

# IS THE NATIONAL POLICY FOR PAYMENT OF ENVIRONMENTAL SERVICES WILLING TO PREVENT DISASTERS?<sup>1</sup>

Patrícia Trovarelli<sup>2</sup>

Klécia Gili Massi<sup>3</sup>

Extreme weather events and disaster records have increased in Brazil and the creation of consolidated public policies for disaster risk management is still recent. The country's history of occupation and economic development has led to the removal of the original vegetation cover and a possible imbalance in ecosystems and their services that contribute to sustainable solutions for disaster risk reduction (DRR), adaptation to climate change and sustainable development. Payment for environmental services (PES) programs can serve as environmental policy instruments for transferring financial resources to those providing environmental services. Brazil recently regulated the National Policy on Payment for Environmental Services (PNPSA) – Law No. 14.119/2021 – and this study aimed to verify the inclusion of regulatory ecosystem services that contribute to DRR in this legislation. It used the problem diagnosis analysis presented by the Public Policy Guide (Casa Civil da Presidência da República, 2018) organized in stages with mixed methodology. This research contributes to scientific investigations for PSE and discusses the contributions of PNPSA in the area of disaster risk reduction that can bring social and environmental gains in the context of the global environmental crisis.

**Keywords:** payment for environmental services; ecosystem services; disaster; disaster risk reduction; public policy.

## A POLÍTICA NACIONAL DE PAGAMENTO POR SERVIÇOS AMBIENTAIS ESTÁ DISPOSTA A PREVENIR DESASTRES?

Eventos climáticos extremos e registros de desastres têm aumentado no Brasil e ainda é recente a criação de políticas públicas consolidadas para a gestão do risco de desastres. A história de ocupação e desenvolvimento econômico do país levou a retirada da cobertura vegetal original e um possível desequilíbrio nos ecossistemas e seus serviços que contribuem com soluções sustentáveis para a redução do risco de desastres (RRD), adaptação às mudanças climáticas e desenvolvimento sustentável. Os programas de pagamentos por serviços ambientais (PSA) podem servir como instrumentos de políticas ambientais de transferência de recursos financeiros para quem presta serviços ambientais. O Brasil regulamentou recentemente a Política Nacional de Pagamento por Serviços Ambientais (PNPSA) – Lei nº 14.119/2021 – e este estudo objetivou verificar a inclusão dos serviços ecossistêmicos de regulação que contribuem para a RRD nesta legislação. Utilizou a análise de diagnóstico de problemas apresentada pelo Guia de Políticas Públicas (Casa Civil da Presidência da República, 2018) organizado em etapas com metodologia mista. Essa pesquisa contribui com as

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2. Master in Natural Disaster from the Graduate Program in Natural Disasters of São Paulo State University/National Center for Monitoring and Alerting of Natural Disasters (Unesp/Cemaden). E-mail: [patricia.trovarelli@unesp.br](mailto:patricia.trovarelli@unesp.br). Lattes: <http://lattes.cnpq.br/4139593890805095>. Orcid: <https://orcid.org/0000-0003-0564-3841>.

3. Assistant professor at the Institute of Science and Technology of Unesp. Graduate Program in Natural Disasters of Unesp/Cemaden. E-mail: [klecia.massi@unesp.br](mailto:klecia.massi@unesp.br). Lattes: <http://lattes.cnpq.br/2020663504934219>. Orcid: <https://orcid.org/0000-0003-1823-7965>.

investigações científicas para o PSA e discute as contribuições da PNPSA na área de redução do risco de desastres que possam trazer ganhos socioambientais diante do contexto de crise ambiental global.

**Palavras-chave:** pagamento por serviços ambientais; serviços ecossistêmicos; desastres; redução do risco de desastres; política pública.

## ¿LA POLÍTICA NACIONAL DE PAGO DE SERVICIOS AMBIENTALES ESTÁ DISPUESTA A PREVENIR DESASTRES?

Los eventos climáticos extremos y los registros de desastres se han incrementado en Brasil y la creación de políticas públicas consolidadas para la gestión del riesgo de desastres es aún reciente. La historia de ocupación y desarrollo económico del país ha llevado a la remoción de la cubierta vegetal original y un posible desequilibrio en los ecosistemas y sus servicios que contribuyen a soluciones sostenibles para la reducción del riesgo de desastres (RRD), la adaptación al cambio climático y el desarrollo sostenible. Los programas de pagos por servicios ambientales (PSA) pueden servir como instrumentos de política ambiental para transferir recursos financieros a quienes prestan servicios ambientales. Brasil recientemente reglamentó la Política Nacional de Pago por Servicios Ambientales (PNPSA) – Ley nº 14.119/2021 – y este estudio tuvo como objetivo verificar la inclusión de servicios ecossistêmicos regulatorios que contribuyan a la RRD en esta legislación. Se utilizó el análisis del diagnóstico de problemas presentado por la Guía de Políticas Públicas (Casa Civil da Presidência da República, 2018) organizado en etapas con metodología mixta. Esta investigación contribuye a las investigaciones científicas para el PSA y analiza las contribuciones del PNPSA en el área de la reducción del riesgo de desastres que pueden traer beneficios sociales y ambientales en el contexto de la crisis ambiental global.

**Palabras clave:** pago por servicios ambientales; servicios de ecosistema; desastre; reducción de desastres; política pública.

**JEL:** Q54.

### 1 INTRODUCTION

Public policy can be generally defined as an institutionalized proposal to solve relevant and real-world problems (Lassance, 2020). In Brazil, environmental legislation began in the 1930s, but since the 2000s several important policies have been created, as the System of Protected Areas (SNUC) – Law No. 9.985/2000 (Brasil, 2000) – and the New Forest Code – Law No. 12.651/2012 (Brasil, 2012b). There have been clear advances in environmental regulation in the country, especially regarding institutional structure; however environmental governance and its principles constitute the main challenges to policy implementations (Moura, 2016). In addition, public policies are not properly planned, designed and evaluated after implementation (Silva, Juras and Souza, 2013). For that reason, methods to evaluate diagnostic, designs, implementation, governance, results, impacts and efficiency of policies are incredibly valuable.

