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REPLY

Epistemological dimensions of the water–energy–food nexus approach: reply to discussions of "Challenges in operationalizing the water–energy–food nexus"*

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ABSTRACT

We thank the authors, Varis and Keskinen, and Nauditt, for their constructive contributions. We endorse their key comments, further referring to recent literature and events, including the UN 2018 High Level Political Forum on sustainable development. Here, we elaborate on the epistemological perspective of the water–energy–food nexus conceptualization, assessment, discourse and operationalization.

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We are grateful to the authors – Nauditt (2018) and Varis and Keskinen (2018) – for their constructive comments on our opinion paper (Liu *et al.* 2017), for recognizing the very issues that we stated about the water–energy–food (WEF) nexus, and for further highlighting some aspects, in the spirit of the *Panta Rhei* opinion paper series (Kreibich *et al.* 2017). The authors back up our appreciation of the underlying complexity and variability across settings; of the relevance of the conceptual perspective to progress in terms of understanding, accounting and operationalization; and so of the major challenges from data handling to multiple-stakeholder engagement.

Varis and Keskinen (2018) emphasize the importance of the WEF nexus as a discourse in emergence in the general framework of the United Nations Agenda 2030 and the corresponding sustainable development goals (SDGs). We of course agree that the WEF nexus has a strong discourse value in society at large to raise awareness, understanding, appropriation and action (Giupponi and Gain 2017). And, despite not being explicitly included in the SDGs (UN resolution A/Res/70/1 – United Nations General Assembly 2015), as stated by Varis and Keskinen (2018), it is indeed strongly underlying intra- and inter-linkages between targets and goals of the architecture of Agenda 2030 (UN Water, 2016, ICSU 2017). The recent United Nations High Level Political Forum on sustainable development, held in July 2018 and focusing on the progress towards the SDG targets for 2030 (https://sustainabledevelopment.un.org/hlpf/2018), was indeed an occasion to elaborate on the nexus approach and discourse, either explicitly or implicitly, either orally or in supporting documents (e.g. TWI2050 2018, United Nations 2018). This was facilitated by the choice of the six SDGs reviewed this year: those dealing with water (6), energy (7), cities and settlements (11), consumption and production (12), terrestrial ecosystems (15) and means of implementation (17). This illustrates how the WEF nexus approach is indeed an emerging discourse, maybe not "*besides being seen as an analytical tool and a governance approach*," as raised by Varis and Keskinen (2018), but

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**Consultant. Disclaimer: The views expressed in this article are those of the authors and do not necessarily reflect the views of the United Nations Economic Commission for Europe or its Member States.

integrated in the newly needed epistemology of planetary complexity under accelerating change, embedded in the Anthropocene (in its wider sense, beyond the strict stratigraphic point of view – see Steffen *et al.* 2011, Bai *et al.* 2016, Brondizio *et al.* 2016). Drivers and symptoms of change are intertwined; science and practice (policy, governance, field actions) need concepts, data and tools to monitor, understand, asses and influence changing complex systems; the science–practice dialogue is a two-way continuum of information flow (data, understanding, options, uncertainties), which implies sharing, translation, articulation and dissemination. The discourse of knowledge (Greek etymology of epistemology) is transversal; facilitates awareness, debates and mutual understanding; can be nuanced according to contexts; and becomes a societal lever through education, capacity building and communication. As implied in our opinion paper, we thus fully agree with the *discourse* dimension emphasized by Varis and Keskinen (2018) in the frame of the actual debate, agenda and actions for sustainable development. But we believe that the challenges we identified are key to progress with concepts and methodologies, to develop a full flexible operationalizable epistemology; that the scientific community has the responsibility to be proactive this way, in dialogue with practitioners; and that the discourse will shape even more strongly and explicitly when substantiated by scientific progress. Varis and Keskinen (2018) rightly point out the risk of obtaining misleading results from oversimplified modelling. In this respect, we think that the scientific community should embrace the challenge of improving the current analytical framework while keeping a vigilant attitude when communicating results to policy makers. Scientists should be very clear about assumptions and limitations associated with modelling results. As pointed out by Stirling (2015), it would be irresponsible to suggest that complex societal issues could be solved with scientific precision, as it would implicitly play down the importance of transparency and accountability in the policy-making process.

