The Nexus+ Approach applied to studies of impacts, vulnerability and adaptation to climate change in Brazil

A Abordagem Nexus+ aplicada a estudos de impactos, vulnerabilidade e adaptação à mudança do clima

Sonia Maria Viggiani Coutinho[a]

Diogo V. Santos[d]

Marcel Bursztyn[c]

José Antônio Marengo[d]

Saulo Rodrigues-Filho[e]

André F. P. Lucena[f]

Daniel Andres Rodriguez [g]

Stoécio Malta Ferreira Maia[h]

[a] Institute of Advanced Studies, University of São Paulo, São Paulo, SP, Brazil
E-mail: scoutinho@usp.br

[e] Ministry of Science, Technology and Innovations, MCTI, Brasília, DF, Brazil
E-mail: diogo.santos@mctic.gov.br

[c] Center for Sustainable Development, University of Brasilia, DF, Brazil
E-mail: marcel.cds@gmail.com

[d] Center for Monitoring and Early Warning of Natural Disasters - Cemaden, São José dos Campos, SP, Brazil
E-mail: jose.marengo@cemaden.gov.br

[e] Center for Sustainable Development, University of Brasilia, DF, Brazil
E-mail: saulofilhocds@gmail.com

[f] Federal University of Rio de Janeiro, Rio de Janeiro, RJ, Brazil
E-mail: andrelucena@ppe.ufrj.br

[g] Federal University of Rio de Janeiro, Rio de Janeiro, RJ, Brazil
E-mail: daniel.andres@coc.ufrj.br

[h] Federal Institute of Alagoas, Maceió, AL, Brazil
E-mail: stoecio.maia@ifal.edu.br

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ABSTRACT
This article aims at presenting the methodological framework applied to the Impacts, Vulnerability and Adaptation (IVA) component of the Fourth National Communication of Brazil (4CN in the Portuguese acronym) to the United Nations Framework Convention on Climate Change - UNFCCC. The methodology adopted in this article considers the application of the *Nexus+* integrated approach, based on impacts and vulnerabilities studies for water, energy, food, and socio-environmental securities. As an attempt to encompass major territories of Brazilian biomes, coastal zones and cities, multidimensional observed and projected impacts and their risk factors for each security were analyzed. In addition, from an inventory of adaptation options in light of the *Nexus+* approach, their synergies and trade-offs were assessed.

Keywords: Nexus+ approach. Climate Change. Impacts. Vulnerability and Adaptation. Brazil.

RESUMO
Este artigo tem por objetivo apresentar o escopo metodológico para a elaboração da componente de Impactos, Vulnerabilidade e Adaptação (IVA) à mudança do clima, integrante da Quarta Comunicação Nacional (4CN) do Brasil à Convenção do Clima. A opção metodológica adotada contempla a aplicação da abordagem integrada Nexus+ com base em estudos de impactos e vulnerabilidades para as seguranças hídricas, energética, alimentar e socioambiental, nos territórios dos biomas brasileiros, zonas costeiras e cidades. Para cada uma das seguranças, houve identificação dos impactos observados; análise dos fatores condicionantes de risco; definição e avaliação dos impactos-chave; análise integrada dos impactos em uma base territorial; levantamento, seleção e análise de opções de adaptação à luz da abordagem Nexus+, com identificação de sinergias e trade-offs. O processo adotado possibilitou um olhar integrado entre os fatores condicionantes de risco, os impactos e as interfaces entre as opções de adaptação propostas.

Palavras-chave: Abordagem Nexus+. Mudanças Climáticas. Vulnerabilidade e Adaptação. Brasil.

1 INTRODUCTION

Based on global emergencies at different scales, the perception of human vulnerability regarding natural human-induced climate change has assumed the status of an urgent issue. This perception is a result of the growing scientific knowledge on the potential harmful effects of climate change to society, considering different time and spatial scales. As an expression of human vulnerability, research applied to climate change has shown a high interdependence with economic and socioecological systems. It also reveals population vulnerability to climate-related disasters, whether for excess or absence of rain, under a new global pattern of rising temperatures.

In this context, the study of climate change and the actions to tackle it have intensified since late the 20th century, with the accumulation of evidence that natural climate variability experiences significant human driven interference. These implications are such that the environmental agenda has been progressively overlapped by the climate agenda (RODRIGUES-FILHO *et al.,* 2016).

The urgency of the issue becomes even more evident when the effects of the profound structural inequality affect the population's ability to cope with impacts. Among them, there is a lack of adequate housing, sanitation conditions and its health effects, for example. Issues related to food, water, and energy security, in addition to the socio-environmental dimension, have great interconnection and their understanding is essential for planning public policies for more resilient societies.

