



Sustainable development and the water-energy-food nexus: Legal challenges and emerging solutions

Damilola Olawuyi

Hamad Bin Khalifa University, College of Law, QFIS Building, Education City, Doha, Qatar

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ABSTRACT

Traditionally water, energy and food (WEF) resources are governed in many countries by separate sets of laws, rules and institutions. However, recent studies have increasingly underlined the WEF nexus approach as a framework for coherent, holistic and integrated implementation of the Sustainable Development Goals (SDGs) to address fragmentations and ensure cleaner and efficient production methods in each sector.

This article examines the legal and governance aspects of integrating and implementing the WEF nexus in practice. Various legal and institutional challenges that arise with a nexus approach, such as incompatibility of WEF nexus aims, limited rule linkages, institutional limitations and resource constraints are examined in order to identify the ways in which an integrative legal framework on WEF can help close these gaps.

The study suggests that enhanced levels of legislation and rule linkage; elaboration of common and shared principles by institutional actors in WEF domains; as well knowledge, expertise and information sharing on WEF-related decision making are significant steps towards advancing systemic and integrated governance of WEF resources.

1. Introduction

Water, energy and food are inextricably linked to all aspects of human life: the ability to work, live, survive, and execute tasks (Pitcock et al., 2015; Dupar and Oates, 2012). Without water, we cannot produce food and energy; and without energy, we cannot process or distribute food and water. For example, a collapse of energy systems could result in the disruption of food preservation and supply. Similarly, water shortage could hinder food production and energy production, especially the effective functioning of hydropower stations (Mayor et al., 2017). Also, without food, human and animal contributors to the energy and water supply value chain may not be able to function well. Global water, energy and food systems are evidently so interlinked that disruption of one resource could result in disruptions of the other two (Liu et al., 2007). On the other hand, energy production can result in the contamination of water and food systems, while food and agricultural processes could result in water pollution and energy inefficiency (Jeswani et al., 2015).

Due to their vital roles, and their interdependencies, addressing the interplay and trade-offs between water, energy and food systems, often described as the water-energy-food (WEF) nexus, has risen to prominence in policy and development discourses as a framework for addressing scarcities and achieving sustainable development in WEF sectors (Simpson and Jewitt, 2019; Leck et al., 2015; Hoff, 2011).

Recent studies, including the World Economic Reports of 2011 and 2014, have underlined the need to develop integrated policy responses that address common threats to the availability, accessibility and affordability of WEF (WEF, 2011; WEF, 2014). Similarly, the National Intelligence Council of the United States identified the holistic management of WEF Nexus as one out of four megatrends that could result in major and transformational global shifts by 2030 (National Intelligence Council, 2012). The European Union (EU) has also canvassed the need for an integrated management of water, energy and land resources in order to address common threats to WEF security (EU, 2012). In international water law, the nexus approach has been considered within the regime of the United Nations Economic Commission for Europe (UNECE) Water Convention as providing a way “to enhance water, energy and food security by increasing efficiency, reducing trade-offs, building synergies and improving governance, while protecting ecosystems.” (UNECE, 2015a,b). These studies emphasize the need to strengthen synergies and policy coherence between water, food and energy sectors in order to address fragmentations and ensure cleaner and efficient production methods in each sector (Weitz et al. 2012).

However, despite the increased prominence of the WEF nexus discourse in science, engineering, policy and development literature, a detailed case has yet to be developed on the

legal and governance aspects of integrating and implementing the

E-mail address: dolawuyi@hbku.edu.qa.

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WEF nexus in practice. Specifically, what is the legal basis for, and practical complexities of, such integration? How will the diverse web of laws and regulations in each domain reinforce or hinder coherent application and implementation? Also, how can decision-making and information sharing across the diverse institutions and stakeholders in each domain be simplified and integrated?

This article develops a profile of legal and institutional challenges that arise with a nexus approach to WEF governance from a comparative lens, in order to identify the ways in which an integrative legal framework can help close these gaps. The study suggests that enhanced levels of legislative and rule linkage; elaboration of common and shared principles by institutional actors in WEF domains; as well knowledge, expertise and information sharing on WEF-related planning at local, regional and international levels are significant steps towards advancing systemic and integrated governance of WEF resources.

The article is organized into five sections, this introduction being the first. Section II explores both the contours and significance of the WEF nexus discourse, including the benefits that can be derived from integrated governance of WEF resources. It discusses how the principle of systemic integration and coherent interpretation of international law obligations provides legal support and basis for ongoing efforts to integrate WEF-related planning and decision making. Section III examines legal and practical barriers to implementing a nexus approach to WEF governance. In section IV, some lessons and recommendations are drawn on the required steps and processes for addressing barriers to WEF nexus governance. Section V is the conclusion.

2. The WEF Nexus discourse: significance and contours

The WEF nexus approach has been widely promoted over the last decade as a framework for promoting coherent and coordinated implementation of sustainable development programs. This section examines the significance and drivers of the WEF nexus approach as a coherent framework for understanding and implementing the diverse SDGs on water, energy, food and climate change.

2.1. Drivers and significance

The WEF nexus discourse recognizes the interlocking pressures and tradeoffs facing WEF systems (Simpson and Jewitt, 2019; Cairns and Krzywoszynska, 2016; Hoff, 2011). It identifies the need for legal and institutional coordination of governance efforts aimed at addressing water, energy and food scarcities in order to address overlap, interdependencies, constraints, synergies and tradeoffs (Weitz et al., 2017a, 2017b; Pahl-Wostl, 2017). It also investigates how technological advancements, policies, rules and/ or legislation in one domain affects and reinforces other domains. The nexus approach advocates a fundamental shift from sectoral and ‘one pipe-at-a-time’ governance approach, to a cross-sectoral, coherent and integrated approach to WEF management. Furthermore, the WEF nexus approach aims to overcome unintended consequences of uncoordinated policy between different sectors (Hellegers et al., 2014).

The WEF nexus discourse is not new (Benson et al., 2017; FAO, 2014; Muller, 2015). As far back as the 1980s, researchers and policy makers began to highlight the need for cross-sector, cross-scale and hybrid reasoning and planning in WEF sectors (Leck et al., 2015). However, the impetus and calls for a nexus approach to WEF governance in decision making and planning have grown geometrically over the last decade due to four main reasons. First is an unprecedented rise in demand for WEF (Hoff, 2011). Demand for food, water, and energy have grown over the last decade, and are projected to grow further by approximately 35, 40, and 50 percent respectively by 2030. This geometric rise in demand is due to an increase in the global population, urbanization and rise in consumption patterns across the world, especially in developing countries (NIC, 2012; WWF and SAB Miller, 2014). As countries develop, their populations will require more energy, food

and water. For example, demand for food and energy is increasing in developed countries, such as in Canada and the United Kingdom, with high populations and high concentration of industries (World Wildlife Fund, 2017; International Renewable Energy Agency, 2015). Also, as wealth increases, so does the demand for energy. For example, intertwined with oil driven wealth and economic expansion in oil and gas producing countries in the Middle East, is a geometric rise in population and energy consumption across the region at a median rate of 4–10 percent per year (Alotaibi, 2011; Olawuyi, 2018a, 2018b). Given these energy demand patterns, there has been an urgency to: increase installed electricity capacity to meet the increasing peak demand load; and reduce the current electricity demand rate by promoting energy efficiency in water, food and industrial sectors and eliminating waste (Ringler et al., 2013; Olawuyi 2018a, 2018b). Addressing demand for food, without understanding the implications of agricultural expansion projects on electricity usage and demand may result in counter-productive policies, and *vice versa*. For example, food and agricultural sector is currently the largest consumer of water (70%) and one of the largest users of energy (30%) (International Renewable Energy Agency, 2015). Food prices are therefore projected to increase as energy, fertilizer and water transportation costs rise (Food and Agricultural Organization, 2011). Also, addressing energy demand through expansion of alternative and renewable energy projects for example could affect land access for agricultural purposes and could impact food security especially in rural communities (Oguamanam, 2016). The WEF nexus model allows policy makers to understand the implications of increasing energy demand on food and water supply, and the implications of rising food production and agriculture sector for water and energy consumption (Pandey and Shrestha, 2017).