Lately, extreme climate events and natural hazards have been increasing in the world (UNDRR, 2020). In Brazil, floods and mass movements in rainy periods and

drought and fire during dry seasons are great concerns (CNM, 2018).<sup>4</sup> Thus, it is urgent to seek approaches that adapt human populations to the consequences of climate change and of natural disasters. Natural ecosystems and its services can provide such sustainable solutions to reduce disaster risks and the severity of their impacts, while adapting to global changes (Scarano, 2017; Faivre et al., 2018). Several major international agreements recognize the role that ecosystems and natural infrastructure can play directly and indirectly in terms of development, in helping to achieve disaster risk reduction (DRR), climate change adaptation and sustainable development (Whelchel et al., 2018), such as United Nations (UN) Convention on Biological Diversity (CBD) and the UN Sustainable Development Goals (SDG) – both Brazil signed.

Ecosystem services include a multitude of benefits to humans (exemplified below) and are related to support, provision, regulation and cultural services.<sup>5</sup> While the first two services (support and provision) are better described, studied (Renard, Rhemtulla and Bennett, 2015; Gomes et al., 2020) and funded, regulating and cultural services are more complex to assess and foment, as they are seen as non-material ecosystem services (Small, Munday and Durance, 2017). Regulating services include pollination, decomposition, water purification, erosion and flood control, carbon storage and climate regulation and have a central role in climate change adaptation, DRR and their multifaceted linkages (Munang et al., 2013).

The complexity to assess regulating services in studies is also seen in payment for ecosystem services (PES) projects. PES involves transfer of financial resources from beneficiaries of certain environmental services to those who provide these services or are fiduciaries of environmental resources (Mayrand and Paquin, 2004). There are several uncertainties related to demonstration of real environmental benefits of PES (Lima, Krueger and García-Marquez, 2017), such as water infiltration or prevention to natural disasters. In Brazil, Guedes and Seehusen (2011) systematized PES projects in the Atlantic Forest biome (mainly in South and Southeast regions of the country, especially in São Paulo state) and found 78 PES projects; of which 33 were related to water, 40 to carbon and 5 to biodiversity. None of these projects directly or indirectly mention the willingness to prevent and mitigate disaster risks. Despite that, in 2020, one of the heads of Environment Secretary of São Paulo state stated that a large state PES project (Conexão Mata Atlântica Project) was built in response to a harsh flood that happened in 2010 in São Luiz do Paraitinga, a small municipality in that state (personal information).

Brazil did not have a specific federal regulatory framework on PES until January 2021, when the National Policy on Payment for Environmental Services

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4. Available at: [cemaden.gov.br](http://cemaden.gov.br).

5. Available at: <https://www.bpbes.net.br>.

(PNPSA) was approved – Law No. 14.119/2021 (Brasil, 2021a). Until then, the New Forest Code – Law No. 12.651/2012 (Brasil, 2012b) – regulated PES as a support and incentive program for vegetation conservation, in addition to providing a market for environmental services (Brasil, 2012b). The National Policy for Payment of Environmental Services aims to guarantee payment of ecosystem benefits conservation and restoration and to organize and regulate the diversity of actions and projects involved in this matter.

Healthy ecosystems are acknowledged to contribute to DRR through their ecosystem services (Walz et al., 2021). There is a clear relation (even if not direct) between the presence of native ecosystems, and its services, and natural hazards prevention, and nature-based solutions and PES must be understood as important tools to prevent extreme events and natural disasters. Thus, this study aimed at verifying the inclusion of regulating services (namely prevention to natural disasters) in a national legislation, by applying a problem diagnostic analysis (Casa Civil da Presidência da República, 2018). The diagnostic of a problem is an initial part of the formulation of a public policy, as it reveals population needs or of a group of people for government intervention to occur (Casa Civil da Presidência da República, 2018). Studies evaluating international environmental agreements and national policies are scarce (Roelfsema et al., 2020), especially in Brazil. Thus, this research is justified by the fact that it contributes to theoretical scientific investigations about PES, recently instituted as a national policy and which still lacks subsidies for future evaluations. It is also justified by discussing possible contributions of the PNPSA in DRR that can bring social and environmental gains in a global environmental crisis context.

To reach its objective, this study was divided into three sections, in addition to this introduction. In the second section, the method used is presented in detail, adapted from the *Problem Diagnosis Analysis* (Casa Civil da Presidência da República, 2018, p. 105-138), composed of eight steps: i) problem description; ii) cause-problem-effect relations; iii) data and problem indicators; iv) affected population and beneficiaries of the politics; v) target alignment and national and international agreements; vi) integrated approach of intervention; vii) problem solution based on international experiences; and viii) recommendations. The third section presents results obtained, followed by a discussion based on the referenced literature. The fourth section closes the article with the final considerations.

## 2 METHODS

We applied the methodological framework of the *Practical Guide for Ex Post Analysis of Public Policies* (Casa Civil da Presidência da República, 2018). In this guide, we chose the diagnostic analysis of a problem (chapter 4 in the guide), to verify whether

the diagnosis for creation of the National Policy for Payment of Environmental Services specifically considered possible contributions of ecosystem benefits to DRR. The methodology for evaluation consists of eight steps, detailed below.

### **2.1 Problem description: problem tree and objective tree**

Firstly, documents relating to the Law No. 14.119/2021, its draft laws, literature, studies, reports and procedures were searched on website of the Chamber of Deputies.<sup>6</sup> Then, a problem tree and an objective tree were drawn, which are representations like diagrams with an identified problem in the center, with possible related causes (lower part) and its effects (upper part). Problem tree built was based on: i) identification of a problem; ii) pointing out possible causes of a problem (brainstorming); iii) analysis of why these causes generate this problem (sub-causes of the problem); and iv) list of main direct and indirect effects of a problem. In an objective tree, a problem becomes the main objective of policies; the causes that will be pursued become a target of this policy; and instead of problem effects, now results are pursued (Casa Civil da Presidência da República, 2018, p. 108-110). Thus, we identified the place given to disaster prevention and reduction as a problem (appendixes A and B).