Therefore, a complex arrangement of public policies is needed to mitigate the causes and adapt to climate change effects, in order to meet the growing demand for water, energy and food. Notwithstanding, both the accelerated environmental degradation and urban sprawl pose further pressure to solve this wicked problem, avoiding the collapse of the ecosystem services on which we depend.

Brazil, as a signatory to the United Nations Framework Convention on Climate Change, has undertaken efforts to implement actions as agreed under the Convention, among which a comprehensive reporting initiative called National Communications, the first of which was submitted in 2004. In the scope of preparing the Fourth National Communication, coordinated by the Ministry of Science, Technology and Innovations, studies on Impacts, Vulnerability and Adaptation (IVA) to climate change were conducted, among others.

Unlike the Third National Communication, which was prepared based on sectors, the 4NC sought greater integration based on water, energy, food, and socio-environmental securities, adopting biomes, the coastal zone and cities as territorial snapshots. Securities also represent more systemic approaches on sectoral/theme axes provided for by the National Adaptation Plan (2016) and cover most of their topics.

This article aims at presenting the methodology developed for the preparation of the 4NC regarding the IVA component. The conceptual and methodological approach aims to assess the climate change impacts and vulnerabilities, under the scope of the four securities, including the Nexus+ approach. Finally, the inter-relations among securities were considered under a crosscutting and integrated perspective, especially applied to adaptation contexts.

2 WHY IT IS CRUCIAL TO INTEGRATE POLICIES

The Federal Constitution (1988) provides that the Public Authority, in all its levels, shall preserve and defend the environment (Art. 225), establishing that the environment is to be addressed in public policies in an integrated manner, at all levels of government.

It is necessary to make a distinction between "policy integration" and "integrating policies", with regard to managing aspects related to climate change. While the former is about incorporating climate change adaptation and mitigation goals into sectoral policy-making, the latter refers to crosscutting policies since their conception.

Policy integration towards climate issues has developed from environmental movements and different perspectives (RIETIG, 2012). This may be understood as "the incorporation of climate change adaptation and mitigation goals into all stages of policy-making in other sectors (whether environmental or non-environmental), thus minimizing contradictions among climate policies and other policies (...). This makes it possible that incentives and mechanisms of different policies, climate or not, are not in conflict" (VAN BOMMEL and KUINDERSMA, 2008, p.17), or, on the other hand, these synergies are enhanced, just like in the National Policy on the Environment (1981), the National Plan on Climate Change (2008), the National Policy on Climate Change (2009, Art. 11), and the National Plan on Adaptation to Climate Change (2016-2020) (MERCURE et al., 2019).

Policy integration is discussed in the literature on Nexus e *Nexus+* approaches (HAGEMANN and KIRSCHKE, 2017; HOWELLS and ROGNER 2014; PAHL-WOSTL, 2017; SCOTT, 2017; WEITZ *et al.,*2017; RINGLER, BHADURI e LAWFORD, 2013; CASTRO e BURSZTYN, 2019; ARAUJO *et al.,* 2019).

Difficulties in integrating climate policies in Brazil involve sectors that work specifically towards achieving goals. In this regard, there are gaps in governance processes which narrow the possibilities of coordinating broader and related initiatives, and generate inconsistencies between the objectives of climate policies and sectoral policies (ADELLE and RUSSEL, 2013; MICKWITZ et al., 2009; WEITZ et al., 2017; BURSZTYN and BURSZTYN, 2017; CASTRO; SABOURIN; BURSZTYN, 2020).

Among the gaps that may undermine the crosscutting approach of policies and the necessary cooperative action among the sectors involved in environmental policy, Neves (2012) mentions the public sector's administrative tradition. Usually, each theme is organized in a fragmented way and dealt with by a specific sector, in addition to the territorial scales of environmental issues that often cross borders and occur at different time scales than electoral mandates.

Some examples of integrating policies are the Brazilian National Policy on Water Resources and the Integrated Management of Water Resources, the National System of Protected Areas, the Ecological-Economic Zoning, the National Coastal Management Plan, the National Plan for Risk Management and Response to Natural Disasters, and the Citizenship Territories Program. The territorial configuration of these instruments does not necessarily take into consideration state and municipalities borders, thus requiring collaborative governance, comprehensive legislation, and integrated plans and programs.

The Integrated Management of Water Resources defines Water Basin as the territorial unit of the National Policy on Water Resources. Although this territorial delimitation progresses towards a decentralized management, with broad participation, there is still a lack of agreement between the territorial scale of the National Policy on Water Resources and that of the Master Plans, or even the management of groundwater. It is pivotal to integrate water resources with environmental management, estuarine and coastal systems, sectoral policies, and coordination with other related resources (SOARES, THEODORO and JACOB, 2008; ROGERS and HALL, 2003).

