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THE RESOURCE NEXUS IN AN UNCERTAIN WORLD
A non-equilibrium perspective

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Introduction
Nexus ‘emerged’ at a critical moment against the backdrop of cascading global crises in energy, food and global finance in 2008. These were further amplified by the ‘uncertainties’ brought about by climate change which were slowly becoming visible to the policymakers (Intergovernmental Panel on Climate Change, 2014). Nexus or interlinked governance across sectors was fronted as a potential solution to the spectre of scarcities in food and energy sectors, and social changes that included population growth, globalisation, economic growth and urbanisation as well as to potentially tackle the anomalies that climate change would bring in future (Hoff, 2011). Some solutions that are proposed in addressing this nexus – i.e. the nexus solutions – tend to gravitate towards a paradigm of control (i.e. stability and durability solutions) in which there is a much higher perception of certainty (Allouche et al., 2014). This proclivity to search for control-oriented solutions for complex systems that are by nature dynamic, ridden with uncertainty and are non-linear may do more harm than good.

We begin with the premise that uncertainty is an intrinsic element of nature itself (Penrod, 2007), and the nexus thinking as well as the nexus solutions should not overlook this element. For instance, climate change-related uncertainties can be approached in two ways. First, would be to speculate on this uncertainty and reduce it to ‘controllable risks’ via market-based instruments (a pathway that many propose through greening the economy) and the other would be to appreciate this uncertainty as fundamental to the socio-ecological world. We propose the latter. Embracing resilient systems that are open to change(s) is likely to yield more sustainable outcomes than control-oriented, top-down solutions that are amenable to policy lock-ins and may lead to perverse outcomes in terms of resource depletion and deprivation.

This chapter is divided into four sections. First, we will outline the limits to the scarcity narrative which seems to be currently driving wide parts of the nexus discourse, and make a case for viewing water–energy–food–climate systems as complex and dynamic. Second, we discuss the concept of the nexus primarily the market-technical framing of the World Economic Forum (WEF). This is driven by business imperatives and the logic of environmental economics overlooking the inequalities in access to resources. Third, drawing on examples from water and energy systems, we unpack how this particular framing is guided by equilibrium thinking which promotes top-down, control-oriented solutions, which – as we argue – have limited potential
in tackling uncertainty and complexity. Finally, we conclude with arguing in favour of dynamic and resilient systems that could provide sustainable pathways for resource use.

Scarcity, uncertainty and complexity

To a large extent, it was the multiple scarcities of 2007–2008 that led to the return of ‘limits to growth’ thesis, with a pronounced sense of urgency and fear. In the 1970s, resource discourses were highly influenced by the Limits to Growth argument; by showing apocalyptic versions of a future fuelled by Malthusian narratives, critical concerns were raised around scarcity. In the backdrop of the oil crisis, and fuel shocks, this created the presumption, at least among policymakers, that resources are ‘scarce’ and they need to be managed and governed in a better way (Mehta, 2010). This very preoccupation with scarcity was further stretched into the commodification argument through the 1990s. In the case of water, for example, to put a premium on the scarcity value of a resource, pricing the resource became the ‘best’ way to curtail wasteful consumption and use with the understanding that through pricing water will gravitate to high-value uses (Winpenny, 2003). This scarcity-efficiency linearity led to different kinds of policy interventions ranging from water pricing, private sector participation, and decentralised models of service delivery. On the one hand, these reified the economic value of water, on the other they also led to water inequities of various kinds leading to deprivation and marginalisation of the resource poor, especially for the small-scale farmers (water for agriculture use) and urban poor (drinking water supply).

The justification of nexus thinking also rests on similar presumptions of compounding scarcities, and solutions tend to follow a similar line of argument–monetisation of natural resources as natural capital (see next section and Chapter 2 of this handbook). For instance, in its 2011 World Economic Forum report, it is stated that the greatest threat to water scarcity and its risk to economic growth is the under-pricing of water as a resource (World Economic Forum, 2011). These in turn have created regional economic bubbles that sustain on poor tariffs and inefficient trade flows having a corresponding effect on food and energy systems. The food and energy crises also fuelled a growing perception of scarcity that was inevitably reinforced by climate change and environmental degradation narratives (e.g. Hartmann, 2014).

