Points of convergence: Deploying the geographies of critical nexus-thinking

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Abstract
In recent years, the concept of ‘nexus’ has become a metaphor for resource interactions (particularly between food, water and energy), a policy apparatus to address resource sustainability and an object of academic analysis. Contending that the ways that nexus has been conceptualised and applied so far are invariably incomplete, this paper marks a concerted attempt to draw geographical scholarship into the conceptualisation of nexus-thinking to offer a more complete reading of resource geographies and their underlying interactions. We present critical nexus-thinking as a conceptual framework for tracing the geographies fashioned by resource nexuses, including the enrolment of human and non-human populations into such nexuses, and how the governance of both routine resource interactions and of ‘shocks’ can impact on such populations. To mobilise critical nexus-thinking as a conceptual framework, we draw out three points of convergence between nexus policy logics and critical geographic/scientific scholarship: socio-material-ecological interactions, politics of scale, and flows, blockages and dis/connectivity. We deploy critical nexus-thinking through analysis that extends the 2014/2015 ‘water crisis’ in the São Paulo Metropolitan Area to other sites, spaces and materials in order to critically evaluate the politics, materiality and spatiality of resource governance, and we use this example to point to how scholars might apply critical nexus-thinking analyses in other contexts.

Keywords
Nexus-thinking, resources, water, environmental governance, politics of scale
Introduction

In August 2015, a severe water shortage affecting 20 million people in the São Paulo Metropolitan Area (SPMA) led the Government to declare a state of emergency. This declaration followed months in which the main reservoir systems supplying the SPMA were recorded at just 5%–10% capacity (Millington, 2018). An additional 20 million people across South East Brazil – in total, around 20% of Brazil’s population in a region that contributes one third of national economic productivity – were estimated to be experiencing or at risk of water insecurity (Nobre et al., 2016).

As the crisis evolved, the Municipal Government, together with the São Paulo State Water and Sanitation Company (SABESP), began a policy of reducing water pressure in the city’s pipes and offering incentives for lower domestic water use (SABESP Regional Manager, 2017, personal communication; Santos et al., 2018). The Government authorised the extraction of the heavily polluted ‘technical reserve’ of water from the city’s reservoirs. In addition, water to SPMA was channelled from water basins with a surplus (Water Basin Committee Secretary, 2017, personal communication), and a pipe was built between two of SPMA’s main reservoirs (Millington, 2018). Despite such interventions, months of scheduled water reductions ensued, and access became increasingly uneven (Cohen, 2016; Millington, 2018).

The crisis also impacted national energy generation and food production, resulting in higher food and energy prices, as well as increased ecological impacts associated with the production of energy. At the height of the crisis, a national order halted hydroelectric generation – Brazil’s main source of energy – in the region for as long as reservoirs remained at low capacity (Operator, Paraibuna Hydroelectric Plant, 2017, personal communication). This order not only impacted ecosystems downstream of hydroelectric dams, but more costly forms of energy generation – notably what one environmental activist described as ‘super pollutant thermal energy plants’ (Water Campaigner, Environmental NGO, 2017, personal communication) – were fed into Brazil’s electricity grid to compensate.

This short vignette – which we return to later in the paper – introduces some of the interdependencies inherent within the production, consumption and distribution of resources. Attempts to manage such interdependencies in response to resource insecurity and sustainability challenges have led to water, energy, food and sometimes other resources being conceptualised increasingly as a ‘nexus’ in policy frameworks and academic discourse (Hoff, 2011; Wietz et al., 2014).

Integrated approaches to resource governance appear unquestionable in a world where resources are not only tightly coupled but increasingly insecure, given the extremes of precipitation and temperature predicted by climate scientists (Dias et al., 2013; Falkenmark, 2013). Nonetheless, the complex material relationalities between resources made visible through the SPMA drought (and other such ‘crises’ around the world, see Anand, 2018; Lavau, 2013) underscore the need for critical analysis of ‘nexus’ policies in resource governance. As we exemplify below, resource systems are often integrated without concomitant planning for how the management of ‘shocks’ might resonate across such systems, generating unforeseen trade-offs that can lead to diffuse and long(er)-lasting impacts across a range of scales and spaces.

Presenting the 2014–2015 SPMA drought, and subsequent crisis, as an indicative example, this paper develops critical nexus-thinking as a framework for enacting such analyses. Whilst there have been existing attempts to analyse nexus policies, we contend that these analyses are often incomplete because they fail to conceptualise nexus-thinking and the ontological logics upon which nexus-thinking is based. A recent exception is presented by...
Zara et al. (2020: 4), who use the nexus concept to analyse the interwoven geographies of food in young people’s lives in Brazil and present nexus-thinking as a ‘lens for tracing resource geographies – revealing the intersecting scales, socio-materialities and human–environment interactions mobilised in resource use and governance – and related socio-ecological impacts’. Building from this and engaging theoretical debates on interdependence, scale and connectivity, we set out to develop critical nexus-thinking as a conceptual framework to trace the geographies fashioned by resource nexuses – including the impacts and ensuing ‘shocks’ that materialise during efforts to manage resource interactions. Where the objective of the nexus-thinking behind much policy making is to manage resource interactions to achieve resource security for human populations (in particular urban, relatively affluent and politically powerful populations), critical nexus-thinking, as we conceptualise it, aims to identify multiple interactions – and the forms of interdependence they testify to – in socio-ecological systems. This sheds critical light on how resource management regimes manipulate interactions to serve particular ends, usually centring on the perceived needs of (urban, affluent, powerful) human populations.

Our aims are twofold. First, by offering a more complete reading of resource geographies and their underlying interactions, we aim to untangle (so-called) resource nexuses to make visible the uneven distributions of materials, resources and power between populations, places and species and the multi-scalar governance arrangements underpinning these distributions. Second, we aim to reshape conceptual debates in human geography by considering the promise of nexus-thinking in relation to more established theoretical frameworks. We argue that the underlying socio-spatial logic implied by ‘nexus’, mobilised as nexus-thinking, has potential to sharpen and reprise long-standing questions relating to the politics, materiality, spatiality and ethics of resource governance. These aims are significant because the logic of nexus is deeply entrenched in contemporary resource governance (see Arboleda, 2020; Bouzarovski and Haarstad, 2019; Foden et al., 2019; Kraftl et al., 2019; Labban, 2014). Thus, how the nexus concept is mobilised has the capacity to impact policy outcomes for good or ill, with impacts on vulnerable populations in particular (Zara et al., 2020).