There are several tools for regulating land use in water basins, aiming at conserving water resources together with socioeconomic development (AQUINO and MOTA, 2019), such as Environmental Zoning, including the definition of Permanent Preservation Areas, Protected Areas, and also the control of land parceling in river basins.

Regarding climate change, one way to make this integration work and to reduce risks and sensitivities (KLEIN et al.,2007) is to implement adaptation measures "as part of a broader suite of measures within existing development processes and decision cycles" (OECD, 2009, p.60). By recognizing the cyclical nature of the adaptation process, the incorporation of climate-related risks into policy instruments must be promoted in a systemic way (UNDP, 2009; IPCC, 2014).

3 THE 4NC'S METHODOLOGICAL APPROACH TO ASSESS IMPACTS AND VULNERABILITIES

3.1 THE NEXUS APPROACH IN THE CONTEXT OF CLIMATE CHANGE

The first studies on the Nexus approach date back to the 90s and addressed the relationship water-food, and also considered the idea of "virtual water" – that is, all water involved in the production process of any industrial or agricultural good, water scarcity and food trade (ALLAN, 1998 and 2003).

Developments on the topic have found their way onto the agenda of international organizations during the 2000s, expanding to a relationship among water-energy-food (ARTIOLI, ACUTO AND MCARTHUR, 2017; ENDO et al., 2017; MULLER, 2015; FAO, 2014; BELLFIELD, 2015; BIGGS et al., 2015; ALLOUCHE, MIDDLETON and GYAWALI, 2014; SHANNAK, MABREY and VITTORIO, 2018), with special attention during the Bonn Conference 2011 (*Bonn2011 Conference: The Water, Energy and Food Security Nexus – Solutions for a Green Economy*).

The concept came up as a response to climate and social changes, as a crosscutting approach to address interdependences and limits after repeated water, energy, and food-price crises in emerging countries. The main focus was on promoting safe access to basic services (HOFF, 2011; ARTIOLI, ACUTO and MCARTHUR, 2017).

Such approach is also used in reports focusing on interdisciplinary solutions aimed at tackling the challenges to water, energy and food supply for all. It manages the synergies and trade-offs among them and deals with understanding how these interactions (which cannot be addressed only by one sector's specific method), are shaped by environmental, economic, social, and political changes (WORLD ECONOMIC FORUM, 2011; FUTURE EARTH, 2014).

Adaptation actions that enhance other actions, or bring co-benefits along with other objectives, may be understood as synergic. Some actions minimize certain risks but aggravate others, thus generating trade-offs. For instance, the same water that generates energy is also used for water supply and food production (MILHORANCE; SABOURIN; BURSZTYN, 2018). Hence, besides water supply, management of water resources needs to consider energy and food production demand.

The resources considered by the Nexus approach have been experiencing significant stress and deficits, with growing demands expected in the coming years, due to the increase in population and urbanization, together with climate change impacts. This increase in demand will come with significant challenges, since the resources addressed by the Nexus approach are fundamental for the proper functioning of society (BAZILIAN et al., 2011).

Therefore, the expression "security" is incorporated into the Nexus approach along with the words water, energy and food, in the context of climate change (HOFF, 2011; PARDOE *et al.,* 2018; FROESE and SCHILLING, 2019; ENDO *et al.,* 2017; AGRAWAL and LEMOS, 2015).

Securities are not only related to the availability of resources (water, food, energy), but also to the access and fair distribution of these resources through the population, together with health, environmental protection, and socioeconomic development policies, which poses major political and institutional challenges. Such a conceptual and methodological option is an evolution, if compared to sectoral approaches (IISD, 2013; RINGLER, BHADURI and LAWFORD, 2013, P.617; SIMPSON and JEWITT, 2019).

The IPCC's Fifth Assessment Report (AR5) indicates that climate change is undermining the livelihood of millions of people worldwide. It also highlights the importance of maintaining livelihoods, early adaptation in contexts of high poverty and vulnerability, reducing disaster risk, and social protection in different contexts. Additionally, it draws on the ethical and political dimensions of engaging with local and traditional knowledge about climate change (IPCC, 2014), introducing the idea of socio-environmental security.

The socio-environmental dynamics or, as some authors prefer, the socio-ecological dynamics, show the relationship between human existence and the ecosystems through the appropriation of natural resources, or the delivery of ecosystem services of provision, support and regulation for the well-being of the population (MEA, 2005; OSTROM, 2009).

Differences in populations vulnerability and exposure arise from non-climate factors and multidimensional inequalities, often produced by social development processes, and shape the risks of climate change and extreme events (IPCC, 2014; PNUD 2008; OLSSOM et al.,2014; SMITH, 2007; ERIKSEN and O'BRIEN 2007). Therefore, socially, economically and culturally marginalized populations are also the most vulnerable to climate change.