Though nexus evokes an ‘integrative imaginary’ (Cairns and Krzywoszynska, 2016) as an integration across various sectors, the boundaries of the nexus are still very much disputed; Srivastava and Mehta, 2014). If we understand nexus to be interlinkages across different kinds of resources – water, energy, food, water, climate (and land and minerals as proposed in the editorial chapter) – then we are essentially referring to not only interdependent systems (as emphasised by the nexus thinking) but inherently complex systems. Bazilian et al. (2011) reveal this complexity when they identify analytical and policymaking entry points. They argue that from a water perspective, both food and energy are users of the resource. From a food perspective, energy and water are inputs (Mushtaq et al., 2009), while from an energy perspective, water is a bioresource required as an input and food is an output. Food and water supply as well as wastewater treatment also require significant amounts of energy. Of course, areas such as food-as-fuels (i.e. biofuels) tend to blur these description (Bazilian et al., 2011). Thus it is hard to define the causal links in a neat input–output framework. This becomes more complex as ecological, social, technological, economic and political systems that govern these systems interact within themselves in the context of climate change. For example, the hydrological cycle is a highly dynamic system – socially, economically and technologically – and will become even more dynamic under the conditions of climate change (Mehta et al., 2007).
The Intergovernmental Panel Climate Change (IPCC) predicts that the effects of climate change will manifest themselves in extreme weather conditions – droughts, floods and heat-waves – which will increasingly become more frequent and unpredictable; these will in turn have negative consequences on soil and crop productivity, and displace seasonal hydrological cycles, the implications of which are still clouded with many uncertainties. Though this has reiterated fears of crises thinking and resource scarcity, this resurgence is also dovetailed with an aspect: uncertainty; that is, the inability to foresee changes that will come through changes in the climate. Thus the concerns over human induced climate change lay a considerable focus on establishing the rate, magnitude and patterns of change so that ‘scarce resources’ can either be ‘stocked, conserved or used efficiently’ for these unforeseeable changes.

Though uncertainty and risk are often used interchangeably, uncertainty means what we cannot know for certain in terms of outcomes, effects or impacts of a particular event; that is, ‘all other forms of ignorance about a system for which we do not have well founded precise probabilities’ (Swart et al., 2009, 5). In classical economic models, ‘[u]ncertainty is understood as the character of situations in which agents cannot anticipate the outcome of a decision and cannot assign probabilities to the outcome’ (Beckert, 1996, 804). This certainty, to borrow from Beckert, has an element of fictionality – ‘[an] inhabitation in the mind of an imagined future state of the world and the beliefs in causal mechanisms leading to this future state. Actors are motivated in their actions by the imagined future and organize their activities based on these mental representations’. Scenarios for future, modelling and predictions are at the heart of such representations. One such powerful representation is the framing that emerged from the World Economic Forum in 2008, and has been reiterated in various international conferences and platforms.

The nexus sectors – food, energy and water – are thus understood to be interdependent and in need of integration (Hoff, 2011). Three guiding principles are proposed: investing to sustain ecosystem services; creating more with less; and accelerating access, integrating the poorest (ibid). These principles are also at the heart of the green economy approach.

The nexus according to the World Economic Forum

It was in the ‘perceived’ scarcity over food, energy and water resources and the various energy and food crises in 2007 and 2008 that the WEF first proposed the concept of the nexus. A year later, 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 World Economic Forum 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 the nexus as an opportunity and a constraint to their business. It strongly links water security to economic growth in the following way:

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, 2011, 3)
The underlying causality is as follows: to grow, economies should shift their water allocations away from farming and towards uses that deliver higher economic value per litre, especially energy production, industry and manufacturing. Within this logic, governments will therefore have to make choices about the allocation of water between sectors, and, of course, are encouraged to pursue high-value water uses. At the same time these shifts 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 (World Economic Forum, 2011).

However universalised portrayals of scarcity that guide the nexus may be simplistic as limits on economic growth due to water is place specific and may not be the general case (Barbier, 2004). Furthermore, it is rainfall variability rather than general scarcity that shapes economic growth (Brown and Lall, 2006). Moreover water scarcity is often mediated through local narratives of conflicts and power differences (Mehta, 2005). So deploying economic rationales and modelling variables may not factor in such differences that are often place and context based (Srivastava, 2015). When does a resource become ‘scarce’ is contingent on how rules of access and use are set, and how they are enforced. Therefore how scarcity is defined, what is the potential source of resource use and the political economy around the use, extraction and in some cases exploitation of the resource will determine the shape of the nexus.