A second driver of the WEF nexus discourse is the unique threats posed by climate change to water, energy and food systems (Wichelns, 2017; Pandey and Shrestha 2017). Apart from climate-induced fatal heat waves and debilitating sea level rise, climate change could have wide-ranging effects on food production, water availability and energy generation in all countries of the world, especially in developing countries (Carter et al., 2015; Assaf, 2009). For example, even without climate change, fragile states in Middle East and African (MEA) region are currently subjected to tough arid conditions and extreme heat, which typically affect the structural integrity, operation and life span of water, energy, coastal and transportation infrastructure (Assaf, 2009). The high intensity and frequency of hot days in the MEA region, coupled with severe water shortages across the region, already affect the reliability of agricultural and food systems, waste management, transportation networks, and energy supply systems. Climate change would only escalate these pre-existing conditions (Intergovernmental Panel on Climate Change, 2013). Climate change could also impact water, energy and food availability and prices in countries that depend on energy, water or food supplies from other climate stressed countries. To effectively limit and address the catastrophic impacts of climate change, the international climate change regime has emphasized the importance of cooperating across relevant sectors in both the preparation and implementation of National Adaptation Plans (NAPs) (United Nations Framework Convention on Climate Change, 2012). Addressing climate change impacts in one domain, without addressing tradeoffs and impacts in other domains may result in maladaptation and ineffectiveness (Wichelns, 2017). Also, given the crosscutting implications of climate change for water, energy and food infrastructure, promoting the design of smart and climate resilient infrastructure can enhance efficiency and reduce emissions across the entire WEF domains (Pittock et al 2015). Infrastructure upgrades for climate adaptation, for example, can be coordinated to promote smart water systems, energy efficiency as well smart food storage and preservation. Furthermore, infrastructure integration can help promote multiple and flexible use of infrastructure, for example dams, irrigation and drainage systems for WEF purposes (Ringler et al., 2013).

A third and related driver of the WEF discourse is the need to

address the interactions and implications of climate and energy expansion projects on human rights, most especially human rights to property, water and food. In order to address global energy poverty, the United Nations' Sustainable Energy for All and the associated Sustainable Development Goal (SDG) 7 encourage countries to develop projects and initiatives aimed at providing access to energy to the over 1 billion people who do not have access to reliable energy (UN, 2015). SDG 7 aims to achieve three goals by 2030: ensuring universal access to modern energy services; doubling the global rate of improvement in energy efficiency; and doubling the share of renewable energy in the global mix (UN 2015). To achieve these targets, many developing countries, especially countries in Africa and Latin America, where many of the world's energy poorest people live, have scaled up investments in infrastructure development projects aimed at expanding energy access ("energy access projects"). However, many of these energy access projects, such as the Mambilla hydropower project in Nigeria; renewable energy projects in Senegal and Tanzania; rural electrification projects in the Philippines; the Three Gorges Dam project in China; hydroelectric projects in Honduras and Panama; and large energy pipeline projects such as the West African Gas Pipeline project in Ghana, have been linked with complex human rights violations (Olawuyi, 2018a, 2018b; Hall and Weiss, 2012). Similarly, low carbon energy projects implemented under clean development mechanism (CDM) and Reducing Emissions from Deforestation and Forest Degradation, sustainable management of forests and conservation, and enhancement of forest carbon stocks (REDD+) schemes have been linked with severe human rights violations in developing countries (Olawuyi, 2018a, 2018b; Roht-Arriaza, 2012). These human rights concerns include compulsory acquisition of lands as project sites; forced displacement; marginalization; exclusion; concentration of energy access projects in poor and vulnerable communities; and governmental repression in developing countries (United Nations Environment Programme, 2015). The gaps and the high incidence of human rights violations resulting from energy access projects have increased calls for a more transparent, accountable, and human rights-based approach to energy access (Olawuyi, 2016a, 2016b). Furthermore, the production of bioenergy crops, such as sugarcane, could reduce land and water availability, which could ultimately result in a sharp rise in food prices (Oguamanam, 2016; Runge and Senauer, 2007). Emerging debates on energy justice, therefore, recognize the growing indirect impacts that WEF projects have on human rights and examine how international law could provide legal frameworks to address these impacts (Olawuyi, 2016a, 2016b). As countries aim to achieve SDG 7 on energy access, the WEF model allows countries to develop a systemic view of the social and human rights implications of energy expansion projects, as well as on long term sustainable development.

The need for coherent and holistic implementation of the SDGs is a fourth and overarching driver of the WEF nexus discourse (Stephan et al., 2018). The nexus approach has become increasingly recognized as an important vehicle through which countries can holistically implement and achieve the Sustainable Development Goals (SDGs) to avoid overlap (Terrapon-Pfaff et al., 2018). SDG 6 (water), SDG7 (energy) and SDG2 (food) encourage countries to develop projects and initiatives aimed at eliminating water, energy and food scarcities by 2030 (FAO, 2014; United Nations, 2018). The 2030 UN Agenda for Sustainable Development also highlights the need for a common approach for the implementation of all the SDGs in order to reduce access inequalities (FAO, 2014). The nexus approach allows policymakers to have a systemic understanding and view of the trade-offs and synergies between the SDGs and to avoid overlapping and duplicative sector-specific actions and programs. It also provides a coordinated platform to pursue and implement related international obligations on WEF security as contained in other instruments. Through information sharing and cooperation between the different stakeholders and institutions responsible for the various SDGs, a country can formulate and implement a multiscale, holistic and integrated plan for achieving the SDGs

(Bielicki et al., 2019).

These drivers have necessitated increased integration of institutions, stakeholders and decision making across WEF sectors to reduce fragmentation of responsibilities and promote collaborative policy frameworks on the SDGs (Hussey and Pittock, 2012; Bielicki et al., 2019). Despite the policy awareness however, the design and implementation of integrated WEF policies raise significant legal and governance questions that have yet to be adequately addressed. To advance integrated WEF governance, there is a need to further the conceptual understanding of the features of WEF governance integration as well as the legal challenges and practical barriers associated with such integration.

2.2. Contours and features of WEF Nexus

A central tenet of the nexus governance model is the idea of integration, *i.e.* integrating or harmonizing WEF obligations, rules and norms into policy making through a coordinated or holistic approach. The nexus approach is characterized by the UNECE to include five core features. These are the integration of: (1) Institutions; (2) Information sharing; (3) Instruments, laws and policies to address trade-offs and exploit synergies; (4) Infrastructure and technological solutions; and (5) International coordination and cooperation at regional levels (the "5-I Principles") (UNECE, 2015a,b). In practical terms, WEF nexus governance entails assessing and mainstreaming the benefits and impacts of projects, programs and infrastructure in one sector on the other two sectors. It draws attention to the potential impacts of actions, measures and projects in one sector on the most vulnerable groups, such as poor and racial communities, women, children, disabled persons, and indigenous peoples (Biggs et al., 2015). For example, rather than focus on energy benefits alone, WEF nexus allows project planners in the energy sector to understand the co-benefits and impacts of energy projects on water access, land use and food security in vulnerable communities. By implementing the 5-I Principles in the design, approval, finance, and implementation of WEF projects, policy-makers are better positioned to anticipate and consider the impacts of a project in one domain on the other domains, and on the public and then take steps to mitigate those impacts. The WEF nexus model aims to reduce fragmentation and strengthen policy coherence between water, food and agriculture and land management sectors at local and regional levels.

