Implementation and Governance Issues in the Water-Energy-Food Nexus

Devishi Jha

Valparaiso High School, 2727, N. Campbell Street, Valparaiso, Indiana, 46383 USA.; jhadevishi@gmail.com

ABSTRACT: With the increasing demand for water, food, and energy in the next few decades, the water-energy-food (WEF) nexus was created to examine the synergies between these key sectors and how they will be implemented in different communities. This paper reviews the current literature on nexus governance and local implementation. This review suggests that a strong understanding of the interconnectedness between the water, food, and energy sectors among decision makers, consideration of values and interests of local stakeholders, and availability of political support are essential for successful implementation of the WEF nexus model at the local level. Decentralized projects also contribute positively to households and local livelihoods. Through several global examples, this paper lists literature-based examples and case studies of how sustainable, rural livelihoods can be promoted with the nexus framework.

KEYWORDS: Water-Energy-Food Nexus; Implementation; Decentralized; Livelihoods; Governance.

Introduction

Adequate food supply, modern energy services, and access to safe drinking water are essential for reducing poverty and moving toward sustainable development. The demand for these basic needs is expected to increase due to rapid population growth, economic development, and urbanization.[1] Many countries, including South Africa, Ethiopia, Mexico, Brazil, India, and Nepal, have been exploring solutions to water scarcity and overconsumption.[1] Jay Famiglietti, senior water scientist at the National Aeronautics and Space Administration (NASA), has cautioned that "the water table is dropping all over the world [and] there's not an infinite supply of water."[2] The Economist reported that water disputes lead to increased international tension.[3] Moreover, in its 2011 publication entitled *Water Security: The Water-Food-Energy-Climate Nexus, the World Economic Forum* emphasized that water has been continuously underpriced, groundwater has been exhausted, and that, unlike energy, water has no alternatives or replacements.[4] Sustaining economic growth in the face of water scarcity and increasing demand for food, water, and energy is one of this century's greatest challenges.

Both water and energy are needed to produce food; energy is required in all phases of water consumption; water is used to make energy. The intricate connections between these three resources were used to create the water-energy-food (WEF) nexus. The WEF nexus was introduced by the 2011 World Economic Forum to "help decision makers better understand risks associated with managing resources ahead of time and respond proactively in times of crisis."[4] The Food and Agriculture Organization states that "the [WEF] Nexus has emerged as a useful concept to describe and address the complex and interrelated nature of our global resource systems, on which we depend to achieve different social, economic and environmental goals."[4] The word nexus means "to connect" and is used to describe the interdependencies and trade-offs between water, energy, and food resources and how they are managed. The WEF nexus's goal is to understand its three different sectors under one complex system. There have been several concerns about the WEF nexus's precise meaning. Some authors claim that the term is seen as a buzzword, or a word that gains prominence due to "a combination of ambiguous meaning and strong normative resonance."[5] Others report that many countries are not aware that the WEF nexus exists, suggesting that the nexus must be adapted beyond the academic domain.[5]

A conceptual framework of the novel WEF nexus debuted on the international stage at the 2008 World Economic Forum. Its introduction encouraged pivotal research on linkages between water and energy to sustainable development and policy integration.[1] Specifically, WEF emerged as a security concept in light of resource scarcity after the energy and food crisis in 2007 and 2008.[1] The WEF nexus has since been used to analyze specific issues like ethanol production, bioenergy, and irrigation. South Korea and Indonesia use the WEF nexus to simulate nationwide resources, plan urban water systems, and develop agricultural plans. Many African countries are using the nexus to advance renewable energy transition plans.[6]

Even so, the WEF nexus is far from perfect and critics worry about its ability to adjust to different contexts. An article published by the *Food and Agriculture Organization* at the United Nations High-Level Political Forum 2018 states that "limited information undermines evidence-based decision-making. This is due to the frequent lack of reliable and up-to-date data on the status of the WEF sectors at local level but also often at national level, in particular in developing countries," and a "lack of motivation to coordinate by relevant sectoral bodies, because the transaction costs of coordination are perceived higher than the benefits."[7] According to Perrone *et al.*, "it is rare that nexus boundaries align with traditional management units or administrative boundaries – for instance, river basins,