**WEF’s resource realism**

WEF’s perspective has ushered into a new brand of resource realism (Wales and Winston, 2012). It has provoked new public–private collaborations between International Financial Institutions (IFIs) and large transnational corporations such as Coca Cola, Nestlé and SABMiller who want to harness the private sector’s ‘comprehensive value-chain viewpoint’ to tackle nexus governance and also advise governments, other corporates and communities in nexus governance (Wales and Winston, 2012). The WEF stressed four follow-up measures: (1) a task force for data collection; (2) a major program of economic modelling of interdependencies; (3) new models for collaborations to help governments make policy changes; (4) re-imagining institutions to improve governance (World Economic Forum, 2011). The operationalisation of the nexus is already underway in debates on fracking or SABMiller’s study on evaluation of malting barley in Rajasthan (India) to determine value trade-offs across sectors (Wales and Winston, 2012; Reig et al., 2014).

This approach to the nexus stresses the business imperative and the need to prepare for investment scenarios in the near future. It underlines that the economics of water is both compelling and challenging and that water security, economic development and Gross Domestic Product (GDP) are interlinked (World Economic Forum, 2009). It thus argues 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.

**Scramble for resources**

The scramble for resources is also evident in the Global Risk Assessment Reports published by WEF. The 2011 reported that the ‘land-grab’ phenomenon is a response to a larger structural and correlated global risk to water, energy and food systems. Over the years, climate change and extreme weather events and their impacts on the nexus system have also become an increasing focus of these reports (World Economic Forum, 2016) which suggest diverse forms of
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public–private collaborations for resource management. The use of market-based instruments for conserving natural capital have also let to enclosures and securitisation of these resources depriving communities of their traditional ownership rights and livelihood practices. Borras, Saturnino 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 often with the active collaboration of the host national governments.

Thus the 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 (Dupar and Oates, 2012). The 2011 Bonn paper also underlined this competition over resources against the backdrop of urbanisation, growing population and increasing levels of consumption, globalisation facilitating trade and investment, and resource degradation, which will be amplified through climate change (German Federal Ministry for the Environment Nature Conservation and Nuclear Safety, 2011; Bogardi et al., 2012).

The green Washington consensus

This framing of the nexus solutions is very much aligned with green economy debates. The green economy refers to a range of ideas including that of ‘clean energy’ and other ecological modernisation concepts, although so-called clean energy options raise other complex socio-environmental issues, in terms of energy use. For example, the rising production of biofuel crops have been linked to deforestation and competing uses of land with agriculture, including small-holder agriculture (Borras et al., 2010).

The Green Economy, an economy that results in improved human wellbeing 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. (Hoff, 2011, 6)

On similar lines, the starting point for the OECD’s deliberations on Green Growth is the risk of climate change and depletion of natural resources such as unchecked biodiversity loss, overfishing, and the growing scarcity of land and water. The OECD report (2011, 4) states that—“We need green growth because risks to development are rising as growth continues to erode natural capital.” The way forward should be characterised by: (1) increased productivity; (2) increased technological innovation; and (3) stimulating new markets.

Though green economy was originally conceptualised as a set of economic tools to operationalise the Sustainable Development Goals (Jacobs, 2012), the concept has been broadened and has become deeply contested over time (Benson and Greenfield, 2012). In the backdrop of the financial crises, it was seen as an entry point to promote green investments (Ocampo et al., 2011) in the wake of impending resource scarcity and climate change. The green economy also pushes for a commodification of natural resources, which provides for a way to deal with resource scarcity linked to the nexus by putting a price on natural resources whereby nature is made subject to financial speculation (Fatheuer, Fuhr and Unmuessig, 2016). It promotes monetisation and financialisation of nature, which is a set of three processes: (1) creation of commodities or marketable goods through market or valuation techniques; (2) introduction
of commercial principles such as efficiency, accounting or cost-benefit assessment and profit maximisation; and (3) creation of tradable instruments such as environmental credits and offsets (Huff, 2015). The World Social Forum has called it ‘the Green Washington Consensus’, as the ‘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).

**Limits to linear solutions in a non-equilibrium world**

In large parts of the current nexus framing, a sense of alarmism and impending scarcity is widely evident which sets into motion supply side responses of augmenting water availability. This – as the nexus thinking suggests – can best be achieved either by making trade-offs or ensuring efficient mechanisms of resource use with maximum avoidance of negative externalities on other resources. As Leese and Meisch (2015, 698) put it, “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’ close with double quotation marks. However, solutions proposed are often about increasing productivity through resource efficiency or availability of resources rather than focusing on supply side challenges such as questioning factors which increase the demand for such resources (Fatheuer, Fuhr and Unmuessig, 2016).

Within the nexus thinking, scarcity is often characterised as a risk – where decisions are made faced with unknown outcomes but known ex-ante probability distributions, rather than uncertainty where the probability distribution of a random outcome is unknown (cf. Knight, 1921). For instance, over the years, the Global Risk Assessment Reports (World Economic Forum) have characterised various elements of the social, economic, environmental and technological systems under the category of ‘risks’, which are interconnected (to a degree) but are largely framed as non-dynamic systems (for example, how does health insecurity or conflict-related migration speak to the nexus question?).

