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Mainstreaming the Water-Energy-Food Nexus through nationally determined contributions (NDCs): the case of Brazil

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ABSTRACT

The Water-Energy-Food Nexus approach to the governance of natural resources seeks to identify and address the synergies and trade-offs amongst traditionally separated sectors, to capture significant feedbacks that have so far remained insufficiently understood and regulated. One key specificity of the Nexus approach is the need for intersectoral, cross-scale and stakeholder integration, which is particularly challenging due to the lack of policy coordination prevailing in many countries. Yet, some emerging integrated policy processes, such as those aimed at implementing nationally determined contributions (NDCs) under the 2015 Paris Agreement, may offer a sufficient level of integration to mainstream the Nexus approach. This article focuses on the potential of such NDC processes in Brazil. NDC processes in China, the European Union, India and Mexico are used as indicators associated with higher or lower degrees of integration for a more specific analysis of the case of Brazil. The article concludes that the barriers to sectoral integration raised by the dominant position of the agricultural sector in Brazil as regards, among other things, environmental legislation, are unlikely to be overcome by internal action. This represents a threat to achieving the target of zero deforestation in Brazil, considering the cropland-livestock forestry feedbacks involved in the growing demand for agricultural commodities from China. NDCs already provide space for international cooperation, which could be further developed to include measures for linking demand for agricultural commodities from the EU and China, and massive land-use change and deforestation in Brazil.

Key policy insights

- The NDCs from India, China, EU, Mexico and Brazil recognize, to varying extents, the Nexus approach in their climate policies, particularly the link with water uses in agriculture. The NDCs from EU, Mexico and Brazil include some elaborated Nexus issues related to indirect land use-forestry-agriculture.
- Sectoral integration could be progressively strengthened under the Nexus approach as part of the five-yearly updates of the NDCs.
- The NDCs from Brazil and China could provide a policy window to integrate indirect land use-forestry-agriculture collaborative measures, for the purposes of tackling the deforestation trade-off resulting from Brazilian exports of soybeans to China.

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1. Introduction

Understanding the inter-dependencies across the water, energy and food sectors is important to tackle the growing pressures arising from climate change on the enjoyment of natural resources. All three sectors involve large-scale extraction and consumption of natural resources and, although the natural world is unified in a physical sense, it has been divided into sectors from a governance standpoint. The Water-Energy-Food Nexus approach ('Nexus approach') seeks to reflect the synergies and trade-offs amongst traditionally separate sectors of regulatory action in order to achieve greater coordination of policies and improve water, energy and food security as well as the efficient and sustainable use of such resources (Hoff, 2011).

The Nexus approach entails cooperation and dialogue amongst the institutions representing each sector for the formulation of genuinely integrated policy. A significant challenge for the implementation of this approach is the fact that the governance of water, energy and food are often entrusted to different sector-specific institutions with additional complexity arising from both the distribution of competences among the local, regional, national, and international levels, and among different stakeholders, including government, the private sector, and civil society. In practice, the institutional and social dynamics within each sector operate independently of one another, which favours sector-driven policies with only occasional cross-sectoral initiatives. In this context, mainstreaming the Nexus approach can be very difficult because there are few policy windows in place that would be sufficiently integrative to accommodate and address Nexus interdependencies. One such window, which is common to many States around the world, is the process to define and implement nationally determined contributions (NDCs) under the 2015 Paris Agreement (UNFCCC, 2015).

The purpose of this article is to assess the potential of NDC processes for the mainstreaming of Nexus considerations. The assessment is based on an analysis of five major jurisdictions, namely Brazil, India, China, Mexico and the European Union (EU), which is intended to shed light, more specifically, on the potential of an NDC-focussed strategy for the mainstreaming of the Nexus approach in Brazil. Brazil presents a textbook example of the trade-offs arising within the Nexus because of its particular exposure to the combined pressures of climate change and global macroeconomic change, as well as its prevailing domestic conditions, namely, massive reliance on hydroelectricity and agricultural exports and the political influence of these two sectors. Despite fluctuations in political priorities, the long-term nature of NDC processes makes them a potentially significant policy window for advancing an integrated view of these problems. Under the Paris Agreement, NDCs must be updated every five years but the goal is for them to guide a long-term path towards decarbonization and resilience; this gives NDCs and their underlying policies a time horizon much longer than political change.

The article begins with an examination of the regulatory fragmentation challenge of the Nexus approach, followed by an assessment of the NDC processes in India, China, Mexico and the EU, to distil indicators of higher or lower degrees of sectoral integration. It then turns to an appraisal of the Nexus issues in Brazil, highlighting the regulatory landscape and the underlying power asymmetries amongst sectors in the policy-making process. This includes an analysis of recent reforms in the Brazilian administration as an attempt to strengthen the agricultural sector. The final part discusses how the sectoral and scale linkages offered by the NDC processes, particularly between international and domestic levels, could change the incentives that drive deforestation in Brazil.

2. The Nexus specificity: integrating sectors, scales and stakeholders

2.1. Sectoral integration initiatives

The Nexus is a new approach to the governance of natural resources introduced at the international conference 'The Water, Energy and Food Security Nexus – Solutions for the Green Economy', held in Bonn in 2011, in preparation of the 2012 United Nations Conference on Sustainable Development – Rio + 20. It highlights the need to reflect more fully the interdependence of the physical world in governance frameworks. The background report for the conference reviewed several case studies suggesting that a Nexus approach could improve water, energy and food security, through governance and management integration of different sectors and at varying scales; with additional benefits for resource efficiency and policy coherence (Hoff, 2011).

Amongst previous sector integration initiatives, Integrated Water Resources Management (IWRM) has been widely adopted for many decades for the management of water, land and related resources (GWP, 2000). Introduced by the recommendations of Agenda 21 of the 1992 UN Conference on Environment and Development (UNCED), IWRM remains relevant for the UN's 2030 Agenda and its Sustainable Development Goals (SDGs), according to SDG 6 (clean water and sanitation), Target 6.5 (implementation of IWRM). The Nexus approach, however, allows for a multi-sectoral treatment, rather than the IWRM's water-centred focus at the river basin governance level, which tends to subordinate the other sectors' institutions and regulations to its priorities (Benson, Gain, & Rouillard, 2015).