Based on Milhorance and Bursztyn (2019, p. 216) and on Araújo et al. (2019), the analytical framework of the *Nexus*+ approach, adopted in the 4NC, converges with the work of Biggs et al. (2014) and Agrawal and Lemos (2015), adding, in the scope of adaptation strategies, the socio-ecological dimension to the nexus among water-food-energy (Figure 1).

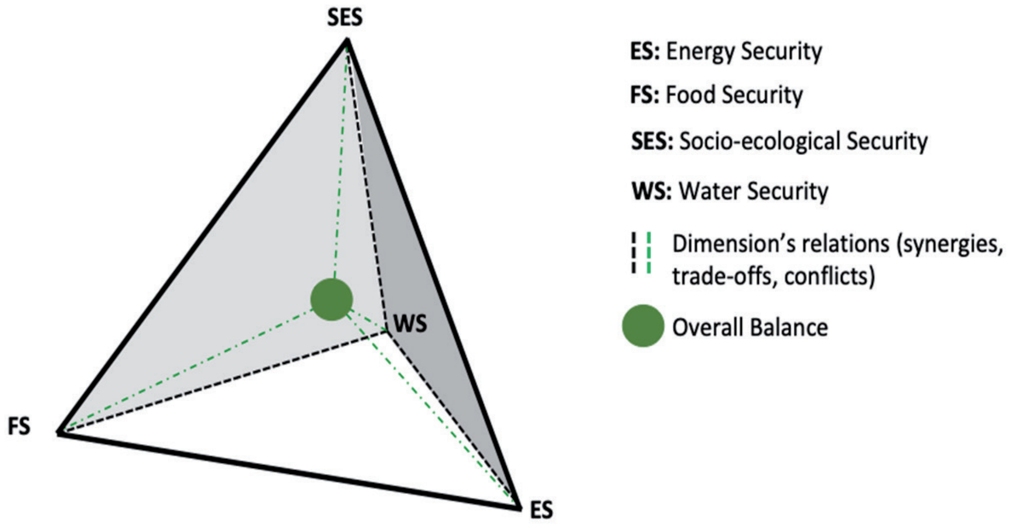

Figure 1 | Illustration of the Nexus+ approach

Source: Araújo et al.,2019, p.64.

3.2 ASSESSMENT OF IMPACTS AND VULNERABILITIES

The technical-scientific literature often describes risk as the probability of hazardous events or trends to occur, multiplied by their impacts in case they do occur. The IPCC (2014a) sees risk in a more flexible way: as the potential for consequences, in which a diversity of values is at stake and where the outcome is uncertain.

Climate change is only one of the many processes that influence the risks to the systems above, and it is overlapped by socio-economic, political, and other types of environmental changes, which are unevenly distributed across the territory. Thus, it is necessary to encompass the multiple sources of risk generation, considering how climate-related risks can be reduced or exacerbated by other biophysical or socio-economic processes, even beyond geographical borders (KLEIN *et al.,* 2017).

For the analyses of risks, or potential impacts from climate-driven stressful stimuli, the following causal chain was considered:

- the current impacts related to climate (climate variability and climate change).
- interactions among climate, socioeconomic factors and other non-climate pressures that could increase vulnerability and/or exposure to variability and climate change.
- impact chains, which can act individually or in combination, directly or indirectly, on individual sectors or in a crosscutting manner (CCRA, 2017).

The assessments focused on impact factors and problems. Then, in reverse, climate and non-climate drivers were explored. This non-traditional approach, based on Reeder e Ranger (2011), instead of starting with the generation and interpretation of climate projections for adaptation planning, started with the context, the drivers, and its impacts, and then assessed the climate and non-climate conditions, as a means of supporting adaptation strategies that are more appropriate and capable of enhancing transformations (Figure 2).

The use of this approach is also reported in the preparation of the *UK Climate Change Risk Assessment*, with a method based on three steps: 1 – understanding present vulnerabilities, based on the assessment of current climate-related risks and opportunities, as well as adaptation levels; 2 – understanding future vulnerabilities and adaptation, based on an assessment of how climate change and socio-economic factors can change future climate-related risks and opportunities; and 3 – prioritize risks and opportunities for which additional actions are needed (on a five-year horizon). In this work, the identification and prioritization of risks and impacts is a preponderant element in the analysis process, with emphasis on the role of non-climate multipliers (WARREN et al., 2016).

Wise *et al.* (2014) stress the importance of considering the historical context and the path in which the socio-ecological system is grounded, in order to understand existing vulnerabilities and support future planning and responses.