Uncertainty defies absolute solutions as one can offer only a range of possibilities, and that too with high degree of spatial variation. Nexus, however, operates on stable system thinking, which is usually informed by certain disciplinary trajectories (Leach, Scoones and Stirling, 2010). These tend to offer highly instrumentalist and oversimplified versions of pervasively complex, interlinked, dynamic social and ecological challenges (Stirling, 2015). For example, the investment scenarios and trade flows – one method for value-chain optimisation in the nexus thinking – may account for the patterns of production and consumption of particular resources, and not the dynamic interactions within these systems as well as across these systems. Furthermore, these large-scale and seemingly ‘objective’ systems are also embedded in social, political, ecological and physical systems that are dynamically interlinked with each other (Stirling, 2015). Compounding this, is also the degree of uncertainty that veils the current climate change scenarios and models (Curry and Webster, 2011). The complexity of decision situations, unforeseen interaction affects between water, food, energy and climate as well as overlapping – and often contradictory regimes – coupled with the choices of other actors limit the predictability and applicability of such scenarios (Dequech, 2011) in a dynamic and non-equilibria world.

Water can be a case in point here especially as ‘water system’ lies at the heart of the nexus thinking. In January 2014, when the World Bank launched its ‘Thirsty Energy’ initiative, it argued that the world’s energy systems are inextricably linked with water systems’ and “with demand rising for both resources, water scarcity can threaten the long term viability of energy projects and hinder development”. In another report, the global demand for food and energy was predicted to grow by 50% and for freshwater by 30% by 2030 (Beddington, 2009). The
supply side challenges of availability of water (for food and energy) will be affected due to increasing uncertainties caused by climate change and its ecological consequences, in addition to the fast changing socio-economic boundary conditions, including global redistributions of wealth and power, and changing flows of people, resources and knowledge (Schmidhuber and Tubiello, 2007). The thrust of green economy on clean sources of energy such as hydropower also depend critically on water resources, but climate variability may have cascading effects on hydropower generation.

Large water infrastructure (e.g. dams) which have almost become a *sin qua non* of augmenting water availability can offer little to mitigate such conditions. Dams have been a preferred choice of policymakers to augment water storage in contrast to small-scale technologies which play a critical role in ensuring water security for small-scale farmers (FAO, 2008; Hagos et al., 2012). However, alternative options such as natural wetlands, enhanced soil moisture, groundwater aquifers, ponds and tanks, and small/check dams are not equally considered within the planning and assessment process. The inherent characteristics of the storage are also affected by site-specific conditions and the way the storage is planned and managed within the context of its geographic, cultural and political location (McCartney and Smakhtin, 2010). Therefore, for water storage to be more reliable and resilient, 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 or other water harvesting measures are likely to be more effective” (Allouche, Middleton and Gyawali, 2014; Rockström and Falkenmark, 2015). Initiatives for harnessing plural water storage options have largely been ad hoc and left to local communities, civil society organisations or local business, though they have proved highly effective in addressing the uncertain effects of climate change.

The case of Maharashtra (India) elucidates this point further. Maharashtra witnessed one of its worst droughts in 2016. The water levels reached abysmally low levels and the government was forced to recommend water rationing for its users. Maharashtra is not an exception but represents another side of the nexus thinking – a nexus between sugarcane cultivation, power generation and growing needs of urbanisation. The growing demands on water in the face of unpredictable monsoons for a period of two years resulted in this situation. At the local level, the effects of this scarcity manifested in crop loss, social conflicts and contested allocation politics – which nexus seems to conveniently bypass (Srivastava, 2015) as with the thinking on plural pathways. For instance, in the drought vulnerable regions of Maharashtra, farmers rely on small check dams to support them during the lean and uncertain monsoon periods and have also migrated to the cultivation of less water-intensive crops. These experiments that are largely localised predate the nexus thinking but have a critical bearing on dealing with uncertain rainfall conditions.

The search for control-oriented, singular and linear solutions is also dynamically interlinked with vested interests in the political economy, which ‘close-in’ the potential for scaling up alternative pathways. For instance, in their 2010 paper, Smits and Bush argue that despite a high potential for hydropower generation, the Lao government has neglected rural electrification, and promoted the singular model for solar home systems. Other priorities such as providing electricity to neighbouring countries, the government’s interests in centralisation of water
resources, and “maximising foreign investment and export revenues” have prevailed over ensuring electricity access to rural households (Smits and Bush, 2010, 126).