2.2. Regulatory fragmentation

The innovative aspect of the Nexus is shifting the regulatory focus from a single-sector view to a balanced perspective of the issues linking the water, energy and food sectors (Al-Saidi & Elabib, 2017). The key specificity of the Nexus is the need for intersectoral, cross-scale and inter-stakeholder integration. This is a challenging insight to implement in practice because of the well-established separation in the governance of these sectors, which are organized largely in isolation from one another (Hussey & Pittock, 2012).

The organization of the sectors according to their functions is consistent with the purpose of improving capacity and efficiency within each sector. Separate institutions, whether ministries, departments and/or agencies, together with the private sector and, sometimes, civil society, are organized on the basis of staff with sector-specific training and capacity to tackle specific problems, reflected as priorities in their respective single-sector regulation. The geographic distribution of the scales of governance is also sector-specific, and the degree of power and functional devolution often varies from one sector to another. Moreover, since the water, energy and food sectors have a strong impact on natural resources, simultaneous layers of governance, coming from the environmental protection frameworks, add both regulatory and stakeholder complexity to the governance of the shared natural resources.

This situation of separate pieces of legislation for each regulatory regime and multiple governance levels for each sector is what is termed regulatory fragmentation, which has caused shortcomings in the governance of natural resources. Overall, the lack of integration between sectors can create regulatory gaps, overlaps or inconsistencies. Additionally, political interests shaping decisions about natural resource allocations can result in power asymmetries, competition for resources, and conflicts amongst the sectors (Leck, Conway, Bradshaw, & Rees, 2015). In particular, a policy focusing on efficiency results for an individual sector may compromise others if it raises natural resource demands (Hussey & Pittock, 2012). The emergence of trade-offs and, hence, of competition between these constituencies, as a result of climate change pressures, could have deep political repercussions.

2.3. Integrating sectors using the Nexus approach under existing frameworks

The debate over how to overcome the challenges of Nexus governance encompasses widely diverse views. At one extreme, some have argued for the creation of new institutions to deal with the integration of different sectors, entailing a new centralized Nexus bureaucracy requiring administrative reforms (Bazilian et al., 2011). In practice, radical measures such as the establishment of a new 'Nexus ministry' would likely encounter much resistance, as they would add further complexity to already fairly complex governance systems and, therefore, they would not necessarily improve cooperation and dialogue. Conversely, relying on existing mechanisms, whether formal or informal, that bring together the institutions established to deal with the three sectors seems more realistic at this still early stage of the Nexus approach. Indeed, such mechanisms could and, in practice, do provide a useful platform to set a common agenda of priorities, tasks and meetings, based on the balance between the sectors (Stein, Barron, & Moss, 2014). The most challenging part of this milder and more realistic approach is a need for an effective authority, which can promote genuine cross-sectoral coordination (Oliver & Hussey, 2015).

Some propositions combine the Nexus and climate change, for example, considering Nexus issues as part of adaptation measures (Rasul & Sharma, 2016). So far, the most prominent views advanced on the Nexus approach

for the integration of tasks have focused on the implementation of the SDG strategies (Weitz, Nilsson, & Davis, 2014). The Nexus approach seems appropriate for assessing and quantifying interactions amongst the SDGs in the course of their implementation. Within the SDG framework, there is one specific goal related to each of the Nexus elements: food (SDG2), water (SDG6), and energy (SDG7). For instance, SDG7 reinforces several other goals, including SDG2 and SDG6, as ensuring stable, affordable and modern energy for all facilitates access to clean water, refrigeration, and safe cooking (Weitz et al., 2014).

Overall, the Nexus approach is probably a fundamental point of intersection to develop joint policies for the SDGs and climate change, towards which both domains are probably heading in the near future. Recent studies incentivise coordination between SDGs and climate action to maximize effects in both frameworks, and for this purpose, better coordination within governments and sectors is essential (Nerini et al., 2019).

Both the NDCs and SDGs involve multiple vertical scales of governance, from global to local, and they require a certain degree of intersectoral coordination. Inevitably, regulatory fragmentation is also a challenge for the SDGs, but it seems NDCs provide more policy traction for the mainstreaming of the information and action organized by the Nexus approach. Specifically, the processes to develop NDCs, which require a clear and integrated forecast of both socio-economic development needs and climate change impacts, as well as sufficient buy-in from different constituencies (sectors, scales and stakeholders), provide a particularly suitable avenue to address the interdependencies among the nodes of the Nexus. In comparison with NDCs, SDGs are rather diffuse. At the same time, it can be argued that the climate targets are simpler, more quantifiable, more specific and subject to more focused global attention, monitoring and understanding. Nevertheless, an in-depth comparison between the advantages of the use of the Nexus for implementation of the SDGs and NDCs falls outside the scope of this analysis.

3. NDC development as a strategic policy window for the Nexus: a comparative assessment

3.1. Aligning the terms of the Nexus through NDCs

The Nexus specificity in sectoral, scale and stakeholder terms can be an important component in the development of a country's NDC, and NDC processes seem well suited to capture the interdependencies highlighted by the Nexus approach. Indeed, NDC processes are, as a rule: (i) sufficiently integratory in sectoral, scale and stakeholder terms; (ii) sufficiently regular (a new NDC must be submitted at least every five years under the Paris Agreement); and (iii) specifically tailored to national circumstances, with unprecedented room for differentiation across countries (Rajamani, 2015; Viñuales, 2016).

At the time of writing, 184 parties (out of the 185 States having ratified the Paris Agreement) have submitted their first NDC to the UN Climate Change Secretariat for inclusion in the interim registry (UNFCCC, 2019). The contents of NDCs vary significantly across countries and although they have a local content, they are inserted within the international context as they serve as an indication of country readiness to contribute to the global effort and the successful outcome of the Paris Agreement (Viñuales, 2016).