The WEF nexus governance approach builds on dominant discussions in international law on the need to address fragmentation and lack of coherence in the interpretation and application of the various international law instruments on water, energy, environment, food, trade, climate change and human rights (Viñuales, 2018; Young, 2012; Biermann et al., 2009; Van Asselt et al., 2008). There have been concerns and evidence that projects at national levels, designed to implement obligations under one treaty produce conflicting or overlapping implications under other treaty provisions and rules of customary international law (Pauwelyn, 2004; Stephenson, 2012; Olawuyi, 2016a, 2016b). Such overlap have resulted in increased discussion of the principle of systemic integration and coherent interpretation of international law obligations, laid down in Article 31(3)(c) of the Vienna Convention on the Law of Treaties, as a potential solution to the problem of fragmentation in international law (Vienna Convention on the Law of Treaties, 2019).

Despite debates on the scope and ambit of the principle of systemic integration and coherent interpretation of international law obligations, it is generally agreed that it provides a legal basis for harmonizing and coordinating international law obligations on water, energy, food, climate change as well as human rights obligations, such that an attempt to perform one obligation does not lead to conflict with or the violation of another (Dupuy, 2009; International Law Commission, 2006). Article 31(3) (c) reinforces the significance of interpreting and applying international law instruments in mutually supportive ways (Mclachlan, 2005; Tzevelekos, 2010). Several of the international obligations on

access to water, energy and food are reflected in treaties such as the United Nations Framework Convention on Climate Change (UNFCCC, 1992), Paris Agreement (United Nations Framework Convention on Climate Change, 2015), core international human rights instruments, such as the International Covenant on Civil and Political Rights (ICCPR, 1966), International Covenant on Economic, Social and Cultural Rights (International Covenant on Economic, Social and Cultural Rights, 1966), as well as non-binding declarations and action plans such as the UN SDGs, Universal Declaration of Human Rights (UDHR, 1948) amongst others. These instruments establish interrelated international law obligations and principles on the right to water, right to food, energy security, climate change mitigation and adaptation, as well as procedural rights on access to information and stakeholder participation in development projects include in WEF sectors. The nexus governance approach is a logical step that could bring about hybrid reasoning in the harmonization and integration of these dispersed, and at times overlapping, obligations to make them operate as part of a coherent and meaningful whole (Oguamanam, 2016). For example, without integration, efforts to fulfil the right to food through massive plantation projects could result in water scarcity, which could impact on the right to water.

Similarly, considering that many of the parties to global climate change treaties are also parties to core international human rights treaties that address access to water and food, an integrative and coherent approach provides an avenue for countries to respect, protect and fulfil human rights on water and food, while combating climate change. The Paris Agreement recognizes that Parties should, ‘when taking action to address climate change, respect, promote and consider their respective obligations on human rights.’ (Preamble, UNFCCC 2015). This speaks to the need for a mutually reinforcing approach that enables a country to ensure that projects, actions and measures designed to meet obligations under climate change regime do not violate international human rights obligations on water, energy and food. A nexus approach to WEF governance is a methodological approach through which human right obligations on water and food, can be incorporated into energy and climate actions and projects to avoid trade-offs, overlaps and inconsistencies.

Furthermore, through knowledge mobilization and information sharing, a WEF nexus governance model can provide opportunities for policy makers to better understand how energy access initiatives under SDG 7 can impact food security and supply within the ambit of SDG 2. It can also provide a basis for addressing the implications of increased agricultural production on water and energy use. Synergies, tradeoffs and challenges at the interface between WEF policies, such as access to water, energy and land for the poorest; reducing resource-intensive consumption and production patterns; and the effective deployment of technologies relevant to all domains, cannot be addressed in isolation. Examining the interplay and nexus between food, energy and water policies enables a holistic management and systemic view of the complex and critical stress-points. Furthermore, rather than considering tradeoffs and risks on a piecemeal, sectoral and technology-by-technology basis, a WEF nexus governance model supports the development of integrated, systemic and multi-sectorial governance and monitoring systems.

The nexus approach to WEF governance provides a normative framework for reducing the fragmentation of international law obligations relating to water, energy, food, as well as climate change and human rights. Through a nexus assessment, actions and measures that negatively impact one sector could be spotted and reconsidered before approval (UNECE, 2015a,b). Furthermore, a WEF nexus governance model can allow countries to integrate their obligations to respect human rights on water, energy and food into climate and environmental programs through a holistic framework.

However, despite the potential and promise of the WEF nexus approach as a framework for promoting integration and coherence the implementation of the SDGs, it is yet to be widely adopted in policy and

development planning, especially at domestic levels (Wicaksono et al., 2017). A significant number of questions about the legal compatibility of WEF governance frameworks remain unanswered (Weitz et al., 2017a; Daher et al., 2018). The task of reconciling the fundamental goals of regulating water, energy and food remains very much a work in progress. Identifying WEF nexus and interdependencies without addressing legal and institutional challenges to practical application in local contexts may not be enough to drive action. Some of the key legal and institutional challenges are discussed in the next section.

3. Implementing a Nexus approach to WEF governance: legal and institutional limitations

While drivers that give impetus to adopting a WEF nexus approach are global in nature, translating WEF nexus governance to practical impacts will vary according to different legal contexts, regimes and actors, including domestic-level institutions, regional organizations, international development agencies, UN human rights bodies, and international food, water and energy regimes. The challenges identified in this section can guide domestic-level institutions, international development agencies, and regional bodies to better understand and assess the legal preconditions and barrier to implementing a nexus approach to WEF governance in local contexts.

3.1. Are the regulatory aims of the WEF sectors compatible?

The first real barrier to WEF nexus approach is the undercurrent of conflict between the prevalent regulatory models in water, energy and food sectors (Stephan et al., 2018; Leck et al., 2015). This is the question whether regulatory approaches promoted in water and food sectors are compatible with dominant regulatory models in the energy sector? Should energy law rules and instruments be self-contained, or should they incorporate water, food, climate change and human rights principles?

The nature of the markets in which they operate often mean that water, energy and food regulation are carried out in different ways (Weitz et al., 2017a). For example, while the commodification and privatization of energy (oil, gas, electricity) is a crucial component of energy regulation, efforts to privatize water has generated enormous debates globally, especially in the global South (Dugard and Koeck, 2016). Furthermore, while water and food regulators and lawyers tend to take a rights-based, moralistic and prescriptive view of regulation, energy lawyers tend to view excessive regulations as anti-competitive and a barrier to effective energy pricing. The concepts of privatization, as well as incentive-based regulation, are therefore highly charged concepts in water and food sectors, arguably more so than in the energy sector.