### **2.2 Cause-problem-effect relations**

Studies and empirical data were analyzed to verify cause-problem-effect relations (vegetation cover-ecosystem services-natural disaster). In this sense, we investigated associations between natural disaster, ecosystem services and native vegetation through a systematic review, identifying relevant studies and evidences, with the words “payment for ecosystem services”, “conservation”, “restoration”, “cover”, “vegetation”, “tropical forest”, “drought”, “burned”, “wildfire”, “inundation”, and “landslide” at sciencedirect.com, search.scielo.org and jstor.org, that are large bibliographic databases of scientific publications, which resulted in ninety-five studies. Ten studies were selected because they evaluated presence of vegetation cover (environmental and ecosystem services), as an explanatory variable, and natural disaster prevention, as a response variable.

### **2.3 Data and problem indicators**

To scale the problem, its causes and consequences, data and indicators available in Brazilian Atlas of Natural Disasters – 1991 to 2012 (Ceped/UFSC, 2013a; 2013b) and in Digital Atlas of Disasters in Brazil<sup>7</sup> were used, both with data from the Integrated Disaster Information System (S2ID)<sup>8</sup> of the National Secretariat for Civil

6. Available at: <https://www.camara.leg.br/propostas-legislativas/946475>.

7. Available at: <http://atlasdigital.mdr.gov.br/paginas/index.xhtml>. Accessed on: Oct. 10, 2021.

8. Available at: <https://s2id.mi.gov.br/>.

Defense and Protection (Sedec). We filtered data by some natural disasters (drought, fire, flood and landslide), number of occurrences and total material damage (in R\$ converted to US\$) by Brazilian regions (South, Southeast, Central-West, North, Northeast). S2ID presents data for regions that declared Emergency Situation (SE) and State of Public Calamity (ECP) published in the Official Gazette.

#### 2.4 Affected population and beneficiaries of the policy

The population affected by disasters (generally urban) was identified in official databases of the Brazilian Institute of Geography and Statistics (IBGE),<sup>9</sup> based on information from 2010 Demographic Census, and risk areas monitored by Cemaden (IBGE, 2018), considering people exposed in areas at risk of floods and mass movements in 872 critical municipalities in Brazil, within the Territorial Statistical Database of Risk Areas (Bater). For beneficiaries of the policy (in general rural landowners), we used data from the Agricultural Census-2017.<sup>10</sup>

#### 2.5 Target alignment and national and international agreements

To find out whether PNPSA objectives are aligned with national and international policies (agreements assumed by Brazil), regarding natural disasters, we searched for words “drought”, “flood”, “fire”, “landslide” and its variants in environmental policies listed below (table 1), to observe if they complemented or overlapped the PES policy (Law No. 14.119/2021) to achieve DRR. In addition, the guide suggests looking at the Multi-Year Plan (PPA), period 2020 to 2023 – Law No. 13.971/2019 (Brasil, 2019b); however, the plan was made before the approval of the PES Law and only makes references to the draft of the National Policy on PES or the Payment for Environmental Services Program.

TABLE 1

#### National policies and international agreements assumed by Brazil and year of law application

	National	Year
1	National Environmental Policy	1981
2	National Water Resources Policy (PNRH)	1997
3	National System of Nature Conservation Units	2000
4	National Biodiversity Policy	2002
5	Atlantic Forest Law	2006
6	Public Forests Law	2006
7	National Policy on Climate Change	2009
8	National Solid Waste Policy <sup>1</sup>	2010

(Continues)

9. Available at: <https://www.ibge.gov.br/apps/populacaoareasderisco/>.

10. Available at: <https://censos.ibge.gov.br/agro/2017/>.

(Continued)

	National	Year
9	Native Vegetation Protection Law	2012
10	National Civil Defense Protection Policy	2012
11	National Policy to Combat Desertification and Mitigate Effects of Drought	2015
12	National Policy for Native Vegetation Recovery	2017
13	National Policy on Payment for Environmental Services	2021
Internationals		
14	United Nations Framework Convention for Climate Change (UNFCCC)	1998
15	Convention on Biological Diversity	2010
16	Sendai Framework for Disaster Risk Reduction 2015-2030	2015
17	Sustainable Development Goals	2015
18	Paris Agreement	2016

Sources: Brasil (1981; 1997; 1998; 2000; 2002; 2006a; 2006b; 2009; 2010; 2012a; 2012b; 2015c; 2017; 2021a); CBD (available at: <https://www.cbd.int/climate/intro.shtml>; accessed on: Nov. 6, 2020); UNDRR (2015); UN (available at: <https://brasil.un.org/pt-br/sdgs>; accessed on: Sept. 25, 2021); and Paris Agreement (available at: <https://antigo.mma.gov.br/clima/convencao-das-nacoes-unidas/acordo-de-paris.html>; accessed on: Sept. 25, 2021).

Authors' elaboration.

## 2.6 Integrated approach of intervention

To analyze whether the policy is being implemented in an integrated and coordinated manner, related to the prevention of natural disasters, the FSD method (fragmentation, overlapping, duplication and gaps) was applied in policies from the previous step, collecting the following information: i) objectives and potential results; ii) target audience and beneficiaries; and iii) institutions responsible for execution. The FSD method originates from the guide prepared by the Government Accountability Office (GAO), the Supreme Audit Institution of the United States, and adapted by the Federal Court of Accounts (TCU, 2017, p. 77-80), to identify as fragmentations, overlaps, duplications and gaps in problem intervention and recognizing positive or resulting effects.

## 2.7 Problem solution based on international experiences

To identify similar policies in other countries, a new systematic review based only on international experiences was performed, with the words “payment for ecosystem services”, “policy”, “payment for environmental services”, “PES” “vegetation cover”, “ecosystem services”, “natural disaster”, “disaster”, “drought”, “burned”, “wildfire”, “inundation”, and “landslide” at [sciencedirect.com](http://sciencedirect.com) and [search.scielo.org](http://search.scielo.org). These word combinations resulted in twelve studies of international experiences with evidence of strategies that could represent a solution clue to the relationship between prevention and reduction of natural disasters and PES in the Brazilian context.

## 2.8 Recommendations

Recommendations are part of final considerations after carrying out the analysis of data, indicators and evidence found by this research, which can improve the National Law of PES as a collaborative instrument in reducing disasters risk.