It is already clear that the first round of NDCs presented under the Paris Agreement will be insufficient to reach its target to limit temperature rise to well below 2°C above pre-industrial levels (UNEP, 2018), with particular risks for not pursuing efforts to limit the warming to 1.5°C (IPCC, 2018). This means that there is a need for further enhancement of NDCs over time, both in ambition and scope, which could involve Nexus initiatives.

3.2. Nexus integration in NDCs

3.2.1. Research method and analytical framework

This section assesses the scope of integration of Nexus issues in the NDCs of four jurisdictions, namely, India, China, the EU and Mexico. These jurisdictions are selected on the basis of their significant level of emissions but also of their representative character of different geographical regions, levels of development, and political processes (with different levels of (de)centralization). The inclusion of Nexus issues in the NDCs is used as a proxy for the potential of NDC processes as a strategy for mainstreaming Nexus issues in policy-making.



An analytical framework was built to admit three degrees of dependent variables, namely: **sufficient (integrated)**, in which the Nexus interdependencies are satisfactorily mainstreamed into NDCs as reflected in the fact that two or three sectors involved in the Nexus are treated without separations across sectors and scales; **hybrid (integrated and sectoral)**, in which there is some level of integration of the Nexus interdependencies in the NDCs, but at the same time, the individual sectors maintain a separate role in the implementation of the NDCs; **minimal or absent (sectoral)**, in which even if the Nexus interdependencies are part of the NDCs, the sectoral separation persists, hence there is a low or non-existent level of integration.

Document analysis was conducted to identify the extent to which there is Nexus integration within the NDCs of these jurisdictions. The NDC review commenced with a demonstration of the main features of the selected jurisdictions' NDCs. Next, the NDC contents were subject to a systematic analysis of the potential water-energy-food synergies or trade-offs recognized in the NDCs. For this purpose, keyword search was used to select passages in the NDCs' provisions that deal with the water, energy and food sectors separately or jointly. Then, the selected passages were isolated for a detailed content analysis of whether the keywords reflect a recognition of the relationship amongst sectors according to the Nexus approach. The detailed content analysis included cases in which sectoral connections were not realized, and thus opportunities to deal with Nexus issues at the NDC level were missed.

Further documents were consulted to complement the NDC analysis, consisting of policy and law at the national level for each sector (water, energy, and food) or related to climate and environment, as part of the countries' climate action plans. Most of the key documents have been explicitly indicated in the NDCs. Others were found by accessing official government websites or by a complementary literature review. Such documents were reviewed in the same systematic way as the NDCs.

A similar approach was used to collect data about the sectoral composition of climate change institutions of the selected jurisdictions. This review began with a search for information on the institutions' composition, i.e. whether there is a reference to multi-sectoral participation, and if the sectors share attributions. This search was based on the information displayed in official government websites and national policy and law, whenever possible, in addition to a literature review, particularly useful in the case of China, where the official documents are in Chinese. The document analysis of institutional aspects was followed by a structured literature review to pinpoint insights into the political context in practice. Although references to inter-sectoral bodies imply intentions, it is not necessarily a guarantee of deeper coordination. The structured literature review permits us to capture how such coordination occurs, with an emphasis on existing barriers and contradictions.

Table 1 presents the analytical framework of the situation in the four aforementioned jurisdictions. The information presented enables an analysis of the level of Nexus integration within NDCs, resulting in the suggested classification as integrated, hybrid or minimal/absent. The same indicators will be used later to analyse the levels of integration of the Brazilian case (see Section 5, Table 3).

3.2.2. Results

The selected jurisdictions of India, China, EU and Mexico have different capacities to mainstream the Nexus approach in their climate policies.

There are similar reasons why levels of integration in India and China are classified as **minimal or absent (sectoral)**. Their NDCs miss some relevant opportunities in connecting sectors. India's plans to expand its vast hydropower potential (more than 100 GW) overlook how the water sector and water scarcity risks would be affected (Saleth, 2011). India's NDC also disregards how the expansion of biomass and the increase of biofuel production affects land uses, that is, displacement of food production and deforestation. Likewise, China's renewable energy transition to solar and wind technologies will maintain hydropower sources, particularly to supply Southeast China (Wang, Wang, Wei, & Li, 2018), a region susceptible to drought episodes in the past (Wang, Liang, Zhang, Wang, & Wei, 2014). However, China's NDC seems to have made advances in policy integration by mentioning that hydroelectricity development will take into account the environment. In this context, the 'Three Red Line' policy establishing quotas for river basins to allocate water uses includes power generation (Qin, Curmi, Kopec, Allwood, & Richards, 2015).

China and India's institutional collaborations through *ad hoc* projects also contribute to their lowest levels of integration as **minimal or absent (sectoral)**. In China, integration barriers consist of centralization and top-