Varis and Keskinen (2018) also suggest to make the wording evolve, from the WEF nexus to the WEF *security* nexus, to move beyond the actual academic approach, acknowledge the emerging wording in policy documents, encompass societal aspects of access and ownership – to which we can add following up affordability, inequalities, crises and conflicts – and raise the power of the associated discourse (Gain *et al.* 2016). Nauditt (2018) *de facto* uses the expanded wording "*WEF security*". This journal discussion cannot of course be prescriptive about terminology. The future will show how the linguistic and societal appropriation of the epistemology will evolve, including the respective definitions of *security* and *sustainable development*.

Varis and Keskinen (2018) further highlight the importance of water quality, on the one hand, and diversity of the energy sector, on the other. We agree that these issues are very important ones, that are indeed under consideration in a variety of settings. For the energy sector, there are a few studies on the water use/consumption of specific energy sub-sectors, e.g. hydropower (Liu *et al.* 2015) and thermal power (Zhang *et al.* 2017), but it will be interesting to understand the water use/consumption for the entire energy sector (e.g. Li *et al.* 2017) or *vice versa* (Li *et al.* 2016). The water quality and quantity issues are also extensively studied in various agro-hydrological settings across the world, and overall assessments are being proposed (e.g. Dalin *et al.* 2017, Pinay *et al.* 2017, Dermody *et al.* 2018). Yet the challenge is to address them in the perspective of a complex system, in the full range of key inter-linkages and in the full systemic nexus approach, beyond the dual approaches, such as water–food/agriculture, water–energy or food/agriculture–energy. In addition to references cited here, see for instance the recent volume of *PIAHS* edited by Jewitt and Croke (2018), as well as the special issue of *Applied Energy*, edited by Liu *et al.* (2018). Beyond this, other key linkages can be of outmost relevance in some settings to assess the nexus itself, and key indicators of other spheres of sustainable development can also be strongly dependent on services or amenities provided by the whole or part of the nexus – see the upcoming 2019 World Water Development Report by UN Water which will focus on the "*no one behind*" perspective. Varis and Keskinen (2018) insist on the variety of the architecture and infrastructure to be accounted for, up to the atmosphere through gas emissions, which is the ultimate planetary common, in the sense of Ostrom (1990). This touches the full complexity encompassed by the Anthropocene, with a general nesting from global to local settings (and the reverse), where subsystems and transformation pathways emerge, intersect and articulate in very heterogeneous ways, resulting from and in a variety of scales, boundaries, architectures, and dominant processes (Bai *et al.* 2016, Brondizio *et al.* 2016, Dermody *et al.* 2018, TWI2050 2018).

Both discussions observe and imply that the WEF nexus approach is actually often seen – eventually biased or simplified – through the water perspective and the IWRM (Integrated Water Resources Management) visions. Nauditt (2018) further debates the ownership and leadership of the approach, which needs truly interdisciplinary, and ultimately dedicated educational and research programmes and institutes. Although Nauditt (2018) presents good examples or experiences to rationalize the stated position, we feel that dedicated institutions may not be justifiable. New institutions will not

necessarily be stronger than a community effort on heterogeneous study cases, comparisons and meta-analyses, knowledge progress, and capitalization through publications (Koutsoyiannis *et al.* 2016, Quinn *et al.* 2018). Indeed, the water community is pioneering in addressing the nexus, elaborating on IWRM and general hydrological approaches, and there are risks of bias. But we believe that this can be overcome and even turned into strengths, thanks to the experience of interdisciplinarity between hydrology and other aspects, the multi-scale and geography-diverse nature of hydrology, the world-diverse experience of water management practices and science–practice dialogues, and the universal values of respect regarding access to water across civilizations (stronger than in agriculture, food and energy, which are more related to ownership and trade).

From this perspective, our initial opinion paper is indeed published in the *Panta Rhei* opinion paper series. But, it claims neither ownership nor leadership of the topic by *Panta Rhei* or by hydrology and water sectors. We believe the opinion paper addresses the nexus in a balanced way, including in the figures. *Panta Rhei* is a decadal agenda-setting framework, proposed by the International Association of Hydrological Sciences (IAHS), which facilitates community efforts in hydrology and in related issues (Montanari *et al.* 2013, Ceola *et al.* 2016, McMillan *et al.* 2016). The opinion paper precisely aims to trigger the epistemological debate about the considered complexity. In that spirit, we do appreciate the two discussion papers, and the highlights and complements they provide. We also acknowledge the publications on the topic which have appeared since the opinion paper was published, in both academic and policy spheres; and thus expect a rapid collective progress on the epistemological dimensions of the WEF nexus approach, in the science–practice continuum.

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