## 3 RESULTS AND DISCUSSION

### 3.1 Problem description

Law No. 14.119/2021, which institutes the PNPSA, presents concepts, objectives, guidelines, actions and criteria for the implementation of the PNPSA, establishing the National Register of Payment for Environmental Services (CNPSA), the Federal Program for Payment for Environmental Services (PFPSA), in addition to providing contracts of payments for environmental services in order to manage public and private spaces eligible for the application of the Law (as a result of Bill No. 312/2015 which after a long period of processing in the National Congress became Bill No. 5.028/2019). In general, the Law aims to guarantee payment for those who contribute to preservation or recovery of benefits generated by ecosystems, in favor of society. We found only one mention of the term “disaster” in the Law. In article 7, actions of the federal program of payment of environmental services are presented and among them are: “conservation and improvement of the quantity and quality of water, especially in hydrographic basins with critical vegetation cover important for human supply and animal watering or in areas subject to disaster risk” (Brasil, 2021a). Before that, in the concepts section, regulating services were defined as responsible for reducing floods, droughts, landslides, and such, but the policy has no real-world application actions related to that concept.

#### *Problem tree*

In 2015, Bill No. 312 (Brasil, 2015a) was proposed as an alternative to repressive legislation (command-control mechanism), i.e., an alternative mechanism with the objective of encouraging rural landowners to promote actions for environmental preservation on their properties (Brasil, 2015a; Börner et al., 2017), but at that time did not make any direct reference to natural disasters. The PES, applied in other countries and in several states in Brazil, could act as an attraction to increase conservation initiatives and encourage greater participation by private owners (Seixas et al., 2020). When this bill was analyzed by the Committee on Agriculture, Livestock, Supply and Rural Development, a Replacement Project was proposed in which the term “disaster” was directly mentioned among its actions in article 6: “II – conservation and improvement of quantity and water quality, especially in watersheds with critical vegetation cover, which are important for human supply and watering animals or areas subject to disaster risk” (Brasil, 2015b). Such mention



was maintained when approved by Environment and Sustainable Development committees; of Finance and Taxation; Constitution and Justice and Citizenship, which recognized the PNPSA as a strategy for restoration of natural ecosystems, capable of providing a return to biodiversity, revitalization of hydrographic basins, recovery of soils and water resources (Brasil, 2019a). In the final version of the law, as previously shown in article 7, this mention was maintained, but not expanded into other actions and services, which indicates the focus of natural DRR in the policy, i.e., water stress concerns.

In problem tree building, a need for organizing and managing environmental and ecosystem services in Brazil appeared as a central axis and problem to be targeted by the policy (appendix A). This was explained by the absence of a previous broad national law, which allowed different approaches to PES in states and municipalities that had a limited capacity for initiatives, given uncertainties in resources sources to ensure durability and efficiency of initiatives, besides a scenario of legal uncertainty that made it difficult for the country to increase PES and to finance scientific research that proved PES effectiveness. The analysis of the problem tree shows that natural DRR or prevention was not among the causes around the need for this law creation, despite some of its causes (as the lack of environmental regularization of rural properties) may indirectly lead to disasters risk reduction and prevention. In addition, we did not identify this issue among the effects of the problem tree, which points the fragility of the law regarding that.

#### *Objective tree*

Objective tree creation (appendix B) indicated that the National Policy aimed to organize the management and guide PES projects to avoid environmental and ecosystem services degradation. For this, it presented actions to create a Federal PSA Program, a CNPSA and a Collegiate Organ to assess the PFPSA that can contribute to better management and effective monitoring of policy actions. Brazil does not have a platform for registering PES, making it difficult to create a database of programs and scientific research. In 2019, Jodas (2021, p. 158) found 316 PES projects in Brazil through the digital platform Brazilian Matrix of Ecosystem Services (MBSE), not available anymore. Mapping PES initiatives would enable investigation of environmental policy effectiveness (Jodas, 2021, p. 158) and cross data to information on areas at risk or vulnerable to disasters in the country and thus help in decision making of priority areas for PES projects.

In the objective tree, we indirectly identified DRR and prevention among the intended actions of the law, mainly related to regulating ecosystem services (appendix B, green board). We identified them in article 7 as conservation, recovery, improvement or restoration of: priority areas for biodiversity; water quality; watersheds with critical vegetation cover; human supply; animal watering; areas subject

to disaster risk; native vegetation cover of degraded areas; capture and retention of carbon and conservation of soil, water and biodiversity (Brasil, 2021a, art. 7<sup>a</sup>). These actions are fundamental to prevent ecosystem degradation and natural disasters (Munang et al., 2013), but natural hazards and extreme events prevention should be clearly treated and stated in programs and laws. In the next section, we describe, based on literature, how ecosystem services could prevent disaster.

Among its objectives, the Policy aims to integrate to other sectorial and environmental policies (Brasil, 2021a, art. 4<sup>o</sup>, § 1), but it does not mention the Law on National Civil Defense and Protection Policy – Law No. 12.608/2012 (Brasil, 2012a) –, which it is the law that directly relates to disasters. Even the Civil Defense Policy is fragile as it does not define disasters, it does not classify different disasters and it does not present a section of instruments or tools to prevent disasters, where PES or nature-based solutions could be presented. In addition, when listing areas that may be eligible to PES projects (for example, protected areas, indigenous land etc.), the National Policy does not include areas at risk or vulnerable to disasters. This again indicates that prevention and reduction of natural disaster risk was less taken into account for the Law planning or it was only indirectly considered through environmental and ecosystem services favoring (for example increasing vegetation cover) that might prevent hazards. Despite this, it is believed that it can be an important preventive measure policy or even to minimize the post-disaster cost.