DOI: 10.36838/v3i3.6

urban areas, or even geopolitical divisions."[8] Cairns and Krzywoszynska found that within natural resource conversations in the United Kingdom, the comprehension of the term *WEF nexus* is "plural, fragmented, and ambiguous."[5]

Another further complication lies in the inability of the nexus to cohesively move from theory to practice. Weitz *et al.* states that "although the nexus literature identifies some barriers to achieving coherence it does not clearly explain why the barriers are present, what influences them, and how they can be acted upon. These gaps disconnect the nexus literature from the governance processes it ultimately seeks to influence."[4] *The Guardian* notes that "under these conditions, it is difficult to see how an integrated solution could emerge that is significantly different to what each sector by itself would pursue."[9] Although the WEF nexus covers a complex and intricate set of relationships spanning multiple sectors, the inherent gaps in its application inhibit meaningful change in the decision-making and policy-making processes.

By drawing on an extensive review of research and case studies, this paper evaluates the effectiveness of the WEF nexus with a focus on governance and implementation. This paper also aims to enhance our understanding of the impact local decentralized projects can have on the water and food dimensions of the nexus. A few examples of the local decentralized projects discussed in the paper are: improved cook stoves in Ecuador; community-based jatropha in Bati Woreda, Ethiopia; and biomass gasifier-based mini grid in Garkha Village, Bihar, India (Table 1). Finally, this paper suggests that integrating livelihoods with the WEF nexus approach is the key to achieving sustainable development. If the status quo is maintained, it will be impossible to meet the concurrently huge demands in water, energy, and food in the next decades. The importance of water, energy, and food in sustainable development is highlighted by the fact that they each have their own sustainable development goal; however, their significance extends to economic development, governance, and environmental systems.

Discussion

Based on a review of the nexus literature, Weitz *et al.* identified three governance gaps that render the nexus concept disconnected from the decision-making and policy making processes it ultimately seeks to influence.[4] One common thread that emerges in the literature is that policies are fragmented across the water, food, and energy sectors. Varying explanations are provided explaining why fragmented policies pose a problem. Three perspectives emerge while discussing governance issues related to the WEF nexus. The first perspective is based on the idea that failing to account for connections between sectors could worsen resource scarcity and induce conflicts. The second perspective relates to economic rationality. Accordingly, the nexus is seen to improve policy cost-effectiveness and resource-use efficiency. This economic rationality perspective encourages green economic growth. However, policy coherence is undermined by a lack of communication and clarity on the rights and responsibilities across sectors. The third perspective focuses on equity and social progress. With this perspective, the key barriers to policy coherence are unequal distribution of power, voice, access to information, resources, and capability among actors. Although there is an agreement that cross-sector collaboration and coordination are desirable, little is explained on how to enable coordination across sectors

Challenges in the governance of WEF nexus:

According to Bhaduri *et al.*, governing the nexus involves dealing with the plurality and interaction of policies between the different sectors.[10] Despite the evidence of strong connections between the water, energy, and food sectors as well as the attention the nexus has received from development agencies, policy analysts, and other stakeholders, the "silo mentality" still exists. This means that food, energy, and water challenges continue to be addressed within sectoral boundaries in terms of projects and policy decisions.[1] Formulating and addressing policies in silos does not guarantee water, food, and energy security and sustainability. For example, governments often design agricultural policies and subsidy programs for fertilizers without considering their interconnectedness with the energy and water sectors. On a similar note, governments provide energy subsidies to farmers without taking into account the implication for groundwater depletion.

For nexus governance to be successful, the values of different stakeholders and interest groups have to be taken into account in a fair and transparent manner. Additionally, the private sector, bureaucratic structures, and informal networks need to be effectively combined. Bhattacharyya *et al.* discussed the implications of the WEF nexus in the 15 countries that make up the Economic Community of West African States (ECOWAS).[11] These countries have a combined population above 300 million and face the prospect of doubling their population by 2030. Almost 58% of the population lives in rural areas and 42% are below the poverty line. While the WEF nexus has inspired the member countries, the degree of success varies. The sector-based approach to policy making continues and the implementation of an integrated approach is rare. The centralized top-down approach of governance prevails while the decentralized bottom-up mobilization of initiatives is lacking. Even when the decentralization has been promoted, the delegation of appropriate authorities has not taken place in ECOWAS.