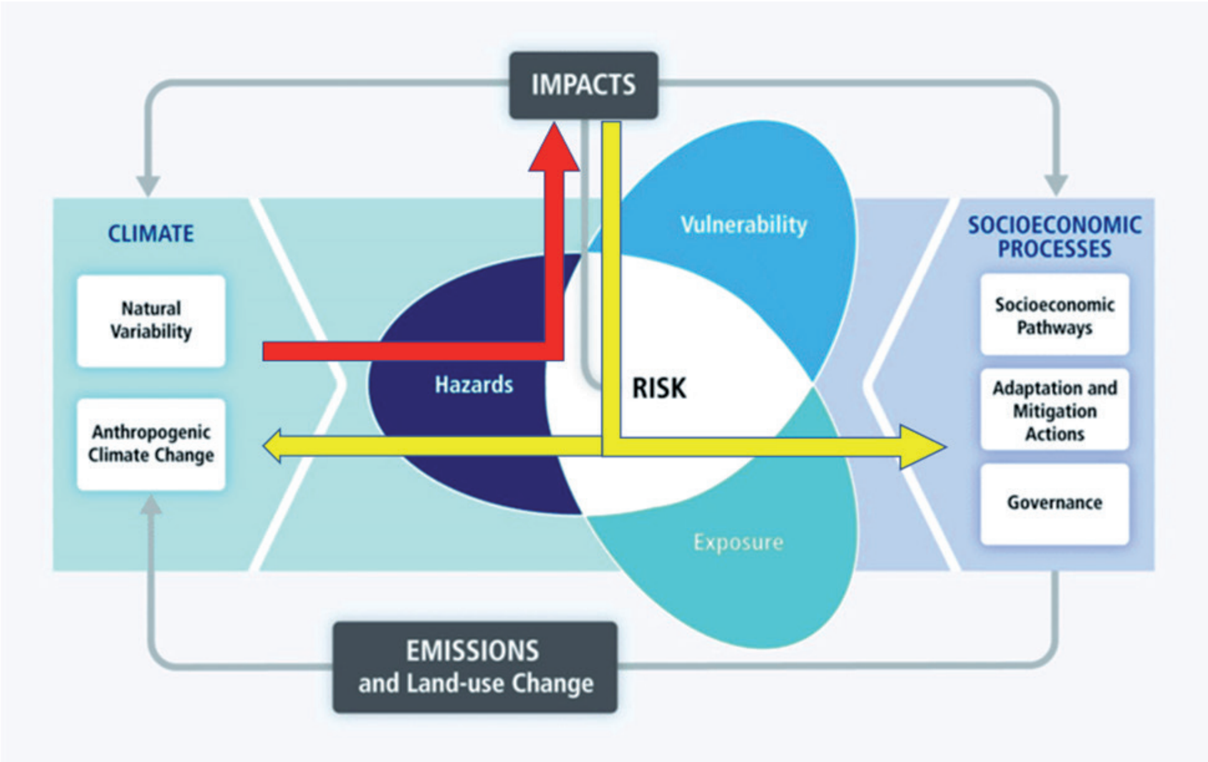

Figure 2 | Illustration of AR5's Working Group II main concepts, with adaptations

Source: adapted from IPCC, 2012, p.3.

The risk of climate-related impacts results from the interaction between climate threats (including dangerous events and trends) and the vulnerability and exposure of human and natural systems. Changes in the climate system (left) and socioeconomic processes, including adaptation and mitigation (right) are the determining risks, exposure and vulnerability factors.

Understanding non-climate socio-economic trends, such as economic growth and demographic (population) changes, can be just as important in determining future climate-related impacts and associated economic costs, as changing the frequency or intensity of climate extremes. When these are not considered, it may be assumed that future climate change will occur in a world similar to today, which is not realistic, since the relationships between climate change, its impacts, mitigation and adaptation vary according to the socio-economic context and are not linear (WARREN et al., 2015, 2016; EVANS et al., 2004).

This broader assessment of conditioning factors for climate-related impacts can support an adequate adaptation plan. According to Wise *et al.* (2014), adaptation is part of a path of changes and responses, in which intention and result would not only be risk reduction, but also an approach of systemic vulnerability factors in dynamic systems.

Buth *et al.* (2017) recommend the creation of impact chains to assess the cause-effect relationship between climate stimuli and possible climate impacts. They may help understand, systematize and prioritize what factors in a system influence climate extremes and climate change impacts. This includes both direct climate impacts on biophysical and socio-economic systems, which are the result of a simple cause-effect action, and indirect climate impacts that are the result of a secondary reaction, or when they are part of a chain of reactions.