### 3.2 Cause-problem-effect relations

The systematic review mostly was based on regional and international studies and most of them used modeling methods. Results indicated that agriculture and pasture was associated to drought (Santos et al., 2021), while forest sites related to water supply increase in India (Mallick and Chakraborty, 2018), China (Nichol and Abbas, 2015) and Brazil (Oliveira et al., 2021). Also, forests responded for less fire expansion in New Caledonia (Curt et al., 2015) and Brazil (Guedes et al., 2020). Unvegetated sites in mangroves explained high waves and flooding in Bangladesh (Deb and Ferreira, 2017), while Molina et al. (2012) and Sandholz, Lange and Nehren (2018), in Brazil, showed reduced erosion, and consequently landslides, due to vegetation recovery. Thus, there is a clear relation (even if not direct) between the presence of native ecosystems, and its services, and natural hazards prevention. The lack of studies in this field, especially in tropical climate conditions, may be taken with care because it might be confused with a lack of provision of ecosystem services to prevent hazards (Sandholz, Lange and Nehren, 2018).

Since 2011, the Brazilian federal government has been prioritizing prevention and mitigation actions for risk management and response to natural disasters, in a multi-sector program that in 2012 was improved by the National Plan for Risk

Management and Disaster Response, organized into four axes: mapping of risk areas; monitoring and alerting; prevention and infrastructure works; and response actions aimed at civil defense.<sup>11</sup> A greater concern with disaster monitoring and response is perceived than with disaster risk prevention and reduction, prioritizing gray infrastructure over ecosystem-based strategies. The essential role of ecosystems, for Munang et al. (2013), is by regulating services that are essential for adapting to climate change and reducing risk of disasters, including climate and water regulation, protection against natural hazards such as floods and landslides, water and air purification, carbon sequestration and disease and pest regulation.

Ecosystem-based disaster risk reduction (Eco-RRD) is, according Estrella and Saalimaa (2013), as the sustainable management, conservation and restoration of ecosystems to reduce risk of disasters, with the aim of achieving sustainable and resilient development. The CBD<sup>12</sup> presents Ecosystem-Based Adaptation (AbE, its acronym in Portuguese and EbA, in English) as an overall adaptation strategy that uses biodiversity and ecosystem services to provide services that help people to adapt to the adverse effects of climate change. AbE can generate economic, social, environmental and cultural benefits, including: i) the reduction of risks related to natural disasters, increasing safety of human communities; ii) the restoration of degraded or fragmented ecosystems, ensuring availability and access to natural resources and conservation of biodiversity; and iii) sustainable water management – the restoration and protection of ecosystems can, for example, reduce runoff surface water during storms and sediment carryover (Colls, Ash and Ikkala, 2009). In Rio de Janeiro, AbE in an urban reforestation program had the potential to reduce risk of landslides and support local communities livelihoods, especially if the governance system involves different actors in a participatory approach and awareness campaigns (Sandholz, Lange and Nehren, 2018).

Despite all this importance, Munang et al. (2013) reinforce the lack of political commitment given the importance of ecosystem management in adapting to and responding to the impacts of climate change associated with disaster risks, in investing in DRR structures and practices, as well as the lack of resources financial, technological and research, including national policy-making and raising awareness, capacity building, planning and DRR practices. The European Union presents itself as a positive example in advancing policies of initiatives based on ecosystems that were promoted by the European Commission, as an example, Solutions Based on Nature, Adaptation Based on Ecosystems, Green Infrastructure and Natural Water Retention Measures, in addition to investing in research to better address technological and knowledge gaps in disaster risk management (Faivre et al., 2018).

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11. Available at: [cemaden.gov.br](http://cemaden.gov.br).

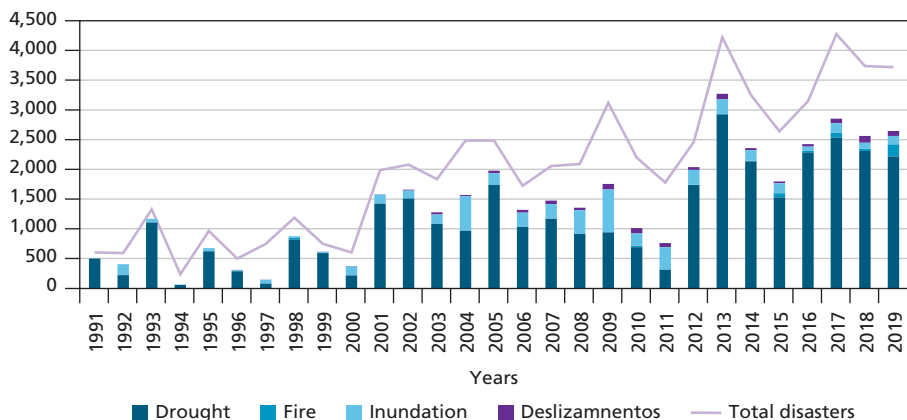
12. Climate change and biodiversity. Available at: <https://www.cbd.int/climate/intro.shtml>. Accessed on: Nov. 6, 2020.

Thus, AbE presents itself as a strategy for adapting to climate change associated with the maintenance of environmental services and conservation of biodiversity and are present in PES programs that strengthen sustainable management and use of ecosystems.

### 3.3 Data and problem indicators: increase in disasters in Brazil

Natural disasters (especially drought, fire, landslides and floods) have increased in Brazil (figure 1). Extreme drought events in different regions of Brazil are rising (Cunha et al., 2019) and drier climate, affected by changes in land use, such as deforestation, increase the risk of forest fires (Marengo et al., 2021; Pivello et al., 2021; Cunha et al., 2019). In addition, from 1991 to 2019, an increase in disaster occurrences and people affected (human damage) in Brazil has been registered.<sup>13</sup> Since 2015, forest fires have been impacting ecosystems and people on a higher scale, especially in the Amazon and Pantanal. Between 2004 and 2013, 25% of Brazilian municipalities presented disaster records annually (Valencio, 2014<sup>14</sup> apud Marchezini et al., 2020), which from 2013 to 2017 increased to 32% (Marchezini et al., 2020). The increase in disasters in Brazil, which are related to changes in land use, is also associated with unprepared institutional capacities and policies, changes in environmental bodies and political initiatives not committed to the goals of sustainable development (Pivello et al., 2021).

FIGURE 1  
Number of records of disaster occurrences in Brazil (1991-2019)



Source: Digital Atlas of Disasters in Brazil. Available at: <http://atlasdigital.mdr.gov.br/paginas/index.xhtml>. Accessed on: Oct. 10, 2021. Authors' elaboration.

