The challenges of Regulatory Integration in Renewable Energy Frameworks: A Case Study of the Brazilian Regulatory Framework

Rachel Marini Ravagnani
UNSW Law, University of New South Wales, Anzac Pde., Kingsford NSW 2032, Australia
Corresponding author: r.mariniravagnani@unsw.edu.au

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Abstract: Over the last decades many efforts have been placed on climate change mitigation, including a profound transformation of the energy sector. Renewable energy is considered to have much to contribute in assisting to decarbonize the energy sector. With major shifts occurring in the energy sector, growing attention has been placed on the spill-over effects of the increased production and use of renewables on related sectors, in particular, the water and food sectors. While renewable energy can be a path to aid in the decarbonization of energy systems, an unregulated increase in their use can impact key sectors, such as water and food. The push to renewables and the interactions exposed by the Water-Energy-Food nexus reveals the importance of an integrated regulatory framework. The nexus introduced a major shift of perspective, providing for visibility to interactions between key sectors and addressing the externalities that ties them together. The nexus is embedded with complex governance challenges such as integrated governance and policy coherence, however, its literature in those aspects is either limited and lacking in legal analysis, creating gaps in processes where the nexus seeks to influence.

Keywords: Brazil; integrative governance; regulative framework; renewable energy; WEF nexus

Introduction

Setting the scene

Renewable energy is considered to have a major role to play in assisting the energy sector to become a low carbon emitter.[1] Technological breakthroughs have already allowed some renewables to become cost competitive in the market. For example, there have been major reductions in the costs of production of solar panels used for power generation, as well as in the production of turbines for wind power generation, which is becoming an increasingly more cost competitive alternative.[2] However, some renewable energy sources, such as biofuels, are still highly dependent on incentives and financial support.[3] Nevertheless, in 2016 total global energy consumption and electricity production from renewables reached its highest annual levels ever - 161 gigawatts of capacity.[4]

With such major shifts occurring in the global energy sector, growing attention has, however, been placed on the impacts and spill-over effects of the increased production and use of renewables on related sectors, in particular, on the water and food sectors. It is clear that intensive use of renewable energy to replace fossil fuels may impact natural resources by creating new impacts upon and a competing need for those renewable resources. For example, the increased use of hydro-power as a renewable source of energy may limit access to water or reallocate water resources away from other existing end-users (such as food producing farmers, communities, or the environment itself).[5]

Energy transformation, production and use now accounts for two thirds of global greenhouse gas (GHG) emissions.[6] During 2015 CO_2 emissions remained flat despite some economic growth although, as with four other periods where emissions production has remained flat or reduced, this was associated with global economic weakness.[7]Nevertheless, developments since 2015 indicate that a profound transformation of the energy sector is in motion. Prices of oil fell dramatically in 2016, reaching their lowest nominal annual level since 2004.[8] Oil remains the world's leading fuel accounting for a third of global energy consumption.[9]However, coal consumption has fallen by 1.7%, which represents 53 million tonnes of oil equivalent (mtoe) and is the second year of successive decline of this fuel. Natural gas consumption has grown by 1.5%, although this was slower than the 10-year average. Renewables have grown 53 mtoe or 14%, even though this, too, is below the 10-year average. Thus, renewables are showing a dramatic growth as compared with other sources of energy.[10]

There can be no doubt that the accelerating transition to renewable energy sources is being spurred by concerns over atmospheric GHG (in particular, CO_2 emissions). Since global demand for energy is projected to rise,[11] renewable energy sources must increasingly play a prominent role in the energy sector. Clearly, the further development of renewables is central to making the energy sector less carbon intensive and compatible with the goals of international and domestic climate regimes.

Regulating renewables – accounting for WEF nexus connections

"Water, energy and food are inextricably linked". This is a common phrase used in the Water-Energy-Food (WEF) Nexus literature to explain the WEF nexus approach.[12] The main reason for stressing the linkages between water, energy and food is because the WEF nexus thinking is built upon the idea of resource scarcity[13] and the need to steer away from sectoral approaches to resource management[14]. These three resources are considered as "fundamental pillars on which global security, prosperity and equity stand".[15] Resource scarcity is widely discussed in the WEF nexus literature, where reports show exploitation of natural resources has grown exponentially, while access to those resources is not equitably distributed.[16]