Nexus governance requires political support for successful implementation at the local level.[10] India is the world's single largest user of groundwater with 19.8 million agricultural wells and tube wells.[12,13] While farmers in India have always used groundwater for irrigation, its rise as the main source of irrigation coincided with the Green Revolution of the 1970s. Many states in the northern and western parts of India face extreme groundwater exploitation. In response, policies were designed to prevent excessive extraction of groundwater through interventions such as the West Bengali policy of groundwater pricing based on metered usage rather than a flat rate.[12] This policy has been successful in reducing groundwater usage and degradation. In northern and western states, electricity feeders for agricultural uses have been separated from feeders for domestic and industrial electricity use, thus controlling over-extraction of groundwater.[12]

Policies made at the national level can have a significant impact on local communities. For example, dam construction significantly impacts water access for local stakeholders. When hydropower development takes place in transboundary river basins, cross-sectoral challenges and policy options are interlinked at different levels.[10] Hensengerth analyzed the limited influence an organization centered on water issues has on hydropower development and addressed the issue of authority in international development and hydropower policy using the Xayaburi Dam in the Lower Mekong Basin as a case study.[14] The Xayaburi Dam elevates WEF nexus issues to the transboundary level. Seasonal differences in water release and use requirements for irrigation and energy production have caused conflicts with significant negative impacts on the local communities. There is a need to protect the water use rights of local stakeholders.[10]

Mayor *et al*. proposed an assessment methodology for WEF nexus implementation at the basin level and applied the tool to a case study of the Duero River basin in Spain.[15] The case study illustrates how to understand trade-offs and synergies, diagnose the level of political coordination needed, and identify existing and potential solutions to improve water, energy, and food resource management in the region.[15] Some of the most important issues found were the limitations posed by rising energy prices for irrigated agriculture due to modernization, limits to treating water, and the emergence of new energy-related water demands in hydraulic fracturing for oil and gas. Mayor *et al*. found that freshwater is being increasingly consumed for oil and gas exploration, often in water-stressed areas. It was suggested that co-optimization of resources is essential to meet energy demands without depleting remaining freshwater reserves.[15]

According to Mayor *et al*., "the WEF nexus can be considered as a framework that helps connect, coordinate and reinforce individual water, energy and food management policies by paying special attention to the identification, understanding, and characterization of interconnections and tradeoffs, in order to build aligned and coherent strategies/actions that permit synergies. This should be applicable both within the political sphere, at either national, regional or local scales, and at a business or even household scale, where resource management and optimization is also required."[15] It is clear that there are gaps in the WEF nexus implementation. Due to its multi-sectoral approach, the nexus becomes difficult to translate into policy. For the WEF nexus to be applicable to communities of different scales, regions, and environments, a significant effort must be placed on its translation into policy.

The risks and uncertainties related to climate change further complicate nexus governance. Therefore, it is important to clearly understand the linkages and vulnerabilities of these resources. Interdisciplinary research is necessary to assess the effect of climate change on water, energy, food, and their related ecological processes.[16] Without research, it is difficult to evaluate the WEF interactions and quantify the benefits and costs between the sectors.[16]

Assessment tools for WEF nexus implementation:

Several scholars have discussed assessment tools that can guide nexus implementation at different scales. For example, the multi-scale integrated analysis of societal and ecosystem metabolism (MuSIASEM) is a framework that focuses on a multilayer analysis of water, food, and energy and takes into account labor, the hours of human activity, and all other elements that could change during analysis. The climate, land, energy, and water systems (CLEWS) framework applies to a number of studies and provides a network for looking at interlinkages while also including stakeholder engagement in testing. The CLEWS model is broken down into three sub-models each focused on a different aspect of water, food, or energy that is later centralized within the larger framework. A number of digital models also exist in mapping out the nexus. *The Commonwealth Scientific and Industrial Research Organization*'s national outlook model (NOM) was created in Australia and provided input access for data later translated to a national scale. However, the NOM framework is very data-heavy and costly, meaning that the implementation of it is largely restricted to Australia. Another model is the WEF Nexus Tool 2.0, which distinguishes itself by allowing for user input data and scenarios to develop a cleaner visualization of nexus goals. This model was used in Qatar to map agricultural crop production but cannot address wider concerns of livestock or processed food.[17] Finally, the Foreseer tool has been used in the United Kingdom and generates scenarios by taking into account natural resource supply. The tool has been able to link models together in developing a final service for the area being targeted. However, no efforts have been made to address more local levels, and this may prove challenging due to limited data.

