



The water-energy-food nexus: An integration agenda and implications for urban governance



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ABSTRACT

The water-energy-food nexus has achieved considerable prominence across academic research and policy sectors. The nexus sets an imperative for integrated management and policymaking, centring on the potential trade-offs and complementarities between interdependent water, energy and food systems. Applications of the nexus focus largely on technical or managerial solutions and calls to acknowledge the political dimension of nexus interdependencies have implications for governance at the urban scale. This paper aims to 'urbanise' the nexus agenda and consider the implications of policy integration for urban governance. This examines the nexus in the context of current approaches to urban governance and power relations shaping the provision of water, energy and food in urban areas. Urban infrastructure networks underpin these resource systems and related management systems, although their management tends to operate in silos, with little joint decision-making and planning. Three hypotheses about the interplay between integrative policy framings and urban governance are explored to reconcile integrative policy framings at the urban scale: the appropriation of the nexus narrative by urban governments; re-establishment of political power through integrated management, and implementation of the nexus through smart city approaches. These hypotheses progress the political dimension of the nexus debate and reflect on the role of urban governance in addressing global challenges.

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1. Introduction

Pressing environmental sustainability issues have confronted cities for over 25 years, since the institution of Local Agenda 21 the 1992 Rio Earth Summit (Bosworth, 1993). The rapid pace of global urbanisation over the past decade heightens the imperative to transition to more sustainable forms of urban development (Bulkeley, Luque-Ayala, & Silver, 2014b; Zhang, 2016). The Sustainable Development Goals prioritise urban resilience and sustainability, reinforcing the urban scale as a priority for global and national governance (Parnell, 2016; United Nations, 2015b). Concern has increased in both local governments, global governance actors and the private sector, around the need to secure the availability of water, energy and food through the management of their structural interdependencies (Beddington, 2009; Hoff, 2011;

Muller, 2015). Water, energy and food systems are essential resources on which all human activity relies (Biggs et al., 2015; Smajgl, Ward, & Pluschke, 2016). Disruptive events such as the crises and the volatility of food prices in 2008, or repeated water and electricity shortages in emerging countries, have led to debate over their interdependence and limits. In this context, the need for cross-sectoral integration of the production and provision of essential resources has garnered greater attention. This cross-sectoral approach, defined as the water-energy-food nexus, has been raised by international organisations and governments as a crucial policy matter (FAO, 2014; Hoff, 2011; Parliamentary Office of Science & Technology, 2016). The United Nations and World Economic Forum focused heavily on the risks of nexus failures, and the link between resource security and economic growth (Hoff, 2011; United Nations, 2015a). This shift in framing suggests the emergence of a 'nexus approach' in policymaking. As a policy frame, the nexus adopts holistic treatment of interdependent sectors or subsystems (Muller, 2015), gives policymakers the mandate to consider broader interdependencies, and emphasises trade-offs and complementarities between systems (Al-Saidi & Elagib, 2017).

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This nexus approach holds that, instead of focusing on water, energy and food systems separately, governance of resource use and service provision should address the multiple causal pathways through which they interact with each other. The underlying assumption is interdependence across the three systems (the 'nexus'), and in turn, their interactions ultimately affect their availability. Similar to other policy framings such as energy security (Bridge, 2015), the nexus is an integrative imaginary which implies that integrated governance of water, energy and food systems is more advantageous than a siloed approach (Szczyszynski & Galarraga, 2013). This doctrine purports an integration approach because external factors including population growth, environmental change and increasing urbanisation put systems under greater strain. In particular, operationalisation of the nexus seeks to integrate across systems through technological and institutional change (Villamayor-Tomas, Grundmann, Epstein, Evans, & Kimmich, 2015; Villaroel Walker, Beck, Hall, Dawson, & Heidrich, 2014). The nexus approach perceives integration as a fundamental step for ensuring resource security in a global context of increasing and competing demands.

While many framings of the nexus contend that there is a co-ordination failure within existing modes of globalised production and consumption, implementing this approach reveals that it is not value-neutral (Allouche, 2011; Scollon, 2005). This paper discusses the implications of the nexus approach for urban governance, drawing on recent calls to 'politicise the nexus' (Williams, Bouzarovski, & Swyngedouw, 2014). Growing urbanisation is seen as a key factor in water-food-energy nexus problems, as it shifts land use patterns, the spatial distribution of populations, and concomitant infrastructures and resource flows (Bridge, Bouzarovski, Bradshaw, & Eyre, 2013). The nexus approach also challenges existing policy configurations on matters such as the supply of water, food, and energy to city dwellers and users (Castán Broto, 2016). Due to their systemic complexity, cities are possibly a critical juncture where the viability, political implementation and challenges arising from nexus thinking will be tested.