The combination of multiple factors (e.g. population and economic growth, urbanization, accelerated development and climate change) have increased pressure on natural resources leading to increases in demand. Population is predicted to grow from seven billion in 2010 to 9.1 billion[17] by 2050; to feed this increasing population agricultural production will have to increase about 70% in the same period. Consequently, about 50% more primary energy will need to be available by 2035. It is also expected that climate change will aggravate pressures on natural resources as a result of increased floods, droughts and extreme weather events.[18] Therefore, it is undeniable that the connection between water, energy and food is a "web of complex relations where resource use and availability are interdependent".[19]

Considering these pressures together, it is clear to see why decision makers and researchers identify more acute pressures on the natural resource base that generates food, water and energy. The formulation of the WEF nexus thinking became a "shorthand for this confluence of trends and need for explicit trade-offs in policy-making".[20] The WEF nexus thinking brings more visibility to each sector while integrating them and making it possible to address the externalities that tie each sector together.[21]

Renewable energies are expected to play a significant role in transforming the energy sector towards a less carbon intensive sector. However, renewables are not necessarily without their down-sides. Construction of major solar facilities requires the clearing of land, creating competition for space and water run-off challenges. The materials used for PV panels are also highly hazardous.[22] Hydropower can lead to dislocation of communities and inundation of arable land, eutrophication of lakes and rivers and water loss among several of other issues.[23]

Thus, while renewables have the potential to assist in the decarbonisation of energy systems, they also have strong connections to key sectors that can be negatively affected in the event of an unregulated explosion in their use. Impacts on the water sector may show as pollution of drinking water sources or reduced access due to redirection of or increased competition for use. Impacts on the food sector can be translated as competition for arable land, reduced access to food and reduction in food quality. What these connections reveal is the strong possibility that the push to renewables may have adverse impacts on water and food security unless their development is appropriately regulated.

The Brazilian case study

There are several renewable energy technologies economically viable[24],nonetheless, this study considered hydropower for evaluation. The main reason for choosing hydropower energy is because it is a solid, traditional and consolidated renewable energy technology. Moreover, hydropower has a clear connection to nexus issues since it permeates the three dimensions. Hydro developments are keen to impact water courses, availability of water for human consumption and for agriculture and cause several other environmental impacts.

Brazil was selected due to its vast experience with the use and deployment of renewable energy since the 1970s. Renewable energy is essential for the country's energy matrix, with hydro figuring as the most relevant primary electricity supplier.[25] Aside from that, Brazil is the fourth largest food producer in the world [26]. Soy, meat, sugar and coffee are among the main products on the Brazilian export list, accounting for approximately 30% of the total exported by the country. Fresh water courses are also abundant in the country.[27] These factors combined allow for investigation of all the aspects of the nexus issues.

The Santo Antônio hydropower dam

Plans to build hydropower plants in the Madeira basin have evolved throughout the decades in Brazil. Back in the 1980s there was a plan to build one major dam however due to the size of the reservoir and transboundary environmental implications in a neighbouring country the plans were suspended.[28] Only in 2001 discussions of building dams in the Madeira resurfaced triggered by the energy crisis and the governmental programme named Growth Acceleration Program. The original plan was to build one mega dam, however due to environmental concerns (i.e. size of the reservoir) these plans were not followed through. To circumvent the environmental problems the solution was to divide the mega dam and build two hydropower plants.[29] In fact, two hydropower plants were built: Santo Antônio and Jirau. It is important to highlight that this study focus only on the impacts of the Santo Antônio hydropower plant.

Santo Antônio is a large-scale dam, built in the Madeira river only 7km away from the Rondônia state capital Porto Velho. The region is located in the north of the state close to the border of the Amazon state and Bolivia. This location is marked by precariousness in access – few roads connect the city to other locations in the state and out of it. Access to services such as energy and sanitation are also problematic.[30]

The Santo Antônio hydro plant follows the water line type, a system in which the river water flows through the bed with normality, smaller reservoirs[31] are built and a smaller area is flooded.[1] In total, the flooded area is about 271km^2 and due to the Amazonian flat territory the plant was built with bulb type turbines, which allow operation without large waterfalls.[32] At the end of its construction, in 2016, with the 50 turbines in operation, the plant entered into full operation with a generation potential of 3,568 MW.[33]

Nexus links for hydropower

Water, energy and food form the core sectors to be assessed considering drivers of pressures for the nexus. Drivers of pressure and impacts, can be understood as "effects on the environment and the impacts on humans and ecosystems".[34] Considering the Santo Antonio case study, the main nexus links, considering cross-sectoral interactions, will be outlined below.