13. Available at: <http://atlasdigital.mdr.gov.br/paginas/index.xhtml>. Accessed on: Oct. 10, 2021. Based on data recorded at the Sedec.

14. Valencio, N. F. L. S. Desastres no Brasil: a face hídrica do antidesenvolvimento. In: Valencio, N. F. L. S.; Siena, M. *Sociologia dos desastres: construção, interfaces e perspectivas*. São Carlos: Rima Editora, 2014. v. 4, p. 109-148.

When analyzed by regions, floods and landslides are more common and cause more monetary damages in the Southeast region, while drought occurrences and damages are higher in the Northeast (table 2). Fire damage is higher in the North region, while occurrences happen more often in the Southeast (table 2). With the growing urbanization in risk areas and population densification in Brazil, human damage and economic losses are increasingly aggravated (CNM, 2018).

TABLE 2  
Occurrences of disasters and monetary damages, by Brazilian region (1991-2019)

Natural disasters		Drought		Fire		Flood		Landslide	
Regions	Population living in risk areas (%)	Occurrences	Damage (US\$)	Occurrences	Damage (US\$)	Occurrences	Damage (US\$)	Occurrences	Damage (US\$)
Center-West	0.004	205	649,795	86	609,645	310	86,784,659	18	2,316,099
North	0.18	300	2,645,040	98	1,677,822	854	594,119,350	64	18,360,405
Northeast	1.5	23944	34,148,277	78	0	1155	610,105,510	98	276,203,411
South	0.37	5238	22,374,020	12	357,186	1142	407,393,906	133	24,590,167
Southeast	2.24	4476	5,195,191	207	78,797	1844	917,051,819	759	309,034,477

Sources: IBGE (2018) and Digital Atlas of Disasters in Brazil (available at: <http://atlasdigital.mdr.gov.br/paginas/index.xhtml>; accessed on: Oct. 10, 2021).

Authors' elaboration.

Obs.: In bold are the highest values per region.

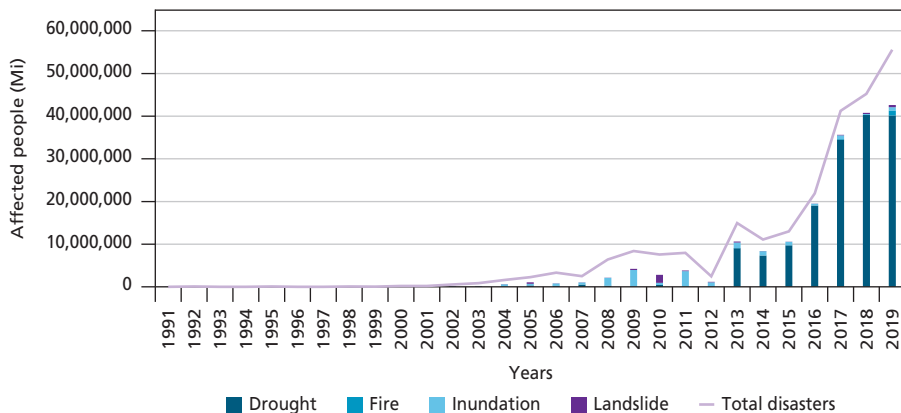
In general, municipalities are the ones that suffer the most, when compared to state and federal power, from negative impacts of natural disasters (CNM, 2018). In fact, municipalities are the places where disasters happen and managers need to handle them. The National Confederation of Municipalities (CNM, 2018) urges managers to charge states and the Union with more efficient public policies that help municipalities in civil defense and protection actions and to recover material, environmental, social and financial damages from natural hazards.

In addition, according to AON (2021), in 2020 Brazil has lost US\$ 3.6 billion attributed to natural disasters as fire, floods and droughts. Freitas et al. (2020) identified nearly R\$ 4 billion of impacts and economic costs of natural disasters only for healthcare establishments (5,000 records from 2000 to 2015). In 2021, the federal government released R\$ 450 million for Civil Defense actions. Although there is not much information on the monetary costs and benefits of public policies to natural DRR and, especially of PES policies to that and to society in general, managers and decision makers must consider that a risk management strategy should include direct impacts – DRR actions – and measures targeting indirect impacts – resilience building actions (Hallegatte, 2015). Thus, it is very likely that PES as an environmental, social and economic approach to DRR and prevention is more than worth it.

### 3.4 Affected population and beneficiaries of the politics

Affected populations by disaster have been increasing in Brazil, especially by drought (figure 2). Among the four studied disasters, two could affect more urban populations (floods and landslides), while the other two (drought and fire) would affect more rural populations in Brazil. Additionally, these two kinds of populations (rural and urban) might be positively affected by PES projects, as the unequal distribution of conservation costs often affects vulnerable populations in economically marginal and environmentally sensitive areas (Montoya-Zumaeta, Wunder and Tacconi, 2021). About a third of Brazilian urban homes in risk areas (in hilly relief) do not have sanitation, promoting soil erosion and increasing the chances of landslides and floods (IBGE, 2018). Children in the northern region and elderly in the southern region (IBGE, 2018) are the most vulnerable people to hazards.

FIGURE 2  
Number of people affected (human damage) by disasters in Brazil (1991-2019)



Source: Digital Atlas of Disasters in Brazil. Available at: <http://atlasdigital.mdr.gov.br/paginas/index.xhtml>. Accessed on: Oct. 10, 2021. Authors' elaboration.

Beneficiaries of the National Policy for Payment of Environmental Services are in general rural land owners, because urban PES projects are still not seen in Brazil. In the last ten years, short-term crops and planted pastures have increased in Brazilian farms and cattle ranches, indicating an intense soil management and use (IBGE, 2017). On the other side, native forest cover has grown and no-till farming areas almost doubled (IBGE, 2017). That shows a scenario of a need for ecosystem restoration, conservation incentives and thus, PES incentives.