The next section provides a brief overview of geographical scholarship on the nexus. We then trace three points of convergence between theoretical scholarship and nexus policy logics, making reference throughout to water governance in SPMA and Brazil, along with other examples. Following this, we step back to discuss the diffuse impacts of the SPMA water crisis and its management, using the identified points of convergence as a critical conceptual framework. In doing so, we illustrate how critical nexus-thinking highlights the displaced effects of nexus governance, extending the sites, scale and territory of the crisis beyond SPMA, and its resource materialities beyond those solely concerned with water. We conclude by reflecting on the wider value and applicability of critical nexus-thinking, particularly in progressing understandings of human–environmental interdependence in the context of growing resource insecurity and climate change.

**Nexus in policy and academic literatures**

Nexus policies have been described as ‘a natural frame for rethinking sustainability as a complex adaptive system’ (Howarth and Monasterolo, 2016: 54). The logic of synergistic integration has been previously conceptualised as systems thinking, socio-ecological systems thinking and integrated water management (Cairns and Krzywoszynska, 2016; Davis et al., 2014; Leck et al., 2015). The current popularity of nexus was engendered by a series of business and global governance conferences organised to launch the 2015 Sustainable Development Goals (SDGs) (Leck et al., 2015). However, Allouche et al. (2015: 611)
comment that the ‘nexus bureaucracy’ discussed in global governance simply gives a policy language to practices taking place in local communities, ‘[where] the relationship between water, food and energy has often not become fragmented in the same way that experts have siloed the sectors’. This resonates with arguments that ‘the nexus’ is a Western policy intervention that obscures the ways in which de facto nexus-thinking is practiced, both by producers – for example, ‘farmers, fishers and livestock herders [who] have been aware of interactions involving water, energy and food production for millennia’ (Wichelns, 2017: 114) – and consumers, as Zara et al. (2020) argue that young people in Brazil knowingly practice a version of nexus-thinking in their everyday food practices.

Much scientific work on nexus – for example, advanced mapping of complex systems – responds to policy priorities to support climate adaptation and mitigation policies by visualising and improving the efficiency of resource circulations (see Bazilian et al., 2011; Hoff, 2011; Miralles-Wilhelm and Muñoz-Castillo, 2018; Zhang et al., 2018). Funded social science research on the nexus has likewise been driven by SDG policy priorities and business-policy-academic consortia. For example, projects making up the UK Economic and Social Research Council’s transdisciplinary Nexus Network have sought to apply nexus-thinking to sustainability challenges in areas such as energy generation, agricultural production and resource-intensive domestic practices (Cairns et al., 2017; O’Donovan et al., 2020). Such policy-driven research illustrates the widespread potential of nexus-thinking, yet without conceptualising its implications.

Also driven by policy challenges, but in contrast to the top-down approach taken by systems-driven nexus-thinking, recent geographical research has applied nexus-thinking to analyses of everyday practices and their intersection with resource availability, considering household sustainability in the UK (Foden et al., 2019) and young people’s experiences of resource insecurity in India (Walker, 2020) and Brazil (Kraftl et al., 2019; Zara et al., 2020). These studies use the nexus concept to ‘trace out’ flows of materials from human bodies, through domestic objects and infrastructures and everyday practices. Zara et al. (2020: 5) comment that this ‘tracing out’ ‘afford[s] a different sense of the nexus as configured by/ from materials, bodies and sites of governance, raising questions of identity and social justice orientated towards the national scale’.

Recent years have seen the emergence of critical social scientific literature that challenges a ‘putatively neutral, a-political’ approach to nexus-thinking (Schwanen, 2018: 7; see also discussions by Allouche et al., 2015; Cairns and Krzywoszynska, 2016). Geographers are accorded a particular role in progressing more critical work on the nexus. Williams et al. (2014: 9), whose envisioning of a ‘nexus assemblage’ approach to progress nexus-thinking is discussed below, call for multi-scalar research into the ‘geographies of the nexus’ – how resource interactions produce the nexus in specific places and how the effects of these interactions reverberate across spaces. Similarly, Schwanen (2018: 15) urges geographers to more fully engage the nexus concept to ‘understand the place-specific and multi-scalar nature of the interconnections of water, energy, food, land and climate, [and in doing so, to] develop epistemologically diverse understandings of the nexus [and] harness the potential of ontological frictions in nexus processes’.

Despite recognition of the importance of the nexus as a concept and policy framing, however, ‘nexus-thinking’ has thus far eschewed robust, critical conceptualisation by social scientists. This paucity enables it to become a ‘technical veil’ that obscures the politics, ethics and power dynamics of nexus policy applications (Allouche et al., 2015). As further discussed below, nexus analyses can also make a priori geographical assumptions about interconnectedness, political formations, associated materials and – particularly – scale(s) without interrogating these (see Bijl et al., 2018). There is also a risk that ‘high-level,
managerial applications of “nexus” policies may not resolve but may simply externalise “trade offs” and displace them to communities and households (Walker, 2020: 360). Widespread applications of nexus-thinking informed by (often unquestioned) rationalistic ontologies of complex ecosystems and their living entities as ‘resources’ may also be yet another way that non-Western ways of being (or being-with) are overlooked and often overpowered by dominant modes of resource governance (Yates et al., 2017: 799).

Taken alongside the urgent policy issues that applications of the nexus concept may help to resolve – minimising inefficiencies of production in the context of complex resource insecurities, addressing multi-scale inequalities of access, stewarding resource ‘excesses’ and avoiding ecological harms in the face of climate change – it is understandable that conceptualising nexus-thinking has not been prioritised. Nonetheless, we contend that developing a clearer theorisation of nexus-thinking and raising critical questions about its underlying ontological bases can sharpen the analytic purchase of nexus, which in turn is essential to support just policy outcomes.

In the sections that follow, we trace three points of convergence between nexus policy logics and theoretical scholarship: socio-material-ecological interactions, politics of scale, and flows, blockages and dis/connectivity. Although we recognise and allude to theoretical debates where relevant, it is our intention in this paper neither to resolve such debates and areas of ontological incommensurability nor to position nexus-thinking as the unique means to do so.