Energy-Food

The agricultural sector is important for the region where the hydropower plant is located. In the state capital, Porto Velho, an average of 5 thousand hectares were destined to perennial crops and almost twice that value was destined to temporary crops.[35] The agribusiness has great economic and social importance and especially family farming contributes significantly to the generation of employment and income in the state.[36] While some crops are destined for subsistence, such as beans and cassava others have great added value and are exported to other stated of the country (i.e. coffee, banana, rice).[37]

Some relevant conclusions are possible with information from the Brazilian Institute of Geography and Statistics (IBGE). The region of Porto Velho presents six different crops, cocoa, coffee, açaí, sugarcane, cassava and corn.[38]Despite the region proximity to the Santo Antônio dam, no real adverse impact could be assessed from the data obtained from IBGE. Virtually all the crops showed increased trends even with the installation of the close by hydropower plant. The only crop that demonstrated some decrease was sugarcane.

While these are the official results presented by the Brazilian government for the region little has been said for the subsistence crops grown in the lowland forests. These areas were once cultivated in the dry season, when the soil is exposed. With extreme fertile soil, riverside communities were able to plant a wide range of products.[39] Since the hydropower plant was built, the area is now constantly flooded, making crop farming impossible. For this reason, several families were relocated by the hydropower constructors to very different locations then they were used to farm. In an interview to a local newspaper a farmer relocated by the hydropower plant affirms: "Here the earth

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[1] This does not mean that the reservoir is small but rather it means that in proportion to its capacity the reservoir is smaller than the traditional Amazon hydropower plants. Comparing to the hydropower plant of Balbina in theAmazonas state, the flooded area was of 2.360 km2 of tropical forest to generate only 112,2 MW of electricity. See Philip M Fearnside, 'Brazil's Balbina dam: Environmentversus theLegacyofthePharaohs in Amazonia', Hidreletricas na Amazonia: Impactos Ambientais e Sociais na Tomada de Decisoes sobre Grandes Obras, vol 1, (editora do Instituto Nacional de Pesquisas da Amazonia (INPA) 2015).

splits, dry. The bananas are smaller[…]" he says. "Those who have not left is because [they] have nowhere to go".[40]

The relation between fishing and food security in the region of where the Santo Antônio dam was built is strong. Fish is the main source of nourishment to people in the Amazon region due to its large availability.[41] Throughout decades small riverside population developed along the river depending on the steady provision of food from the river. Selling extra portions of the catches was a mean of adding to the family income. The variety of fish is enormous and the methods for fishing still rudimentary (i.e. nets and spears).[42] Porto Velho is one of the most important fishing markets in the madeira basin region in the Rondônia state, which represent 25% of the fish caught in the state.[43]

However, evidences point that the dam brought even bigger impacts for this important source of food. The location chosen for the study is among the only one in Brazil where the population has a preference for fish in their meals.[44] The extractive fishing comprehends one of the main activities of the region and is responsible for supplying urban and riverine communities.[45]

The impacts of the Santo Antônio dam on fishing[2] lies in the loss of habitats and hydrological shifts, implicating on ecological processes for maintaining diversity of local fish stocks.[46] These changes can "alter and interrupt migration routes, modify the abundance, composition and trophic configuration of their communities, including an increase in the abundance of some species; whereas the populations of other species may be greatly reduced or even become extinct".[47]

The analysis of the environmental assessment study it brings a comprehensive table with 35 impacts ranging from fauna, flora, wildlife, however, focusing on fish/fisheries it shows the following impacts:

- Interruption of migratory fish routes
- Modification of fishing in the reservoir area
- Concentration of shoals downstream of dams
- Change in fish community structure
- Elimination of natural barriers for river dolphin
- Local reduction of fish diversity
- Loss of fish spawning areas

For all the impacts listed above only the first two cases the environmental impact assessment presented some kind of preventive or compensating measure. In all the other cases the measure reported in the assessment is "no measures, monitoring".[48] This is extremely concerning because points to evidence that such impacts are likely to have bigger dimensions than the ability of the developers of the hydropower plant to estimate and are beyond their capacity to solve.[49]

Furthermore, the environmental assessment study conducted by the developers in 2005 was able to identify in region selected for the study a contingent of 1,952 fishers and an average of only 470 unregistered fishers.[50] Nevertheless, it was later identified that a great portion of riverine families and indigenous people were not included in this assessment. It is estimated that 8,000 of the most river dependent people were left out of the original mitigation assessment.[3] This is an important event that ties to the upcoming analysis of the overall weakness of legal framework especially dealing with water and food.