**Table 1.** Assessment of the Nexus levels of integration in NDCs: selected jurisdictions.

	India	China	EU	Mexico
NDCs' main features	<ul style="list-style-type: none"> Reductions of emissions intensity of its GDP by 33–35% by 2030 (2005 level) Increase non-fossil fuel energy sources to 40% of the installed capacity by 2030, mainly through wind and solar Cleaning technologies for biomass and thermal power Creation of carbon sink of 2.5–3 GtCO₂e by afforestation 	<ul style="list-style-type: none"> Lowering CO₂ emissions per unit of GDP by 60–65%, by 2030 (2005 level) Increase non-fossil fuels in the energy mix to approximately 20%, through: coal control and clean use, development of natural gas and hydropower, wind and solar acceleration Forest stock expansion by approximately 4.5 billion m³ over 2005 level 	<ul style="list-style-type: none"> Domestic reduction of at least 40% of GHG emissions by 2030 (1990 level), to be fulfilled jointly by the 28 EU countries This overall aim covers the sectors of energy, agriculture, industrial processes and product use, waste, land use, land use change and forestry 	<ul style="list-style-type: none"> Emissions reduction between 22% (unconditional) and 36% (conditional on other countries' targets) by 2030, based on Business as Usual (BAU) scenarios, (2013 level)
WEF synergies or trade-offs recognized in the NDCs	<ul style="list-style-type: none"> Treated effluent for irrigation, and rainwater harvesting for supplying large buildings and recharging of groundwater Development of climate-resilient and less water-consuming crops 	<ul style="list-style-type: none"> Carbon sinks increased by the cut of deforestation-related emissions Hydropower development should be made under the premise of ecological and environmental protection Optimal allocation of water resources including recycled water, desalinated sea water and rain and flood water Introduction of water-saving agricultural irrigation and of crops resistant to heat and drought 	<ul style="list-style-type: none"> The NDC refers to legislation conceived to harmonize with climate change action. These includes some nexus issues, i.e. the land use change connected to the agricultural sector and forestry, as EU provides financing for REDD+ initiatives in Asia, Africa and Latin America; and the sustainability criteria for biofuels and land use changes, by encouraging second generation biofuels and certification schemes under the Renewable Energy Directive. The interdependencies amongst the water and food sectors are expressly recognized, i.e. sustainable agriculture restricting the use of water pollutant fertilizers and reducing water consumption. 	<ul style="list-style-type: none"> Mitigation strategies refer to indirect land use and forestry, water technologies for irrigation, water management for different uses, and the link of food security, water management and land conservation. Ecosystem-based adaptation strategies mention the targets of zero percent deforestation and of integrated water management for its different uses (agriculture, ecological, urban, industrial and domestic)
Sectoral composition of climate change institutions	<ul style="list-style-type: none"> The Ministry of Environment, Forests, and Climate Change ('MoEFCC') is in charge of environmental policies The NDC's targets are embedded in eight 'National Missions' of its 2008 National Action Plan on Climate Change – NAPCC (including, water, solar, energy efficiency, sustainable agriculture and climate change). Separate Ministries oversee the Mission Plans to their areas. States and territories have implemented State Action Plans on Climate Change – SAPCC to integrate climate change in their plans, incorporating local needs and priorities. 	<ul style="list-style-type: none"> The Development and Reform Commission (NDRC) is responsible for the climate change governance and it leads the process of the NDC development and implementation (Tsang & Kolk, 2010). It is the policy-making body in the central government that establishes the Five-Year Plans. The Department of Climate Change is the institution directly involved in climate change governance for the NDRC (Barbi, Ferreira, & Sujian, 2016) Local governments (states and municipalities) are responsible for developing and implementing policies 	<ul style="list-style-type: none"> Climate change legislation rests on a 'multi-level governance' approach involving the EU and Member States, where climate change laws and policies emerge in a fragmented way, from local, national, regional, and global, as well as private and public legal regimes (Bogojević, 2016; Van Zeben, 2014). The European Climate Change Programme was launched in June 2000 to develop coordinated policies. Decision-making institutions responsible for EU climate change include: the Council of the EU (ministers of the Member States that adopt laws, and coordinate policies); the European 	<ul style="list-style-type: none"> The Secretariat of Environment and Natural Resources (SEMARNAT), with the status of Ministry, is in charge of the environmental public policies related to climate change and sustainable energy sources, assisted by the federal agency National Institute of Ecology and Climate Change (INECC) Resources SEMARNAT delegates to the Planning Department the functions of coordinating the contributions of various sectors and of tracking sector's progresses (OECD, 2013) The Inter-Ministerial Commission on Climate Change (CICC, a commission of 13 federal government ministries including, of Agriculture, Rural Development,

(Continued)

Table 1. Continued.

	India	China	EU	Mexico
Levels of integration	<ul style="list-style-type: none"> India's NDC overlooks some relevant issues, particularly involving the energy production impacts on water and land use, and the coordination between different ministries, scales and sectors does not seem sufficient at present to address Nexus interdependencies. Therefore, the degree of integration of the Indian NDC is minimal or absent (sectoral). Multisector coordination is represented in the National Leading Group to Address Climate Change, under the State Council, the main organ for the deliberation and coordination of climate change policy and strategy in China, comprising representatives from 21 institutions such as State Council, Ministry of Foreign Affairs, NDRC, Ministry of Land and Resource, Ministry of Environment Protection, Ministry of Water Resources, Ministry of Agriculture, State Forest Administration, and National Energy Bureau. 	<p>and programmes to meet their assigned targets</p> <ul style="list-style-type: none"> Multisector coordination is represented in the National Leading Group to Address Climate Change, under the State Council, the main organ for the deliberation and coordination of climate change policy and strategy in China, comprising representatives from 21 institutions such as State Council, Ministry of Foreign Affairs, NDRC, Ministry of Land and Resource, Ministry of Environment Protection, Ministry of Water Resources, Ministry of Agriculture, State Forest Administration, and National Energy Bureau. 	<p>Parliament (elected by citizens of the Member States); the European Commission (executive body, responsible for proposing and implementing EU law); and the European Council (heads of Member States and leaders that set the broad direction of EU policy, without legislative powers).</p> <ul style="list-style-type: none"> The European Commission is divided in several Directorate-Generals, of which the Directorate-General for Climate Action ('DG Clima') leads the process of formulating climate policies at the EU level, with the participation of: European Parliament – Environment; Public Health and Food Safety Committee; Council of the EU – Environmental Department; European Economic and Social Committee – Agriculture, Rural Development and Environment Section; Committee of Regions – Commission for Environment, Climate Change and Energy; and the European Environmental Agency 	<p>Fisheries and Food, of Energy, and of Environment and Natural Resources) and the expert multi-stakeholder Climate Change Council (C3, composed by private sector, academia and civil society) participate in the elaboration of the National Strategy for Climate Change</p> <ul style="list-style-type: none"> The National System on Climate Change (SINACC) congregates institutions operating at different scales, including State, municipal and Congress representatives, encouraged to create cross-sectoral commissions (OECD, 2013).

down governance, in which fewer interests influence the making of climate change policies (Averchenkova et al., 2016). In India, sectoral missions, for example on solar and energy efficiency, have been implemented, but mainstreaming cross-cutting issues stands as a challenge due to financial constraints, lack of inter-ministerial coordination and technical expertise (Rattani, 2018).