Studies and analysis of the key impacts and vulnerabilities have been carried out for water, energy, food, and socio-environmental securities, with specific conclusions according to the territory. Some issues or sectors have been addressed in a crosscutting manner. For each security, the studies considered the following steps: conceptualization, relevance and governance of each security; delineation of the impact chains and conditioning factors; identification of observed impacts (current); characterization and evaluation of future key impacts, considering trends in climate and non-climate pressure factors (socio-economic and environmental); integrated analysis of key impacts and vulnerabilities on a territorial basis (Figure 3); interrelation with other securities; survey and selection of adaptation options, with identification of synergies and trade-offs.

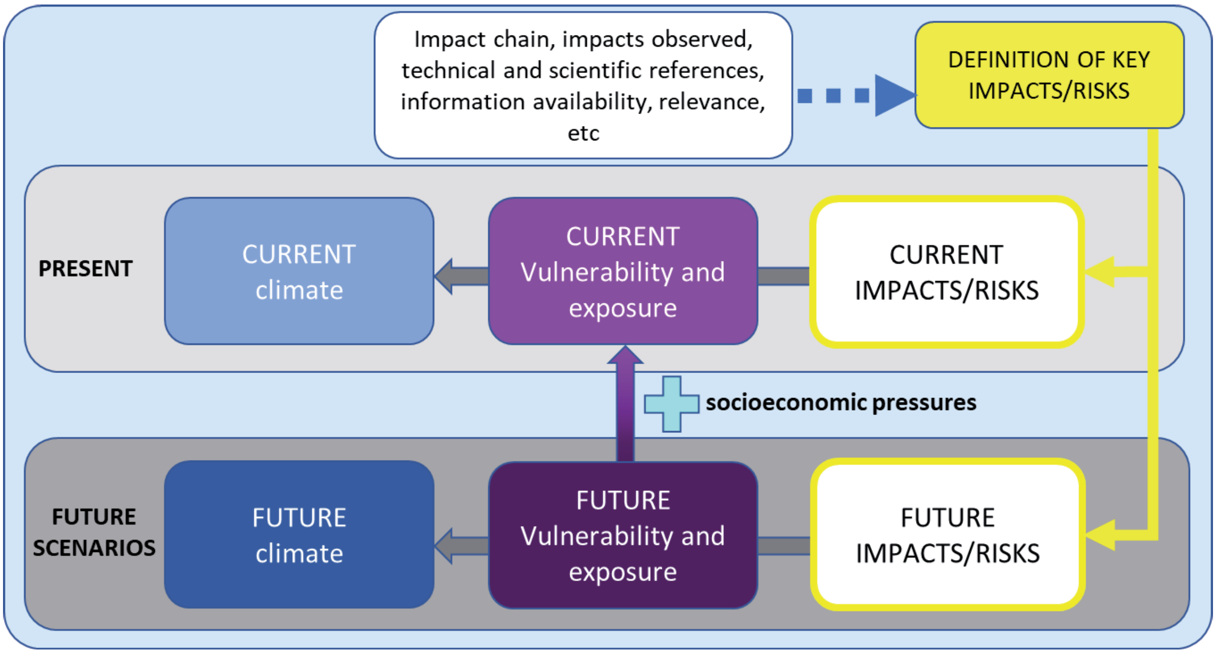

Figure 3 | Outline of the methodological approach adopted for the 4NC for the assessment of impacts and vulnerabilities

Source: Prepared by the authors

The assessment of impacts and vulnerabilities in the context of securities was carried out based on specific methods related to each field of knowledge, available information and references, and conditioning factors considered critical. As an illustration, a risk modeling has been adopted, focusing on climate projections and non-climate factors, when available, historical analysis of impacts related to climate, development of a risk factor index, among other methodological approaches (whose details and main results are presented in other articles of this dossier).

During a workshop carried out in 2019, with 41 participants, including representatives of the government and academia, results of the analysis of current and future impacts and vulnerabilities were presented in the context of the four securities, followed by the identification of adaptation options, considering the territorial specificities, circumstantial and conditioning factors for each of the securities (MCTI, 2019).

The process was oriented in a crosscutting manner, and involved multidisciplinary interactions, which led to the identification of adaptation options for each security, based on selection criteria such as: i. options that consider current climate variability and/or arise from "no-regret" measures, that is, those that are justified even in the absence of future climate change; ii. options that lead to decisions with long-term repercussions or have lasting consequences; or iii. options that are linked to a long implementation period (structural and slow measures).

Those criteria are based on the need mentioned by *Wise et al.* (2014) for adaptive actions focused on both near-vulnerability causes (incremental) and broader and systemic (transformational) long-term changes. This kind of approach is justified, since most adaptation efforts so far have adopted a rationalistic and linear scientific approach, based on a static comparison of a reference scenario, which focuses on specific risks, rather than the generic and complex risks that characterize real-world decision-making (DOWNING *et al.,* 2012).