Energy-Water

The North region of Brazil suffers a grave paradox, the region presents the higher indexes of freshwater per capita but suffers with the lowest rates of access to water in the country.[51] While the country shows high rates of access of services of water and sewage networks the North of Brazil has a little over half of its population served with proper access. The city of Porto Velho is among the last in rates of water services in the country.[52] Uses of water

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[2] For more studies and impacts on fishing see: Doria, C. R. C., Ruffino, M. L., Hijazi, N. C., & Cruz, R. L. (2012). A pesca comercial na bacia do rio Madeira no estado de Rondônia, Amazônia brasileira. Acta Amazônica, 42(1), 29–40. and Cardoso, R. S., & Freitas, C. E. C. (2007). Desembarque e esforço de pesca da frota pesqueira comercial de Manicoré (médio rio Madeira), Amazonas, Brasil. Acta Amazonica, 37(4), 605–612. and Rangel E Santos and others, 'The Decline of Fisheries on the Madeira River, Brazil: The High Cost of the Hydroelectric Dams in the Amazon Basin' (2018) 25 Fisheries Management and Ecology 380.

[3] On this subject see: MAB – Movimento dos atingidos por barragens<www.mabnacional.org.br/> and Carolina Rodriguesda Costa Doria and others, 'The Invisibility of Fisheries in the Process of Hydropower Development across the Amazon' (2018) 47 Ambio 453 <https://doi.org/10.1007/s13280-017-0994-7>

vary in the region selected for the study. In Porto Velho, almost 50% of water is destined to consumption while 5% is destined to irrigation despite the gap in water services mentioned above [53].

Losses of ecosystems can directly impact on the availability of water resources. Forests have a significant role in controlling erosion, desertification and water quality therefore controlling deforestation to preserve water resources is of utmost relevance.[54] Despite hydropower plants can be an important vector for deforestation the major contributor to deforestation in the Porto Velho region is the use of land for livestock. The clearing of land in the Porto Velho region saw cattle herds increase an average of 284% from 2000 to 2009.[55] The impact of deforestation on the Amazon forest is complex since the hydrologic cycle of the Amazon basin is still to be fully comprehended. Nevertheless, studies indicate that the advanced rate of suppression of coverage results in a hotter and drier Amazon which has a direct impact on the maintenance of the Amazon biome.[56]

Brazilian regulatory framework for hydropower

Engineering and environmental studies

A hydropower project in Brazil is a complex and bureaucratic process. The first relevant assessment is the hydropower inventory study andthe legal basis for this phase is given by a combination of legal documents. Fist Law nº 8.987 from 1995 provides for the regime of concession and permission of the provision of public services. This law also establishes the set of responsibilities of the grantor power towards public concessions in article 29.[57] Complementary to it, Law nº 9.074 from 1995 establishes the norms for the granting and extensions of the concessions and permissions of public services with a chapter dedicated to energy services. The objectives for the granting of a concession can be found in article 5 of the Law. The procedures for conducting hydrographic inventory basin studies are established in Normative Resolution nº 672 from 2015 enacted by the National Electricity Agency [58].

The inventory process can take from 2 to 4 years for involving not only desk studies but also "field information, guided by basic cartographic studies, hydro, energy, geological and geotechnical, environmental and multiple water uses".[59] During this phase of the process, it is the crucial to identify environmental and social impacts of the development and take into perspective different alternatives for the hydro project along with the restrictions imposed on (and by) other uses of water resources.[60]

The next step comprises the phase of feasibility studies. At this stage there are conducted assessments of the overall design of a given water use, for its technical-economic and environmental optimization in order to obtain the associated benefits and costs of the project. This study has some specific goals, firstly to conclude on the feasibility of the project through evaluations, analyses and definitions based on the costs and the multiple benefits that can be obtained and to subsidize the preparation of the necessary documents for the environmental licensing.[61] Therefore, the feasibility studies phase is one of the most important in the decision-making process, since with its approval the process for bidding and granting for exploitation concessions can proceed.