Mexico's classification as **hybrid (integrated and sectoral)** is justified by its disconnected sectors, in practice, in spite of legal provisions for multisectoral policies and institutions on climate change (Von Lüpke & Well, 2019). The Mexican NDC elaborates on Nexus issues such as indirect land use and forestry, water management for different uses, and the links between food security, water management and land conservation. Also, Mexico's decentralized climate change framework favours sectoral coordination, including by establishing inter-ministerial commissions and working groups throughout the climate change institutions. Nevertheless, synergies could be further progressed in Mexico, particularly towards a convergence of interests and priorities amongst sectors throughout consultative processes, the empowerment of central institutions, overcoming staff and resources constraints, and control of the strong fossil fuel lobby in setting long-term direction of climate policy (Averchenkova & Guzman Luna, 2018; Von Lüpke & Well, 2019).

Conversely, the EU's classification as **sufficient (integrated)** corresponds to its NDC's recognition of potential trade-offs between agriculture, energy sources and land use, with opportunities for coordination at the regional level. In the EU's NDC, the reference to European Legislation on climate change and energy implies the adoption of sustainability criteria for biofuels and land use changes, through second-generation biofuels and certification schemes, according to the Renewable Energy Directive. Improvements in forest governance likewise depend on the adoption of environmental standards in the agricultural sector. On the other hand, although the EU does not have a comprehensive policy to apply the Nexus approach, several pieces of legislation under its NDC make connections across the water, energy and food sectors, allowing for a considerable degree of coordination within the institutions involved in climate change policy implementation.

At the regional level, the Directorate-General for Climate Action takes the lead for the drafting of climate policy, which seems to be effective in coordination of different areas and consultations with stakeholders, as an organ that is integrative and cross-sectoral by nature (Delreux & Happaerts, 2016). Different to top-down approaches, the EU's 'multi-level governance' approach on climate-change implementation, involving the EU and Member States, means that several interests influence the creation and implementation of climate policy, which can either promote or inhibit coherence and communication (Kingston, Heyvaert, & Čavoški, 2017).

In summary, all the selected jurisdictions' first NDCs (and related climate policy) have recognized at least one Nexus issue, with some jurisdictions such as the EU and Mexico with higher levels of recognized issues. The most recognizable Nexus issue in all the four cases is water use for agricultural purposes. It is a promising starting point, considering that countries must necessarily increase ambition in future NDCs, which may include the furthering of the sectors' integration using the Nexus approach.

Regarding institutional aspects, all the selected jurisdictions seem to delegate the formulation and implementation of climate change policies to institutions dealing with the environment, composed of representatives of the three sectors of water, food and energy. Absolutely essential to the classification of levels of integration is not just the existence of legal provisions on collaboration, but actual collaboration. Background features of the domestic government structures are highly influential in the lack of incentives for work across institutional boundaries, as shown by the example of Mexico.

4. The dynamics of the Nexus in Brazil: institutional fragmentation and integration attempts

4.1. The regulatory landscape

Brazil is a particularly apposite example of a country with significant regional variation, whose vast territory is governed by a multitude of natural resource institutions. Brazil also has a strong reliance on the exploitation of its natural resources for economic and social development.

The water, energy and food sectors in Brazil each have their own distinct institutions and governing laws, with a clearly sectoral focus. In the water sector, legislation deals with the allocation of rights, management and conservation of water resources (Law 9,433/1997). For the power sector, the relevant legislation concerns

the systems of generation, transmission, distribution and commercialization (e.g. Laws 9,074/1995, 9,427/1996, 9,648/1998, 10,848/2004, and 12,783/2013). As for the agricultural sector, the main themes of the legislation are food production, credits for farmers, transfer of technology, and sanitation (Law 8,171/1991).

The law-making and administrative functions in Brazil involve at least one of the three governance spheres, namely federal, state and/or local. The federal government and states attribute functions to regulatory bodies such as agencies to deal with specific matters. Brazil is also an active participant in international governance arrangements. In addition, depending on the sector, different configurations of public and private stakeholders are at play. This makes for a highly complex governance picture in which interdependencies are particularly important in practice, but insufficiently reflected in legal and institutional terms.

In accordance with the 1988 Brazilian Federal Constitution (CF), the legislative competence for energy is federal (art. 22, IV), whereas for water resources there is decentralization between the federal government and the federated states (arts. 20, III, 22, IV and XIX, and 26, I), with participation of municipalities. For the agricultural sector, the federal government is in charge of the law-making powers (art. 22, I, CF) but there are arrangements delegating services from the Ministry of Agriculture to federated states and municipalities (art. 23, VIII, CF). Regarding competence for environmental regulation, since the country comprises a large number of biodiversity-rich ecosystems, the CF establishes that all levels of government must share the duty to protect the environment (arts. 23, VI, and 24, VI and VIII, CF), including the exercise of law-making powers to secure an ecologically-balanced environment throughout Brazil's territory without disregarding the singularities of its parts. This means that all three governance levels – federal, state and municipal – may legislate upon environmental protection but the rules at the federal level are general and binding to states and municipalities, which may enact supplementary rules according to their particularities and local interests. However, the federal level concentrates broad powers to pass legislation applicable nationwide, holding 70% of the national tax revenue to provide resources to the lower levels through specific programmes; the federated states and municipalities share the remaining 30% (arts. 145–162, CF).

The environmental institutional structure acts as a platform to establish connections with the processes of climate change policymaking, comprising the regulatory and institutional functions through arrangements at the local, state and federal levels, but also consultation across sectors about plans and policies. Since the 2000s, Brazil has adopted climate change legislation and policies, including the 2009 National Policy on Climate Change (NPCC), which established the country's voluntary emissions reduction target and incorporated laws and policies relating to climate change. As part of the NPCC, the 2016 National Adaptation Plan (NAP) refers to adaptation strategies and guidelines for 11 sectors, to be implemented within the timeframe of four-year cycles, including explicitly intersectoral goals such as the need to take into account interactions with other sectors in energy and water policies.