**Points of convergence I: Socio-material-ecological interactions**

Schwanen (2018: 1) describes the academic interest in nexus as ‘the latest instalment in a series of movements focused on coupled human-environment systems’, leading to critiques that the promises of nexus-thinking are nothing new. Indeed, theoretical framings such as assemblage, actor-network theory (ANT) and new materialisms are stock in trade for human geography (Anderson and McFarlane, 2011; Coole and Frost, 2010; Müller and Schurr, 2016) and reflect a wider ‘ontological turn’ in the social sciences (Escobar, 2007), wherein a growing body of work ‘takes the nature of being (ontology/ontologies) as the primary focus of enquiry’ (Yates et al., 2017: 800). Common to these framings are analyses of human and non-human subjects’ ontological ‘becoming’ through entering into new relational configurations (Bennett, 2010). Notably for this review, some scholars have used such analyses to develop an ‘ontological politics’ (Mol, 1999) that can be used to critically examine the ‘political consequences’ that arise when ‘multiple worlds interact’ and ‘some ontological enactments are prioritised over others’ (Yates et al., 2017: 800). Yates et al. (2017), for example, draw on critical indigenous and political ecology scholarship to argue that a rationalist ontology of water (as primarily a ‘resource’ to support human practices) frequently overpowers pluralist understandings of the meanings of water, particularly in settler-colonial or otherwise contested regions.

From these areas of scholarship, we identify two theoretical implications of relevance to nexus-thinking. The first is the tendency to treat constituent elements – whether referred to as objects, actors, actants, nodes or relations – as equally important. This enables scholars to articulate the ways in which even small changes to individual components or their organisation within a given network or assembly can lead to significant, system-wide impacts and lend individual components agency to make systemic changes outside the realm of human decision making. The second implication is that their respective networks or assemblages only come into being as they are practiced, performed and activated and as such lend them a phenomenological character. Bennett’s (2005) analysis of the 2003 North American
blackout, for example, illustrates the multitude of human and non-human participants and events, organised and connected at a range of spaces, times and scales required to enact the electricity grid, although perhaps it is through their ‘dissonance’, and consequent failures to connect that these relationships (or lack thereof), became apparent during the blackout. This implies an ontology that privileges relationality over structure and suggests that networks and assemblies are continuously coming into being as they are (re)fashioned by their multitude of components. Alterations to their ordering, or their disordering – or what Lavau (2013) refers to as ‘ontological cleaving’ – lead to new structures and arrangements. The methodological impetus is to reveal, or otherwise make legible, as much of the system as possible through detailed accounts that trace out relations and their points of connection (see also Latour, 2005), an impetus shared with nexus-thinking.

It is worth noting, however, that from historical-materialist perspectives, such a focus on relationality overlooks the historical/material elements of a given structure (Blomley, 2019; Murphy, 2013). As further elaborated through discussion of scalar politics below, we argue that these two positions are not incommensurable. Our position is that sites of practice (Schatzki, 2002), or indeed place(s) (Malpas, 2012) put the conditions into play whereby such assemblies and networks can come together – extending space and thereby generating relations and their potential for connection. Critical nexus-thinking that is attentive to place and power, as well as relationality and interconnectivity, focuses attention onto how particular socio-material-ecological interactions and relationships take shape through particular sites, are generated by particular places and extend to engender others and yet are shaped by wider (often relatively more durable) structures and practices.

Similarly to the electricity grid analysed by Bennett (2005), water distribution as well as electricity generation in much of Brazil relies on a range of largely hidden socio-material and bio-climactic interactions that in normal times lead to such connections – but which become apparent when they are disrupted. Chief among these is the hydrological cycle of the Amazon basin, which provides the engine for atmospheric water circulation on the continent (and the planet) (Nobre, 2014), and thus the natural ‘capital’ that underwrites much of Brazil’s economic capacity in terms of hydroelectric generation and agriculture (Nobre et al., 2016).

In order to capitalise on these natures, successive governments – beginning in the mid-20th century and notably during the military era (1964–1989) – embarked on a suite of ‘modernizing’ infrastructure projects that sought to exploit Brazil’s ‘natural’ capital (Ioris, 2020a; Schmink and Wood, 1992). Along with roads (Campbell, 2015), this period resulted in a range of big and small hydroelectric dams and distribution infrastructures for both water and electricity – e.g. pumping and transmission stations, pipes and powerlines and systems of governance that connect Brazil’s urban core(s), mainly in the South East of the country, to the Amazonian frontier (Bunker, 1988). As the military dictatorship gave way to civilian democracy, national-level governance was devolved to regional and state governance, and scales of distribution and governance became focused on the ‘natural’ scale of the water basin (Formiga-Johnsson et al., 2007).

As could also be argued with regards to the electrical grid, it is possible to see through this example how, whilst the distribution of resources comes into being through a myriad of practices, objects and materialities assembling at particular points in time and space, the physical infrastructure, sites of practice, modes of governance and institutional memories required to generate and distribute resources are durable. They are therefore subject to specific applications of power whereby physical infrastructures and their operations materialise. This is also evident in the management of the SPMA water crisis, analysed below.
Within nexus scholarship, there have been few attempts to connect the policy interest in managing resource interactions with theoretical developments that conceptualise human/non-human interactions as co-constitutive relational ontologies. One exception is Williams et al. (2014: 19–20), who propose the concept of a ‘nexus assemblage’ – ‘a sociotechnical configuration that, because of its extraordinary qualities, highlights, exemplifies or reconfigures the interactions between areas of environmental governance’ – to emphasise ‘the complex, contradictory and contested development of nexus interactions’. The authors argue that mobilising the concept of assemblage in nexus-thinking can generate understanding [that] goes beyond the quantitative view of technologies as ‘using this much water’ or ‘this much energy’, and highlights [the] heterogeneous nature of nexus technologies, or rather the infrastructures through which the interactions between water and energy are reconfigured. (2014: 20)

Even in this framing, however, the environments, materials and bodies enrolled in the circulation of food, water and energy are recast as enabling ‘infrastructures’, overlooking their inherent value, complexity and rights (see Yates et al., 2017: 208) and continuing a persistently anthropocentric understanding that obscures ‘the relations between infrastructure and other-than-human life’ (Barua, 2021: 2).

Considering nexus policy applications through the lens of socio-material-ecological interactions draws attention to the interdependencies that sustain so-called resource nexuses, for example, the interdependence of human and non-human life in ‘the shared corporeality of agro-food practices – of nature into the human body and of humans into the complex life ways of the natural world’ (Fitzsimmons and Goodman, 1998: 194). However, despite the undeniable ways that human activities benefit from the non-human world, there has been almost no discussion of nexus interactions from a posthuman perspective. Instead, analyses have viewed the non-human world as either a resource to sustain human life or as a model of synergistic interactions that humans can emulate to build resilient socio-ecological systems (Cote and Nightingale, 2012; Stringer et al., 2014). A more fully conceptualised nexus-thinking is sharpened by engagement with the ‘ontological politics’ (Mol, 1999) developed by ANT scholars and in turn can contribute to (posthuman) theoretical understandings of socio-material-ecological interdependence through a focus on nexus interactions and their effects.