### 3.5 Target alignment and national and international agreements

The PPA for the period 2020 to 2023 (Law No. 13.971 of December 27, 2019) which reflects public policies, guides government action and defines guidelines, objectives, goals and programs, was made before the approval of the PES Act of January 13, 2021. Thus, there are no references to the National PES Policy. However, in the publications of the Intermediate Results, which is a result of government action that significantly contributes to the achievement of the Program's objective or goal, the PPA 2020-2023 makes reference to the normative act (base year 2020) and the ordinance (base year 2021) published, establishing the Payment for Environmental Services Program (PES or PSA, in portuguese) only related to the "Prevention and Control of Deforestation and Fires in Biomes" (Brasil, 2021b), which could help to achieve the goal of reducing deforestation and illegal fires in biomes by 90%.

Among the 12 other studied national policies (table 1), when analyzed by the relationship between ecosystem services and disaster prevention, the national policy is aligned with 5 of them, namely:

- PNRH (Law No. 9.433 of January 8, 1997) with regards to prevention and defense against critical hydrological events of natural origin or resulting from inadequate use of natural resources (Brasil, 1997, art. 2<sup>a</sup>, III);
- Native Vegetation Protection Law (Law No. 12.651 of May 25, 2012) with regards to carbon sequestration, conservation of water and water services, climate regulation and soil conservation and improvement (Brasil, 2012b, art. 41);
- National Policy for the Recovery of Native Vegetation (Decree No. 8.972 of January 23, 2017) regarding adaptation to climate change and mitigation of its effects, prevention of natural disasters, protection of water resources and soil conservation, encouraging conservation and restoration of biodiversity and ecosystem services (Brasil, 2017, art. 4<sup>a</sup>);
- National Civil Defense and Protection Policy (Law No. 12.608 of April 10, 2012) regarding urban planning and rural land occupation, with a view to its conservation and protection of native vegetation, water resources and of human life (Brasil, 2012a, art. 5<sup>a</sup>); and
- National Policy to Combat Desertification and Mitigate the Effects of Drought (Law No. 13.153, of July 30, 2015) with regard to preventing and combating desertification, land degradation, effects of drought, instituting protection mechanisms, preservation, conservation and recovery of natural resources (Brasil, 2015c, art. 3<sup>a</sup>).

Despite the importance of these alignments, the clear and direct prevention to natural disaster in the National Policy for Payment of Ecosystem Services is incipient.

Regarding international agreements and commitments, the PNPSA has been aligned with four of them, namely: *the Sendai Framework for Disaster Risk Reduction 2015-2030*, the UNFCCC (Decree No. 2.652, of July 1, 1998), Paris Agreement and the SDGs, which are part of the 2030 Agenda of the UN. The benefits provided by ecosystem services could directly contribute to objectives that involve, in general, adaptation to climate change, reduction of greenhouse gasses, DRR instruments, implementation of ecosystem-based approaches, especially areas subject to floods, drought and desertification.

Specifically, to the SDGs, the PNPSA can directly relate to:

- goal 2 – Zero Hunger and Sustainable Agriculture, in goal 2.4, which involves sustainable food production systems that help maintain ecosystems and the capacity to adapt to climate change, extreme weather conditions, droughts, floods and other disasters, in addition to improving soil quality;
- goal 6 – Drinking Water and Sanitation, in target 6.6 to protect and restore water-related ecosystems;
- goal 13 – Action Against Global Climate Change: take urgent action to combat climate change and its impacts; and
- goal 15 – Land Life, especially in goal 15.3, which aims to combat desertification, restore degraded land and soil, including land affected by desertification, droughts and floods, and strive to achieve a neutral world in terms of land degradation.<sup>15</sup>

The PNPSA, as an instrument of Brazilian environmental policy, meets many environmental needs, not only locally, but also globally. We must consider that PES, as a market incentive, is not yet fully aligned with safeguarding nature and improving ecological behavior and perceptions of social actors, serving as a stimulus to the market by not questioning current production patterns and consumption (Jodas, 2021). This discussion is necessary in new studies and future assessments of the PNPSA.

### 3.6 Integrated approach of intervention

The application of analysis of FSD allowed identifying alignment and overlapping of the PNPSA's objectives with various national and international policies (table 1), especially with regards to preservation, conservation and recovery of

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15. Available at: <https://brasil.un.org/pt-br/sdgs>.



environmental resources. The target audience and beneficiaries of these policies are society in general, but PNPSA addresses also traditional communities, indigenous peoples, family farmers and rural family entrepreneurs.

As this is a new policy, it still does not have direct and perceived benefits delivered to society (besides the police itself). But again, the relation between ecosystem services and DRR needs to be better approached by involving the National Civil Defense and Protection Policy, and by coordinating inter-ministry institutional management (Ministry of Environment and Ministry of National Integration) and governance mechanisms to the execution of the PNPSA. The need for coordination between government bodies could make resources allocated to these policies meet the needs and involve all interest groups in society, especially the most vulnerable communities throughout the national territory, at their appropriate municipal and state scales. Establishing a well-structured database for these future assessments is also important, combining information sent by federal, state and municipal governments, by private agents and non-profit organizations (Brasil, 2021a, art. 16).

### **3.7 Problem solution based on international experiences**

PES as an economic tool is increasingly being used to protect ecosystems and their ecosystem services under threat, improving climate change mitigation efforts on a global scale and reducing carbon emissions from land use change. However, biophysical stressors external to the PES project site, such as forest fires, can threaten ecosystem stability and become a challenge for PES project development (Friess et al., 2015). Strategies to deal with these stressors should be incorporated into the PES project, such as: exposure and vulnerability assessment, mitigation and financial instruments for accommodation. (Friess et al., 2015).

In Brazil there is still a lack of results evaluating PES programs. In 2021, the São Paulo state Secretariat of Infrastructure and Environment (Sima) and the Research Funding Agency (Fapesp) released a call for researchers that would evaluate a great PES state program (Conexão Mata Atlântica). The inclusion of natural hazards prevention in their researches was not mandatory, though. In Denmark, PES programs have been generating recorded benefits related to natural hazards prevention: water quality, in addition to reducing the risk of flooding, mitigating climate change, recreation and other ES through tree planting, replacing polluting agricultural activities in specific areas of the watershed, which led to retention of nutrients, erosion control, river flow regulation, protection against extreme events (Valatin et al., 2022). In Mexico, hydrographic basins are taken as a study unit, with the aim of mitigating and improving the population and ecosystems' adaptive capacity to climate change, through a comprehensive, systemic, participatory, territorial and transdisciplinary approach, which includes

the identification of areas of greater vulnerability and risk of landslides, with recommendations for land use planning and disaster prevention. A differential is a population capacity development, organizing them into Intercommunity Territorial Action Groups (Giat), to enable management based on collective action, common interest and organized participation. Something similar was observed in Thailand (Kanchanaroek and Aslam, 2018) using interviews with land owners to identify incentive-based policies, such as PES, and strategic areas for effective implementation of policy frameworks. These are possible strategies for Brazil, via river basin committees that can assess local population needs and development of PES programs.

