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Advancing the Implementation of SDGs in Brazil by Integrating Water-Energy Nexus and Legal Principles for Better Governance

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Abstract

The close relationship between water, energy and sustainable development has been on the international political radar for some time. The multiple targets contained in the newly developed Sustainable Development Goals (SDGs) often crosscut and refer to more than one sustainable goal, suggesting the need to consider the potential for synergies and analyse the nature and extent of trade-offs. SDGs subscribe Brazil to new action targets that explicitly crosscut and refer to multiple goals and resources (e.g., water, energy). Current work on indicators concluded Brazil should consider recognising and forging connections between goals but lacked to consider any synergies between water and energy (SDG6, SDG7). However, a challenge is that energy and water in Brazil are dependent and serve as input of each other but follow two different management approaches: electricity is centrally governed by the federal government (taking a top-down approach), while the water sector is polycentric (following a bottom-up approach). Such institutional and administrative differences create the potential for tensions in drawing these sectors together according to the principle of integration, in order to create an integrated and holistic approach to policy making, decision making and functional operation of the sectors. This potential for disconnection also leads to serious instances of environmental injustices. This study contributes to existing studies with a normative framework (sustainable development) from which to derive further sense of the relationship between water and energy; and provides the legal tools that informs the values (legal principles), which will support the development of ethical nexus regimes, so that the negotiation of outcomes between more coherent water and energy policies also promote fairness within their regimes.

Keywords

water-energy nexus, SDGs, legal principle of integration, Brazil, co-governance of resources

1. Introduction

Sustainable development is a common and longstanding worldwide goal—its prevalence and breadth of application suggests a policy-making success story. Although the term lacks a universal definition, the idea of sustainability is well established (Bleischwitz, 2007). The current sustainability analytical policy framework, agreed in 2015, exists as a set of 17 goals and 169 targets (SDGs). This set of multiple and wide-ranging goals and targets provides a globally endorsed normative framework and is designed to guide both national and international policy-making post-2015 (UNGA, 2015). Although the SDGs demonstrate elements of an integrated approach, and also multiple goal areas that are intrinsically connected to each other, the framework fails to forge any explicit linkages between the different goals and targets. This characteristic has attracted criticism, with Nilsson et al. (2016) suggesting that interactions between different SDGs and understanding of synergies and trade-offsare crucial to promotesustainable outcomes. For instance, Fuso Nerini et al. (2017) have identified 113 targets requiring actions to change energy systems and published evidence of relationships between 143 targets (143 synergies and 65 trade-offs) and efforts to achieve SDG7. Coopman et al. (2016) also argue in favour of implementing the SDGs incoherent ways and contribute towards a holistic approach to the 2030 Agenda.

The potential impacts of SDG interactions are context-specific, because of different political priorities and challenges to the realization of sustainable development of different jurisdictions (ICSU, 2017). Nevertheless, an important starting point is to recognise the interrelationships between SDG policy areas, which are characterised by resource-management challenges rooted in its common-pool nature. Water and energy (goals 6 and 7) are a key example, because they are mutually dependent on complex natural systems that produce many goods and services that lead to benefits of drinking water, sanitation, hydroelectric power generation, biomass production and cooling of thermal power systems. Although their planning and policy processes tend to be structured and operate within silos, with corresponding multiple and separate objectives, when seen as a whole or in relation to each other, policy conflicts and the great potential for trade-offs can be identified, raising resource allocation issues.

In this article, we argue that the exact nature, strengths and impacts of such conflicts and potential trade-offs are fundamentally context specific. Brazil represents an important case study, because its water and energy sectors are highly dependent on shared river basins. These common-pool resources areproving increasingly hard to manage in a country heterogeneous as Brazil, characterised by: the disparate governance approaches of both sectors, planning and regulatory challenges, administrative and data mismatches, procedural injustices and policy incoherence under conditions of scarcity, climate change, population growth and increasing urbanisation. All these factors not only undermine efforts to create sustainable energy and water systems, but also create the conditions for environmental injustices relating to the low levels of water and sanitation services.

The paper is structured as follows: Section 2 provides the background and key issues, and Section 3 describes a methodology developed for connecting water-energy nexus with SDG normative framework and the legal principle of integration. This framework is constructed on an elicit survey of current studies, with evidence and mapping under Section 3.2 providing the analysis of interconnections by determining which interactions are positive and thereby capable of advancing multiple goals in connection to water and energy. This methodological framework was applied to a case study. Brazil was chosen because water is the backbone of its water and energy sectors and we identify trade-offs and feedback loops resulting from their historical-institutional and policy developments under Section 4. Our analysisreveals the extent to which connections are needed between SDGs in relation particularly to water and energy in Brazil, but also other relevant goals interacting with these. This approach leads us to introduce the legal principle of integration as the legal mechanism by which interactions, relationships and knock on effects between the core elements of sustainability can be acted upon with positive results. We contribute to the current literature by combining the SDGs with water-energy nexus thinking, underpinned by the legal principle of integration and its correlated principles to support the 2030 Agenda in a holistic and value-led manner.

2. Method

By definition, the SDGs contain elements of integration of economic, social and environmental dimensions, but the goals do not refer to links between targets and with other goals. Nevertheless, multiple targets crosscut goals, and these connect positively, or negatively, as empirical evidence demonstrates. There is an emerging literature conceptualizing and addressing SDG interactions (Weitz et al., 2014; Coopman et al., 2016; Nilsson et al., 2016; ICSU, 2017; Fuso-Nerini et al., 2018). All authors agree that a closer investigation of interactions is key to more coherent and effective decision-making in benefit of sustainability, and to facilitate monitoring progress. For example, to increase substantially renewable energy (SDG 7) using biomass, or developing hydropower, it will be necessary to consider the targets of water regarding water-use efficiency and protection of water-related ecosystems (SDG 6). Moreover, increasing agriculture to advance SDG 7 (develop renewables) could constrain food production, and thereby fail to advance SDG 2 (end hunger) and in turn constrain access to water (SDG 6). These are typical nexus goals that confront the core character of common-pool resources and raise conflicts and trade-offs to be considered in light of the many competing interests (Acheson, 2006).