Similarly, due to the typically high costs of energy infrastructure, and the existence of monopolies with regards to production, supply, distribution and transport facilities which cannot easily be duplicated, long term contractual arrangements (of 25–30 years) are very prevalent in the energy sector (especially oil and gas) unlike in water and food sectors (Von Hirschhausen and Neumann, 2008). Consequently, unless properly designed and integrated, a single model of regulation may not fit all WEF systems. The need to develop integrated laws and policies that are compatible with the three sectors raises complex issues for policy-makers and regulators, including how to integrate possibly conflicting doctrines and policy goals across the WEF sectors. For example, reducing energy consumption in water and agricultural sectors, may not be compatible with the economics of investing in expensive energy infrastructure projects from the perspective of energy actors. Balancing these issues will undoubtedly be a complex process, which if not well addressed may result in toxicity and norm disintegration.

The idea of inter-doctrinal legal transplants or infusing legal norms and practices from one genre of law to another is itself not without debates (Rock and Wachter, 2002). However, despite debates on inter-

doctrinal legal transplants, it is generally accepted that the transfer of norms and best practices between different bodies of law is desirable and possible if done with careful attention to context (Spamann, 2009). While harmonizing principles, best practices and governance structures across different legal domains, as contemplated in the WEF discourse, is important and possible, policymakers and regulators will have to develop careful and common understanding of the regulatory contexts and tensions across the domains.

It is essential to analyze and carefully reflect the varying contexts and diversity in the WEF domains in order to arrive at mergeable and workable solutions these important sectors. The complexity of the norms and policy goals creates a real possibility that a nexus approach to WEF governance may not encompass or address all possible scenarios and factors, however by developing a detailed and common understanding of the regulatory priorities across the sectors, realistic and well aligned instruments, that provide adequate time-scales for integration, can be achieved. In the short term, for example, increased energy efficiency in water and food production may increase food prices, but in the longer term, with new technologies becoming available and cheaper, it may well result in reduced prices.

3.2. Are there opportunities for rule linkage in practice?

Another challenge is the web of diverse rules, regulations and legislation across WEF sectors. In many countries, water, energy and food sectors are governed by segregated and compartmentalized legislation, rules and procedures. For example, in the UK, as it is in several countries, the energy legislation does not include any textual reference to food, land-use and water (Energy Act, 2014; Sharmina et al., 2016; Lekunze and Lekunze, 2017). Similarly, the water legislation does not make direct mention of energy, land use and food production (UK Water Act, 2014). Likewise, food and agriculture legislation in the UK do not address energy and water. This traditional and sectoral way of regulating WEF resources makes it difficult to operationalize the WEF nexus in practice. Consequently, while the WEF nexus idea is generally clear, what it requires in practice remains unclear. Different instruments on WEF contain different interpretations, requirements and procedures for projects in their domains. They also prescribe approval processes that are not interlinked and coordinated. This creates interpretation gaps on the legal basis and source of responsibility when it comes to detecting the nexus. The fragmented legal and regulatory frameworks have led to the charge that the WEF nexus is fuzzy and ambiguous in practice (Cairns et al., 2012).

While some of the legal obligations to achieve energy efficiency in water and food projects can be inferred or drawn from climate change legislation and other policy documents, such an approach is indeterminate and may not provide an opportunity for a clear and robust understanding of the critical interplay, tradeoffs and synergies that exist in decision making and planning across the domains. Clear, comprehensive and specific legislation is critical in order to effectively advance the WEF nexus approach from theory to practice. The absence of linked rules, procedures and obligations across the WEF domains makes it difficult to reflect WEF nexus considerations in the design, approval, financing and implementation of multi-scale and multi sectorial projects. Furthermore, lack of linked rules and processes could also complicate the process of obtaining approvals, permits, and demonstrate compliance for multi sectorial projects across WEF domains. For example, environmental impact assessment (EIA) is often required to construct and implement projects across water, energy and agricultural sectors. What is however unclear is whether an EIA conducted and approved for an energy infrastructure project will be sufficient for a water project given the diverse technological, location and social issues raised and the different stakeholders involved in the approval processes. For the WEF nexus to be operational in practice, licensing, permitting and project approval processes have to be clarified and linked to promote coherence and simplify the procedures and rules for

implementing multisector projects in WEF domains.

To develop linked legal framework and rules for WEF action and projects, there is a need for cross sector analysis and conceptual development of the nature, scope and content of the WEF nexus in legal context, what it would look like in practice in terms of project design and approval, how it would be implemented, monitored and supervised across the diverse domains. An important starting point will be to create a common understanding on WEF nexus amongst the various public and private actors on water, energy, food, land and climate change. Such a common understanding can help detect and address conflicting or overlapping provisions and rules across the WEF domains. It can also allow for the development of consistent and coherent legal knowledge on the WEF nexus. Such an operational framework will also make it possible to evaluate its practical efficiency and measure progress on WEF nexus governance.

3.3. Problems of institutional operationalization

Developing clear and comprehensive legal framework on WEF nexus is one part of the task, creating the right institutional set up for practical coordination and cooperation of the diverse stakeholders and institution in the WEF domains is another complex challenge (Bielicki et al., 2019; Bizikova et al., 2013). The overarching mandate to supervise WEF programs remain under the purview of separate agencies and institutions, such as trans-boundary water commissions or planning ministries/ departments (Bielicki et al., 2019). The fragmentation of WEF responsibilities across different agencies and institutions, with distinct financial and resource allocations and most times competing and conflicting priorities, raises complex questions in terms of potential for developing and implementing integrated solutions across the sectors (UNECE, 2015a,b). Consequently, water, energy and food security programs continue to be implemented and articulated in a largely sectoral and fragmented manner. This makes it complex and difficult to integrate and implement WEF nexus considerations in local contexts.

The value of institutional coordination and cooperation in implementing WEF programs has been emphasized at the international level by UN agencies (United Nations, 2018). For example, the United Nations Water was established in 2003 to coordinate efforts of United Nations entities and international organizations working on water and sanitation issues (UN Water, 2015). Similarly, in 2009, the United Nations Development Group launched Human Rights Mainstreaming Programme (UNDG-HRM) which aims to strengthen coherence in human rights mainstreaming policies and practices across UN systems. It also aims to enhance UN system-wide knowledge codification and sharing, capacity development, collaboration and policy dialogue on human rights mainstreaming across the UN (UNDG, 2011). Despite ongoing debates on the efficiency of the UN coordination efforts, it is generally accepted that institutional coherence and coordination in the design and implementation of development projects, especially with respect to food, water, energy, environment and human rights, can help leverage strengths and reduce inconsistencies (Viñuales, 2018; Belinskij, 2015). The UN efforts can also provide normative guidelines and lessons on how to achieve institutional coordination for WEF related activities and programs at the national level.

Domestic-level implementation of intersectoral coordination is often stifled by capacity questions (Bielicki et al., 2019). For example, assessing the interplay of water laws and policies in an energy institution or ministry would require expanding staff capacity or recruiting experts in water management. Similarly, implementing energy efficiency policies in the food sector could require recruiting staff that can understand, analyze and implement energy legislation and rules. Furthermore, assessing the human rights implications of an energy access project on the right to water, food, land and property would require significant human rights knowledge and expertise. These are complex transformations that could expand the scope of activities of entity into uncharted areas such as interpreting energy efficiency and making

decisions on the human rights implications of an energy project for water and food security.

