

Climate public expenditure and institutional review CPEIR in Pernambuco state (Brazil)

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ABSTRACT

Climate change is a reality that governments at different levels around the world need to consider in their planning agendas. This work aimed to analyze public spending related to climate change in the state of Pernambuco between 2008 and 2019. United Nations and World Bank methodologies were used to identify and classify official public documents. The results showed that only 0.16% of public spending is related to climate change. On average, only 54% of the authorized budget is in fact executed for climate change programs in just one year there was a reduction in emissions, in the others the average of 25% increase in relation to 2005. Thus, there is evidence that the actions of the government of the state of Pernambuco are being inadequate to cope with climate changes and, consequently, public spending may be inefficient.

Keywords: Public Environmental Expenditure Review, Public Policies, Environmental Economics, Public Budget, Climate Change.

Revisão institucional e dos gastos públicos no enfrentamento às mudanças climáticas no estado de Pernambuco (Brasil)

RESUMO

As mudanças climáticas são uma realidade que governos de diferentes níveis pelo mundo precisam considerar em suas agendas de planejamento. Este trabalho visou analisar os gastos públicos relacionados às mudanças climáticas no estado de Pernambuco entre 2008 e 2019. Utilizou-se a metodologias das Nações Unidas e Banco Mundial, para identificação e classificação de documentos públicos oficiais. Os resultados demonstraram que apenas 0,16% dos gastos públicos são relacionados com mudanças climáticas. Em média apenas 54% do orçamento autorizado é realmente executado para os programas de enfrentamento as mudanças climáticas. Em apenas um ano houve redução das emissões, nos demais a média de 25% de aumento em relação a 2005. Dessa forma há indícios que as ações do governo do estado de Pernambuco estejam sendo inadequadas ao enfrentamento as mudanças do clima e consequentemente os gastos públicos podem estar sendo ineficientes.

Palavras-Chaves: Revisão de Gastos Públicos Ambientais, Políticas Públicas, Economia Ambiental, Orçamento Público, Mudanças Climáticas.

1. Introduction

Over the past three centuries, the effects of humans on the global environment have increased. The extent of these alterations has generated changes considered sufficient for the recognition of the Anthropocene as a new geological epoch (Waters et al., 2016; Zalasiewicz et al., 2008). Among these changes, the increase in anthropogenic carbon dioxide emissions has generated modifications in the global climate that may have its natural behavior altered for millennia (Crutzen, 2002), reflecting the increased frequency of extreme events.

These extreme weather events are risks aggravated by climate change. The Intergovernmental Panel on Climate Change (IPCC) suggests that climate change accelerates various processes that imply loss of biodiversity (UNDRR, 2019), with an impact on the health, socio-economic and well-being of society (Eckstein, Künzel, Schäfer, & Wingses, 2020; Diffenbaugh & Burke, 2019).

Guiding society toward environmentally appropriate management is one of the most challenging tasks for scientists during the Anthropocene era. It will require appropriate human behavior at all scales and involve large-scale projects to "optimize" the climate (Crutzen, 2002). Thus, public policies must be effective instruments in optimizing the relationship between society and its environment to adapt to this new era of the Anthropocene.

However, public policies have costs when implemented, especially when related to climate change (Tozato, Luedemann, Frangetto, & Moreira, 2019). In this aspect, public spending is crucial in environmental policy since the execution of these policies depends on the availability of the public budget (Gramkow, 2018). In addition, there is a lack of information about the analysis of environmental public spending in Brazil, especially regarding subnational levels of government (Tridapalli, Borinelli, Campos, & De Castro, 2012).

Thus, this paper aims to evaluate public spending on the State Policy on Climate Change in Pernambuco. It is considering that this is a fundamental policy for the state's adaptation to the challenges imposed by the climate in the current context.