The guiding principles of the nexus approach (efficiency and effectiveness) have become essential to the progress of SDGs (Weitz et al., 2014). The water-energy nexus literature highlights that interdependencies of sectors requires integration across both sectors (Webber, 2008; Golstein et al., 2008; Scott et al., 2011; Siddiqi et al., 2013). Furthermore, recent work shows the need of an integrated comprehensive approach for five resource nexuses: water, energy, land, food, and materials (Spataru, 2018). In broad terms, this body of literature recommends the move away from the existing institutional silo mentality in policy-making, so that actions under both of these sectors become more efficient and cost-effective. On the other hand, the sustainability framework contributes to the nexus discourse by adding other dimensions to efficiency and effectiveness, which are in line with the key elements and principles of sustainable development: intra-generational equity, intergenerational equity, environmental protection and integration of economic, social and environmental dimensions of sustainability.

By focusing on water and energy under this study, we argue they need to be considered in connection with one another not only for advancing their individual set of targets under the 2030 Agenda, but to support advancing other goals connected to them, which involve human wellbeing and protection of natural environment. Considering the importance of investigating, in detail, the interlinkages, we developed a method to assess interactions between SDG 6 (water) and SDG 7 (energy) and all other goals of the 2030 Agenda. This method is particularly useful for case studies where water and energy serve as inputs to each other and mutually depend on common-pool water resources that are increasingly hard to manage in light of climate change, higher population densities and pollution, urbanisation and lack of efficiency. By identifying further goals that could benefit from co-advancing water and energy in connection to each other, our framework identifies key multilateral relationships between water, energy and correlated goals, which have great potential for realising and acting upon synergies.

We move forward by bringing in the legal principle of integration under the combined frameworks, recognizing that this principle can underpin and give legal weight to attempts to combine and connect different but related policy sectors. The legal principle of integration includes procedural and substantive components. In the former, it requires that policies integrate into them a high level of environmental protection from initial steps of decision-making procedures. In its substantive dimension, it provides the means of balancing two existing competing norms, including water and energy. Other legal principles hanging from sustainable development (e.g., equity, precaution, polluter-pays, public participation) are connected in a fundamental way to the principle of integration and should also form the base of future normative construction involving nexus SDG advances. This broader set of principles indicates the common values and social interests to be pursued by the collection and combination of rules that will support a holistic approach to advance the SDGs through nexus thinking. The method we developed to connect the SDGs, WE nexus frameworks and legal principle of integration involves the following steps:

(i) Analysis of crosscutting areas for water and energy goals;
(ii) Mapping connections beyond trade-offs;
(iii) Identifying the nature of connections;
(iv) Operating connections with legal principle of integration.

2.1 Analysis of Cross-Cutting Areas for Water and Energy Goals

In most studies, water-energy nexus is conceived as linked in terms of resource use (Scott et al., 2011). Water is essential for power generation, extraction and processing of fossil fuels, as well as hydropower generation and irrigation of biomass/biofuel crops; and energy is necessary to secure, treat, distribute and deliver WSS. Accordingly, advancing the targets for SDG 6 and SDG 7 require adjustments between competing interests. Table 1 gives an overview of possible areas that needattention when considering trade-offs. The importance given to each area will be different in each country, depending on how water-energy nexus issues are characterised in each placeand the risks they represent to the realization of Goals 6 and 7. For example, countries that depend on water intensive energy to advance the renewable energy target (7.2) will need to consider water needs of different users and regions, multi-purpose dams and dry cooling technologies, so that risks to the water targets of equitable and universal supply are reduced (6.1).

Table 1. Areas of Water and Energy, WE Trade-offs and Risks to SDG 6 (Water) and SDG 7 (Energy)

Areas	WE trade-offs and risks to SDG 6 and SDG 7
Water for Energy	Hydropower is the most water-intensive source due to large volumes of water evaporated from its surface area. Second is thermoelectric generation, with water requirements varying according to cooling technologies and fuel source. Unless it is rain fed, biomass is the most water-intensive fuel source due to irrigation needs. Water-intensive electricity sources may support renewable energy target, but without consideration of water needs, multipurpose use dams, dry cooling technologies and regional differences it may compromise sub-national policy objectives regarding multiple uses of water and hinder water targets.
Water for WSS	Widespread lack of access to WSS leads to pollution and compromises health and wellbeing. Universal, adequate, affordable and equitable access to WSS will require more energy and dispute water resources with energy sector in areas where it is mainly water-dependent. Depending how water and energy are sourced to expand WSS it may hinder advances to targets of renewable energy and sustainable withdrawal and supply of freshwater, especially in case of coal-based energy sector and inefficient water sector that wastes both water and energy on extraction, treatment and distribution of WSS.
Water Scarcity and Pollution	Water-stressed areas depend on energy-intensive water withdrawal, pumping, desalination and water transfers. More energy will be required to reduce growing figures of untreated wastewater and increase recycling and safe water reuse. Depending how energy is sourced it may compromise target of increasing renewable

	energy. If sourced through renewable energy it may dispute scarce water resources (hydropower), or raise costs depending on renewable technology, which may compromise access to affordable energy and water.
Water related disasters	The frequency and intensity of water-related hazards are raising, including floods and droughts, which compromise resilience of water and energy systems. More energy is needed for water in drought areas, but reduced levels of water hinders energy generation under majorly hydro-based systems.
	Water related disasters puts into risk the promotion of clean, affordable, equitable and universal water and energy services, especially in cases of decreasing levels of resilience aggravated by droughts and floods.
Water and Energy Losses	Water loss under WSS systems translates into energy losses, while energy losses under water-intensive electricity systems translate into water losses.
	Lack of efficiency in connection to energy and water promotes losses for both sectors and compromises targets 6.4 (water efficiency) and 7.3 (energy efficiency); and access to resources and services.
Energy for WSS	Energy needs by water sector depends on availability of water for WSS and expansion requirements. In areas of water scarcity and/or high expansion requirements, more energy will be required to source water.
	Depending how energy is sourced it may compromise target of increasing renewable energy. If sourced through renewable energy it may raise costs connected to renewable technology.
Energy price	Where electricity prices are dependent on hydro supply to be kept affordable (Brazil), water related disasters such as droughts compromise hydro contribution to supply and may raise price of energy significantly.
	Affordable, reliable and modern energy services may be compromised and affect the water targets related to access to equitable, adequate and affordable WSS (6.1 and 6.4) because electric-intensive sectors like WSS will face struggles with rising energy bills.