The IPCC (2014) recognizes that adaptation measures are becoming more integrated into political structures, which can avoid incompatibilities with planning objectives, facilitate the combination of various sources of financing, and reduce the possibility of "maladaptive" actions, enabling better action regarding uncertainty on the extent of climate change and the nature of its impacts.

There are significant co-benefits, synergies and trade-offs among different adaptation responses. Such interactions occur within and between regions (IPCC, 2014), and must be taken into account for the formulation and implementation of adaptation options. Sectoral political approaches may result in competing and/or counterproductive actions. Therefore, changes towards integrated approaches, with political coherence between sectors, can maximize gains, optimize trade-offs, and avoid negative impacts. Synergies may be understood as adaptation actions that enhance other actions, or bring co-benefits with other objectives (DI GIULIO et. Al., 2017). However, there are adaptation actions that minimize certain risks, but aggravate other actions, generating trade-offs.

Twenty-eight adaptation options have been identified from the selection criteria described above, among which five are related to socio-economics, six to the environment within the scope of socio-environmental security, six to food security, six to energy security, and four to water security.

4 INTERFACES OF ADAPTATION OPTIONS AMONG WATER, ENERGY, FOOD AND SOCIO-ENVIRONMENTAL SECURITIES

Some interfaces of the options for adapting one security with the others are described below.

4.1 WATER SECURITY INTERFACES WITH OTHER SECURITIES

When it comes to synergies among the adaptation options, water occupies a central position among securities, and its governance – complex in itself and challenged to integrate energy and food security regarding climate change impacts – stands out, requiring more complex and diverse arrangements, cited as "multilevel coordination challenges" (PAHL-WOSTL, 2009).

Thus, strengthening capacities and the political-institutional articulation for crosscutting approaches with other policies, at different levels, can amplify the management and more efficient use of water, avoiding crises and low water availability impacts, favoring water availability for food and energy production.

Promoting actions for the efficient use of water as well as prioritizing the use of reclaimed water in the industrial, agricultural and urban sectors are adaptation measures that offer synergy with other securities, considering the multiple uses of water.

Incrementing infrastructure interventions may guarantee water supply for human consumption and use in productive activities, and reduce the risks associated with critical events, such as droughts and floods, benefiting the energy and food production sectors. However, purely structural/physical interventions have a high environmental cost and may influence fisheries management adversely, and cause the removal of vegetation, loss of connectivity in protected areas and alteration of water ecosystems, generating trade-offs with socio-environmental security.

Options that strengthen the integration of green infrastructure and integrated management of natural resources with gray infrastructure for water production and protection of water resources have synergy with integrated urban planning, minimizing the risk of disasters.

4.2 ENERGY SECURITY INTERFACES WITH OTHER SECURITIES

In Brazil, renewable energy sources (water, solar, wind power, and biomass) already present vulnerabilities due to climate change. Actions that strengthen the resilience and adaptive capacity of the energy system can be beneficial for all other securities. Measures of efficiency and energy conservation in all user sectors can contribute to the reduction of the energy demand.

Improving the physical energy infrastructure can contribute to stability and/or increase energy supply, but there would be trade-offs with other securities. Of note, are the impacts of the constructions on the environment and ecosystem services, the reduction of water availability for other uses and the reduction of areas for the production of food and fishing resources, in addition to emissions increase of local air pollutants and greenhouse gases - GHG, in the case of thermoelectric plants.

Further complementarity studies of water energy source, considering as adaptation options - for example, the implementation of hybrid wind-photovoltaic plants and the incentive to decentralized energy generation, from non-water renewable sources - can benefit water security in resource availability for other users, including agriculture.

Incentives to bioenergy, with genetic improvement, may make crops feasible in future climate scenarios, and may contribute to water security in terms of availability of the resource to other users (with complementary use to hydroelectric plants), although the demand for irrigation may increase (with an increase in sugarcane and soybean cultivation areas). For food and socio-environmental security, trade-offs may be generated by the advancement of these crops over preservation areas and agricultural production for consumption within the country.

On the other hand, he uses of residual biomass as an alternative source of energy can generate synergies with other securities, since it is based on the use of agricultural, agro-industrial and urban solid waste, thus giving destination to such waste that would otherwise be forwarded for disposal.

4.3 FOOD SECURITY INTERFACES WITH OTHER SECURITIES

Food security may generate synergies with the other securities, especially when adaptation options include maintaining and restoring natural environments and/or via sustainable agriculture, with the development of agricultural varieties and management systems adapted to climate change.