**Points of convergence II: Politics of scale**

One of the main appeals of nexus approaches is their potential to illustrate how interactions between materials at particular points in space and time are powered by resource interactions at other points, making the ‘end use’ interaction a meeting of spatial-temporal scales (Scott et al., 2011: 6623). However, despite some debate about the scales that (particularly top-down) nexus analyses have enacted (or which they overlook; see Allouche et al., 2015; Howarth and Monasterolo, 2016, Leck et al., 2015), social scientific work on the nexus has yet to engage substantially with the considerable conceptual debates on scale that have shaped and animated geographical scholarship in the last 30 years.

It is beyond the scope of this paper to rehearse or resolve these debates, but in our view, engagement with them offers a way to sharpen the analytic potential of nexus-thinking. As discussed elsewhere by MacKinnon (2011), thinking on scale has polarised into two, not entirely incommensurable positions: one generally deriving from political economy and the other from poststructural approaches to social-spatial relationships, both of which
thoroughly reject simplistic notions of nested scalar hierarchies. The first, as Brenner (2019) outlines, is concerned with scale-making as a social and political process with material effects – especially as they pertain to and are situated within historical contingencies of capitalist modes of social reproduction (Arboleda, 2020). Focused on articulating the ‘politics of scale’ (Smith, 1992), this position generally holds that scales are relational (Brenner, 2001), the objects of political struggles over space (Swyngedouw, 1997) and are mobilised to affect particular political-economic projects (see Bakker, 2013; Brown and Purcell, 2005).

The second position all but rejects scale and instead locates social-spatiality in ‘flat ontologies’ of ‘self-organizing systems […] where the dynamic properties of matter produce a multiplicity of complex relations and singularities that sometimes lead to the creation of new, unique events and entities, but more often to relatively redundant orders and practices’ (Marston et al., 2005: 422). Through site-ontologies (Schatzki, 2002) that flatten nested and hierarchical configurations, a poststructural analysis of scale focuses on ‘horizontal’ connectivity to engender a politics of site and practice (Escobar, 2007) whereby, following the theoretical logics of assemblage and distributed agency outlined above, discourses, decisions and acts of power can be interrogated and their effects mapped out by tracing interconnections. Scholars have argued that this position opens ‘more entry points […] for progressive politics, [and the] possibility of enhanced connections across social sites’ (Marston et al., 2005: 427). This is compelling, because not only does it highlight the multiple and complex practices, connections and interactions through which a nexus comes into being, but it also gives license to nexus-thinking to analyse constituent interconnections and relations, particularly as they fall out of a normative scalar ordering.

One shortcoming, as we see it, however, is that whilst a nexus may be drawn together through a multiplicity of interactions, resource governance is rarely a ‘self-organising’, ‘flat’ system. Instead, it relies on and results in readily identifiable and powerful scalar configurations – most notably the State – through which power is deployed through new and existing frameworks of territorial organisation, specifically infrastructure (see Brenner, 2019: 54). In relation to the SPMA water crisis, this is visible in the ways in which state power has the capacity to structure the scales at which resources are governed and, in times of crisis, restructure them – in the process exacerbating, displacing or alleviating ‘existing socio-environmental injustices or create[ing] entirely new ones’ (Cook and Swyngedouw, 2012: 1969). Here there is conceptual convergence with what MacKinnon (2011: 22–23) refers to as a ‘scalar politics’ that brings together political-economic and poststructural approaches to scale to ‘interrogate specific processes and institutional practices that are themselves differentially scaled’.

Applying scalar politics to SMPA’s water management system reveals not only that it is organised at the water basin scale but also the decisions, institutions and actors occupying multiple positions within the municipal, state and national governments that established the ‘natural’ scale of the water basin as the de facto organisational unit for both water management and the supposed participatory democracy that underlies its governance (see Abers and Keck, 2011). A more complete application would likewise reveal the multiplicity of sites and practices through which the everyday practicalities of water distribution are negotiated and managed, and subsequently its scale(s) reproduced. As we outline later, this approach also illustrates how the water crisis was able to undo existing scales, and fashion new scales of distribution on top of existing infrastructure, as powerful agents ‘jumped’ scale (Smith, 1992) to marshal the resources of the State to manage the crisis (see also Brenner, 2001).

Stepping back from the two points of convergence discussed so far, we reiterate that our conceptualisation of nexus-thinking is less concerned with establishing ontological primacy – i.e. the order in which materials and scalar boundaries come into being – and more concerned
with the widespread effects of socio-material-ecological interactions in particular times and places. We turn now to consider the limitations or unforeseen consequences of human-led management as interactions are disrupted or changed, by turning to a third point of convergence: flows, blockages and dis/connectivity.

**Points of convergence III: Flows, blockages and dis/connectivity**

We begin this section by briefly examining scholarship that has used the concept of metabolism to attend to circulations of materials within and between sites of activity. The Marxian concept of metabolism alludes to the processes by which ‘nature’ is transformed through human labour into ‘natural resources’ that power social reproduction (Swyngedouw, 2006). As is the case with nexus scholarship, assumptions of connectivity and flow lie at the centre of discussions surrounding metabolism. Urban planners concerned with sustainability write about improving a city’s ‘metabolic rate’ by addressing shortages and surpluses in food, water, energy and waste resources (e.g. Kennedy et al., 2011). Critical urban scholars (for example, Cook and Swyngedouw, 2012; Gandy, 2004; Heynen et al., 2006; Millington, 2018; Newell and Cousins, 2014) approach resource flows through the lens of power, specifically endeavouring to uncover the ‘unequal power relations that are inherently bound up in the metabolism of nature’ (Cook and Swyngedouw, 2012: 1966).

By tracing where and for what purposes flows of resources like food, water and energy come together – whether in households, city infrastructure or industrial and agricultural production– nexus-thinking can direct attention to the metabolic processes resulting from these interactions, highlighting the differential and often spatially dislocated effects of trade-offs on different populations. A more conceptually-engaged form of nexus-thinking than is found in (most) existing nexus scholarship also broadens the analytic lens of metabolism beyond the usual spatial boundaries – particularly cities – of existing studies. This methodological shift from seeing the city as an artefact, to that of a driver of urbanising processes (see Angelo and Wachsmuth, 2015), calls for empirical investigation of other sites of metabolic activity where resources come from, go, and visit, and the ‘displacements’ that they generate in turn (Crang, 1996).