Until 2019, the institutional instruments of the Brazilian NPCC, composed of representatives of several sectors, also reflected some degree of interaction, and sub-national governments had an important role in establishing and implementing climate policies. The administration of President Jair Bolsonaro, however, made significant changes in climate change governance at the federal level. Despite campaign promises to merge the Ministries of the Environment and Agriculture, and withdraw from the Paris Agreement, Brazil has not done so, but the Ministry of the Environment has lost a Secretary and Departments with climate change functions have been removed or replaced by the Ministry of Agriculture (Decrees 9,672 and 9,667, both from 2019).

Under the NPCC, eight sectoral plans have been developed, and are in different phases of implementation, including the Action Plan to Prevent and Control Deforestation in the Amazon (PPCDAm), the Action Plan to Prevent and Control Deforestation and Fire in the Cerrado (PPCerrado), the Low-Carbon Agriculture Plan (ABC Plan), and the Ten-Year National Energy Expansion Plan (PDE). The implementation of these plans has occurred mainly through a sector-by-sector process led by respective government entities. It is unclear whether these plans will remain active under the recent changes in climate change governance, but they will most likely be affected by the budget reductions of May 2019, when the government blocked 96% of the funds destined for climate change policy implementation (Decrees 9,741/2019).

Table 2 summarizes the complex landscape of Brazilian institutions involved in climate change decision-making. The state of São Paulo is used as an example of state and municipal regulation, but many of the 26 States and one Federal District also have their own regulatory climate change institutions.

Table 2. Brazilian climate change framework.

International regulation	Federal institutions
United Nations Framework Convention on Climate Change Kyoto Protocol Paris Agreement – NDC Federal Regulation National Policy on Climate Change (Law 12,187/2009, regulated by the Decree 7,390/2010)	Until January 2019 <ul style="list-style-type: none"> Ministry of the Environment and its Secretary of Climate Change and Forests Inter-ministerial Committee on Climate Change (CIM), composed of representatives from 16 Ministries (Head of the Presidential Staff – coordinator; Environment; Science & Technology; Foreign Affairs; Mines & Energy; Cities; Agriculture, Livestock & Supply; Development, Industry & Foreign Trade; Transport; Health; Planning, Budget & Management; Finances; Education; National Integration; Agrarian Development; Defence), and the Secretariat of Strategic Affairs of the Presidency of the Republic (Decree 6,263/2007) Brazilian Forum on Climate Change (FBMC), chaired by the Brazilian President and composed of Ministers, Directors of Regulatory Agencies, States' secretaries of the environment and representatives of the business sector, civil society, academy and non-governmental organizations (Decree 9,082/2017) CIM/Executive Group on Climate Change (GEX), composed by representatives of 7 Ministries (Environment – coordinator; Head of the Presidential Staff; Science & Technology; Foreign Affairs; Mines & Energy; Agriculture, Livestock & Supply; Development, Industry & Foreign Trade; Agrarian Development), and the FBMC (Decree 6,263/2007)
	After January 2019 <ul style="list-style-type: none"> The Secretary of Climate Change and Forest was replaced by the Secretary of Forest and Sustainable Development, as part of the Ministry of Agriculture, Livestock and Supply. Former Departments of Climate Change Policy and of Monitoring, Support and Promotion of Climate Change Action were removed. It is not clear yet how the recent administration changes will affect the multi-sectoral organs responsible for the development and application of the climate change policy
State Regulation (State of São Paulo) State Policy of Climate Change (State Law 13,789/2009, regulated by the State Decree 55,947/2010)	State Institution (State of São Paulo) <ul style="list-style-type: none"> State Secretary of the Environment Management Committee of the State Policy on Climate Change, composed of representatives from 12 State Secretaries (Head of the State Staff; Environment; Metropolitan transports; Transports; Public Management; Finances; Economy & Planning; Development; Agriculture & Supply; Sanitation & Energy; Housing; Health) State Board of Climate Change (headed by the Governor of the state of São Paulo, and composed by 42 members of the state government, mayors, and civil society)
Municipal Regulation (City of São Paulo) Municipal Policy of Climate Change (Municipal Law 14,933/2009)	Municipal Institutions (City of São Paulo) <ul style="list-style-type: none"> Municipal Secretary of the Environment Municipal Committee on Climate Change and Eco-economy (composed by representatives of the municipal and state government of São Paulo, and civil society), according to the municipal Decree 50,866/2009

4.2. Power asymmetries in the policy-making process

The Nexus specificity of sectoral, scale and stakeholder integration entails that the three sectors of food, energy and water are balanced from a policy standpoint, which is further complicated when, as is common, certain stakeholders hold privileged and powerful positions in the decision-making processes (Pahl-Wostl, 2019). The experience of Brazil provides one example of power imbalance amongst the sectors, demonstrating how certain forces behind the Brazilian policy-making process may hinder the integration of the insights derived from the Nexus approach.

The example concerns the dominant position of the agricultural sector as regards, among other things, environmental legislation in Brazil. This was particularly evident during the political debates that culminated with the enactment of the 2012 Forest Code (Law 12,651), which establishes rules for the protection of native vegetation in private rural lands, including in the Amazon and in the Cerrado, the two main forested

areas of Brazil. Environmental movements opposed the proposal of the agricultural sector to adopt an amnesty for all illegal deforestation that had occurred before 2008 (Soares-Filho et al., 2014). They also opposed disparities in requirements for the definition of 'legal reserves', which impose a legal obligation for private properties to reserve a percentage of their total area for native vegetation. The strong lobbying power of the agricultural sector prevailed leading to the inclusion of both measures in the Forest Code.