The reduction and/or management of the use of fire, efficient use of water in agriculture, increased productivity, and promotion of integrated systems are adaptation options that present synergies with the other securities. Agricultural management without the use of fire minimizes the occurrence of forest fires, protecting the ecosystems and contributing to soil conservation.

Increased productivity to the detriment of soil quality and greater use of pesticides may cause trade-offs with socio-environmental, water and food securities. Likewise, irrigation may generate trade-offs with the other securities, by reducing water availability for other uses.

Strengthening agro-climate risk monitoring systems and risk-transfer mechanisms (such as credit and farming insurance) may assist producers in managing rural risk, creating synergy with socio-environmental security. However, the eventual migration of crops to more favorable areas may increase the demand for land-use conversion and cause loss of ecosystem services, which is a trade-off for socio-environmental and water security.

Technical assistance and income transfer measures for traditional populations and smallholder farmers may enable them to use more adequate technologies, allowing them to settle to the land, contributing to their subsistence and maintenance of protected areas.

Improving the food distribution and storage infrastructure may favor some smallholder farmers, linking agricultural production to market demands, creating synergies with the other securities

Incentive to urban agriculture help to reduce the pressure of urban areas on ecosystems and rural areas, enhancing synergies with other securities.

4.4 SOCIO-ENVIRONMENTAL SECURITY INTERFACES WITH OTHER SECURITIES

Ecosystem services provide several benefits to human needs, and it is essential to keep them as a synergy for all securities. Adaptation actions based on the integrated management of natural resources are the ones that contribute the most to the overall balance of *Nexus+*. Such actions can involve Ecosystem-Based Adaptation (EBA), Nature-Based Solutions, among others.

Economic, social, environmental, and cultural benefits can be obtained by using EBA, since healthy environments play an important role in protecting infrastructure and expanding human security, acting as natural barriers and reducing the impacts of disasters caused by extreme weather and climate events.

Maintenance and recovery of areas with natural vegetation favor pollination, benefiting both ecological balance and agricultural production (MEA, 2005), and contribute to reducing the risk of a water crisis, particularly in the face of future climate stress (OZMENT, DIFRANCESCO and GARTNER, 2015). Preserving the Amazon and restoring native forests in the Brazilian Southeastern region favor conditions for water jets to continue acting and feeding reservoirs (FUNDAÇÃO BOTICÁRIO and ICLEI, 2015), creating synergy with energy security.

Integrated urban planning stands out, prioritizing afforestation, soil permeability, urban agriculture, intelligent densification of regularized and consolidated city areas, urbanization of precarious settlements, and maintenance of social relations for low-income populations. Such measures contribute to minimizing heat islands and energy costs with air conditioning, allowing rainwater harvesting and reducing water pollution by urban sewage. These actions have synergies with risk monitoring and communication systems, with underground and surface water availability, and with the health of the population.

Fostering and improving the management of reporting systems on risk and disasters, heat islands, and bush fires present synergies with all securities.

5 FINAL CONSIDERATIONS

This article presented a methodological proposal based on a concrete experience. For the elaboration of the 4NC, the option was a strategy that treats the complex framework of themes, territories and sectoral cutouts that shape the reality in an integrated way. The usual practice is to break the topics down into parts that are studied individually by experts. Conversely, the identification of elements that allow complementary approaches from different perspectives offers a better understanding of the object's dynamics: climate change and the understanding of its impacts, vulnerabilities, and adaptation processes in Brazil.

There is a risk that the integrating approach may lead to reductionism and oversimplification of the reality. Yet, seeking to frame reality into sectoral approaches lacks analytical strength. The Nexus approach, with water as an integrating axis in the contexts of food, energy and water supply, allows to objectively dealing with the interfaces of such themes. The option for Nexus+, in the way it was adopted for the 4NC, introduced new ingredients, which ensured greater organicity and comprehensiveness to the process. In practical terms, the strategy was:

- an approach on the securities' perspective.
- the inclusion of the socio-environmental security axis, which allows for the consideration of aspects such as the relations of the human sphere with the natural world, and ecosystem services in their interfaces with the dynamics of the economy.
- an approach according to the different biomes and coastal ecosystems.
- an analysis of cities as an environment with their own characteristics, regardless of the biome they are in.
- the consideration of crosscutting issues, such as health, traditional peoples and populations, and public policies (both sectoral and those targeted at actions involving different sectors, with synergies and trade-offs).

It was necessary to resort to an interdisciplinary team and to integrating events, such as work meetings, consultations with specialists and seminars bringing together academics, public policy-makers, and operators. The way the outcome will be assimilated by decision-making levels is still unknown. However, the adopted methodological procedure is documented herein, as a proposal to be considered and improved.

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