In the policy arena, most of the work focuses on ways to alleviate or remove trade-offs, or their costs, and to maximise synergies (Nilsson et al., 2016). The majority of authors agree that negative trade-offs should be avoided, and synergies amplified through greater integration of both sectors to promote policy coherence and optimise policy options (Sovacool, 2009; Siddiqi et al., 2013; King et al., 2013). One of the major key issues is governance, because policies, planning, regulation, institutions, knowledge and information are mostly restricted to sectoral boundaries and fragmented between different scales, sectors andmultiple actors. This way, the state is challenged to move towards the development of new cross-sectoral governance regimes (Hiteva & Watson, 2016). The nexus literature emphasizes three main perspectives to advance nexus governance: technical, administrative and political (Weitz et al., 2017). The dominant technical-administrative approach focuses on risks, security and economic rationales (ibid.). It arguesthat better data collection is necessaryto enhance understanding of interactions and that administrative processes should strengthen cross-sectoral cooperation, so that policy cost-effectiveness and resource-use efficiency are achieved through greater communication under dialogue platforms or within interagency mechanisms (ibid.). The third perspective considers that addressing trade-offs is apolitical process. This way, it should be negotiated amongst multiple stakeholders (ibid.). These current perspectives have gaps, which the integrative environmental governance literature provided important conclusions, including that certain degree of fragmentation might be recommendable to the extent that it can promote the inclusion of distinct stakeholders sharing different degrees of power and perspectives on how nexus outcomes should be balanced (ibid.).

We move forward by bridging disconnections between the nexus literature, SDGs and the decision-making and policy-making processes through a greater focus onthe legal perspective rooted on legal principles. Without guiding principles the negotiation of nexus outcomes will likely succumb to power imbalances and distance itself from what should be achieved by greater policy coherence (ibid.). In general, legal principles have the role of guiding judicial decisions, policy makers and legislators when passing norms or amending them, which includes not only the executive, but also regulatory agencies. The legal principles indicate what are the common goals that need to be pursued by a collection of rules, including those that will achieve the policy changes recommended by the nexus approach.

2.2 Mapping Interactions beyond Trade-offs

Beyond trade-offs, the relevant connections are foundunder Table 2. We analyse if water (SDG 6) and energy (SDG 7) goals affect or are affected by all other goals, with exception of goal 17, by virtue of its overarching nature. The empirical evidence-based that are coloured dark grey, indicates if advancing the targets of water and energy could potentially hinder the indicated goal, and/or if advancing the relevant goal could potentially compromise water and energy goals. On the other hand, the empirical evidence-based that have a light grey shading indicates positive effects. All other neutral connections or probable connections without empirical evidence are left blank.

Table 2. Mapping Connections beyond Trade-off

SDGS	WATER		ENERGY	
	Affecting water targets	Affected by water targets	AAffecting energy targets	Affected by energy targets
SDG1: No pverty		Enables pverty reduction in		Enables pverty reduction in

		connetion to other fators (Hagos et al., 2008)		connetion to other fators (Wilcox et al., 2015)
SDG 2: Zero hunger	Sustainable agriculture enables water pollution control (Edwards et al., 1990; Ripa et al., 2016)	Water access enables the fight against under nutrition (Dangour et al., 20136)	Multi-tier cropping enables food/bioenergy growth (Kline et al., 2016).	Clean energy enables sustainable agriculture (IRENA, 2015)
	Farming can hinder water availability and quality (Sall & Vanclooster, 2009)	Improving water quality can hinder certain agriculture practices (Prada et al., 2017)	Increasing food production can hinder water and land use for energy (Fraiture et al., 2008)	Renewables can hinder land and water for food (Fraiture et al., 2008)
SDG 3: Health and well-being		WSS eneables healthy lives (Bartram & Cairncross, 2010)		Energy is an enabler of healthy lives (W.H.O, 2015)
SDG 4: Quality education	Enables higner awareness for sustainable uses of water (Heath and Mitchell, 2002)	WSS enables education purposes (Freeman et al., 2012; Zhang & Cu, 2016)	Enables higher awareness to increase energy user-efficiency (Gill & Lang, 2018)	Energy access enables education purposes (UNDESA, 2014; Sovacool & Ryan, 2016)
SDG 5: Achieve gender equality	Empowering gender enables participation of woman in water system (Bank AD, 2015)	Access to WSS is vital to enable gender equality and empower women and girls (Bank AD, 2015)	Empowering gender enables participation of woman in clean energy transition (Fraune, 2015)	Modern energy services enable empowerment of woman (Cecelski & Crgce, 2006)
SDG 8: Sustainable economic growth	Enables investments on infrastructure of	Enables sustainable growth; and	Enables investments on clean, modern energy ("UKERC	Enables growth decoupled from environment

and decent work	WSS (OECD, 2011)	promotes jobs (Hutton, 2013)	Energy Strategies Under Uncertainty-Finacing the Power Sector”, n.d.)	degradation (Jackson, 2017)
	Growth can hinder water quantity and qua;ity (DISTEFANO & Scott, 2017)		Non-renewable energy can contribute more to growth than renewable (Adams et al., 2018)	
SDG 9: Resilient infrastructure, sustainable industry & innovation	Resillient green infrastructure enables water quality (EPA 100-R-14-006)	Efficiency enables sustainable industrialization (Alkaya & Demirer, 2015)	Enables resilient energy systems (Cabinet Office UK, 2011)	Efficiency enables sustainable industrialization (Alkaya & Demirer, 2015)
SDG 10: Reduce inequalities	Enable input of Marginalized in water managing (Butler and Adamowski, 2015)	Access WSS enables reduction of inequalities (Hagos et al., 2008)	Empowering and inclusion enables energy transition process (Osnes, Weitkamp, & Manygoats, 2015)	Enables income growth and creats jobs (IRENA, 2017)
SDG 11: Inclusives, safe, resilient and sustainable cities	Sustainable urbanization enables improved WSS (Starkl et al., 2013)	IWRM enables sustainable urbanization (Leeuwen, 2017)	Sustainable urbanization enables low carbon energy transition (Yu, 2014)	Enables sustainable urban forms (Yu, 2014)
SDG 12: Inclusive, safe, resilient and sustainable sities	Sustainable manufacturing enables waste management (Alayon, Safsten, & Johansson, 2017)	Water efficiency enables sustainable production (Kurle et al., 2017)	Enables improvements to energy use efficiency (Brizga et al., 2014)	Clean energy enables sustainable production (Ludin et al., 2014)

