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The critical role of risk in setting directions for water, food and energy policy and research

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The sustainable development goals (SDGs) challenge markets, regulators and practitioners to achieve multiple objectives on water, food and energy. This calls for responses that are coordinated and scaled appropriately. Learning from water–energy–food nexus could support much-needed building of links between the separate SDGs. The concept has highlighted how risks manifest when blinkered development and management of water, food and energy reduce resource security across sectors and far-reaching scales. However, three under-studied dimensions of these risks must be better considered in order to identify leverage points for sustainable development: first, externalities and shared risks across multiple scales; second, innovative government mechanisms for shared risks; and third, negotiating the balance between silos, politics and power in addressing shared risks.

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Introduction

The sustainable development goals[1] provide a timely opportunity to clarify how research and policy on the water–energy–food nexus must develop if it is to contribute to implementing sustainable development [1•].

The SDGs challenge markets, regulators and practitioners to identify where and how to act to achieve multiple objectives on water, food and energy. This calls for responses that are coordinated and scaled appropriately. Yet experience tells us that inter-sectoral compromise and cooperation is unavoidably piecemeal and fragile [2]. Despite progress, our ability to integrate patchwork policies and political goals for food, energy and water remains extremely modest in most contexts [3].

[1] Website: https://sustainabledevelopment.un.org/sdgs, last accessed 25 September 2016.

The water–energy–food nexus could support much-needed building of links between the 17 separate and, at times, conflicting SDGs. 'Nexus thinking' [4] is a concept recognising that water, food and energy sectors are interdependent and, as such, must be viewed as one system. Though still ill-defined [5•], its recent emergence suggests that while bilateral links between water, energy and food have been acknowledged [6•], insufficient attention has been paid to the full systemic connection between these [4]. The concept has gained momentum with some private, public and civil society actors because it promotes the analysis and governance of complex trade-offs to better manage water, food and energy resources [7]. Their concern is that blinkered development of resources within each sector reduces the effectiveness of our planning and management systems to deliver a sustainable flow of basic resources, creating water, food and energy risks [8].

There is some basis to this approach. Risks are inherent to systems in which different sub-sectors share similar types of resources, face similar uncertainties and undesirable outcomes [9,10]. Identifying and, where possible, measuring these *shared risks* may be a new entry point for realising improvements in governance frameworks and capacities, with participation by key actors to ensure sufficient coordination. Incentives for joint action are stronger when risk cannot be managed or mitigated by one sector or perspective alone. However, as this paper argues, the policy and research agenda on the water–energy–food nexus needs to consider three under-studied dimensions of shared risks before it can help identify leverage points for sustainable development: first, externalities and shared risks across multiple scales; second, innovative government mechanisms for shared risks; and third, negotiating the balance between silos, politics and power in addressing shared risks.

Externalities and shared risks across multiple scales

Hayes and Crilly [11] illustrate that risks manifest at different scales within the water–food nexus. The exposure and materiality of these risks are poorly recognised and defined precisely because there is little understanding of *how* risks emerge for various stakeholders.

One critical dimension is that of ecosystem integrity and environmental quality within the nexus between water, food and energy. The natural asset endowment of countries that underpins water, energy and food services is at risk of degradation to the point where environmental services may not be assured [12–14]. In the Mekong River Basin, 88 new dams could be built in the basin to meet growing regional energy needs by 2030. The economic rewards from greater energy production are produced through changing the hydrological, biological and nutrient cycling systems of the Mekong river [15–18]. In effect, energy needs and protein supply are competing priorities across nations and scales because they are linked by river health [19]; different conditions of river flow and the quality of the water are required for stable energy supply and resilient food production. As a result, proposed hydropower development could result in a 23–38% net loss in locally produced fish protein directly impacting on up to 60 million people [14,20]. Shared risks at different geographical scales due means risks to other priorities that must be considered in the well-established paradigm of 'cheap energy for all'.

The energy sector has begun to price externalities. Coupling the consumption of natural resources and impairment of ecosystems with market price signals is a good idea; but not always feasible [21]. Politicians, regulators and energy operators have to deal with the political imperatives, and market and development demands to deliver ever cheaper food and energy. Across local, national and regional populations 'win–win' outcomes are doubtful. Some stakeholders will be negatively affected by underpricing in one form or another, including the environment that provides the river flows. In short, the water–energy–food nexus is 'multi-centric' in terms of sectors, participation and resource use and a critical question remains on how best to balance needs across scales [5•].

Reconciling trade-offs that occur in producing food and energy and managing water is complex and challenging. The capacities of different actors to cope and respond to these are variable [22]. Regulators should be mindful of these points when asking private and public sector actors to implement integrated management, pricing, or other supposedly optimal solutions. A first enabling condition is that technical, individual and institutional capacities can at least account for cross-scale interactions between the sectors. Future research will need to be strategic in collecting new data and knowledge assessing how individual food, energy or water security policies create social and environmental risks that can manifest farther afield or ahead in future. Research must focus on organizing and brokering information in new and transparent ways for all actors to understand consequences of single-sector and single-scale objectives.

Innovative governance mechanisms that respond to shared risks

Joint policies on water, food and energy differ depending on regional practices, institutional architecture and scientific inquiry [23]. The US focuses on information transparency and disruptive technologies; in Europe, many public policy makers focus on regulation and management as the solution to shared risks created by water–energy–food interconnections [24]. However, as shown by different authors [2,6•], risks from poorly integrated food, energy and water management can always be resolved once adequate governance is achieved. But governance frameworks have their limits.