The feasibility phase has its legal grounds on Law 9427 from 1996 combined with ANEEL Resolution 395 from 1998. Article 28 from the Law reads: "the feasibility studies, drafts or potential hydraulic exploitations projects should be informed to ANEEL for registration (…)".[62] In light of the Law, ANEEL enacts Resolution 395 from 1995 with the general procedures for recording and approving feasibility studies of hydropower generation projects. Finally, Law 10.847 from 2004, creates the EPE with the specific function in conducting feasibility studies.

Once the feasibility studies are approved the auction process can start. Hydro projects are subjected to an auction process because the Constitution in article 37, item XXI establishes that "public works, services, purchases and disposals shall be contracted by public auction process". [63] For the Brazilian administrative law "auction is the administrative procedure by which the Public Administration selects the most advantageous bid for the contract of interest".[64] It is Law 9.074 from 1995 that establishes the rules for granting concessions for public services, article 5 lists what may be object of concession through biddings. Among them it is set the use of hydropower potential (…) with a power of more than 50,000 kW (fifty thousand kilowatts). The authority of ANEEL to perform the tender process is indisputable, in view of the provisions of article 3-A, item 1, §2 from Law 9.427 from 1996 which expressly delegates to ANEEL the responsibility to implement bidding procedures.[65]

After the auction process follows the phase to the preparation of the Basic Project. This project for medium and large developments consists in the detailing, under technical-economic and environmental aspects, the hydro potential alternative chosen.[66] The basic project is a deepening of the studies conducted in the feasibility study. It is Resolution 395 from 1998, article 3 that establishes the procedures for the basic project.

The final phase of studies consists in the development of the executive project, an extensive document that contemplates the description of the construction, the equipment necessary, and which contains all the information necessary for the civil construction of the hydropower plant. It is in this stage that the measures for implementing the reservoir are taken for this reason the previous environmental studies are so relevant. Concomitant to the implementation of the reservoir, the socio-environmental measures are put in place to prevent, mitigate or compensate environmental damage cause by the construction and operation of the dam.[67]

Once the construction is completed, the reservoir will be filled and the hydropower will start to operate, generating energy. The beginning of operations is accompanied by actions aimed at monitoring and, eventually, correcting the measures taken during all the previous stages.[68]

Environmental licensing

Environmental licenses are preventative instruments for activities that use and potentially can harm environmental resources. They are instruments that aim at establishing, among other things, risk management measures, to prevent or, at least, minimize damage, as these activities will often generate irreversible environmental damages.[69] Law 6.938 from 1981, that establishes the National Environmental Policy (PNMA), introduces the licensing into the Brazilian legal system by setting it as one of the mechanisms of the Policy.[70] As previously mentioned, the importance of the PNMA to Brazilian environmental law is uncontested; it is the cornerstone for the development of environmental concerns towards harmful developments using natural resources.[71]

Environmental licenses are defined by the National Council for the Environment (CONAMA) Resolution nº 237 from 1997 in article 1:

Art. 1 - For the purpose of this Resolution, the following definitions are adopted:
I - Environmental License: administrative procedure whereby the competent environmental agency licenses the location, installation, expansion and operation of projects and activities that use environmental resources considered as being actually or potentially polluting or those who, in any form, cause environmental damage, considering the legal and regulatory provisions and the technical standards applicable to the case.
II - Environmental License: an administrative act by which the competent environmental agency establishes the conditions, restrictions and environmental control measures that must be obeyed by the entrepreneur, individual or legal entity, to locate, install, expand and operate enterprises or activities that use the resources environmental impacts considered to be effective or potentially polluting or those that in any way could cause environmental degradation.

The PNMA determines that the construction, installation and operation of activities that use environmental resources and can pollute or generate environmental degradation will depend on environmental licensing.[72]

Complementary Law 140 from 2011 in article 7, item XIV establishes which developments are susceptible to environmental licensing. Article 3, item VII, “a” of Decree 8.437 from 2015 establishes when the competence to conduct the licensing of a hydropower scheme will fall under the Brazilian Institute for the Environment and Renewable Natural Resources’ (IBAMA) jurisdiction. The procedures to be followed for the licensing are determined in Normative Instruction from IBAMA nº184 from 2008.