Recent scholarship has adopted – in our view – nexus-thinking in spirit by extending metabolic analyses beyond the city to consider how socio-material-ecological interactions reverberate across spaces, scales and times through material flows and blockages, often in unforeseen ways. Drawing on Kaika’s (2005) notion of the ‘ecological uncanny’, Arboleda’s (2016) analysis of the industrial development of the Chilean mining town of Huasco, for example, teases out otherwise illegible material-ecological interactions by analysing what happens when submerged infrastructural networks, ‘supersized’ through the globalised networks that connect local ‘operational landscapes’ through material flows, ‘spill out their contents’. In a striking example of the food-water-energy (and more) nexus, Arboleda’s analysis shows how mercury in water contaminated from mining in Chile and consumed by pigs in a nearby meat processing centre became embedded in the bodies of pork consumers as far away as China.

Similar understandings of the de/territorialising tendencies of resource infrastructure can result from an analysis of the material flows embedded in the SPMA water crisis, and of the ways that their disruption makes them visible. Borrowing from Nobre’s (2014) notion of ‘flying rivers’ (in which Amazonian trees evaporate water into enormous streams of vapour that fall as rain in the Brazilian southeast), Cohen (2016: 268), for instance, argues that market-orientated agri-capitalism (namely soya and cattle production) short-circuits hydrologic cycles, diverting water from the Amazonian watershed by embedding it indirectly in
Legumes and flesh. It is commoditised and subsequently transported to distant cities, where it feeds domestic and international food markets, whilst simultaneously disrupting the Amazonian ecosystem, rainfall in other parts of Brazil and perversely, the natural capital on which Brazil’s water (and, as we argue later, food and energy) distribution infrastructures rely (see also Dias et al., 2013; Ioris, 2020b). Cohen’s analysis highlights the wider interconnections between São Paulo city and regional infrastructure, and geo-climatic and hydrological systems – especially the distant and ‘natural’ hydrology of the Amazon that is enrolled into urban resource provision.

These examples illustrate how non-human bodies carry resources for human consumption, sometimes with adverse effects. Elsewhere, Barua (2021: 1) argues that ‘some species have become cosmopolitan as infrastructure – containers, cargo, ships and railways – has moved them around the world’. Nexus-thinking can push this further by offering a lens through which to consider the ways in which distant sites and practices, such as those associated with agri- and supply-chain capitalism (see Coles, 2016; Tsing, 2009), facilitate flows and act as blockages that re/route material flows of resources, and in the process enrol new actors and agents as a result of their attempts to govern commodities. In the process, it highlights the ways in which such disruptions alter the scales and territories nominally constituted by given resources – extending them through the spatial and scalar logics of nexus.

These examples have clear lessons for both academic and policy applications of nexus-thinking. The ‘unprecedented density and breadth’ of ‘infrastructural networks’ and ‘metabolic flows’ (Arboleda, 2016: 247) referred to in these analyses suggests that the priority for policy-makers is not to establish a nexus across ‘silod’ systems and sectors. Rather, it is to attend to the already-existing but often occluded social-material-ecological nexuses that connect individuals, species, materials, sites and technologies of governance. Attention to how flows resume or are reconfigured following disruptions to interactions allows attention to how the legacies of crisis may play out in spatially dislocated ways once ‘usual activity’ resumes.

We turn now to apply our nexus-thinking framework – informed by the three points of convergence discussed above – in greater depth to the SPMA water crisis. Following brief contextualisation, we review existing analyses of the crisis and its governance, before using our framework to highlight the critical insights that nexus-thinking can afford by focusing on water-energy coupling at different scales, and the knock-on effects set in train both by the initial disruption to water and energy, and efforts to manage their disruption.

Discussion

The challenges of water governance – When water is no longer water

Though still yet to be fully implemented, the establishment of multi-stakeholder water basin councils in Brazil in the 1990s posed a significant challenge to State control over water, and at the time led to its rescaling to the ‘basin-scale’ (Abers and Keck, 2011). The uneven progress of different councils in adopting this ‘new’ scalar configuration, however, shows the limitations of using ‘natural’ scales as ‘eco-scalar fixes’ to resolve systemic political and economic conflicts in resource governance (Cohen and Bakker, 2014: 142).

One area for potential conflict is over the multiple uses of water. The same era in which Brazilian governments embarked on large-scale infrastructure projects for hydropower (as discussed above) saw parallel government moves to ensure first food and then water security, resulting in the industrialisation and mechanisation of agriculture (Klein and Luna, 2018), and the increased connectivity to water distribution infrastructure, particularly for urban populations (Abers et al., 2017). Subsequent efforts have been made to commoditise
these sectors by focusing on exports and privatisation, increasing pressures on water as a resource and at the same time further deterritorialising its governance through that of the market. Critical scholarship has focused on the political economies and ecologies of dam building, but less attention has been paid to the problematic that lies at the centre of such a strategy: the requirement of a steady and predictable supply of available water to ‘feed’ hydroelectric turbines, alongside concurrent demands to irrigate crops, supply large urban and rural populations, power industry and maintain ecosystems populated by myriad non-human species.

To regulate fair access to water, Brazil’s national water agency has a system of categorisation where water is ranked from 1 (very good quality) to 4 (bad quality), or marked for special protection, and quality determines the possible uses of the water, including human consumption, animal consumption, irrigation and aquaculture, among other uses. The different market values assigned to these categories achieves an ontological enactment of water as a resource that can be separated into ‘exchangeable commodities’ and transferred between uses, following both needs and profit (Lavau, 2013: 427). Lavau, whose analysis of sustainable water management in Australia centres on the distinction drawn in environmental policies between ‘irrigation water’ (designated for agriculture and human consumption) and ‘environmental water’ (designated to support biodiversity and ecological health), comments that ‘the attribute of being exchangeable can also make environmental water more vulnerable. There is a real danger of coercion or marginalisation when demand for irrigation water is high in a harsh drought situation’ (Lavau, 2013: 429). This was the situation in Brazil in 2014/2015, as already complex negotiations over different actors’ access to water came into even sharper relief during a water crisis affecting over 20 million people.

The 2014/2015 water crisis: Revealing the holes in a ‘broken model’

Commentators have argued that the 2014/2015 water shortage in the SPMA was as much a social and political ‘crisis’ as it was an environmental event, resulting from years of poor planning and management of the area’s hydrological system. This is exemplified through what Cohen (2016: 277) describes as a ‘broken model’ whereby water was channelled into the city from distant watersheds to make up for water courses being almost entirely paved over during the exponential growth of the city, and the remaining water being severely polluted as well as depleted. A regional manager for the São Paulo State Water and Sanitation Company (SABESP) explained how even prior to the 2014/2015 crisis, ‘the search for more distant rivers to bring water here was necessary’ (SABESP Regional Manager, personal communication, 2017).