Complexity and uncertainty is not unique to water or energy systems but has been a way of life for populations who live with this uncertainty on a day-to-day basis. Research on pastoral livelihoods in India (Mehta, 2005) and Africa (Scoones, 2004) also highlights these limits to singular, technology-led policy solutions that are at odds with the unruly realities that people face in their everyday lives and the multiple coping strategies they employ to mitigate these effects; these include planning migration patterns or diversification of livelihoods. Of course, these measures may be opportunistic, short term and unsustainable in the face of large-scale uncertainties but they tend to have better proofing outcomes than solutions guided by standard equilibrium thinking (cf. Scoones, 2004).

To accommodate complexity of ecological, social and political systems would also require a shift in governance from ‘stability and durability thinking’ towards incorporating ‘resilience and robustness thinking’ where the limits to control are acknowledged and adaptive solutions that incorporate plural solutions are pursued to address uncertainty and complexity.

**Conclusion: living with uncertainty and complexity**

In the preceding sections, we have argued that large parts of the current nexus thinking and its solutions are primarily guided by a scarcity narrative, which is often described in absolute and apolitical ways, overlooking the political economy that ‘constructs’ this scarcity. Correspondingly, the solutions are often framed on the technology-led demand side i.e. increasing availability via hard infrastructure, efficient uses of resources through necessary trade-offs or value-chain optimisation. This framing, as we argue, has problems: First, such notion of the nexus draw on simplistic causal relations between availability and access. For example, the fears around potential food crises portray a simple causality between food and water availability and reduction in hunger or improved access to water (Allouche et al., 2014). The relationship between availability and access is often mediated by monetary (resources available to access) and non-monetary factors (inequitable power relations in the given context, institutional arrangements) that are critical in providing access. Second, the nexus thinking tends to propose technology-led solutions which are closed, top-down, and control oriented rather than questioning the inequalities within the system that mediate access and use of these resources. Instead of questioning the structural inequalities within the nexus, this framing confirms them (Leese and Meisch, 2015). It fails to ask the next critical questions: Who benefits from these improvements and at whose or at what costs?

The logic of optimisation, embedded within the nexus thinking, has clear limits. It treats resource allocation in a perfect equilibrium model (as evidenced through neoclassical economics) (Allouche et al., 2015). However, this does encourage the commodification of resources, and may result in neglecting other issues such as environmental externalities, poverty alleviation and everyday realities at the local level (cf. Dupar and Oates, 2012). For many rural communities, food, water and energy have never been conceptually separated in the way that experts have sought to understand them. Indeed, it may be that the water–energy–food nexus is the (re)discovery by experts working in silos of what practicing farmers and fishers already know. However valuing nature as particular kind of capital and the regimes of financialisation and commodification that accrue with them may not only engender inequalities related to access and control, but could also lead to disrupting these ‘local nexuses’ which are more attuned to addressing complexity and uncertainty. In light of the myriad physical uncertainties and social vulnerabilities that different societies in varied ecosystems face, one needs to acknowledge pursuing
plural pathways that work in bottom-up ways and are more attuned to local systems of resource availability as well as its uses and consumption.

We live in a complex world with a multitude of interactions between the material, social and the biophysical elements that are by nature intractable and difficult to grasp. The nexus thinking may be described as an attempt to render these interactions visible and amenable to policymaking (cf. Dupar and Oates, 2012) and policy solutions, but as we have argued that there are clear limits to such a framing and their corresponding solutions. First, it is difficult to predict and capture the dynamics of this interaction as they are ridden with uncertainties – the unknown unknowns – more so in the context of climate change. Second, the solutions provided by the nexus often prioritises particular causal loops which are over simplistic and neglect the political economy of these interactions especially around the questions of resource access and use; there are inherent dangers that this ‘closed’ framing may render those local actions and needs invisible or peripheral as they get pushed out of the policy discourse.

In this light, reversing the gaze and thinking of systems as dynamic and open-ended becomes crucial. We need to think of better ways to understanding and working with alternative development choices which privilege local and diverse ways of knowing, as we work across scales to understand these ecological, social and technical interactions. The way forward begins with acknowledging the value of plural frames and solutions, and recognising the deeply political nature of resource use and access.

Notes
1 Drawing on ongoing work on the project ‘Uncertainty, Climate Change and Transformation’, funded by the Norwegian Research Council (forthcoming IDS Working Paper). www.ids.ac.uk/project/climate-change-uncertainty-and-tranformation

References