More importantly, given that these respective institutions are currently not constituted or designed to analyze and implement WEF knowledge, their ability to analyze and implement different types of information and data may be limited by differences in skill sets and expertise (Howarth and Monasterolo 2016). For example, some human rights advocates consider it as dangerous to place the function of interpreting human rights in the hands of professional administrators (Koskenniemi, 2010). As Tallant rightly notes, epistemic distinctions can be fueled by the tendency of actors to remain within the formal confines of their areas of mandate (Tallant, 2012). Such inertia is also fueled by the divergent training, styles and perspectives by actors in the respective fields (Bielicki et al., 2019; Hussey and Pittock, 2012). Similarly, institutional requirements such as fiduciary and non-disclosure obligations in some water, energy and food utilities and the risk of being in breach of their legal and institutional responsibilities, can serve as a disincentive for actors to be willing to collaborate across sectors (Stirling, 2015).

This problem of practical operationalization can be addressed through pragmatic and standardization approaches that foster co-operation and minimize duplication. This will require building shared and common understanding by institutional actors in WEF domains, sharing information and knowledge in open and linked systems, and constituting cross sectorial panels and committees that can provide informed picture of WEF interdependencies and interplay. A necessary starting point will be to elaborate and develop cross sector analysis of the key institutions at the municipal, local, national, basin, trans-boundary and regional levels governing the use of water, energy and land resources. Such analysis will examine to what extent the mandates of existing institutions are coherent, conflicting and/or duplicative and also whether there are linked platforms in place to support knowledge and information sharing and intersectoral cooperation. For example, institutions can leverage on their respective expertise, facilities and best practices by engaging with staffs and experts across sectors to assist with reviewing and assessing multisector projects. Inter-agency linkages and partnerships, through joint initiatives and knowledge sharing, could increase trust and enhance synergic solutions that enhance WEF governance.

3.4. Resource constraints

Linked to the question of capacity and institutional coordination is the question of resources. Integrating WEF knowledge and practices across the domains will come at considerable costs. For example, cost of upgrading existing infrastructure, expanding current institutions, staffing, training, field inspections, project review panels, and program design to integrate WEF perspectives. Due to limited resources and competing budget priorities, WEF nexus integration may run into implementation problems, especially in developing countries with limited financial capabilities (United Nations, 2018). For example, water, energy and food security programs have been stifled in many Africa and Latin America due to inadequate funding, understaffing, budget mismanagement and lack of sustained commitment by governments (Olawuyi 2018).

However, WEF nexus governance could be met at lower costs, and deliver greater cost saving in the long run, if planners in each sector develop opportunities for sharing resources and infrastructure. For example, designing energy efficient water infrastructure and programs can reduce spending on electricity (FAO, 2015). Also, when food is wasted, energy, water and land are also wasted (FAO 2015). Therefore, promoting sustainable food consumption and sustainable agriculture could reduce public spending on energy and water infrastructure in the long run.

Furthermore, to reduce the cost of WEF nexus governance, it is essential for actors across the domains to build on existing capacities and

resources. This will require building on internal programs and capacities and streamlining them to avoid duplication and waste. Linking new programs to already existing ones would save some cost and provide ready infrastructures to work with. As noted earlier, instead of focusing on expert recruitment, ministries can build joint committees and panels that allow them to explore co-benefits in WEF nexus implementation. This may require appointing an Ombudsperson, co-ordination agency or committee to spearhead sustainable development and synergic use of resources across the domains. A good example is the Office of the Commissioner of the Environment and Sustainable Development, an independent unit, housed within the Office of the Auditor General of Canada, which oversees, reviews and appraises sustainable development programs across all government departments (AOG, 2019). The Commissioner supports the work of government ministries and assists them in harmonizing their working methods and reporting requirements on sustainable development. Such a co-ordinating entity or unit would bring together key actors to address intersectoral impacts and opportunities and to avoid duplication of roles. It could also be well placed to identify areas of priorities and distribute resources in accordance with the priorities identified.

The aforementioned gaps and barriers to the application of a nexus approach to WEF governance can be addressed through an integrative legal framework that fosters synergies and rule linkage across WEF domains. The next section discusses the guiding principles of an integrative legal framework that can inform and support WEF nexus governance in national contexts.

4. Improving integrative governance of WEF resources: emerging solutions and ways forward

The interconnections between the SDGs, underscore the need for a WEF nexus approach to advance the SDGs in a coherent and integrated manner (Salam et al 2017). Promoting coherence and coordination in the implementation of the SDGs, especially with respect to WEF resources, requires clear, comprehensive and integrative governance framework that recognizes and contextualizes WEF interdependencies and nexus. An integrative governance framework will provide appropriate incentives such as linked and coordinated regulation, structural integration of expertise, knowledge and information, as well as holistic programming by actors in WEF domains that can help move towards successful transformation. The fragmentation of legislation and responsibilities across WEF domains has significant consequences in terms of developing and implementing integrated solutions that allow progress across the three sectors. An integrative governance framework can provide legal basis for promoting the incorporation of WEF nexus considerations across all policy areas. The complexity of integrating WEF considerations across different sectors, institutions and departments should not be underestimated. However, the below step-by-step approach can provide a framework for addressing the complexities and challenges associated with linking WEF nexus analysis and assessments in water, energy and food projects and decision making.

4.1. Align legislation and procedures across WEF domains

To implement a nexus approach to WEF governance, a comprehensive linkage of legislation, rules and procedures across the WEF domains is essential. Recent legislative developments in the UK and Alberta, Canada suggest that rule linkage across the WEF sectors is indeed possible and emerging. However, greater clarity will be required to fully implement the WEF nexus approach in practice. For example, UK's *Environmental Permitting (England and Wales) Regulations* (EPEWR 2016) offers an example of innovative legislation that integrates the administration of a range of environmental regimes. The system requires regulators to control certain activities that could harm the environment or human health, and covers facilities such as the energy industry, waste operations, food industry, and water discharge and

groundwater activities. The system also allows a single permit to cover more than one regulated facility if they are on the same site. However, this is as far as the Act goes, and it does not address issues of food security, nor does it address issues of water and energy security.

Similarly, in Alberta, Canada, section 2 of the *Responsible Energy Development Act* (REDA 2012) empowers the Alberta Energy Regulator (AER) to regulate water conservation and management, environmental protection, and public lands management with respect to energy resource activities in Alberta. Section 67(1) also creates an obligation on the AER to ensure that its activities are consistent with programs, policies, and work of the government in respect of energy resource development, public lands management, environmental management, and water management. This provision aims to ensure systemic coherence and integration of activities and programs related to water, energy, and public lands management in Alberta. By empowering the AER to consider water, energy, and land protection in energy resource development, the AER is responsible for streamlining the licensing, permitting, and project approval processes for energy activities to avoid negative impacts across the diverse domains. This integrated process provides an example of the nature of hybrid reasoning and rule linkage that is required for WEF nexus implementation. However, this is as far as the Act goes, and it does not address issues of promoting energy efficiency in water and food projects, nor does it address questions of climate change impacts on food and water security. Furthermore, the AER's mandate and activities relate mainly to the approval of energy resource projects and do not extend to broader issues relating to low carbon and renewable energy project.

These emerging legal solutions show that the diffusion and linkage of permitting and approval responsibilities across multiple sectors is already evolving, but will require further elaboration and wider coverage. The UK example demonstrates the approach of granting a single permit for multiple cross sectorial activities on the same site to reduce permit duplication and inefficiency. On the other hand, the Alberta approach focuses on integrating the permitting procedures under one single regulator to reduce delays. Both approaches offer opportunities to reduce fragmentation in project approval processes across for WEF sectors. A streamlined and integrated permitting process can help reduce complexities, delays and inefficiencies in the planning, realization and delivery of vital WEF infrastructure projects (Government of Alberta, 2010). Reducing delays in project approval and permitting procedures is very critical for countries to achieve SDGs on WEF, especially the renewable energy transition targets (European Commission, 2011; Stephan et al., 2018).