The failings of the ‘broken model’ were exacerbated by hydro-climatic changes meaning that, in the years leading up to the drought, ‘long periods of water scarcity were broken up by intense weather events’ (Millington, 2018: 28). Reflecting on the technical strategies taken by the State, along with SABESP, to address the water shortage and mitigate its effects, Millington argues that ‘had rains not returned in sufficient volumes in 2015, there was no next step’ (2018: 32). Indeed, it is important to note that the state of emergency for São Paulo was called off only when the 2015/2016 rainy season recorded higher than average rains.

Nonetheless, attempts were made to mitigate the water crisis through political-economic and socio-technological interventions that mobilised water’s material properties (i.e. its capacity to be stored and to flow) to cross the scalar boundaries defined by water’s management at the watershed level, redefining them in the process. Within SPMA, a complex institutional coalition, including state, federal and municipal actors, community collectives,
non-governmental organisations, state-owned companies and the World Bank, was established to manage the crisis (see Santos et al., 2018: 278–281). Ultimately, SABESP, with the support of the state Governor, launched an emergency plan to build a 13-km underwater pipeline from Billings, the largest reservoir in SPMA, and transport water to the Alto Tietê reservoir serving the east of the city (Santos et al., 2018). This complemented the existing suite of mitigation measures, including financial incentives and schemes to enhance conservation, such as encouraging domestic water capture and storage systems to augment household supply (Millington, 2018).

Both Cohen (2016) and Millington (2018) use a lens of urban political ecology to draw attention to the politics of crisis management, and the geographically uneven effects of the city’s hydrological system. This analysis is instructive in exposing the ways that inequalities are woven into the infrastructure of a city and reinforced through governance that prioritises infrastructural solutions. Similar narratives have been written about water scarcity and its mitigation in other places (see Angel and Loftus, 2019; Mustafa and Tillotson, 2019). Nonetheless, using nexus-thinking to attend to the ways that usual synergistic socio-material-ecological interactions were disrupted and made visible in the context of scarcity, and how these disruptions were addressed (incompletely and imperfectly) by additional technological interventions to maintain resource circulations, extends understandings of the distributed spatio-temporal effects of the crisis. Such an analysis also highlights the need for a more complete policy consideration of nexus-thinking in this and other contexts by drawing attention to the obfuscated effects that the mitigation of the water crisis in the city had on other spaces, sectors and scales. The following analysis draws from empirical research conducted by the authors in the Metropolitan Region of the Vale do Paraíba and Litoral Norte (Paraíba Valley and North Shore), directly to the north and east of SPMA, and nominally outside its watershed ‘scale’.

**Beyond the city: Applying nexus-thinking to the SPMA crisis**

Multiple scales and an array of governance, actors and material infrastructures were enrolled into interventions outlined above. Following Bouzarovski and Haarstad’s (2019: 261) observation that ‘[D]iscourse, power and contentious politics are central to processes of territorialisation and negotiation around scale’, a more in-depth analysis of water governance illustrates webs of interconnected actors and sites, as well as distribution of power and mobilisations of discourse. As multiple resources, such as food, water and energy interact, the institutional arrangements necessary for their governance demonstrate the difficulty of aligning governance to ‘natural’ resource flows (Scott et al., 2011; Yates et al., 2017). Further, decision making is often sited at a distance (physical, temporal, etc.), making governance appear as deterritorialised – something that is exacerbated when resources and governance are subject to market-forces. This makes it difficult to read how impacts reverberate through the nexus, or are territorialised, yet places the imperative on nexus-thinking to make such a reading.

In the SPMA crisis, the socio-material-ecological interactions centre on water, its distribution systems and their governance, which, through water’s material importance to food and energy sectors, activate other interactions. Indeed, water is important because its material properties make it instrumental to these other sectors (see Yates et al., 2017 for a longer discussion of how water’s ‘inherent multiplicity’ makes water governance a frequent site of political contestation). Focusing on the materiality of resources, and treating it as a driving component of interrelated systems of resources, as well as social, political and economic reproduction – i.e. as a ‘nexus’ – reveals further and increasingly complex interactions and
trade-offs embedded both within the resources themselves and their management, as well as concomitant resource systems. Though always present, these interactions become particularly acute, and the interrelations of the nexus more visible, during times of scarcity.

When questioned about such interrelations, for instance, a biofuels specialist interviewed by the authors highlights both the importance of treating resources as part of a nexus, and of concentrating on their material properties to illustrate how such a nexus is constituted:

The nexus is profound, these relationships are very profound. In Brazil’s case it is simple to say that an important part of the energy of our country comes from hydroelectric sources, although the electricity generation is a use that does not consume water [emphasis added]. We have a word for this…non-consumptive use. Of course, [as] water goes through the turbines and generates electricity…[it] the water goes from an upper level to a lower one [but assuming] that the flow is kept…water availability [for other uses] is kept. (Biofuels Specialist, 2017, personal communication)

This notion of ‘non-consumptive use’ is particularly important to water’s utility as a resource, which in turn is entirely owing to water’s materiality – e.g. its capacity to flow, be ‘kept’ and to be utilised multiple times (Lavau, 2013; Yates et al., 2017). These material properties inform both its management, its capacity to be managed and – crucially for our arguments about the nexus – the spatio-temporalities (and scales) enacted by its management.

This is illustrated by impacts of the ‘water crisis’ on energy production and consumption. At the height of the crisis, hydroelectric production was halted in São Paulo state (although not elsewhere in Brazil). An Operator working at Paraibuna Hydroelectric Plant, 133 km northeast of São Paulo city explained that ‘[I]n January 2015, the reservoirs got down to the dead volume […] energy generation had to be paralysed for some days’. This disrupted the usual synergistic interaction between water and energy, which the Operator explained as a series of connections:

The first connection [e.g. use of water] happens in the development of its product [energy]. The dammed water spins the turbines that transfer the kinetic energy through an axis that will be transformed into electric energy in the generators. Besides this direct relation, the energy generated is provided to industries, rural properties and urban houses, where different steps of the productive process are realised. Some hydroelectric reservoirs in Paraiba Valley also play the flow regulation role, the regularity in the supply and flooding reduction, [enabling] food production. (Operator, Paraibuna Hydroelectric Plant, 2017, personal communication).

