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PERSPECTIVE
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The Water, Energy, and Food Nexus: Health is yet Another Resource

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This perspective highlights a place for Health (H) in the Water, Energy, and Water (WEF) nexus. It reviews the reference to health in the WEF nexus literature and makes the case for its inclusion into the WEF Nexus. We argue that although the nexus concept of water, energy, and food is relatively recent, it has been adopted by several UN agencies and international organizations and it will continue to draw emphasis in research, politics and communications of the scientific community. Now is the time to integrate health.

Keywords: WEF-health nexus, nexus and human health, health-water interface, food-health interface, ecosystem-health, sustainable development

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INTRODUCTION: WHERE IS HEALTH IN THE WEF NEXUS?

The concept of the WEF Nexus is relatively recent and it presents a framework for the analysis of the interrelatedness and interconnectedness between the water, energy, and food resources. Over the last decade, the concept was studied extensively and it exhibited much flexibility. In spite of a controversy about its novelty and practical application, it was adopted by many UN and international organizations (Mohtar, 2011) and it encompassed many disciplines (Simpson and Jewitt, 2019) and will continue to draw emphasis in research, politics and communications of the scientific community (Finley, 2000). Proctor et al. (2021) stated that researchers from various disciplines "engage with and study the nexus from differing perspectives with distinct motivations and analytical methodologies." Several researchers recently recommended the inclusion of additional and new resources to the WEF Nexus, such as forests (Melo et al., 2021) and land (Wolde et al., 2021).

Despite the engagement of multiple disciplines, the interactions between the WEF Nexus and human health have not been widely studied (Calder et al., 2021) and current Nexus studies "do not capture (its) effects on human health" (Slorach et al., 2020). To illustrate, we conducted a preliminary search of a health/medical database of publications to explore how frequently the Nexus concept was discussed in relationship to Water, Energy, and Food (WEF) and of these, how many engaged concurrently with the theme of health. We searched Ovid MEDLINE®, Epub Ahead of Print, In-Process, In-Data-Review and Other Non-Indexed Citations, and Daily data bases (Ovid MEDLINE, 2021). We searched for all peer-reviewed papers published between 1946 and 16 August 2021 that contained each of the following terms in the title, abstract, or text of the article: water, energy, food, nexus, health, wellbeing/well-being. Over one million publications referenced "water," 785,373 referenced "energy," and 641,850 referenced 'food'. The term "nexus" was used in 4,842 publications. Yet, when we searched the publications that addressed the three resources (water, energy, and food) and the concept "nexus" concurrently in the same paper, only 180 records were identified. Similarly, we identified 3,180,787 publications that used the word 'health' and an additional 110,000 publications that used the term 'wellbeing'. We then combined the two searches and found that only 33 articles referenced food, energy, water, and health in the same paper together

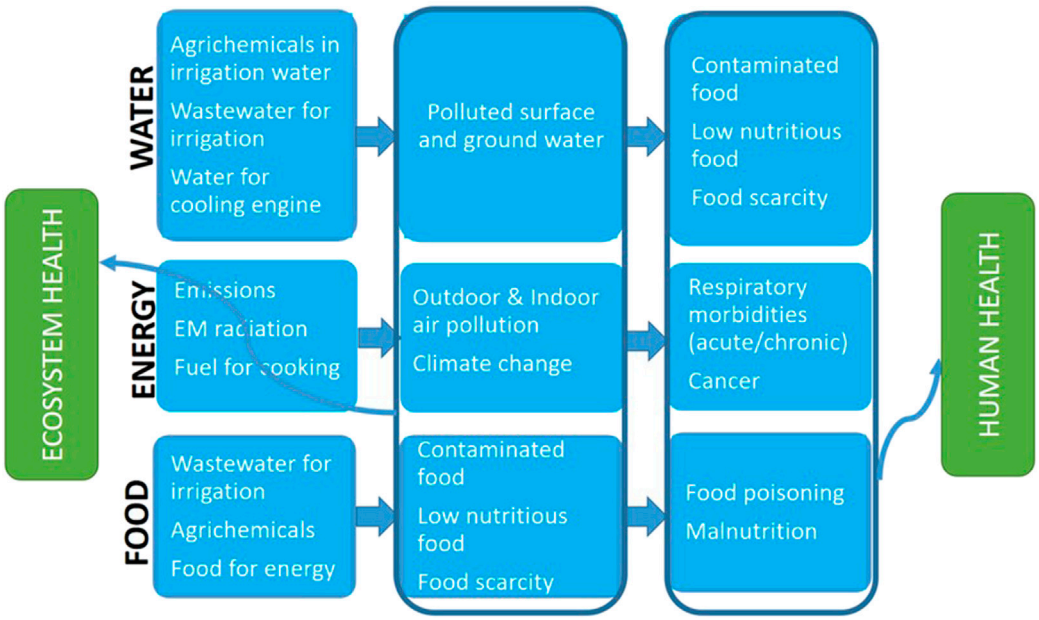

FIGURE 1 | Diagrammatic scheme of how health is part of the WEF Nexus.