2. Theoretical Background

The analysis of climate change policies is a way to explore the connections between adaptation and mitigation concepts that recur in the academic landscape. Policies with objectives categorized into adaptation and mitigation can increase synergies and reduce unintended consequences, increasing their cost-effectiveness (Locatelli et al., 2020). They classify the Policies and projects relevant to climate change as mitigation, adaptation, an interface between mitigation and adaptation, and natural disaster risk reduction (Le et al., 2015).

The policies, plans, and projects of these themes act in an integrated and complementary way to address the consequences of climate change. Mitigation is an intervention to reduce sources of emissions or increase sinks of greenhouse gases (GHG). Adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. These two main strategies differ in terms of their spatial scales. While climate change is an international issue, the benefits of adaptation are local, and mitigation benefits are global. Mitigation and adaptation also differ in terms of time scales and economic sectors (COBAM, 2011).

The Disaster Risk Reduction (DRR), the fourth classification for climate change-related actions, consists of a series of interconnected actions to minimize vulnerability to disasters by avoiding or limiting adverse effects. DRR and adaptation have overlapping objectives and involve similar types of intervention and share the goal of reducing the impacts of shocks by anticipating risks and addressing vulnerabilities (Twigg, 2015).

Based on the understanding of these concepts, the methodological proposal of this work is to conduct a Public Expenditure Review (PER). This review is a diagnostic study that helps national or subnational governments understand economic challenges, provide insights to guide policy dialogue, and recommend more effective mechanisms to allocate available public resources (Boueri, Rocha, & Rodopoulos, 2015). Public spending reviews involve analyzing the allocation, management, and outcomes of public spending and can

cover all government spending or focus on priority sectors (CDDE - THE CAPACITY DEVELOPMENT FOR DEVELOPMENT EFFECTIVENESS, 2012).

More specifically, the Public Environmental Expenditure Review (PEER) process helps assess a government's environmental management capacity by looking at the results of that management as reflected in public expenditures (Swanson & Lunde, 2003). Thus, public expenditure review, although often an underrated environmental policy tool, has a vital role in addressing environmental concerns (Gupta, Miranda, & Parry, 1995).

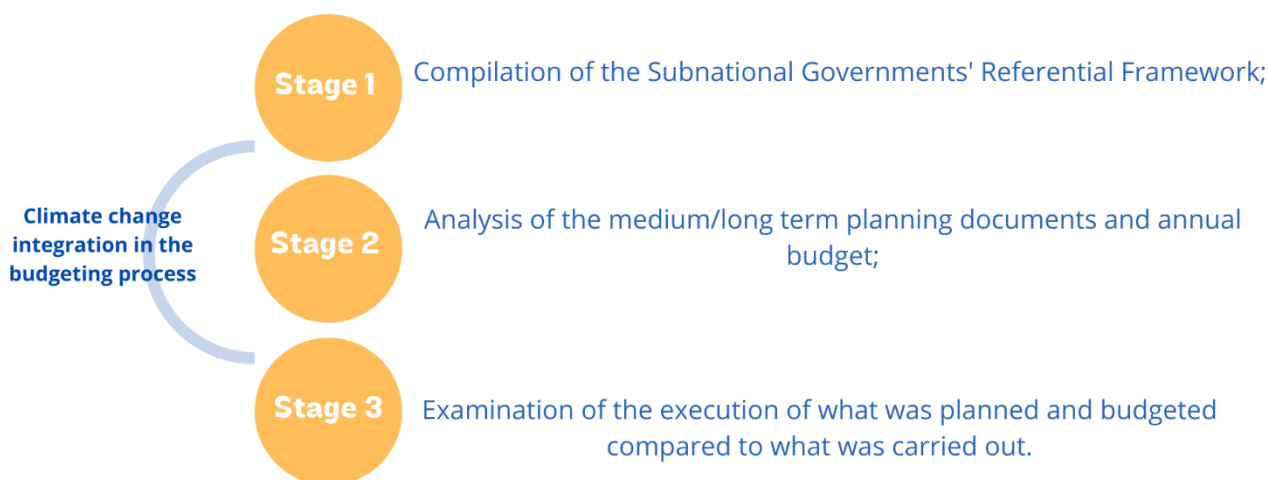
The Climate Public Expenditure and Institutional Review (CPEIR) examines the links between the three spheres: climate change policy; the institutional structures through which policy is channeled; and the resource allocation processes through which public funding is made available to implement relevant projects, programs, and policies (Bird et al., 2012).