Since January 2019, new administrative reforms are intended to strengthen the powers of the agricultural sector in Brazil. Traditional functions of the Ministry of the Environment have been transferred to the agricultural sector, such as the management of forests of the Brazilian Forestry Service, and the demarcation of indigenous reserves (Decree 9,667/2019). These reforms are part of the current administration's plans for the so-called 'development' of the Amazon region, opening it up for activities such as logging, farming, and mining. Alongside the implementation of the Forest Code (Azevedo et al., 2017), these plans seem to be accelerating deforestation in the Amazon, which reached record highs in the first months of the Bolsonaro government (INPE, 2019).

The loosening of the rules against deforestation reveals the vast scale of the Nexus in Brazil, which reaches global proportions. On the one hand, deforestation in Brazil has a global impact on the issue of climate change, given the importance of both the Amazon and the Cerrado to global climate (Nepstad, Stickler, Soares-Filho, & Merry, 2008). What happens in Brazil on these issues affects the global climate system, and could ultimately trigger 'tipping points' (Rocha, Peterson, Bodin, & Levin, 2018). On the other hand, deforestation in Brazil is largely a result of a complex phenomenon driven by international trade and, more specifically, by the great demand from China for soybeans to supply its pork and poultry industries (Mercure et al., 2019). Indeed, soy plantation requires new land and its development tends to displace pasture and cattle activities, which in turn resort to deforestation as a means to find new land (Nepstad et al., 2008).

5. Discussion: mainstreaming the Nexus in the Brazilian NDC process

As noted above, the Nexus specificity of intersectoral, cross-scale and inter-stakeholder integration can be aligned with the NDC processes. The institutional arrangements relating to climate change and NDC development present, however, different degrees of receptivity for the alignment to occur. As noted earlier, this ranges from sufficient levels of interactions, both in terms of the institutional and policy framework, to hybrid situations in which the climate change framework allows the interactions to coexist with the sectoral activities and to situations in which the levels of interactions are minimal or non-existent.

This section focuses on Brazil's NDC in order to assess its potential for the mainstreaming of Nexus issues through this process. Using the same indicators as Table 1, Table 3 below contains the relevant information for the examination of the Nexus levels of integration into NDCs in the Brazilian case.

Some issues touched upon in Brazil's NDC such as land use effects on the conservation of forests and the energy expansion of non-hydro sources are all complex Nexus problems that can only be solved through an intersectoral, cross-scale and inter-stakeholder approach. In this respect, Brazil's NDC has similarities with the NDCs from Mexico and the EU, in which some encompassing and sophisticated Nexus issues were also recognized. Although the express recognition of Nexus issues would suggest that Brazil's NDC has a sufficient level of integration, it is more accurately characterized as a hybrid scheme. Indeed, despite the fact that the Brazilian framework includes eight sectoral plans in different phases of implementation that could be part of a more integrated governance approach, they are conducted by their respective sectoral structures with specific and separated institutions and pieces of legislation, and ultimately individual interests prevail in their policy-making processes. This resembles the Indian climate policy that involves eight 'National Missions', implemented by each sectoral Ministry, each of which ultimately tends to prioritize sectoral goals over diverging interests.

Moreover, a parallel can be drawn between the Brazilian and Mexican climate change institutional framework. As described above, legal provisions of multisectoral institutions do not necessarily translate into actual coordination, as seen in the Mexican case in which weakness in interactions and staff and resource constraints reinforce the regulatory fragmentation. In the Brazilian case, the climate change institutions are composed of members of several sectors, but the dominance of the agricultural sector not only prevailed in the formulation of policies with environmental intent (i.e. the Forest Code) but is also putting at risk the existence of multi-

Table 3. Nexus levels of integration into NDCs: The Brazilian case.

	Brazil
NDCs' main features	<ul style="list-style-type: none"> Reduction of emissions of 1.3 GtCO₂e per year (2025 target) and 1.2 GtCO₂e (2030 target), equivalent to 37% and 43%, respectively, below the 2005 level Increase the share of sustainable biofuels in the energy mix to approximately 18% Enforce the Forest Code implementation, including measures to achieve zero illegal deforestation in the Amazon Achieve 45% of renewables in the energy mix, by increasing non-hydro renewable energy between 28% and 33%, and expanding non-fossil fuel energy sources to increase the share of non-hydro renewable in the power supply to at least 23%, by raising the share of wind, biomass and solar Restoration of degraded pasturelands and enhancement of integrated cropland-livestock-forestry systems
W-E-F synergies or trade-offs recognized in the NDCs	<ul style="list-style-type: none"> The 'sustainable biofuels' target can be linked with the National Biofuels Policy enacted in 2017 (Law 13,576), known as RenovaBio, which provides mechanisms for the production of low-carbon fuels such as certification schemes (Mercure et al., 2019). Such policy has not contemplated yet some crucial nexus issues, including measures against direct and indirect land use impacts as the displacement of food by energy crops and deforestation. The development of 'non hydro' renewable energy is aligned with the 2027 Ten-Year Energy Expansion Plan (EPE, 2018), which has updated the past plans to increase hydro sources. Hydroelectricity currently provides approximately 65% of Brazil's generation capacity, making the country vulnerable to serious droughts (Paim et al., 2019). During the 2013–2016 São Paulo water crisis, the state's main reservoir was operating at its lowest capacity due to a combination of problems of water management, inefficiency of use, and consecutive years of reduced precipitation, drastically affecting the supply of water and energy for the main economic centre of the country (Millington, 2018). The 'sustainable agriculture' measures follow the 2010 Low-Carbon (ABC) Plan to help reduce emissions in the agricultural sector by giving financial incentives and technical assistance to farmers who adopt sustainable practices, including those related to the use of water (Mercure et al., 2019).
Sectoral composition of climate change institutions	<ul style="list-style-type: none"> As discussed in Table 2 above, until January 2019, the Brazilian institutions responsible for the implementation of climate change policy were composed by members of various sectors. However, recent changes in the government have given a certain privilege to the agricultural sector in the definition of the environmental and climate change priorities. In any case, the implementation of the climate change eight main plans has always been confined to the specific sectors stewardship.
Levels of integration	<ul style="list-style-type: none"> The degree of integration of the Nexus in the Brazilian NDC is hybrid. As further discussed in this Section, although the Brazilian NDC and national plans recognize Nexus issues, the responses are not yet fully developed and asymmetries of powers amongst institutions compromise a meaningful integration.

sectoral institutions. Besides, the recent decreasing budget for the climate change and environmental sectors in Brazil could negatively impact cross-sectoral collaboration, as occurred in Mexico, where budget constraints have reduced opportunities for knowledge exchange and communication processes for the formulation of common policy outputs (Von Lüpke & Well, 2019).