Water, in this example, is more-than water. It represents energy that becomes electricity, and by extension the economic impetus for the Paraiba Valley (northeast São Paulo state) region. The material properties that enable water’s multiple uses mean that water is also a driving force for the region’s energy and food production, which in turn powers the region’s political economy. In essence, this rescales water and its governance from that directly associated with its hydrological infrastructure (e.g. the water basin) to the scales implicated in, and fashioned by, electricity, food production and industry.

In Brazil, hydropower is recognised as ‘non-consumptive’ use of water because it flows through hydroelectric turbines before making its way downstream to other potential uses. Bennett’s (2005: 450) discussion of ‘reactive power’ as a ‘profitless commodity’, necessary to keep things moving and capable of drawing the electricity grid to a halt if absent or insufficient but which does not have economic value for consumer use, is analogous here.
Regardless, water’s consumptive and non-consumptive uses depend both on its material properties to flow or be pumped, or to be stored, and on its availability to the system in the first place. Water diverted upstream to consumptive uses, or indeed water cycles disrupted by distant processes (such as deforestation and agriculture in the Amazon region) limit other potential uses. Maintaining this flow and capture is crucial to water’s governance, but until use/exchange values are negotiated and water is used, its value lies in its potential and presence (Lavau, 2013).

During the crisis, the emergency coalition of governance in SPMA recruited the same materialities that enable water’s different uses, and consequently refashioned the spaces and scales of its uses to mitigate the effects of the crisis. In the process, they generated further, future resource ‘trade-offs’. These in turn resonated across interconnected systems with varying effects for different actors, extending the nexus in which water is embedded by revealing even more multiple, entangled relations. This has lessons for both policy applications and academic analyses of nexus: to pay greater attention to different uses for ostensibly the same ‘resource’, as well as articulate the points of divergence and convergence where its flows are maintained or lost, and the conflicts that arise when they are disrupted.

Applying our conceptualisation of a nexus-thinking that is attentive to place and power, as well as relationality and interconnectivity, not only highlights these entanglements and spatialities, but grounds them into particular sites from which and to which their relationalities are established. Paraibuna hydroelectric plant, for instance, is not only critical to generation of hydropower, and thus to the distribution of water’s active power, but is also a distribution point for the reactive powers embedded in water’s other materialities – e.g. its other non-consumptive, consumptive and potential uses. The nexus in which water is embedded is therefore enacted by the institutional knowledges and practices that, along with interconnected relations, constitute sites such as Paraibuna and is territorialised as these relations extend outward to other sites, spaces (and times).

Indeed, long after state officials took emergency action to redirect water across the region from its non-consumptive uses to supplement the city’s water supply, knock-on effects continued to be felt. In particular, the region’s capacity to supply electricity to customers – including local level water managers – became apparent. As technical advisors from one of Brazil’s largest electric utilities companies, which serves the Paraiba Valley region, explained:

[...]

the water crisis ended up reflecting the electricity generation capacity of hydroelectric plants. The government through its respective agencies had to put the thermoelectric plants in use [...] here in Brazil; there is a merit system in the generation, in which the first ones [are] more renewable and have lower operational cost and then come the ones that are less renewable [...]. In 2014 and 2015 the thermoelectric plants had to operate during most of the year, and one of our plants was in this situation [...] this caused a market and electricity sector cost increase as a whole [...] the distributers had to purchase electricity at a [much higher] cost. (Technical Advisors, Electric Utilities Company, 2017, personal communication)

These higher unit costs for electricity (as well as for food and water) were eventually passed down to consumers across the electricity grid, impacting regions that were otherwise isolated from the water shortage. Again, a nexus-thinking analysis of this ‘trade-off’ or spatial dislocation helps to elucidate the challenges of resource governance. Water provision across the region relies on energy intensive systems of catchment, storage and pumping. Thus, water scarcity generates a multi-fold blow in terms of long-term costs for water and electricity, as well as food (and other commodities generated through the consumptive use of water). In the situation outlined by the Technical Advisors, the higher electricity costs of thermo-power

Walker and Coles
generation, plus the need to buy electricity from the market, led to higher water costs, themselves already high owing to water shortages. The connection between material flows and marketisation is further entrenched by differential pricing mechanisms that charge more or less per unit of electricity or water depending on time of day and amount of use, and crucially, the extent to which the source of energy is deemed to be renewable (this was confirmed by a Regional Manager of SABESP in a personal communication). Additionally, Brazilian law sets limits on tariff increases, which are periodically reviewed – meaning that consumers are protected in the short-term, but companies can incrementally increase their tariff to recoup their costs, enrolling multiple circuits of debt-financing into the nexus in the process. As another Advisor explained:

> when we were in the water crisis, the distribution companies could not immediately transfer costs of the electricity price increase to customers, it was necessary to wait [to] transfer [e.g. float costs] from one month to another [...] causing less impact in a tariff review, it will impact customers less immediately. (Technical Advisors, Electric Utilities Company, 2017, personal communication)

Therefore, the economic cost of the crisis was felt by consumers but not immediately – meaning that the costs of water’s (mis)management at the hands of actors within the SMPA were borne outside the region and long after the SMPA governance coalition declared an end to the crisis.

To conclude this discussion, we suggest that nexus-thinking not only illustrates the ways in which the crisis outlived (and may still outlive) the drought, it also illustrates the ways in which the material interactions of ‘resources’ extend far beyond the nominal spaces, scales and temporalities of their governance. Applying the points of connectivity outlined above, socio-ecological-material interactions, the scales they mobilise (and that are mobilised in their management) and the modes of their flow and dis/connectivity both generate and comprise a nexus of relationships that can be analysed and traced out from particular sites of activity. SPMA’s water crisis was ‘easily’, though expensively, mitigated through various strategies in the sense that water supplies continued to urban inhabitants. Viewing its region- and nation-wide impacts through the lens of critical nexus-thinking, however, highlights the multiple spatio-temporalities, scales and practices generated by the nexus, the non/human actors enrolled in its reproduction and, importantly, the ways in which the impacts of seemingly deterritorialised governance are realised through territorialised manifestations of power transmitted through the nexus. A nexus-thinking perspective also draws attention to the impacts that (mis)management of resource crises such as the SPMA water crisis may yet have, particularly as its effects on different species and populations may not yet be recognised.