SDG 13: Climate action	Strong resilience to climate-raleted hazards enables water targets (Luh et al., 2017) Certain climate measure can have negative impacte on water quality (Wallist et al., 2014)	Transboundary IWRM enables adaptive response to climate change (Varady et al., 2013)	Climate measures enables system changes and security consideration (Jewell, Chero, & Riachi, 2014)	Clean energy and efficiency enable the fight against climate change (Sugiyama et al., 2014)
SDG 14: Oceans and seas	Cutting marine pollution from land-based activities needs WSS (Jambeck et al., 2015)	WSS enables reduction of marine pollution (Jambeck et al., 2015)	Reducing ocean acidification requires renewable energy dissemination (IPCC, 2009)	Clean off-shore energy can impact on marine pollution (CMACS, 2003)
DDG 15: Protect restore ecosystems, biodiversity, forest, land degradation, desertification	Ecosystem restoration enables improved water quantity and quality (Mello, Randhir, Valente, & Vettorazzi, 2017)	Sustainable water withdrawals enable healthy ecosystems and biodiversity (Richter et al., 2003)	Biodiversity conservation can limit renewable biomass hydropower energy and targets of energy (Santangeli et al., 2016)	Efficiency enables protection of land/ecosystem (Kalogirou, 2009) Clean hydro energy hinder biodiversity (Pang et al., 2015)
SDG 16: Inclusive societies, institutions, justices	Improving governance enables IWRM (Allan & Rieu-Clarke, 2010)	IWRM enables inclusive societies and accountable institutions (Tortahada, 2017)	Improving governance enables energy sector to contribute to sustainability (Mendonca et al., 2009)	Reliable energy enables reduction violence and allow safe waliking in cities (Pease, 1999)

Figure 1 has an overview of the above mentioned interactions beyond trade-offs, so that further analysis of interactions can follow under the next section. It shows that the majority of goals are positively connected and have great potential for an integrated approach to implementation and monitoring.

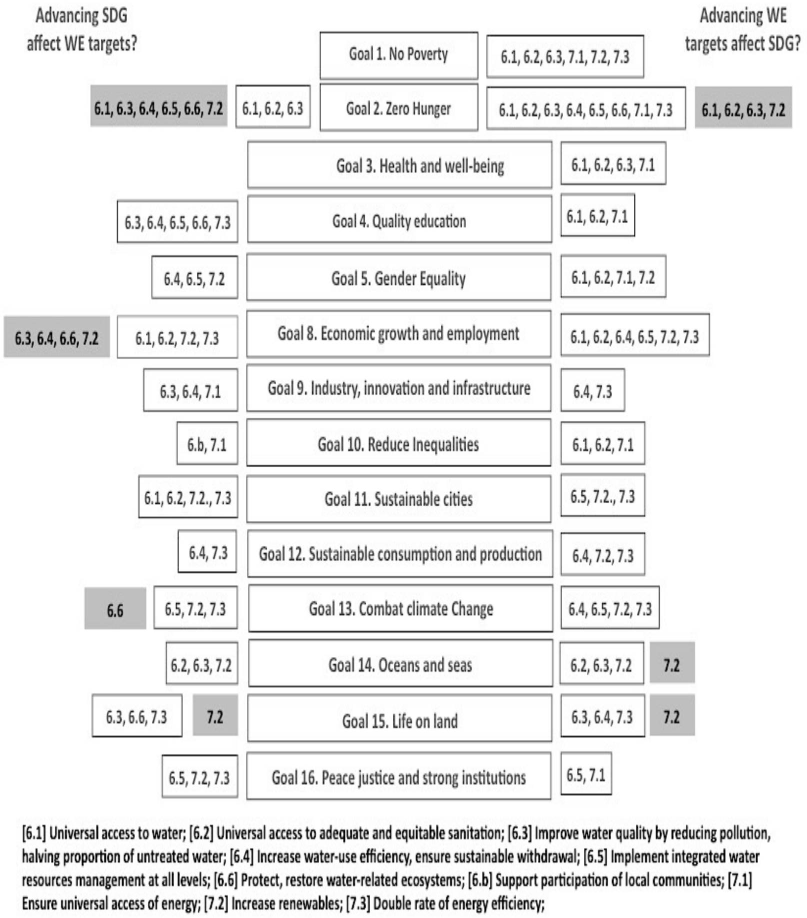

Figure 1. SDG Connections beyond Water-Energy Trade-Offs

2.3 Identifying Positive and Negative Connections

The positive multilateral interactions involve cases where connections between water and energy targets could supporta relevant goal and the advancing of such a goal could also support water and energy targets (SDGs 4, 5, 9, 10, 11, 12 and 16). These connectionsmhave great potential for the development of co-implementation strategies rooted nexus thinking, guided by legal principles, which could potentially lead to more equitable, efficient, sustainable, and cost-effective results to society through benefitting multiple goals simultaneously. We also identified positive one-way interactions where advancing water and energy targets would likely support the advancing of goals, but the inverse is not necessarily true. This is the case for SDG1 (reduce poverty) and SDG3 (health). Empirical evidence demonstrates that affordable access to WSS and energy arekey requirements for poverty purge (SDG 1) and promotion of healthy lives (SDG 3). Nevertheless, healthy lives and/or reduced poverty do not promote direct advances to water and energytargets.

Contrarily, negative multilateral interaction involves thecase in which advancing the targets for water and energy could potentially compromise referred goal and vice versa. This takes place between SDG 2, 6 and 7. From water and energy perspective, food is a user of their resources and may hinder advances towards sustainable water and energy systems. From a food perspective, increasing agriculture can deter water availability and quality, and also compromise water and land use for energy. We also identified negative one-way connections, which are characterised by goals that may affect adversely the targets of water and/or energy, or vice versa. This takes place with SDGs 8, 13, 14 and 15. For instance, when advancing economic growth to attend goal 8, it can increase pressure on water resources and hinder water quantity and quality, while also push for higher shares of non-renewable energy to support development. In terms of SDG 13, empirical work shows that certain climate measures impact negatively on water resources (Wallis et al., 2014). While the negative connection with SDG 15 is rooted on studies in which the conservation of biodiversity can challenge advances to clean energy (Santangeli et al., 2016). Finally, off shore wind farm that would enable the renewable energy targetmay impact negatively on oceans and seas due to electromagnetic fields and hinder advances to goal 14 (CMACS, 2003).

In all cases, we argue that the grouping of data, planning, policies and regulationby sector and scale are no longer a fitting method of governance to supportsustainable outcomes. The system of governance should be focused on governing by goals; instead of a sector-by-sector basis that hasled to fragmentation of resource governance. SDGs could help governing resources through high-level ambitious goals that are formed by economic, social and environmental dimensions. The framework we developed supports these different dimensions, because different proportions of these elements form eachgoal that we assessed the relationship with water and energy. For instance, SDG 4 (education), which is mainly formed by social targets, when advanced in connection to water and energy, it has the potential to support the environmental and economic targets connected to these goals. The role of legal principles within the movement to integrate more concretely the dimensions of SDGs is vital in terms of nexus governance for sustainability.