Additionally, it is unclear whether measures relating to land-use, agriculture, livestock and deforestation in Brazil's NDC take into account the international trade dimension underpinning the problems in these areas. As mentioned before, one of the factors that contribute to deforestation in the Amazon and Cerrado is the export of soybeans to the growing Chinese meat market (Brown-Lima, Cooney, & Cleary, 2010). Therefore, the effective integration of such Nexus issues in Brazilian climate change policy will not depend purely on domestic measures taken within the territory. Effective measures at the international scale can be related to the supply-chain governance, for instance the soy moratorium, an initiative from the private sector to refrain from buying soy originating from areas in the Amazon deforested after 2008 (Gibbs et al., 2015). After eleven years in operation, the soy moratorium contributed to a reduction of deforestation caused directly by soy

expansion in the Amazon, with the land converted into soy plantation in the Amazon accounting for less than 5% of deforestation after 2008 (ABIOVE, 2019). However, as the soy moratorium is geographically limited to the Amazon, other areas such as the Cerrado are currently under the risk of conversion of native vegetation to soybeans (Soterroni et al., 2019).

Significantly, the incipient trade war between the United States and China – a typical example of global economic change – is likely to have a direct impact on Brazilian exports of soybeans. As imports of soybeans from the United States become more expensive in China (due to the new tariffs imposed by China), Brazilian exports may be much more in demand, which in turn may re-trigger the indirect land-use change cycle, despite the inward-looking policies adopted with support from the agricultural sector (e.g. the Forest Code). Such exports would provide an important test for the policy relevance of the Nexus approach. If, indeed, demand from China is a driver of the new wave of deforestation, this may highlight that a merely sectoral policy (e.g. Forest Code) is insufficient to tackle the problem.

On the other hand, the concerns raised by the trade deal signed in June 2019 between the EU and Mercosur – Brazil, Argentina, Paraguay and Uruguay – have a slightly different focus. Such a deal could potentially encourage deforestation due to increased production of agricultural and livestock commodities, based on evidence that an increasing share of deforestation is attributed to international demand of forest and agricultural products (Pendrill, Persson, Godar, & Kastner, 2019). The European Commission has already released communications about its commitment to implement the Paris Agreement and support environmental standards (EC, 2019).

Overcoming the obstacles of sectoral focus and limited cross-scale integration is therefore not only a matter of policy design. Beneath the sectoral regulation of the Nexus components, there is a political economy configuration making reorientations particularly challenging. The political entrenchment of the agricultural – including soy – sector, reflected in the sectoral organization of the laws and institutions governing this aspect of the Nexus, would likely resist efforts at further integration with other sectors (with a possible loss of power) or the highlighting of links to international trade.

Depending on the level of integration of cross-scale and sectoral institutional composition, climate change institutions with an overarching mandate could help overcome this challenge. If Brazil's Inter-Ministerial Committee on Climate Change (CIM) maintains its functions under the recent political reforms, it will potentially be able to counteract the contentious power dominance of the agricultural sector for the purposes of reaching Brazil's NDC pledges to achieve zero illegal deforestation by 2030 and to reforest 120,000 km². However, in view of the above discussion, it now seems unlikely that the CIM could impose restrictions on the agricultural sector, which has obtained the status of a super-Ministry with climate change and environmental functions.

This, nevertheless, still leaves room for action at the international scale, which could involve companies and governments boycotting products originating from deforested areas. Future versions of NDCs could give policy traction for such measures. In this respect, the general provision in China's NDC to promote 'policy coordination and concrete cooperation in related areas' amongst developing countries, also reflected in Brazil's NDC in a section on South-South initiatives, could be further developed to contemplate policy coordination at the international level that would address the impacts of China's demand for soy on Brazil's deforestation.

6. Conclusion

The multiple institutions and pieces of legislation involved in the water, energy and food sectors can be an obstacle for the mainstreaming of Nexus issues. Due to their integrative format, NDC processes under the Paris Agreement may offer a useful platform to incorporate Nexus insights, both at the national and international levels.

The case-studies examined in this article highlight that NDC processes present different degrees of receptivity to the Nexus approach, but all of them (i.e. India, China, EU, Mexico and Brazil) mention at least one of the Nexus issues. Future NDCs, to be updated every five years, offer opportunities to refine the Nexus approach in climate policies, and hence, increase the countries' ambitions over time to reach the Paris Agreement targets. The case-studies also demonstrate that environmental institutions in charge of the definition and implementation of climate change policies are normally composed of representatives of the sectors of water, food and

energy. However, the existence of programmes to be implemented by one sector, along with budget and resource constraints, are barriers to actual coordination.

The experience of Brazil in the agricultural, land use change and forestry sectors suggests that the climate change framework, and particularly the NDC process, could indeed offer a useful platform for mainstreaming Nexus interdependencies. However, one of the main barriers is the powerful agricultural sector, ultimately dictating the implementation of environmental law. In the current context, this appears to pose insurmountable obstacles to meaningful internal action towards environmental legislation, leaving international action as the most promising remaining option. It is expected that NDCs can promote traction for international cooperation, as a legitimate way to surpass the internal barriers created by the dominance of agricultural interests. These can certainly open opportunities for linking Chinese demand for soy and massive land use change and deforestation in Brazil.

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