What can and should be expected from centralised governance structures in addressing complex challenges of inter-sectoral and cross-scale joint management of water, food and energy resources? By 2050, resource limitations will be hit irrespective of governance approaches if a 50% increase in global water and energy consumption is pursued under current demographic, technology and global change conditions [25–27]. Depending on one central actor to react effectively to solve this problem brings new dependency and possible policy capture risks. Coherent and context-specific answers provided at different scales is what is needed [9,22].

Policy makers can increase the use of flexible governance mechanisms to address risks at multiple scales through a number of approaches, for example:

- Decentralise authority to the most appropriate levels for dealing with problems [28].
- A mix of formal and informal polycentric governance measures [29–31] which promise to overcome dependence on a single actor to be the solution provider.
- Adaptive management [32] and social learning to identify multiple, if not always shared, visions for the future, increase cooperation and improve knowledge sharing [33,34].
- Transboundary dialogues, participatory research, data democratization and sharing, regional and peer-to-peer knowledge exchange, all providing enabling conditions for new alliances across sectors [35].

The value of these approaches is that governance systems are better equipped to plan for change rather than only what can be predicted [36,37]. In Brazil, the Secretariat of Strategic Affairs for the Presidency conducted a national multi-sectoral scenario study to assess the likely impacts of climate change, and only then identified strategies for adaptation.[2] The analysis highlighted what happens under allocations of resources to different climate adaptation actions rather than focusing on one certain future. More analysis like this would help to define and implement flexible governance within timeframes that can address shared risks at different geographical levels for water, food, and energy security. Investment in the enabling conditions for flexible governance mechanisms will be an important element in making this shift.

Negotiating the balance between silos, politics and power to address shared risks

Institutional silos are needed for both science and policy to derive expertise, knowledge, resources and capacity to take action. Yet this operational convenience runs the risk of resource allocation choices being made to address the interests and needs of one sector or group, often at the exclusion of others.

Links between agriculture (including food production, energy and industrial crops) water, energy, and increasingly climate, are data rich and deeply informed in many cases. Yet, incentives for powerful players in these sectors often work against moving to mutually beneficial management of food, water and energy for multiple actors [38]. Economies have deeply established market hegemonies and operational norms that materialise as entrenched supply chains — and so feedbacks and unintended consequences on other sectors endure. For example, although water resources are increasingly managed at the basin-scale [39], basin agencies often lack the legal or political authority to address the control and use of water for electricity generation and agriculture, or even redistribute existing *de jure* and *de facto* water allocations [19]. Integrated management of water, food and energy resources is not just about technical solutions, but also an issue of hegemony and institutions.

Nexus research and policy brokers need to engage with public and private stakeholders to understand why they allocate scarce resources as they do and hear what *can* be done — what is politically acceptable, feasible, and where is the 'room for manoeuvre' [40]. Initial success with transboundary assessments shows how to bring scale complexity, multi-sector ownership, resource condition and economic opportunity together [41,42]. Crises in the form of water or energy supply disruption can result in sudden renegotiation of objectives beyond vested interests. Appropriate leadership change, policy change and new technologies can all enable more purposeful and gradual shifts in status quo narratives and institutional arrangements [43].

Institutions must also consider that joint action is not always required. It may be sufficient for the strongest player to adopt a nexus perspective and act accordingly. Those guiding policy in particular must identify power and harness it or challenge it, as needed, in political processes [44,45••]. Evidence-based investment and policies can follow to urge stakeholders to account for the risks they generate, their exposure to risks and their capacity to deal with risks related to water, food and energy security. Transversal and inclusive metrics will help to secure political attention for this. Accepting the reality of power imbalances and focussing on identifying synergies between water, food, and energy objectives that benefit the hegemon as well as the disempowered may well be required if the SDGs are to be achieved.

Conclusions

Policy makers and practitioners charged with implementing the sustainable development goals are asking for more useful and usable knowledge that clarifies choices,

[2] Website: http://www.sae.gov.br/imprensa/noticia/strategic-note-1-adaptation-to-climate-change-in-brazil-scenarios-and-alternatives/, last accessed 21 March 2016.

explores alternatives, and enables decision makers to make responsible decisions under conditions of uncertainty and complexity [46].

Rather than providing decision makers with 'one' answer about how to deal with inter-linkages across the SDGs (which may also be the wrong answer) it may be more helpful to focus on processes of simulating alternative scenarios, trade-off analyses, and explorations into systemic 'cause and effect' relationships down supply and value chains. By maturing to consider the three dimensions of food, energy and water security *shared risks*, 'nexus thinking' can improve theoretical and practical understanding of how and where risks emerge across scales, where they are shared or not, pointing the way towards solutions which will work within political as well as technical processes. This should help to identify key leverage points for sustainable development by exploring different options for action and resource allocations amongst 'winners and losers' at different points and scales of the water–energy–food nexus.

Pragmatic research and policy development must go hand-in-hand [37,47], grounded in sound theory and reflecting multiple perspectives of actors working 'beyond all disciplines' [48]. Research and development must extend beyond scholars to include the R&D arms of corporations to be effective. Disciplinary silos between hard and soft sciences [49] will have to be overcome to find the combined governance and scientific solutions needed to advance the water, food and energy sustainable development goals.

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