2.4 Operating Connections with The Legal Principles of Integration

The legal principle of integration offers the necessary means by which connections between social, environmental and economic factors involving water, energy and correlated goals can be operationalised (or concretised) in policy and practice. There are key tools emerging from the procedural aspect of the principle of integration, which are useful to the regulation of water-energy nexus. For instance, environmental impact assessments and strategic environmental assessments for policies, plans and programmes (Hussey & Pittock, 2012). Where the legal principle of integration and its correlated principles are well developed and there is an obligation of legislators and decision makers to abide to them, it is likely that the law will be able to play its role in helping solve nexus issues in benefit of sustainability. Contrarily, if the principles are not under the constitution or in high-ranking laws, or they are defined in ways that are so vague that don't lead to any kind of consequences there will be legal issues in promoting an integrated approach to policies. This way, it is important to consider the legal principles that lay the foundations of the legal system under analysis.

The legal principle of integration applies at the conceptual level of policies and laws, as well at the implementation stage of these policies and laws, being relevant to all levels of government and all sectors of society (Scotford, 2017). It is a critical principle, because it also enables the introduction of other legal principles into all public policies. The substantive principles connected to integration, include the principle of polluter pays, equity and principle of precaution. The procedural principles connected to integration, includes the principle of access of information, principle of public participation and access to courts. They are the tools of law that points towards solutions, including those that will support greater integration and policy changes in line with nexus thinking. They form the overarching and ethical framework for improving coherence between different policy areas, including water, energy and the correlated SDG policy areas made evident under our framework. This approach advances the water-energy nexus discourse to recognize the distributive and procedural justice issues between existing communities and also future populations that share interests on common-pool resources.

3. Result: Water-Energy Nexus and Implications of Governance Gaps in Brazil

Brazil participated actively in advancing the 2030 agenda and is committed to its implementation through its newly created SDG National Committee ("D8892," n.d.). We propose the SDG-nexus-principle approach as the way to move forward. Brazil is a typical case in which water and energy serve as vital inputs to each other, dependent upon common-pool water resources, which are increasingly hard to manage. The severe drought that happened in 2014/2015 associated with governance and planning failures have made especially evident the vulnerabilities of both sectors. Whereby the more the energy sector relies on water (hydropower reaches over 65% of supply), the greater its vulnerability in energy generation to hydrological variations and competing uses, especially under basins suffering with water scarcity, like the São Francisco. Whereby the Sobradinho hydropower plant (1050 MW) had to reduce its minimum water discharge level from 1.300 m3/s to 570 m3/s (ANA, 2018). Consequently, some turbines had to be turned off, while thermal power plants had to be turned on, which are more expensive and uses non-renewable sources and may hinder advances SDG 7.

On the other hand, the exclusive reliance of the water sectoron centralised water-dependent electricity also increases its vulnerabilities connected to water stress and increasing costs of energy due to reasons that include reduction in hydro generation due to water scarcity. For instance, although water-rationing programmes were implemented inthe occasion of the drought of 2014/2015, reducing the total consumption of energy by the water sector, its total costs associated with electricity (historically their second highest cost) were 50% higher (SNIS, 2016). It coincides with periods when energy is the most expensive due to greater reliance on thermal power. In connection to widespread WSS tariffs that currently do not cover the costs of services, especially in the North and Northeast regions, the expansion of services are not supported by increasing energy costs and high levels of inefficiency. Nevertheless, other important issues hinder WSS expansion: lack of a robust regulatory framework, high dependency of public funds and costly operational inefficiencies. Altogether they impact adversely on Goal 6.

Brazil has more than 35 million people without access to water services and over 100 million people without access to sewage collection (Instituto Trata Brasil, 2016). As consequence many rivers are polluted. This widespread lack of access to WSS raises significant sustainability concerns and, relatedly, significant environmental justice issues about the fair and equitable distribution of essential sanitation services (as opposed to a more general and traditional concern with access to natural resources). Although the distributional justice issues raised by uneven access to safe water and sanitation are now well recognised and form the subject of a growing body of scholarship on the justice of global water law (Hey, 2009), this article contextualises such concerns in Brazil (Figure 2). It becomes clear that the negative consequences of water development, scarcity and lack of services are systematically affecting the country's poorer groups. There is a dislocation between energy and water use and negative impacts of the nexus.