Environmental licensing is composed of three steps: a) grant of the preliminary license; b) grant of the installation license; and c) grant of the operation license. It should be noted that between these steps it may be necessary to provide an environmental impact study and its respective environmental impact report (or EIA/RIMA).[73]

The preliminary license, as provided in article 8, I of CONAMA Resolution 237/97, is granted in a primary phase of the development, the planning steps. The purpose of this license is to grant an approval of the location and the basic conception of the project, certifying the environmental feasibility and establishing the basic requirements and conditions to be met in the next phases of its implementation.[74] This license is requested after the viability studies are carried out.

In sequence, there is the installation license which is requested by the winner of the bidding after the approval of the basic project. This license will authorize the installation of the development in accordance with the specifications contained in the approved projects, including environmental control measures and other constraints. Finally, the operation license allows for the operation of the development after verifying compliance with what is stated in the previous licenses, with the environmental control measures and determinants for the operation.[75] This final license is required by the end of the construction of the hydro.

Regarding the environmental procedure, some remarks must be made on the environmental impact study and the respective environmental impact report. The environmental impact study is one of the most important mechanisms in Brazil for environmental protection, deriving from the preventive principle141 and enshrined in the Constitution in article 225, §1, IV.

It is interesting to note that the evaluations for environmental impacts were already an instrument of the PNMA according to article 9, item III. However, according to the author Fiorillo (2011), no contents for the study were established and, more important, there was no express provision determining the study to be prior to the development of the project. This changed with Decree 99.274 from 1990, instrument that regulated the PNMA and gave CONAMA the authority to set the criteria for the environmental study. In Annex I of CONAMA's Resolution nº 237 from 1997 is the list of activities subject to preliminary environmental study, including works for the development of a hydropower plant.

Discussion

The framework and spill-over impacts

This paper aimed to analyse the Brazilian regulatory framework for hydro energy, in order to evaluate the level of coordination between food, energy and water legislation and its adequacy in avoiding further cross sector and environmental damage from energy output.

The first connection between the impacts from the Santo Antônio dam and the legal framework that can be pointed out refer to the environmental sector. The environmental sector is very influential on the framework for hydropower since nearly every step of the processes involve an environmental measure. Nevertheless, when analysing the coherence of the framework, it is possible to affirm that there are problems that are brought by the redundancy.[76]

Despite the relevance of the environment on the framework, there is an intrinsic problem in the efficiency of environmental legislation. In the Brazilian case, taking as reference the Santo Antônio hydropower, some factors corroborate the precariousness of the efficiency of environmental legislation. The environmental licensing process has been largely pointed out as problematic and the environmental law seen "as a mere framework which does not fundamentally prevent the construction of structures".[77]Another author go on further to affirm that there has never been a single case of full compliance with environmental legislation for the construction of hydropower dams in Brazil.[78]

The evidence on impacts for the food sector, diminished agriculture and fishing, exemplifies the importance of carrying out environmental impact assessments which derives from the national environmental legislation. One of the main points of a thorough impact assessment is to offset or mitigate the expected impacts and make them acceptable.[79] Nevertheless, the evaluations carried out revealed incongruencies from the information on the environmental assessment study that led to substantial impacts on the region, impacts that have not been mitigated and will hardly be repaired.

It became clear how fish production is important for the region. Nonetheless, the study related to fishing and fishes considering the construction of the hydropower dam was not as comprehensive as it should have been. The companies suggest in the document the implementation of structures for fish transposition and monitoring[80], nonetheless this sort of measure is not effective for all species of fish, especially giant catfish[81] – a traditional fish for locals.

Considering energy, food and land use or even agriculture the federal legislation is silent on the matter except for a mention of the Forestry Code. Law 12.651 from 2012 established the Forestry Code and its importance towards hydropower plants is in the establishment of permanent protected areas (or *Áreas de Proteção Permanentes*).[82] Legislation on food, agriculture and land are left on charge of the state. The state of Rondônia has laws to support and regulate fishing and family agriculture.[4] Specifically state law nº1.038 from 2002 that sets guidelines for fisheries protections. Nevertheless, it becomes clear that this law is not stringent enough due to the effects reported on the fisheries. The loss of habitat, impact on migratory patterns and overall diminished quantity of fish observed is a result inefficient legislation that does not meet its outcomes.