In Peru, involvement of non-governmental organizations (NGOs) as implementers or facilitators was essential for progress of PES programs, as they carried out environmental education work. Payment models must consider legal constraints and financing scarcity, giving preference to rewards in form of technical assistance, reforestation and agroforestry inputs, and promoting sustainable economic activities. Transparency ensures reliability of SE payers in the programs, especially including participatory spaces to inform stakeholders about management aspects of common interest and expansion of communication through different media (Montoya-Zumaeta, Wunder and Tacconi, 2021). Lastly, the Chinese government changed environmental views and policies to benefit long-term ecological services provided by ecosystems in forest management, such as soil and water conservation, sandstorm control and climate regulation (Zhang et al., 2017). Thus, environmental education and a long-term view of environmental policies are very much needed for Brazilian policies.

Besides these recommendations, a consultative board composed of representatives of public power, productive sector and civil society, evaluating, monitoring compliances and suggesting adjustments to the policy, is necessary.

#### **4 CONCLUDING REMARKS**

This study aimed at verifying the inclusion of regulating services (namely prevention to natural disasters) in a national legislation, the National PES Policy. In general, we found that the clear and direct prevention to natural disaster through actions in the National Policy for Payment of Ecosystem Services is incipient. It is known that PES can maintain and increase the supply of ecosystem services by reducing soil erosion and water production and hazards risk (Sone et al., 2019). Based on this research, new forms of approach and treatment of disaster risk management may be proposed in future public policies involving ecosystem services, at municipal, state or federal levels, supported by adaptation strategies based on ecosystems in search for mitigation and prevention of events that lead to disasters.

Further studies are needed to understand how and how effective these conservation tools are and how PES, by encouraging farmers to restore and protect ecosystems, contributes to the conservation of ecosystem services. Maintaining a registration and monitoring network will be essential to generate a database that will contribute to future assessments of the PNPSA.

Benefits of PES are not limited to the provision of ecosystem services, but a social dimension is also perceived by involving local populations in designing and executing programs that raise awareness of forest and soil conservation importance, fire prevention and water uses. Thus, this research can bring reflection to governments and the private sector on that (Brasil, 2021a, art. 15).

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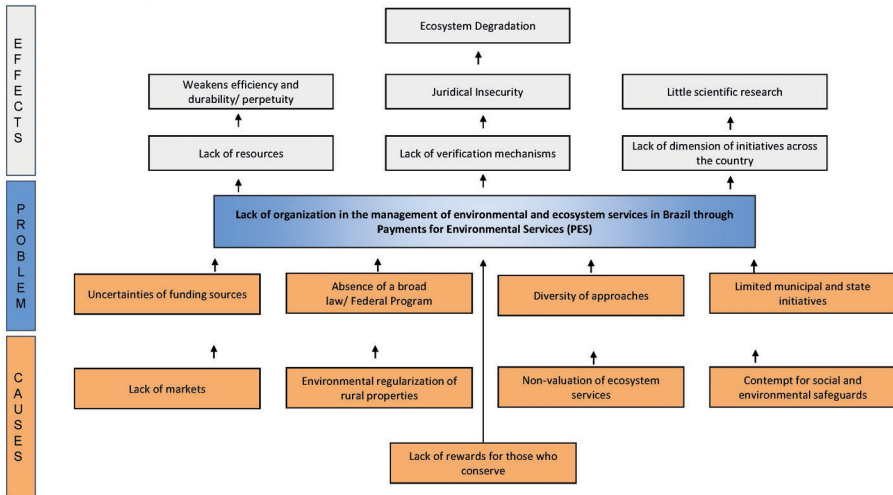
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**APPENDIX A**

**FIGURE A.1**  
**Problem tree for the diagnosis of Law No. 14.119/2021 (National Policy on Payment for Environmental Services): causes, problems and effects**

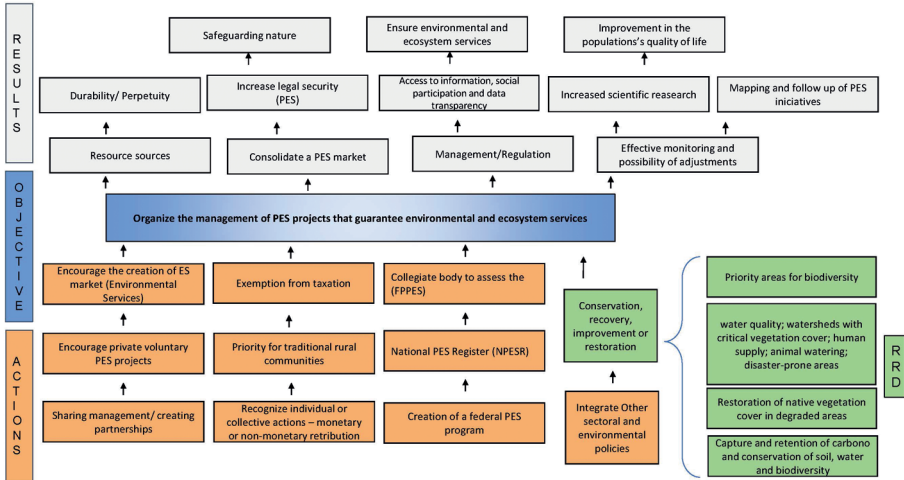


Authors' elaboration.

Obs.: Figure whose layout and texts could not be formatted due to the technical characteristics of the original files (Publisher's note).

APPENDIX B

FIGURE B.1  
**Objective tree for the diagnosis of Law No. 14.119/2021 (National Policy on Payment for Environmental Services): policy actions and processes, objective and results**



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