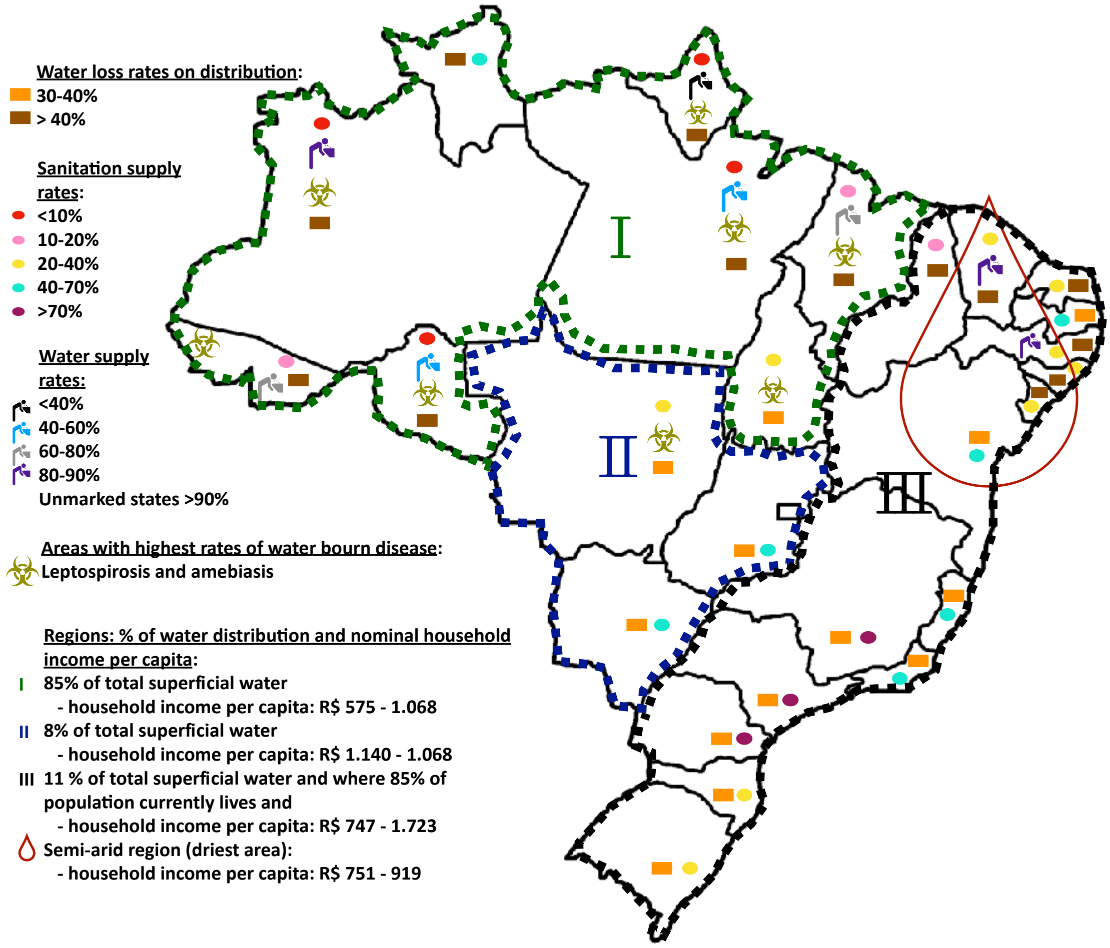

Figure 2. Water Distribution, Supply Rates and Losses

Sources: IBGE, 2017; Instituto Trata Brasil, 2016; SNIS, 2016.

Region (I) holds 85% of all superficial water in Brazil and more than 90% of all hydropower projects are planned to take place in this area between 2014 and 2024 (EPE, 2015). Nevertheless, in terms of WSS it presents one of the lowest rates of supply in Brazil, followed by the Semi-arid area under Region (III). Both these areas facevery high losses on water distribution (>40%). The high rates of water losses in Brazil can be translated into loss of energy too. Vilanova and Balestieri (2015) have shown that water supply systems accounted for 1.9% of total electricity consumption in Brazil in 2012. Although this does not represent a high percentage, the loss of water accounted for 27% of total water and energy wastes in the water supply system (ibid.). They demonstrate that energy losses eliminated from water losses in the water supply systems represents 6.7% of the projected increase of the total power consumption of Brazil in a year (ibid.). For Brazil to advance the targets of improved water efficiency and energy efficiency, the reinforcement of both the energy access and the sustainable water withdrawals targets are necessary.

3.1 Understanding Water and Energy Governance in Brazil at different Scales and Feedback Loops

Until the reforms starting in the 1990s, water management in Brazil was mainly a sub-sector of energy, most specifically hydroelectricity. As a consequence, for many years all institutions at national level were managing water for the purpose of developing hydropower. The electricity sector acted as the main user and principal management agent of water (Klingberg, 2016). The historical top-down, centralised governance approach to energyfederalised all decision-making, including about the use of water for energy, with reservoirs planned exclusively for hydropower generation. In connection with the late establishment of the water governance framework (1997) and the current struggles involving its implementation, it hasresulted in feedback loops across temporal and spatial scales. One of the many challenges travelling across spatial and temporal scales is connected to the disruption in water flows promoted by energy infrastructure, which has important knock-on effects for downstream users. Under the São Francisco basin the examples have been aggravatedby the long years of drought. The decreasing levels of water discharged after the hydropower of Sobradinho and Xingó affect the river flow, local communities, fisherman, irrigated agriculture and WSS. For instance, with a reduced flow on its arrival at the sea, the river faces salty water inflows into the river mouth (250 km) impacting negatively on water supply in the area and on human health (Torres, 2015). Procedural environmental justice issues are raised to the extent that these voices are rarely heard (Hey, 2009).

Moreover, the later establishment of the water governance framework in relation to energy, means that it was not until 1997 that national and state databases were initially developed to collect, store and recover information about water beyond its use for hydroelectricity. It is common for many water basins, like the São Francisco to have the majority of its hydro-meteorological stations located at focal points for energy, instead of following a whole-basin approach. This way, another issue travelling across temporal and spatial scale isthe lack of update, consistent and comparable data and integrated information for water. The current state of art does not support a consistent and robust development of knowledge about the actual state of water resources. The information systems are not well developed at state level and there are yet desired levels of transparency of available data (OECD, 2015). The lack of information and lack of transparency about real state of resources and market leads to accountability gaps (ibid.).

3.2 Challenges from Disparate Governance Structures

Fundamental challenges stem from water and electricity operational-resource interdependencies in Brazil and their disparate governance structures. Current institutional structure for water (decentralised) and electricity (centralised) (Figure 7), demonstrates the potential for tensions created by their administrative and institutional differences when these sectors are drawn together according to the principle of integration, in order to create an integrated and holistic approach to policy making, decision making and functional operation of these sectors.