There have been several solution-based contributions to scaling the nexus with one of the largest being to take political systems and stakeholders into account rather than just technical variables. Another is to build and encourage the establishment of inclusive institutions with the capacity to take on policy-building via the nexus approach, with both horizontal and vertical coordination. In regard to knowledge-based changes, a major concern of researchers is the lack of open data on the use of the nexus.

Capacity building and knowledge synthesis for sustainable implementation of the WEF nexus:

Capacity is best strengthened by developing coordination mechanisms for existing institutions to support addressing WEF nexus objectives. Strong coordination mechanisms allow synergies to develop between the three sectors. A variety of institutions at local, regional and national levels, including the private sector, international development partners, and civil society organizations can jointly meet capacity development needs to not only improve the understanding of interlinkages but also generate greater efficiencies through joint management and operations, as well as increased opportunities of inter-institutional innovations.[10] Individual capacities do not develop in a vacuum but are embedded in wider institutional networks, which adds to the complexity of capacities. Emerging evidence shows that capacity develop

DOI: 10.36838/v3i3.6

ment can be effective from the individual to organizational levels but can take time to achieve outcomes.[10]

Along with strengthening capacity for existing institutions to address the nexus objective and face nexus challenges, the other challenge is a lack of synthesis for nexus knowledge. There is a lack of communication among the institutions that collect data and the decision makers who use these data. Currently, most data-providing portals are scattered, and unconnected. There is also a gap between data required by decision makers and easily accessible data. Resultingly, there is a need to build comprehensive datasets by integrating data from different portals. To increase capacities for analyzing such integrative datasets, the next generation of scientists and practitioners needs to be trained in the interconnectedness of water, energy, and food. Organizations will need to work across administrative boundaries to turn nexus thinking into meaningful practices.

Decentralized energy projects and the WEF nexus:

Guta *et al*. employed a qualitative case study methodology to study the complex interactions between the WEF nexus and energy transitions within six local contexts in developing countries.[18] The selected locations represent different geographic, socioeconomic, and institutional contexts from India, Ethiopia, China, Ecuador, and Nepal.[18] The case studies incorporated four renewable energy sources – biomass, hydro, solar, and wind – and different experiences of successes and failures. The China case study focused on the household biogas project in the Chunfeng village on the Sichuan–Yunnan province border. Biogas usage mitigated the contamination of drinking water and reduced the pollution of local surface water and groundwater caused by chemical fertilizers. Additionally, use of biogas instead of firewood helped avoid damage to watersheds and forests. There were some barriers to implementation, including overemphasis on low cost, which resulted in the short life of the digesters and stoves. Another case study focused on the improved cook stoves in the highland region of Ecuador.[18] Improved cook stoves resulted in reduced wood consumption for cooking, which reduced deforestation. Some barriers to implementing the improved cook stoves were related to strong bonds to traditional cooking practices involving wood.

In the Ethiopian case study, the jatropha plant was substituted for biomass and fuel. Using jatropha reduced land degradation and improved soil and water retention. Barriers to the implementation were related to low jatropha yields, poor market linkages, and a lack of financial and technical support. In another case study, a biomass gasification plant was installed in a village in Bihar, India to overcome the problem of unreliable electricity supply from the grid. The plant provided reliable power to ten water pumps in the village at a reasonable price. This positively impacted agricultural production; farmers were able to remove water from the waterlogged field and use it for farm production. Although the concept of biomass gasification has gained popularity over the last decade, there are several barriers, such as the unwillingness of banks to finance such technologies.