with the concept "nexus." We realize this is a very preliminary analysis that could have missed on publications that adopted a nexus approach to water, energy, and food with or without health without using the term nexus, yet we are interested in documenting whether the nexus concept is consciously addressed or adopted. Our analysis confirmed as noted by Slorach et al. (2020) that the interaction between health and the WEF Nexus is not well studied, begging the question: *how is health perceived or approached in the context of the Nexus?*

PROPOSAL: HEALTH AT THE HEART OF THE WEF NEXUS

It is safe to assume that health is not perceived as a resource or component of the WEF Nexus. Instead, when health is linked to elements of the environment (water, energy, or food resources), it is perceived as a burden. The burden of the environment (its pollution or degradation) on health translates into an unavoidable health care cost that must be paid. Globally, the World Health Organization reports that 22.7% of deaths and 21.8% of the disability-adjusted life years (DALY) were attributed to environmental risks (Prüss-Üstün et al., 2016). In other words, health is implicit in the Nexus.

At the interface of health and water, are agrichemicals that seep into irrigation water, the water table, wastewater used in irrigation, and cooling water used for engines. Each of these practices pollute surface and ground water and has health outcomes, such as diarrhea, blue baby syndrome, or chemical poisoning. At the interface of health and energy are gas emissions, electromagnetic radiation, and fuels used for cooking. These lead to indoor and outdoor air pollution, climate change, and consequently, to health outcomes such as acute and chronic respiratory morbidities and cancers. As for the food-health interface, the use of wastewater in irrigation, agrichemicals, and food for energy lead to contaminated food, foods with low nutritional value, and food scarcity as outputs and to food poisoning and malnutrition as health outcomes. The outputs associated with the interfaces of water-health, energy-health, and food-health reflect the health of the ecosystem (ecosystem health), while the different health outcomes associated with these outputs reflect the health of affected populations (human health). **Figure 1** shows how human and ecosystem health are part of the nexus.

More recently, the literature has proposed new WEF Nexus models that implicitly include health. The International Water Association presented an approach in which people, landscape, and ecosystems are placed at the center of nexus model, implicitly integrating health (https://www.iwa-network.org/wp-content/uploads/2018/05/sfs.jpg). Melo et al. (2021) presented a new model in which forest security is recommended as a fourth, foundational dimension of a water, energy, food, and forest security nexus framework.

While we have made a lot of progress in linking health to the WEF Nexus, we need to be more explicit. It is time to integrate H into the WEF Nexus, where H stands both for human and ecosystem Health. It is time to place Health at

the core of the Nexus in our search for resource security. Why?

First, because health is the culmination of our management of the resource nexus. Second, because it humanizes the nexus by placing people and ecosystem at the center of the dialogue. Health should be addressed as a renewable resource, an asset that involves behavior, policy, choice, and values. Our premise is that only fulfilled individuals, who live with dignity in a participatory setting, can contribute to their imagined communities. Hence, we need to transition from individual health into community and population health, and to transition away from the frameworks of 'disease' and "burden" into an asset of wellbeing.

As we integrate Health into the Nexus, we must embrace it as a holistic, social, and political concept with which we must engage at three levels. At the individual level, it encompasses mental and spiritual health, dignity, and self-expression. At the community or population level, it relates to social determinants, such as poverty, low education, gender inequity, and lack of participation or agency. After all, poor health outcomes undermine peoples' appreciation of WEF resources. Finally, at the macro or global level (be it governments, multinational corporations, or dominating global economic model), global health inequities are the outcome of greed, nepotism, self-interest, economic disparities, injustice, and the unrestrained exploitation of WEF resources.

CONCLUSION

We need a different approach. Only when we manage and invest in health as a resource, can we achieve and nourish healthy societies and healthy ecosystems. It is all about context: the social, the political, and the economic. We must understand and alter the context if we are aiming to achieve healthier communities and properly manage our water, energy, and food resources. This can be accomplished through engaging people in responsible decision making and allowing space for innovation. Only people experiencing socio-economic wellbeing have the capacity to promote sustainability and defend ecosystem health.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

IN prepared the initial manuscript and conducted the MEDLINE data search. RM contributed to, edited, and consulted in all aspects of the work. Both IN and RM were and are actively involved in the Water-Energy-Food Research and Action for Health (WEFRAH) Initiative of the American University of Beirut.

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