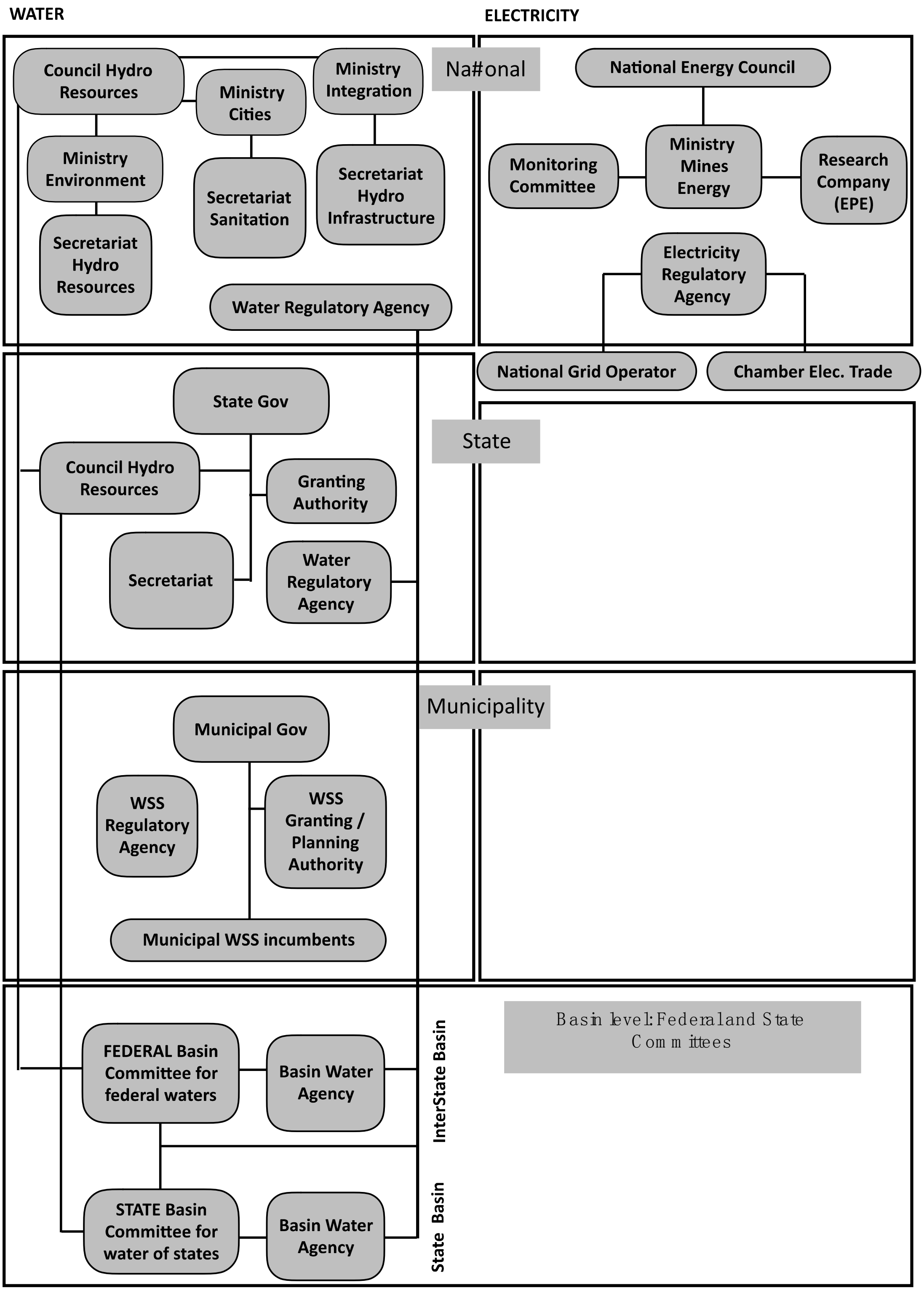

Figure 3. Current Institutional Set-up for Water and Electricity

The governmental institutions, which are responsible for electricity policies (Ministry of Mines and Energy and National Energy Council), regulation (Electricity Regulatory Agency), planning (Energy

Research Company), and centralised operations and monitoring (National Monitoring Committee) are all restricted to the national scale. Moreover, the federal government has the exclusive competence to explore (directly or by means of authorisation, concession or permission) the services related to electricity and the use of the country's hydraulic potential (Constitution of Brazil, 1998). It also holds exclusive competence to legislate about energy related matters (ibid.). Centralising all normative, management and planning decisions under the federal government was thought to guarantee security of supply and affordable tariffs on short and long term. Nevertheless, the regulatory framework allowed for concentrated risks on big hydroelectric projects contracted by means of public auctions. Whereby centralised operational and regulatory structuresand severe droughts have promoted a systemic overexploitation of reservoirs raising energy security and affordability issues (TCU, 2014). Impacting directly on water sector.

All other non-hydroelectric users of water are subject to the decentralised and participative governance approach of the water sector set under the national water policy (Figure 3). Similar institutional structures exist at state and national scales for implementing management systems for waters under their respective domain (Figure 3). Nevertheless, the waterbasin serves as the management unit. Whereby federal or state water committees, formed by government representatives from all levels, users and NGOs are responsible for managing the resource at its catchment area, developing basin plans, implementing water charges and supporting the fair allocation of water resources (Law, 1997). The greatest challenge is related to the implementation and effectiveness of this decentralised model in a country historically developed under a federative rational erooted on a centralised approach, with a very strong national scale and subsidiary roles forstates andmunicipalities. Consequently, the institutional capacities for implementing the water policy are not aligned with its design. The majority of states lack administrative structure, human resources and financial capacity to implement the water policy (Johnsson, n.d.).

The disparate governance approach of water and energy is problematic for integrative efforts from a management and normative perspectives. It results in situations where part the river is subject to the decentralised approach of water governance, with the extent used for hydropower subject to the centralised electricity regime of national government. This leads increasingly to disputes, because basin committees and states frequently have different priorities from national government in terms of water use. Furthermore, when it comes to water charges, for example, water charges paid by non-hydroelectric follow the decentralised approach, with proceedings (in the few places it has been implemented) earmarked to return to the basin. In contrast, the flat fee paid as a financial compensation for water use by hydropower producers are transferred to municipalities and states, and to national regulatory agency of water, with funds also transferred to ANA. There is no guarantee that any amount returns to the basin where local communities and local environment were affected. From water management perspective the flat fee paid by hydropower could be revised to consider better issues of water availability, competition and destination of funds (OECD, 2015).

4. Discussion: An Integrated Approach for the 2030 Agenda in Brazil with Nexus Thinking and Legal Principle of Integration

In the case study we identify the key implications arising from WE nexus resulting from the ambitions of 2030 SDG agenda, water and energy operating at different scales of governance in Brazil, the challenges from disparate institutional structures and problems arising from gaps in knowledge and information. We analyse open and transparent policy making backed by legal principles and the comprehensive involvement of multiple stakeholders. A principled approach to the water-energy nexus is the only way in which the law will be able to address the multitude of facts and interests concerning the common-pool resources these sectors dispute. The closeness of the legal principle of integration with sustainable development and the principles of equity/justice means that a principled approach to the water-energy nexus in Brazil can offer more progress in terms of both inter- and intra-generational equity. Inter-generational equity refers to equity issues and access to resources between current and future generations. While intra-generational equity is the term used to refer to the equities between different community groups and stakeholders of a region, distributing the benefits and burdens of nexus resource challenges.

A fundamental rule in Brazil is that the management of water resources should always promote its multiple uses (art. 1, IV of Law 9.433, 1997). The legal mechanism that could potentially be used to establish the rules for co-governance of resources between all scales, backed by the legal principle of integration, for the promotion of a rational allocation between different uses is set under article 23 of the Constitution (Constitution of Brazil, 1988): “supplementary laws shall establish rules for the cooperation between the federal government and the states, the federal district, and the municipalities, aiming at the attainment of balanced development and well-being on a nationwide scope”. A supplementary law focused hydro resources could address shared legal principles, nexus objectives, instruments and procedural cross-sectoral cooperation and collaboration involving multiple stakeholders to support the move away from silo thinking in policy making and help advance the SDG in a holistic way. It would increase the need for co-ordination and design of horizontal/vertical cooperative structures, and multi-stakeholder participatory-joint development and use of public intervention instruments (Hajer, 2003). We recommend building on and strengthening the existing platforms, which are the water committees in Brazil, so they have stronger normative and management capacities. One of the main instruments existing under the current legislation that should be strengthened and duly implemented are the basin plan, which should count with the participation of all user sectors. Another instrument that exists today and could be further adapted is the water use license. In order to promote more flexibility on the allocation of water resources between its multiple users, it would be important to consider rules that allow greater flexibility (for example to adjust to crises periods) and possible transferability between different users.