The last case study, a micro hydro plant in Siklesh Village in Nepal provides access to electricity for a variety of domestic and productive uses including operation of agricultural processing mills. The availability of electricity has benefits in terms of food preparation, thanks to higher quality lighting in comparison to kerosene lanterns. Even though switching from kerosene to electricity for lighting has been clearly observed, the generated electricity has not been able to replace fuelwood for cooking. All the case studies by Guta *et al*. indicate that alternative energy sources positively contributed to households and livelihoods. The case studies identified barriers mostly related to installation of technologies, cost of maintenance, and operations.[18]

Integrating local livelihoods and the WEF nexus:

Biggs *et al*. explains that the WEF nexus was initially framed from a resource security perspective to protect against risks to resource availability.[19] However, framing the WEF nexus in terms of resource security instead of distributive justice shifted the focus from the needs of the poor toward global issues, large infrastructure developments, and macro resource flows. The focus on the challenges faced by the poor at local, community, and household levels is missing. The local livelihood aspect of the nexus has not been part of the nexus research.[20] Billions of people who lack access to safe drinking water and energy services often depend on agriculture for their livelihoods. The current siloed sectoral approach directly impacts livelihoods as the impoverished population generally lack the resources to adapt to change.

A sustainable livelihood is defined as "capabilities, assets, and activities required for a means of living. It is deemed sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities, assets, and activities both now and in the future, while not undermining the natural resource base."[21] Transitioning the WEF nexus to include local households and livelihoods has been a challenge and an ongoing topic of discussion and research; the nexus was originally created to be implemented using an implicit top-down approach that often reiterates power dynamics and disregards local concerns.

In a survey of 549 households in Ethiopia, locals were asked about the operation of two large irrigation and hydro-powered dams using the nexus model. The study found that the effects of water infrastructure did not necessarily translate to livelihoods; the local people perceive limited access to both irrigation and electric power. According to the study, "assessing the nexus at household level revealed the concerns of local communities whose views and concerns are obscured in national- and global-level debates. Large-scale water infrastructures are characterized by uneven distribution of costs and benefits."[6] The WEF nexus must go beyond and examine sociopolitical benefits to populations where needs must be met. The question of whose needs are being met and who is being undermined are still unanswered.

To understand local community perceptions of the WEF nexus challenges, Wolde *et al*. conducted a survey of local farmers and representatives of the Gidabo sub-basin in central

Ethiopia.[22] They found that the majority of people are susceptible to recurrent drought, food insecurity, and extreme poverty. Lake Abaya, the main water source, shows signs of overuse and extraction. The local community perceives natural resources as sources of income and subsistence which further aggravates natural resource degradation.[22] Therefore, many scholars suggest that local environmental conservation should be an important component of the WEF nexus. More research is needed to understand the local community perception of their livelihoods and WEF nexus resources.

The nexus is crucial for rural household communities but has not been thoroughly researched for those areas. Despite expectations of the nexus to support the *United Nations*'s Sustainable Development Goals, the poor have neither been targets nor beneficiaries of the nexus.[23] Additionally, very few authors have developed step-by-step frameworks for putting the nexus into practice.

Terrapon-Pfaff *et al*. created a thorough framework of linkages for operationalizing the nexus using a household model.1 Their method was to "analyze the linkages between small-scale energy projects in developing countries and the food and water aspects of development."[1] Their paper suggests a four-step nexus assessment approach to operationalize the WEF nexus at the local level: (1) qualitatively map the WEF nexus links, (2) quantify the links, (3) identify critical links, and (4) leverage the results to improve project design and implementation.[1] While this is a good start in mapping out local implementation of the nexus, more emphasis needs to be placed on the specificities of integration of water and energy into local-level planning.

Another important aspect to consider within the realm of the nexus intersecting with social science is the data accountability based on location. In a case study of the WEF nexus in Kenya, researchers came across the issues of organization and coordination in the local policy sector. Kenya is a water-scarce country, with 80% of the country being arid or semi-arid. Kenya's legislative institutions are divided in a way that created a lack of communication between sectoral departments. At the county level, there was a clear inability to follow the nexus due to a lack of capacity and reluctance of the central government to pass responsibility down to local counties.[24]

A similar study was conducted in Indonesia, a country with one of the highest rates of deforestation in the world. Unlike Kenya, the nexus was able to be implemented at the district level. However, the structure of the government system was not able to maintain the nexus; specifically, there was no provincial water management system implemented in the country.[6] These two studies emphasize the fact that regardless of where the nexus is being used, the decisions of the nexus are political. The WEF nexus approach combines the trade-offs between its key resources and the competing demands of the resources for human and economic development.[25] The rising issues of resource scarcity and climate change increases the significance of such trade-offs. There must also be more thought placed into strengthening local governments, especially in rural areas, so they can handle large government institutions.