Considering the water sector, despite the structure of the water framework and the reforms brought by the National Water Policy, a legislation from 1997, that aimed at shifting the water management approach in Brazil and enlarging the scope of the Water Code.[83] Despite important improvements were brought to Brazil with the alteration of the

[4]Rondonia State Law 1.038 from 2002 - establishes guidelines for fisheries protection. Rondonia State Law 3.968 from 2016 - institute the state plan intended for acquiring seeds, plant seedings and propagative material for free distribution to family agriculture producers. Rondonia Law 3.969 from 2016 - institute the state plan aimed to encourage the recovery of areas degraded in properties of family farming.

Water Code and the creation of the Water Agency[5], due to political pressures water management appears to be still based on the demands of the energy sector. The high number of hydropower plants under construction in Brazil is a proof of that.

The challenge of integrated regulation

From the review of the legislative framework on hydropower it becomes clear that Brazil has a comprehensive regulatory framework pertaining energy, water and environmental matters. Nevertheless, such frameworks have been developed in isolation from one another only occasionally referencing to issues from other sectors[84] or even with no references, as it is the case of agriculture for the framework under study.The Brazilian case for hydropower, a traditional renewable source of energy for the country, the high number of relevant legislations proves the high complexity of the system.

In spite of the complexity of the overall legislative framework, most of the criticism regarding the process for hydropower plants in Brazil derives from the environmental licensing process. Brazil is one of few countries still grants a different license for each distinguished stage for a given project. This format contributes to maintain conflicts without objectively resolving them at any stage of the licenses, continuing uncertainties.[85]

The high volume of scattered norms and statutes, sometimes conflicting with each other,contributes to the complexity of the system.[86]Added to that there is the institutional confusion scenario regarding environmental activities. According to Hofmann "agencies are performing fragmented activities in parallel, with no hierarchical relationship with the entity responsible for the integrated perspective with the entire process: the licensing authority."[87]This compromise profoundly the decision-making capability.

Considering the problematic presented by this paper the WEF nexus concept can be an optimal solution for the development of more integrated regulation on renewable energy. In the literature, the nexus has been well-received, being perceived as a promising and innovative approach.[88]It does entailagreat ambition "to overcome the unintended consequences of uncoordinated policy between different sectors."[89]However, so far the most innovative facet of the nexus remains the shift of attention from the siloed perspective to connecting the interdependencies from resources.[90]

As Allan points out, "a theory on the grand WEF nexus is still missing"[91] and despite the number of frameworks and analytical tools this has not been translated into meaningful governance and policy change.There are still limitationsin the nexus literature on governance combined with a lack of legal critical analysis, for the nexus to become an effective solution for integrative regulation. As properly pointed out by Weitz et al. (2017) it appears that the nexus is disconnected from the policy-process and that the policy changes that are expected from it can derive from technical analysis.[92]

Conclusion

This paper has made an extensive review on the regulatory framework for hydropower in Brazil. It has explored the main connections between water, energy and food in the context of the Santo Antonio hydropower. It is undisputed that major constructions such as hydropower plants such as the Santo Antonio can cause environmental impacts and affect interconnected sectors, such as water and food.

The legal framework assessed does recognize the potential of hydroelectric projects in causing environmental harm. For this reason, the Federal Constitution adopts the prevention principle in article 225[93] with the clear command for the Public Power and the society to protect and preserve the environment.[94] The National Environmental Policy sets the environmental licensing process with the same preventive character. Nevertheless, it became apparent that those laws, to some extent, are only apparent standards – not actually enforced – from the impacts evidenced throughout the paper.

The analysis for environmental licensing showed that there are issues brought by redundancy which creates "regulatory pollution". This favours conflicts and normative antinomies, created by an extensive framework.[95] Despite its relevance on the building of the framework an intrinsic problem lies in the efficiency of environmental legislation. The Brazilian case, taking as reference the Santo Antonio dam, points to some factors corroborating the precariousness of the efficiency of environmental legislation.

[5] The Water Agency has implemented the Brazilian Water Balance System to control the water availability of its watersheds and to have better monitoring of critical hydrological events. ANA's goals are to promote the regularization of water courses, water distribution and to reduce water pollution.

The push for renewables can be perceived as a mitigating action for climate change and to catalyse a much-needed energy transformation[96], the effects of such action must be carefully watched. The case study showed that improved integrated regulationcould have showed better results for hydropower in Brazil. Nevertheless, while the nexus highlights important interdependencies it still presents gaps that must be bridged to make the nexus a more effective approach.

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