This leads to our final point: there is an environmental cost to the crisis that is not yet fully understood. To return to a quote from early in this paper, thermal energy generators are considered by many environmental campaigners to be ‘super pollutants’, and in Brazil, their economic cost is in part due to their lower rating in the national merit system mentioned above. This is extremely important to consider in light of identified patterns that scientists working in the region have attributed to climate change – where already changes to the ‘flying rivers’ phenomenon (Nobre, 2014) are a major driver of uncertainty in a region constantly teetering on the edge of water crisis (Dias et al., 2013; Escobar, 2015; Millington, 2018). At the time of the crisis, scholars from the University of São Paulo argued that

[A]lthough pressing actions are needed to avoid water collapse in Brazil, an understanding of the importance of preserving large tracts of tropical forest, such as the Amazon rainforest, is
essential to promote more effective climate change policies and lower the risk of future droughts. (Nazareno and Laurence, 2015)

An additional release of greenhouse gases through thermal power generation in the eventuality of another water crisis is anathema to mitigative action on climate change and could further exacerbate the unpredictability of rainfall, thus drawing into sharper relief the relationship between resource sustainability and climate change in a water-pressured region.

Given that the crisis was resolved only when it rained, the efficacy of the intervention remains questionable, particularly when viewed in light of future resource security and resilience. This has clear lessons for nexus policy applications designed to ‘quickly solve long-term fundamental and structural issues’ without considering how the ‘technical veil’ of efficiency ‘masks a bigger debate […] around resource inequality and access’ (Allouche et al., 2015). The realisation that, ultimately, rain (not human intervention) resolved the crisis shows human–environmental interdependence in sharp relief and underscores the extent to which the non-human world supports human activity in ways often taken for granted in dominant modes of governance.

Conclusions

At a time when the nexus concept has been mobilised by policy-makers, the business community and researchers in many contexts, we have argued that identifying nexus-thinking’s ‘points of convergence’ with contemporary theoretical development from within critical human geography and social-sciences can enhance the concept’s analytic efficacy. Furthermore, by more clearly and completely articulating the social-spatial reproduction of the nexus, we argue that nexus-thinking renders complex resource interactions, their often-uneven distribution of materials and their embedded power relations and impacts more visible, enabling critical analysis of multi-scaler resource governance. Drawing together points of convergence between theoretical scholarship and nexus policy logics, we have set out to present critical nexus-thinking as a conceptual framework that enables scholars to interrogate nexus policy applications and enact conceptually informed nexus analyses. We argue that this framework is capable of engaging the underlying ontological questions about the constitution of particular nexuses that are often taken for granted or obscured in dominant policy-led approaches that use the notion of ‘nexus’ to envision and enact more ‘efficient’ resource management.

This is important because, as a governance tool with ‘far greater international traction – especially in policy arenas – than many concepts that animate much geographical scholarship’ (Kraftl et al., 2019: 303), current nexus approaches are concerned with maximising synergies and minimising trade-offs, yet trade-offs within a nexus are often disproportionately borne by particular populations or species, and displaced to other spaces and territories. Following the lead of posthuman, assemblage and ANT-oriented scholarship reviewed in sections above, questions of which scales or populations (human or otherwise) are prioritised and protected in nexus policy applications are an ethical concern that geographers and other scholars must consider in relation to nexus policy applications. Critical nexus-thinking helps clarify the grounds on which such ethics can be established. In addition, and whilst acknowledging that notions of interdependence are nothing new to geography, we argue that critical nexus-thinking can generate new modes of knowing human–environmental interdependence and thus has greater theoretical value than has been realised through existing nexus scholarship.
Our approach to nexus-thinking goes beyond tracing out assembled relations, identifying actors and revealing spatio-temporally specific points of intersection within and between spatial scales. It also entails identifying key materials and materialities, and tracing their circulations to key points where their flows intersect or are disrupted, as well as where their materialities become mutable. Nexus-thinking can thus be employed to ‘think’ laterally about the relations whereby such scales are (and have been) made, as well as mobilised for political ends, and to highlight the practices whereby scales continuously come into being. It does this by tracing out relations and sites of power, and identifying the invisible connections that might alter the scales otherwise in play – enrolling any number of wider ecologies, and more completely identifying the territorial extents over which resources and resource governance operate. By encompassing perspectives from the human and non-human margins, critical nexus-thinking also sharpens social scientific understandings of interdependence.

As the effects of climate change disrupt and highlight the precariousness of many existing socio-ecological-material interactions, critical nexus-thinking is more important than ever. Synergistic interactions are already in place, but the complexity of the relations stemming from these interactions has not been fully theorised. This means that nexus policy applications are invariably incomplete, geographically contingent and isolated. Whilst complete consideration of the effects that might resonate across complex and interwoven resource systems is impossible, we argue that greater attention is needed to illustrate the multiple scales, sectors, populations and materials that are enrolled into – and in turn affect and are affected by – resource nexuses. Not only will this offer nexus-thinking greater conceptual purchase than has been achieved so far, but it is also essential to avoid applications of nexus policy logics that might otherwise reinforce already-existing injustices and inequalities between regions, populations and species.

Highlights

- Attempts to conceptualise and apply ‘nexus’ as a policy apparatus and object of analysis are invariably incomplete.
- The authors draw geographical scholarship into the conceptualisation of nexus-thinking to offer a more complete reading of resource geographies.
- Three points of convergence between nexus policy and scholarship are identified: socio-material-ecological interactions, politics of scale and flows, blockages and dis/connectivity.
- These points of convergence are applied to critically evaluate the politics, ethics, materiality and spatiality of water crisis in Brazil.
- Critical nexus-thinking can be applied to highlight and address the uneven effects of resource ‘crises’ and their governance on different regions, populations and species.

Acknowledgements

The authors are grateful to participants in the ESRC/FAPESP/Newton Fund (Re)Connect the Nexus project, whose interviews for the project informed our understanding of the workings of the nexus in southeast Brazil (and beyond). We wish to thank David Evans and members of the (Re)Connect the Nexus team for helpful early discussions towards this paper, and Peter Kraftl in particular for useful comments on later drafts. Finally, we thank the editor and two anonymous reviewers for their constructive comments which further strengthened the paper.
Declaration of conflicting interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding
The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Our writing of this paper was funded by the Economic and Social Research Council (Grant No. ES/K00932X/1) as part of the ESRC/FAPESP/Newton Fund (Re)Connect the Nexus project.

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Notes
1. Personal communications in this paper are drawn from interviews by the authors for (Re)Connect the Nexus, a research project funded by the UK Economic and Social Research Council, the Newton Fund and FAPESP, the São Paulo state research foundation.
2. There are 11 possible uses for freshwater (água doce) in the categorisation. See Agência Nacional de Água (ANA; National Water Agency, n.d.) for a Portuguese language explanation of these uses and their categorisation.

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