A growing body of research has focused the value of nexus-based approaches for evaluating the effects of development on livelihoods and for promoting sustainable livelihood practices.[19] For example, Rasul's analysis of the Hindu Kush Himalayan region from a nexus perspective has highlighted the positive effects that stronger regional integration across the WEF sectors has on livelihoods.[26] Bouapao has taken the WEF nexus approach further by modeling the cumulative effect of impending development decisions designed to improve food, water, and/or energy security on livelihoods.[27] Population in the lower Mekong region could experience changes in household food and income levels as a result of development decisions that impact fish, crops, vegetables, wetlands, and non-timber forest products.[27] In Myanmar, foreign investment to intensify production from the agricultural and energy sectors may have harmful effects on rural populations who rely on shared land and water resources but have insecure access.[28] Examples in Nicaragua demonstrate how sustainable rural livelihoods can be promoted in harmony with the nexus framework, such as rainwater-harvesting systems for small landholders using small-scale water capture and storage systems. These provide potential for increasing the consumption of underutilized but abundant food and flour as well as producing bioenergy from sugarcane.[27]

Environmental livelihood security: The way forward:

Environmental livelihood security (ELS) refers to the challenges of maintaining global food security and universal access to fresh water and energy to sustain lives and promote inclusive economic growth while sustaining key environmental systems.[19] The term was theorized to address a lack of consideration of livelihoods within nexus frameworks which is required to ensure that WEF securities enable sustainable development and livelihoods. A system's ELS is met when the human demand on the environment and environmental impacts on humans are balanced. The desire to achieve sustainable systems places the concepts of sustainable development and sustainable livelihoods as the core ideas of ELS.

The ELS framework acknowledges the mutually dependent relationship between water and livelihoods: (i) water is needed to support livelihood activities such as fisheries or irrigated agriculture; and (ii) livelihood activities and capitals may contribute to the preservation (or depletion) of water supplies and access. For example, physical capital (infrastructure) may enable more efficient water extraction and transportation and financial capital (public or private funds) may assist in implementing more sustainable practices in water use or purchasing alternative supplies.[18]

Conclusion

The WEF nexus was created to examine the synergies and trade-offs between these three key sectors in different communities. Through reviewing the current literature as it applies to the nexus governance and implementation, there is a clear need for a social science and governance lens rather than a technical perspective. If concrete changes are to be made, governments will need to integrate the nexus into policy decisions. Despite the nexus's scientific ingenuity, significant time must

DOI: 10.36838/v3i3.6

be spent in analyzing how the nexus will account for policy and individual livelihoods. If the nexus is to be scaled down from a national perspective to more regional areas, there must be more data collected to ensure that proper policies are implemented through the nexus's findings.

Table 1: Summary of findings from selected past research.

Paper	Findings
Bhaduri, A., Ringler, C., Dombrowski, I., Mohtar, R., Scheumann, W. (2015)[10]	A broad involvement of stakeholders to work collaboratively towards sustainable development is an important step for successful implementation of WEF nexus
Terrapon-Pfaff, J., Ortiz, W., Dienst, C., Gröne, M. C. (2018)[1]	Complex links exist between sustainable energy projects and the food and water sectors. The energy needs addressed are often directly connected to food or agricultural activities or are connected indirectly by providing energy for water use in agriculture. A more systematic approach integrating the water and food pillars in energy planning at local level in the global south should be advocated to avoid trade-offs and enhance the development potential of energy projects
Cairns, R., Krzywoszynska, A. (2016)[5]	The mobilization of the nexus terminology can best be understood as symptomatic of broader global science policy trends, including an increasing emphasis on integration as an ideal; an emphasis on technical solutions to environmental problems; achievement of efficiency gains and 'win-wins'; and a preference for technocratic forms of environmental managerialism.
Guta, D. D., Jara, J., Adhikari, N. P., Chen, Q., Gaur, V., Mirzabaev, A. (2017)[18]	The decentralized energy projects have positively contributed to household and community livelihoods and are an integral component of the WEF Nexus.
Wolde, Z., Wei, W., Kunpeng, W., Ketema, H. (2020)[22]	The WEF nexus resources have the potential to contribute to different livelihood aspects (i.e., human, physical, social, financial, natural, and environmental).