This paper constitutes an initial attempt to 'urbanise' the nexus approach to explore the implications for cities, in light of the governance tools and power relations shaping provision of water, energy and food in urban areas. Trends in the growth of cities, albeit varied across regions, have diverged from historical forms of governance and spatial development. New flows of international capital, decentralised governance, and economic forces driving agglomeration of particular industry sectors in urban areas all drive new patterns of spatial development (Schmid, Brenner, & Topalovic, 2016; Seto, Sanchez-Rodriguez, & Fragkias, 2010). The global trend toward urbanisation presents both challenges and opportunities for sustainability and resource management, and well-informed governance and planning have a central role in addressing these. Growing concentration of populations to urban areas heightens the imperative for the equitable and effective management of interdependent resource systems, with greater criticality around localised failures. Transitions to sustainable urban development can take the form of 'tweaks' to existing systems, or transformative structural changes to confront technological lock-in and systemic inertia (Childers, Pickett, Morgan Grove, Ogden, & Whitmer, 2014).

The implications of a nexus approach for urban governance have thus far been an object of little systematic attention. Most nexus literature focuses on quantitative modelling of system interactions (Bazilian et al., 2011; Chang, Li, Yao, & Zhang, 2016; Chhipi-Shrestha, Hewage, & Sadiq, 2017; Dhakal & Shrestha, 2017), technological and policy innovations (Brekke & Brugmann, 2016; Muller, 2015; Schlor, Venghaus, & Hake, 2017; You, 2016; de Grenade et al., 2016) and regulatory approaches (Larcom & van

Gevelt, 2017). Attention to the nexus at the urban scale connects technical analyses and outputs with urban planning and governance frameworks (Engström et al., 2017; Kenway, 2015; Lenzen et al., 2017), to a more explicit consideration of their underlying governance frameworks - something with which literature on these themes has only begun to grapple. In this sense, we do not wish to understate the important advancement of much recent cutting edge nexus work (Kenway, 2015; McPhearson, Haase, Kabisch, & Gren, 2016; Scott et al., 2011) but rather argue here for more explicit exploration of the political and governance dimensions of the global and local spatial shifts of urbanisation called into question. The political dimension of multi-scalar water, energy and food systems introduce significant complexity to nexus management (Romero-Lankao, McPhearson, & Davidson, 2017). Our goal is twofold: First, we provide a conceptualisation of the nexus to evaluate the interplay between this policy framing, especially as elaborated at national and international levels, and urban policy-making. We build on public policy theory to conceptualise the water-energy-food nexus approach as a causal story and agenda (Stone, 1989) promoting cross-sectoral integration. Current nexus literature in social sciences is polarised between macro-dynamics and place-specific studies (Stein, Barron, & Moss, 2014; Williams et al., 2014). Our middle-range approach conceives the nexus approach as a 'policy story' that opens up possibilities for the reconfiguration of existing governance arrangements. Second, we aim to develop a set of hypotheses about the interplay between this approach for cross-sectoral integration and urban governance. In particular, we discuss the urban dilemmas of cross-sectoral integration, regarding power scales, state/market relations and tools of urban governance.

While an integration agenda is often seen by global governance and funding agencies as a panacea to resource crises and risks of cascading failures (Cairns & Krzywoszyńska, 2016), our perspective discusses it as a realm of policy alternatives. Policy integration is not assumed as inherently beneficial, although it should reconcile itself with an understanding of the power relations and institutions shaping policy change. This approach sets an agenda for empirical analysis. Understanding the negotiation of possible integration policies is a crucial matter when considering if and how cross-sectoral policies can contribute to universal, equitable and sustainable access to resources.

Our critique of the nexus approach offers insights on models for 'urban integrated management', such as the smart city or resilient city paradigms (Hodson & Marvin, 2009; Pitrenaitė-Zilėnienė & Torresi, 2014), as calls for both urban integrated management and infrastructure re-bundling are flourishing in response to 'wicked problems' dominated by interdependencies and spillovers (Frame, 2008; Stirling, 2010). The opportunities for urban intervention are often seen as pertinent for so-called 'wicked problems' (Rittel & Webber, 1973). Wicked problems are conceived as complex problems with ill-defined boundaries and solutions, subject to multiple competing views across actors and scales, conflicting values, and only partial comprehension of a problem across different actors.

2. The nexus approach and the urban question

While initial studies of the water-food-energy approach appeared as early as the 1990s (McCalla, 1997), the nexus has seen unprecedented prominence in the agendas of international organisations over the last decade (Endo, Tsurita, Burnett, & Orenco, 2017). The extent to which nexus thinking has influenced international debates is evident by looking at the flagship topics put forward by international organisations involved in these three sectors, as well as the proliferation of literature on the matter (Bizikova, Dimple, Swanson, Venema, & McCandless, 2013; Brekke

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