Furthermore, other policy issues beyond project approval, such as resource efficiency, co-financing, joint supervision and information sharing across the sectors will need to be integrated to improve overall efficiency. A starting point is for national authorities to update current legislation on water, energy and food to recognize the 5-I Principles and to establish clear guidelines for their application in the respective sectors. Such a reform will provide a legal basis for implementing the WEF nexus in practice. It will also provide opportunities to link the applicable rules on the design, approval, financing and implementation of projects across the sectors.

An integrated legislative framework will provide comprehensive standards and rules on the use, treatment, waste management and discharge, emission reduction, savings and efficiency, project design, approval, reporting and monitoring with respect to WEF resources and projects. For example, it may be more efficient and effective to broaden the scope of existing environmental impact assessment (EIA) requirements in water legislation to address food, agriculture, land use, and climate risks especially on the most vulnerable groups, such as poor and racial communities, women, children, disabled persons, and indigenous peoples, as opposed to establishing and implementing parallel procedures for screening projects for these risks (Agrawala et al., 2010). Furthermore, a comprehensive integration process will identify regulations, rules and procedures that act as barriers and disincentives to

institutional coordination, information sharing across the sectors, and simplified permitting and licensing processes across the sectors. For example, instead of having multiple and parallel licensing processes for climate adaptation projects that are of common interest to water, energy and food sectors, an integrated legislative process could result in a streamlined, coordinated and simplified process and procedure for fast tracking permitting and licensing. Streamlining measures across WEF sectors could include collating and identifying projects that are of common interest to the sectors (such as climate smart infrastructure projects, efficiency projects, waste treatment and pollution control etc) and then ensuring that such projects benefit from interlinked, simplified and faster permitting procedures. While country specific assessments will be required to identify how simplifying measures can be designed and applied in WEF sectors and the possible political barriers, rule integration and the elimination of duplicative procedures is an essential step towards integrative governance of WEF sectors.

4.2. Establish focal institution on WEF integration

To advance institutional coordination and cooperation in the design and implementation of programs, projects and policies across WEF sectors, it is important to designate a focal institution or administrative unit that will coordinate knowledge, expertise and information sharing across the sectors. Apart from serving as a one stop shop that will facilitate and integrate permit and approval processes for projects, such an institution would also provide capacity development opportunities for administrators to acquire technical knowledge about the methods, requirements and data in other sectors. This could help ensure standardized and systematized understanding and documentation of plans and programs across WEF domains. A focal institution can also facilitate and simplify data collection and information sharing across the WEF sectors. By creating a platform for data sharing, such a focal unit can help detect conflicting projects, rules and procedures. Similarly, by empowering and establishing a focal institution on projects, stakeholders across private and public sectors can obtain relevant information and develop an institutional understanding about the process and methodology for implementing projects that are of common interests to the sectors.

Implementing an integrative framework on WEF does not necessarily mean building new institutions or establishing a new agency. It is possible to expand the scope of one or more existing organizational structures that already have a multisectoral scope to enable them promote cooperation and dialogues between several actors in the WEF domains. The most important step is to designate an effective platform that can spearhead knowledge exchange, information sharing and dialogue between the diverse actors and stakeholders in WEF domains.

4.3. Promote regional cooperation and knowledge sharing

Regional interaction and knowledge sharing between countries with experience and practice on WEF nexus governance can help promote expertise on the instrument design and implementation. For example, while a number of WEF related success stories are emerging in across Europe with Poland, Finland and Italy, as well as in developing countries such as India and Nepal, some countries have little to no experience at all with WEF nexus design and implementation (Diriba Guta et al., 2017). It is therefore important to promote transboundary co-operation and knowledge sharing between regional networks and institutions on how to design and implement integrative frameworks on WEF nexus governance.

Regional centers and platforms can also enhance the exchange of ideas, best practices and knowledge on existing project opportunities, model contracts and practical steps for planning and implementing multiscale and multisectoral projects on water, energy and food. A good example is the EU/Germany -funded WEF Nexus Resource Platform that promotes knowledge exchange and strengthen political processes at

national and regional levels on WEF nexus (Nexus Regional Dialogue Programme, 2019). Similarly, the Asia Pacific Water Forum provides information and resources on nexus programs in the Asia-Pacific region (Asia Pacific Water Forum, 2019). Also, the Regional Center for Renewable Energy and Energy Efficiency (RCREEE), (2019), an inter-governmental organization, promotes knowledge and experience on the adoption of renewable energy and energy efficiency in the Arab region.

It is important for countries to key into regional knowledge sharing platforms on WEF nexus. Such regional knowledge hub could help capture the common challenges and approaches in the design and implementation of multi-sector infrastructure and integrative frameworks on WEF issues. It could also help monitor and disseminate best practices that can inform reform processes that can steer a country in the right direction. Regional knowledge sharing could also provide a basis for the future development of an interconnected WEF management programs and strategies in riparian countries with transboundary river basin.

5. Conclusion

Given the interdependencies between water, energy and food sectors, the nexus approach provides an important framework for promoting a coherent, holistic and integrated implementation of the SDGs relating to WEF to avoid fragmentation and overlaps. The promotion of the WEF nexus at international, regional and national levels shows an increasing recognition of the importance of an integrative and multi-centric approach to WEF governance. However, to ensure that the WEF discourse moves from theory to successful practical integration and adoption, fragmented legal structures and sector-based programs that stifle the development and application of hybrid and linked rules, procedures and processes across the sectors will have to be comprehensively addressed.

Legal and institutional barriers to the implementation and adoption of a nexus approach to WEF governance can be addressed by linking policies, rules and/or legislation across the WEF domains to make them more coherent and streamlined. Furthermore, country-specific analyses of the costs, opportunities and risks of the integrative process and scenarios across WEF domains can provide better foundation for cross sector partnership and linkages amongst WEF institutions.

Regional cooperation and sharing of expertise, knowledge and best practices on WEF governance could also provide an effective platform to share best practices, challenges and cooperation opportunities with respect to WEF management. Education and skills development programs will also play important roles to help administrators understand legal and institutional aspects of the nexus approach.