There are billions of people in rural areas who depend on agriculture for their livelihoods. Governance mechanisms should be strengthened at local levels to improve well-being and build resilience into rural livelihoods. Embracing a cross-sector approach will reduce the negative impacts of policies on each individual sector. Policies need to become more inclusive and better coordinated with each other. Innovative research and technologies are important to support the implementation of the nexus at local levels. The initiation and implementation of decentralized energy projects that recognize the interconnectedness of the water, energy, and food sectors are great steps in this direction. These decentralized energy projects use resource-efficient technologies that enhance sustainability at the local level, but more are needed to better support land, water, and energy. The use of green energy sources such as wind and solar can not only increase energy availability and access, but also easily reach the poor rural areas.

References

1. Terrapon-Pfaff, J.; Ortiz, W.; Dienst, C.; Gröne, M. C. Energising the WEF nexus to enhance sustainable development at local level. J. Environ. Manage. 2018, 223, 409-416.
2. Frakkel, T. C. New NASA data show how the world is running out of water, 2015. The Washington Post. https:// washingtonpost.com/news/wonk/wp/2015/06/16/new-nasa-studies-show-how-the-world-is-running-out-of-water/ (accessed Sep 15, 2020).
3. The Economist. Disputes over water will be an increasing source of international tension, 2019. https://economist.com/special-report/2019/02/28/disputes-over-water-will-be-an-increasing-source-of-international-tension (accessed on Oct 18, 2020).
4. Weitz, N.; Strambo, C.; Kemp-Benedict, E.; Nilsson, M. Closing the governance gaps in the water-energy-food nexus: Insights from integrative governance. Global Environ. Change 2017, 45, 165-173.
5. Cairns, R.; Krzywoszynska, A. Anatomy of a buzzword: The emergence of 'the water-energy-food nexus' in UK natural resource debates. Environ. Sci. Policy 2016, 64, 164-170.
6. Gebreyes, M.; Bazzana, D.; Simonetto, A.; Müller-Mahn, D.; Zaitchik, B.; Gilioli, G.; Simane, B. Local perceptions of water-energy-food security: Livelihood consequences of dam construction in Ethiopia. *Sustainability* 2020, 12(6), 2161.
7. *Food and Agriculture Organization* at the United Nations High-Level Political Forum 2018. https://sustainabledevelopment.un.org/hlpf/2018.
8. Perrone, D.; Murphy, J.; Hornberger, G. M. Gaining perspective on the water-energy nexus at the community scale. Environ. Sci. Technol. 2011, 45(10), 4228-4234.
9. Boccaletti, G. Solutions to the water energy nexus remain elusive, 2014. The Guardian. https://theguardian.com/sustainable-business/ 2014/sep/10/world-water-week-water-energy-nexus-solutions-elusive (accessed Sep 15, 2020).
10. Bhaduri, A.; Ringler, C.; Dombrowski, I.; Mohtar, R.; Scheumann, W. Sustainability in the water-energy-food nexus. Water Int. 2015, 40(5-6), 723-732.
11. Bhattacharyya, S.; Bugatti, M. N.; Bauer, M. H. A bottom-up approach to the nexus of energy, food and water security in the Economic Community of West African States (ECOWAS) region, 2015. The Nexus Network. https://thenexusnetwork.org/wp-content/uploads/2014/08/Bhattacharyya-thinkpiece_2015.pdf (accessed Sep 15, 2020).
12. Shah, T. Climate change and groundwater: India's opportunities for mitigation and adaptation. *Environ. Res. Lett.* 2009, 4(3), 035005.