Finally, our framework shows that addressing water and energy in connection to each other has the potential to advance not only the targets of water and energy under the 2030 Agenda, but other SDGs that are highly relevant in Brazil, such aseducation, reduction of inequalities and sustainable cities. By correlating the key institutions existing in Brazil for each goal area which we identified to have a positiveor negative multilateral connections with water and energyunder Figure 4 we make explicit the nexus beyond water and energy that from a policy perspective have potential for co-implementation strategies through greater dialogue betweenthe identified ministries and councils at national level, or require the careful considerations of trade-offs, so that multiple goals can be advanced simultaneously.

ZERO HUNGER **Ministry of Agriculture**	Food - energy trade-offs	Food - water trade-offs							
Energy - food tradeoffs	**ENERGY** **National Energy Council** **Ministry of Mines of Energy**	Energy - water trade-offs	Energy for education	Energy for gender equality	Energy for industry and innovation	Energy for reduction of inequalities	Energy for Sustainable cities	Energy for sustainable consumption and production	Energy for peace and justice
Water - food trade-offs	Water - energy trade-offs	**WATER** **National Council for Hydro Resources** **Ministry of Environment** **Ministry of Cities** **Ministry of Integration**	Water for Education	Water for Gender Equality	Water for Industry and Innovation	Water for reducing inequalities	Water for sustainable cities	Water for sustainable consumption and production	Water for inclusive societies and justice
	Education for energy	Education for water	**QUALITY EDUCATION** **National Education Council** **Ministry of Education** **Universities**	Education for Gender Equality	Education for Industry and Innovation	Education for reduction of inequalities	Education for sustainable cities	Education for sustainable consumption and production	Education for peace and justice
	Gender equality for energy	Gender equality for water	Gender equality for Education	**GENDER EQUALITY** **Ministry of Human Rights** **Secretariat of Policies for Promotion of Racial Equality**	Gender equality for industry and innovation	Gender equality to reduce inequalities	Gender equality for sustainable cities	Gender equality for sustainable consumption and production	Gender equality for peace and justice
	Industry and innovation for energy	Industry and Innovation for water	Industry and innovation for education	Industry and innovation for gender equality	**INDUSTRY AND INNOVATION** **Ministry of Industry, International Commerce**	Industry and innovation to reduce inequalities	Industry and Innovation for sustainable cities	Industry and innovation for sustainable consumption and production	Industry and innovation for peace and justice
	Reducing inequalities for energy	Reducing inequalities for water	Reducing inequalities for Education	Reducing inequality for gender equality	Reducing inequality for industry and innovation	**REDUCE INEQUALITIES** **Ministry of Social Development**	Reducing inequalities for sustainable cities	Reduce inequalities for sustainable consumption and production	Reduce inequalities for peace and justice
	Sustainable cities for energy	Sustainable cities for water	Sustainable cities for education	Sustainable cities for gender equality	Sustainable cities for industry and innovation	Sustainable cities for reducing inequalities	**SUSTAINABLE CITIES** **Ministry of Cities**	Sustainable cities for sustainable consumption and production	Sustainable cities for peace and justice
	Sustainable Consumption and production for energy	Sustainable consumption and production for water	Sustainable consumption for education	Sustainable consumption and production for gender equality	sustainable consumption and production for industry and innovation	Sustainable consumption and production to reduce inequalities	Sustainable consumption and production for sustainable cities	**SUSTAINABLE CONSUMPTION AND PRODUCTION** **Ministry of Industry** **Ministry of Environment**	Sustainable consumption for peace and justice
	Peace and justice for energy	Peace and justice for water	Peace and justice for education	Peace and justice for gender equality	Peace and justice for industry and innovation	peace and justice to reduce inequalities	Peace and justice for sustainable cities	Peace and justice for sustainable consumption and production	**PEACE AND JUSTICE** **Ministry of Justice and Security**

Figure 4. Areas and Actors beyond Energy and Water Trade-offs

5. Conclusion

Our analysis shows that connecting SDGs with WE nexus thinking, and the principle of integration could progress towards a more coherent value-based mentality in policy making and sustainable outcomes. Historically, there is a lack of such coherence between water and most sectoral policies in

Brazil, including energy. The national approach, that supports water-intensive electricity sources increasingly requires the consideration of multiple uses of water and regional differences, so that it does not compromise sub-national policy objectives regarding multiple uses of water and SDGs. Furthermore, and significantly, in Brazil there are many complexities regarding basin management, which influence the move towards meaningful and effective integration of sectors. In contrast, our proposed connection between nexus thinking, the dimensions of sustainability and the legal principle of integration has the potential to push forward the incorporation of other factors to determine water and energy security and efficiency. This integrative dynamic is motivated not solely by the availability and efficient use of resources, but also by the distribution of these resources, their protection and human capacity to use them now and by future generations. This approach is useful to water-energy nexus case studies, because it adds a normative framework (sustainable development) from which to derive further sense of the relationship between water and energy; and provides the legal tools that informs the values (legal principles), which will support the development of ethical nexus regimes, so that the negotiation of outcomes between more coherent water and energy policies also promote fairness within their regimes.

The principle of integration, for example, will inform through its two dimensions internal and external (at general level) that there should be an integrated approach to water and energy regulation and management, and that policies of water and energy are to be developed together with environmental policy. Any changes to existing institutional and legal set-ups to promote greater integration, for example through supplementary law in Brazil, should be guided by legal principles that hang from sustainable development, which are well specified in international and national laws. Integration efforts in the EU could serve as inspiration for Brazil, and as the source of future comparative research on the operationalisation of the legal principle of integration, at multiple levels of governance and, in the case of the EU, across territorial boundaries. For instance, "Connection Europe", (European Commission, 2011) an overarching programme, encourages greater synergies between programmes and sectors, such as electricity and transport. This case study makes clear that Brazil could consider usefully some of the rationales and principled underpinnings of "Connection Europe" to support efficiency gains through a more systematic approach to water and energy interdependencies.

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