate change – "storage 'systems' [i.e. a mix of storage types] that combine and build on complementarities of different storage types is likely to be more effective". In other words, plural storage systems are more likely to be more sustainable by combining traits of stability, durability, resilience and robustness in response to shocks and stresses (Leach et al., 2010: 62). Drawing on cultural theory, these plural solutions might be considered as 'clumsy solutions' that benefit from the deliberative interaction of multiple worldviews on perceptions of problems and associated risk, ways of organising social relations, and ultimately generating creative, new solutions and alternatives and plural policy responses (Verweij et al., 2006).

Analogous analysis can be made for energy and food production, storage, distribution and consumption systems. For example, the concept of food security has been juxtaposed against the concept of food sovereignty. The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life" (FAO, 1996). Meanwhile, food sovereignty has been both defined and put into action in multiple ways (Patel, 2009), with the basic concept captured by Via Campasina in 1996 as "[f]ood sovereignty is the right of each nation to maintain and develop its own capacity to produce its basic foods respecting cultural and productive diversity". The crux of the debate is the access to, and control over, the food system, including, for example farmer versus transnational corporation control of seeds, or control of the distribution and retailing system, and the relative power of the farmer (see Millstone, 2010).

In the case of energy, a high-profile debate emerged over energy pathways in 1976 when Amory Lovins first proposed the soft versus hard energy path in the US. More recently, Hildyard et al. (2012), highlight that attaining 'national energy security' is typically interpreted as energy to ensure economic growth, which is not necessarily equivalent to 'energy for all' that prioritises energy to meet basic needs.

> Like many other political buzzwords, 'energy security' has become a plastic phrase used by a range of different interest groups to signify many often contradictory goals. For many individuals, energy security may simply mean being able to afford heating in the depths of a cold winter or having access to a means of cooking – a 'logic of subsistence'. For political parties in government, it may mean ensuring that a nation's most important corporations have reliable contracts with guaranteed fuel suppliers until the next election.

> For exporting countries, it may mean making certain that their customers maintain their demand for their oil or gas via long-term contracts… (Hildyard et al., 2012: 5-6)

Hildyard et al. (2012) highlight how the word 'energy security' is often used to justify energy enclosures, whilst masking energy inequalities, creating new scarcities and insecurities as people are dispossessed of energy, food, water, land and other necessities of life.

Thus, when food and energy systems are added to the water-security mix, complexity and uncertainty are further compounded. Indeed, complex food-water-energy nexus security problems are so-called wicked problems to which there is no easy definition and no easy solution (Rittel and Webber, 1973; Lach et al., 2005). They are complex and dynamic systems, and even more so, under the uncertainty inherent in climate change discourse. This would suggest the value of plural approaches towards 'nexused' challenges. Yet, the current global policy-framing of the nexus around a scarcity crisis narrative, is driving proposed solutions towards a paradigm of control (i.e. stability and durability solutions) in which there is a much higher perception of certainty in understanding the water-energy-food systems than is actually warranted. Pursuing plural pathways to accommodate complexity and (climate) uncertainty would require a shift in governance towards "resilience and robustness thinking", where the limits to control are acknowledged and adaptive solutions that incorporate plural solutions are pursued (Leach et al., 2010: 62).

To step towards dynamic plural approaches to complex problems, Leach et al. (2010) have argued for 'empowering designs' that:

- "*broaden out inputs*" to planning processes and appraisal methods, which include: participatory engagement; extended scope to include multiple criteria and scales; an acceptance of a diversity of knowledges; the need to acknowledge uncertainty; and the importance of addressing issues of rights, equity and power.
- "*open up the outputs*" to decision-making and policy, including: giving serious consideration to a range of options and possible alternatives; and a move towards more adaptive, deliberative and reflexive forms of governance and political engagement.

A related literature has emerged on grassroots innovations for sustainable development (Seyfang and Smith, 2007). It emphasises how empowered communities can act and innovate for themselves, thus developing situationally appropriate solutions using appropriate technologies and that reflect the interests and values of the communities involved. Examples include community energy projects; local food production; and low-impact eco-housing. These types of local initiatives also often require the creation of new social institutions and 'systems of provision' (Seyfang and Smith, 2007; Smith et al., 2014).

This raises important questions about the relationship between innovation, poverty reduction and sustainability that are pertinent to ecological modernisation approaches to the nexus, especially where large-scale versus small-scale solutions may be pitted against each other, revived or stoked by nexus-thinking. Innovation for inclusive development has been broadly defined as "innovation that reduces poverty and enables all groups of people, especially the poor and marginalised to participate in decision-making, create and actualise opportunities, and equitably share in the benefits of development" (UNIID-SEA, n.d.). This would suggest the need for a nexus approach to give greater emphasis to decentralised and democratised decision-making as the source of solutions, as well as the source of understanding the challenges faced. Therefore, the emergent challenge to research on the nexus is how nexus thinking can facilitate empowering food-water-energy designs that decentralise, democratise, and facilitate social and environmental justice.

CONCLUSION

To start a critical and open debate on the concept of the nexus is timely as it is very much in its infancy (or period of rediscovery c.f. Gleick, 1994). The nexus as a concept must more fully embrace inclusiveness, so that the interrelationships it represents – including planetary boundaries and the manifestation at the local level – can reflect local realities and human needs. The objective of this special issue is to show the diversity and complexity of various perspectives on the nexus, which we, as editors, may not share, but that highlight the limits of how the current concept is being approached, namely as a (magical) solution that will quickly solve long-term fundamental and structural issues. This technical veil masks a bigger debate, which lies around resource inequality and access that contribute to social instability.

The challenge is that each of the institutions contemplating the nexus comes with its own framings, different definitions of the problem, and particular histories and proclivities. There is, we argued, a need for space for different providers to provide diverse options, and for negotiation between them across different groups. The imagination of plural pathways can only become a reality if a diversity of users and their practices are involved. Plural pathways and clumsy solutions are needed. Only a diversity of responses – 'many ten percent solutions' – can create pathways to sustainability more effectively and securely.

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