13. Mukherji, A.; Das, A. The political economy of metering agricultural tube wells in West Bengal, India. *Water Int*. 2014, 39(5), 671-685.
14. Hensengerth, O. Where is the power? Transnational networks, authority and the dispute over the Xayaburi Dam on the Lower Mekong Mainstream. *Water Int*. 2014, 40(5-6), 911-928.
15. Mayor, B.; López-Gunn, E.; Villarroya, F. I.; Montero, E. Application of a water–energy–food nexus framework for the Duero river basin in Spain. *Water Int*. 2015, *40*(5-6), 791-808.
16. Liu, J.; Yang, H.; Cudennec, C.; Gain, A. K.; Hoff, H.; Lawford, R.; Zheng, C. Challenges in operationalizing the water–energy–food nexus. *Hydrol*. Sci. J. 2017, 62(11), 1714-1720.
17. Daher, B. T.; Mohtar, R. H. Water-energy-food (WEF) Nexus Tool 2.0: Guiding integrative resource planning and decision-making. *Water Int*. 2015, 40(5-6), 748-771.
18. Guta, D. D.; Jara, J.; Adhikari, N. P.; Chen, Q.; Gaur, V.; Mirzabaev, A. Assessment of the successes and failures of decentralized energy solutions and implications for the water–energy–food security nexus: Case studies from developing countries. *Resources*, 2017, 6(3), 24.
19. Biggs, E. M.; Bruce, E.; Boruff, B.; Duncan, J. M.; Horsley, J.; Pauli, N.; Haworth, B. Sustainable development and the water–energy–food nexus: A perspective on livelihoods. *Environ*. Sci. Policy 2015, *54*, 389-397.
20. Leck, H.; Conway, D.; Bradshaw, M.; Rees, J. Tracing the water-energy-food nexus: Description, theory and practice. *Geography Compass* 2015, 9(8), 445-460.
21. Serrat, O. *Knowledge solutions: Tools, methods, and approaches to drive organizational performance*. Springer: Singapore, 2017.
22. Wolde, Z.; Wei, W.; Kunpeng, W.; Ketema, H. Local community perceptions toward livelihood and water–energy–food nexus: A perspective on food security. *Food and Energy Security* 2020, 9(3), e207.
23. Albrecht, T. R.; Crootof, A.; Scott, C. A. The water-energy-food nexus: A systematic review of methods for nexus assessment. *Environ. Res. Lett.* 2018, 13(4), 043002.
24. Wakeford, J. and Robinson B. The Energy-Food_Water nexus in Kenya: A case study. Sustainability Institute 2017. https://www.sustainabilityinstitute.net/5392-the-energy-food-water-nexus-in-kenya/.
25. Scott, A. Making governance work for water–energy–food nexus approaches, 2017. CDKN. https://cdkn.org/wp-content/uploads/2017/06/Working-paper_CDKN_Making-governance-

work-for-water-energy-food-nexus-approaches.pdf (accessed Sep 15, 2020).
26. Rasul, G. Food, water, and energy security in South Asia: A nexus perspective from the Hindu Kush Himalayan region. *Environ. Sci*. Policy 2014, 39, 35-48.
27. Bouapao, L. Livelihoods and migration. *In The Water-Food-Energy Nexus in the Mekong Region*; Smajgl, A., Ward, J., Eds.; Springer: New York, 2013; pp. 143-178.
28. Kattelus, M.; Rahaman, M. M.; Varis, O. Myanmar under reform: Emerging pressures on water, energy and food security. *Nat. Resour. Forum* 2014, 38(2), 85-98.
29. Gourdji, S.; Craig, M.; Shirley, R.; Barido, D. P. L.; Campos, E.; Giraldo, M.; Kammen, D. M. Sustainable development opportunities at the climate, land, energy, and water nexus in Nicaragua, *Center for Latin American Studies* 2014, 33.

Author

Devishi Jha is a 17-year old social entrepreneur from the Chicago area. She is the CEO at Voyagers, a youth-led sustainable business organization. Devishi is on the National Council at UNICEF USA and Director of Partnerships at Zero Hour; she has been featured by the UN, EarthX, and NextGen.

DOI: 10.36838/v3i3.6