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References

- Agrawala, S., Kramer, A.M., Prudent-Richard, G., Sainsbur, M., 2010. Incorporating climate change impacts and adaptation in environmental impact assessments: opportunities and challenges. *OECD Environmental Working Paper No. 24*. pp. 9–10.
- Alotaibi, S., 2011. Energy consumption in Kuwait: prospects and future approaches. *Energy Policy* 39, 637–643.
- Asia Pacific Water Forum [accessed 2019 Jan 22] <http://apwf.org/background/>.
- Assaf, H., 2009. Impact of Climate Change: Vulnerability and Adaptation Infrastructure. [Accessed 2018 Dec 22]. pp. 1–5. <http://www.afedonline.org/afedreport09/english/char9.pdf>.
- Benson, D., Gain, A., Rouillard, J., Giupponi, C., 2017. In: Abdul Salam, P., Shrestha, S., Prada Pandey, V., Anal, A.K. (Eds.), *Governing for the Nexus in Water-Energy-Food Nexus: Principles and Practices*. John Wiley and Sons Inc., Washington DC, pp. 77–88.
- Belinskij, A., 2015. Water–energy–food nexus within the framework of international water law. *Water* 7, 5396.
- Bielicki, J.M., Beetsma, M.A., Kast, J.B., Wang, Y., Tang, S., 2019. Stakeholder perspectives on sustainability in the food-energy-water Nexus. *Front. Environ. Sci.* 7 (7), 1–16.
- Biermann, F., Pattberg, P., Asselt, H., van Zelli, F., 2009. The fragmentation of global governance architectures: a framework for analysis. *Glob. Environ. Polit.* 9 (4), 14–40.
- Biggs, E.M., Bruce, E., Boruff, B., Duncan, M.A.J., Horsley, J., Natasha, P., McNeill, K., Neef, A., Ogtrop, F.V., Curnow, J., Haworth, B., Duce, S., Imanari, Y., 2015. Sustainable development and the water–energy–food Nexus: a perspective on livelihoods. *Environ. Sci. Policy* 54, 389–397.
- Bizikova, L., Roy, D., Swanson, D., Venema, H., McCandless, M., 2013. The Water Energy Food Security Nexus: Towards a Practical Planning and Decision Support Framework for Landscape Investment and Risk Management. Manitoba: International Institute for Sustainable Development, pp. 14.
- Cairns, R., Krzywoszynska, A., 2016. Anatomy of a buzzword: the emergence of ‘The water-energy-Food Nexus’ in UK natural resource debates. *Environ. Sci. Policy* 64, 164–170.
- Carter, J.G., Cavan, G., Connelly, A., Guy, S., Handley, J., Kazmierczak, A., 2015. Climate change and the city: building capacity for urban adaptation. *Prog. Plann. J.* 95 (1), 1–66.
- Center for Renewable Energy and Energy Efficiency [accessed 2019 Jan 22] <http://www.rcreee.org/content/who-we-are>.
- Daher, B., Mohtar, R., Pistikopoulos, E., Portney, K., Kaiser, R., Saad, W., 2018. Developing Socio-Techno-Economic-Political (STEP) solutions for addressing resource Nexus hotspots. *Sustainability* 10, 512.
- Diriba Guta, D., Jara, J., Adhikari, Narayan Prasad, Chen, Q., Gaur, V., Mirzabaev, A., 2017. 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* 6 (3), 24.
- Dugard, J., Koeck, E., 2016. Water wars: anti-privatization struggles in the global South. In: Alam, S., Atapattu, S., Gonzalez, C., Razzaque, J. (Eds.), *International Environmental Law and the Global South*. Cambridge University Press, New York, pp. 469–470.
- Dupar, M., Oates, N., 2012. Getting to Grips with the Water-energy-Food ‘Nexus’ Climate and Development Knowledge Network, London.
- Dupuy, P.M., 2009. Unification rather than fragmentation of International law? The case of International investment law and human rights law. In: Dupuy, P.-M., Francioni, F., Petersmann, E.-U. (Eds.), *Human Rights in International Investment Arbitration*. Oxford University Press, Oxford, pp. 45–62.
- European Commission, 2011. Permitting Procedures for Energy Infrastructure Projects in the EU: Evaluation and Legal Recommendations. pp. 3–25. https://ec.europa.eu/energy/sites/ener/files/documents/2011_ten_e_permitting_report.pdf.
- European Union, 2012. The 2011/2012 European report on development, confronting scarcity: managing water. Energy and Land for Inclusive and Sustainable Growth.
- FAO, 2014. Walking the Nexus Talk: Assessing the Water–Energy–Food Nexus in the Context of the Sustainable Energy for All Initiative. 2–14. FAO Environment and Natural Resources Working Paper No 58, Rome.
- Food and Agricultural Organization (FAO), 2011. Energy-Smart Food for People and Climate Rome. FAO iv-v.
- Government of Alberta, 2010. Regulatory Enhancement Project, Technical Report at 2. online: < www.energy.alberta.ca/Org/pdfs/REPTechnicalReport.pdf > accessed 12 November 2018.
- Hall, M., Weiss, D., 2012. Avoiding adaptation apartheid. *Clim. Change Adapt. Hum. Rights Law Yale J. Int. Law* 37 (2), 309.
- Hoff, H., 2011. Understanding the Nexus. In: *Proceedings of the Bonn 2011 Conference: The Water, Energy and Food Security Nexus*. Bonn, Germany. pp. 16–18 November 2011.
- Hussey, J., Pittock, J., 2012. The energy–water nexus: managing the links between energy and water for a sustainable future. *Ecol. Soc.* 17 (1), 31–32.
- Intergovernmental Panel on Climate Change (IPCC), 2013. Working Group I Contribution To The IPCC Fifth Assessment Report. *Climate Change 2013: The Physical Science Basis. Summary for Policymakers* (Intergovernmental Panel on Climate Change, 2013. pp. 2–10.
- International Covenant on Civil and Political Rights (ICCPR) 1966, 16 December, 999 UNTS 171 (entered into force 23 March 1976).
- International Covenant on Economic, Social and Cultural Rights (ICESCR), 1966. International Covenant on Economic, Social and Cultural Rights (ICESCR). Dec. 16, 993 U.N.T.S. 3.
- International Law Commission (ILC), 2006. Fragmentation of International Law: Difficulties Arising From the Diversification and Expansion of International Law. Report of the Study Group of the International Law Commission. A/CN.4/L.682 (13 April 2006).
- International Renewable Energy Agency (IRENA), 2015. Renewable Energy in the Water Energy & Food Nexus. IRENA, Abu Dhabi, pp. 12.
- Jeswani, H., Burkinshaw, R., Azapagic, A., 2015. Environmental sustainability issues in the food-energy-water nexus: breakfast cereals and snacks. *Sustain. Prod. Consum.* 2, 17–28.
- Koskeniemi, M., 2010. Human rights mainstreaming as a strategy for institutional. *Power Hum.* 1 (1), 47.
- Leck, H., Conway, D., Bradshaw, M., Rees, J., 2015. Tracing the water–energy–food nexus: description, theory and practice. *Geogr. Compass* 9 (8), 445–460.
- Lekunze, J., Lekunze, A., 2017. Linking energy efficiency legislation and the agricultural sector in South Africa. *J. Transdiscipl. Res. South. Afr.* 359.
- Liu, K., Dietz, T., Carpenter, S., Alberti, M., Folke, C., Moran, E., Pell, A., Deadman, P., Kratz, T., Lubchenco, J., et al., 2007. Complexity of coupled human and natural systems. *Science* 317, 1513–1516.
- Mayor, B., Rodríguez-Muñoz, L., Villarroya, F., Montero, E., López-Gunn, E., 2017. The role of large and small scale hydropower for energy and water security in the Spanish Duero Basin. *Sustainability* 9 (10), 1807.
- Mclachlan, C., 2005. The Principle of Systemic Integration and Article 31(3)(C) Of The

- Vienna Convention ICLQ 54, pp. 279.
- National Intelligence Council, 2012. Global Trends 2030: Alternative Worlds. Office of the Director of National Intelligence 2012, Washington DC Iv.
- Nexus Regional Dialogue Programme, 2019. Nexus Regional Dialogue Programme. [Accessed 2019 Jan 22]. <https://www.nexus-dialogue-programme.eu>.
- Oguamanam, C., 2016. Sustainable development in the era of bioenergy and agricultural land grab. In: Alam, Shawkat, Atapattu, Sumudu, Gonzalez, Carmen G., Razzaque, Jona (Eds.), International Environmental Law and the Global South. Cambridge University Press, New York, pp. 401.
- Olawuyi, D., 2018a. Advancing innovations in renewable energy technologies as alternatives to fossil fuel use in the Middle East: trends, limitations, and ways forward'. In: Zillman, D., Roggenkamp, M., Paddock, L., Godden, L. (Eds.), Innovation in Energy Law and Technology: Dynamic Solutions for Energy Transitions. Oxford University Press, Oxford, pp. 354–370.
- Olawuyi, D., 2018b. energy (and human rights) for all: addressing human rights risks in energy access projects'. In: Salter, R., Gonzalez, C., Kronk Warner, E. (Eds.), Energy Justice: US and International Perspectives. Edward Elgar, Cheltenham, pp. 73–104.
- Olawuyi, D., 2016a. The Human Rights-Based Approach to Carbon Finance. Cambridge University Press, Cambridge, pp. 1–25.
- Olawuyi, D., 2016b. Climate justice and corporate responsibility: taking human rights seriously in climate actions and projects. *J. Energy Nat. Resour. Law* 34 (1), 27–44.
- Pahl-Wostl, C., 2017. Governance of the water-energy-food security nexus: a multi-level coordination challenge. *Environ. Sci. Policy* 92, 356–367.
- Pauwelyn, J., 2004. Bridging fragmentation and unity: international law as a universe of inter-connected islands. *Michigan J. Int. Law* 5, 903.
- Pittock, J., Hussey, K., Dovers, S., 2015. Climate, Energy and Water: Managing Trade-offs, Seizing Opportunities. Cambridge University Press, New York (NY).
- Ringler, C., Bhaduri, A., Lawford, R., 2013. The Nexus Across water, energy, land and food (WELF): potential for improved resource use efficiency? *Curr. Opin. Environ. Sustain.* 5, 617–624.
- Rock, E., Wachter, M., 2002. Dangerous liaisons: corporate law. *Trust Law Inter-doctrinal Legal Transpl. Northwestern U. L. Rev.* 96 (2), 652.
- Runge, C.F., Senauer, B., 2007. How Biofuels Could Starve the Poor 86 *Foreign Affairs*. pp. 41.
- Simpson, G.B., Jewitt, G.P.W., 2019. The development of the water-energy-food nexus as a framework for achieving resource security: a review. *Front. Environ. Sci.* 8 (7), 1–7.
- Spamann, H., 2009. Contemporary legal transplants: legal families and the diffusion of law BYU L. Review 2009 (6), 18.
- Stephan, R.M., Mohtar, R.H., Daher, B., Irujo, A.E., Hillers, A., Ganter, C.J., Karlberg, L., Martin, L., Nairiz, S., Rodriguez, D.J., Sarni, W., 2018. Water–energy–food Nexus: a platform for implementing the sustainable development goals. *Water Int.* 1–7.
- Stirling, A., 2015. Developing 'Nexus Capabilities': Towards Transdisciplinary Methodologies. *ESRC Nexus Network*, pp. 22–23.
- Tallant, J., 2012. Forging Stronger Cooperation between Human Rights and Climate Change Communities. United Nations Seminar to Address the Adverse Impacts of Climate Change on the Full Enjoyment of Human Rights 23–24 February 2012 – Palais Des Nations, Salle XII – Geneva, Switzerland. [Accessed 2019 Jan 22]. www.ohchr.org/Documents/Issues/ClimateChange/Seminar2012/DanielTaillant_24Feb2012.pdf.
- Terrapon-Pfaff, J., Ortiz, W., Dienst, C., Grone, M.C., 2018. Energising the WEF Nexus to enhance sustainable development at local level. *J. Environ. Manage.* 223, 409–416.
- Tzevelekos, V., 2010. The use of article 31(3)(c) of the VCLT in the case law of the ECtHR: an effective anti-fragmentation tool or a selective loophole for the reinforcement of human rights teleology? *Between Evol. Syst. Integration' Michigan J. Int. Law* 31 (621) at 631.
- UNDG, 2011. UNDG Human Rights Mainstreaming Mechanism: Operational Plan 2011–2013. [Accessed 2019 Jan 22]. .
- UNECE, 2015a. Methodology for Assessing the Water-Food-Energy-Ecosystems Nexus in Transboundary Basins (2015) ECE/MP.WAT/WG.1/2015/8, 15 June 2015. .
- UNECE, 2015b. Reconciling Resource Uses in Transboundary Basins: Assessment of the Water-Food-Energy-Ecosystems Nexus. UN Doc ECE/MP.WAT/46. [accessed 2018 Dec 22]. https://www.unece.org/fileadmin/DAM/env/water/publications/WAT_Nexus/ece_mp.wat_46_eng.pdf.
- United Nations Environment Programme (UNEP), 2015. Climate Change and Human Rights. UNEP, Nairobi, pp. 9–10.
- United Nations Framework Convention on Climate Change (UNFCCC), 2012. National adaptation plans: technical guidelines for national adaptation. *Plan Process* 11–13.
- United Nations Framework Convention on Climate Change (UNFCCC), 2015. Conference of the Parties Twenty-First Session Paris. 30 November to 11 December 2015, FCCC/CP/2015/L.9.
- United Nations Water, 2015. About UN Water. [accessed 2019 Jan 22]. <http://www.unwater.org/about-unwater/>.
- United Nations, 2018. Water-Energy-Food Nexus for the Review of SDG 7 (Policy Brief 9). [accessed 2018 Dec 22]. <https://sustainabledevelopment.un.org/content/documents/17483PB9.pdf>.
- Universal Declaration of Human Rights. 1948. Adopted 10 Dec.1948, G.A Res.217A9 (III), 3 UN GAOR, UN Doc. A/810 at 71. Article 25 (1).
- Van Asselt, H., Sindico, F., Mehling, M., 2008. Global climate change and the fragmentation of international law. *Law Policy* 30, 423.
- Vienna Convention on the Law of Treaties (VCLT), 22 May 1969, 1155 UNTS 331.
- von Hirschhausen, C., Neumann, A., 2008. Long-term contracts and asset specificity revisited: an empirical analysis of producer-importer relations in the natural gas industry. *Rev. Ind. Organ.* 32 (2), 131–143.
- Weitz, N., Strambo, C., Kemp-Benedict, E., Nilsson, M., 2017a. Governance in the Water-Energy-Food Nexus: Gaps and Future Research Needs. Stockholm Environment Institute, Working Paper No. 2017-07, pp. 3.
- Weitz, N., Strambo, C., Kemp-Benedict, E., Nilsson, M., 2017b. Closing the governance gaps in the water-energy-Food Nexus: insights from integrative governance. *Glob. Environ. Chang.* 45, 1872–9495.
- Wicaksono, A., Jeong, G., Kang, D., 2017. Water, energy and food nexus: review of global implementation and simulation model development. *Water Policy* 19, 440–462.
- World Economic Forum, 2011. Water Security: The Water-Food- Energy-Climate Nexus. [accessed 2018 Dec 22]. http://www3.weforum.org/docs/WEF_WI_WaterSecurity_WaterFoodEnergyClimateNexus_2011.pdf.
- World Economic Forum, 2014. World Economic Forum's Global Risks Report 2014. [Accessed 2018 Dec 22]. . www3.weforum.org/docs/WEF_GlobalRisks_Report_2014.pdf.
- World Wildlife Fund (WWF), 2017. Watershed Reports: A National Assessment of Canada's Freshwater. [Accessed 2018 Dec 22]. . http://assets.wwf.ca/downloads/WWF_Watershed_Reports_Summit_FINAL_web.pdf.
- Young, M. (Ed.), 2012. Regime Interaction in International Law: Facing Fragmentation. Cambridge University Press, New York.