The challenge in tracking climate spending in developing countries is the lack of definition of climate change spending and how and what the criteria and method for tagging such spending should be. Therefore, implementing strategies to mark these expenses can be used to define the current picture better. According to Le et al. (2015), mitigate the risk is essential of overestimating climate change expenditures in cases where 100% of the expenditures are counted as funding for these purposes, while the activity is only slightly relevant to the topic.

The financial aspects of a state or local government comprise a set of economic, social, and demographic variables. Regarding the data produced by the government, can observe some points: a) define the level of the analysis; b) establish the objectives of the analysis; c) determine the temporal dimension; d) determine an analysis model; e) ensure reliable financial information; f) determine and analyze the benchmarks to judge the financial condition in the government (Lima & Diniz, 2016).

3. Material and Methods

According to the theoretical background, this study aims to analyze public spending on climate change at the subnational level based on the methodology by Mendes et al. (2017). This methodology aims to incorporate the issue of climate change in the process of financial planning and budgeting. It covers three of the four steps: 1) compilation of the reference framework of the Subnational Governments; 2) analysis of the medium/long term planning documents and annual budget, and 3) examination of the execution of the planned and budgeted face to face what was effectively carried out (Figure 1).

Figure 1 – Stages of the institutional review process and public spending on climate change in subnational governments

Source: Elaborated by the authors based on Mendes et al. (2017).

Selected as referential frameworks: 1 - the State Policy for Confronting Climate Change in Pernambuco (PEEMC/PE Portuguese abbreviation) Law No. 14.090, of June 17, 2010; 2 - the State Policy for Technical Assistance and Rural Extension for Family Agriculture of Pernambuco (PEATER - Portuguese abbreviation), the State Program of Technical Assistance and Rural Extension for Family Agriculture (PROATER - Portuguese abbreviation), Law No. 15. 223 of December 24, 2013; 3 - The State System of Nature Conservation Units (SEUC - Portuguese abbreviation) Law No. 13.787, of June 8, 2009, and 4- State Policy for Payment for Environmental Services and the State Program for Payment for Environmental Services and the State Fund for Payment for Environmental Services, Law No. 15.809 of May 2016. In addition, analyze Multi-Year Plans for 2008 to 2011, 2012 to 2015, and 2016 to 2019 years and the respective Budget Balance in transparency portal of the government of Pernambuco.

It is necessary to understand that the budget can be described as a fiscal plan to allocate government spending (Howard, 2001). The current planning and budgeting system adopted by the Union (Federation), states, and municipalities are built based on the 1988 Federal Constitution of Brazil (Garson, 2016). The Executive Branch forwards to the Legislative Branch the projects that refer to the budget laws. These laws have the support of three instruments:

- a) The Multi-Year Plan (PPA): consolidates, qualifies, and sizes the government programming for the next four years.
- b) The Budget Guidelines Law (LDO): establishes goals and priorities in the government programming for the following year.
- c) The Annual Budget Law (LOA): allocates resources to the programming for the year, following the guidelines of the LDO.

The PPA, the LDO, and the LOA are linked. The PPA of each administration is submitted to the respective legislature and must be voted on by the end of the first fiscal year, covering the second, third, and fourth years of this administration and the first year of the next, in the current arrangement of four-year terms. To this PPA (and its possible revisions) are linked the LDO's and the LOA's of each of the four years (Table 1) (Garson, 2018).

Table 1 – Relationship between the PPA, LDO, and LOA in the budgeting process.

Administração 1 - 2007 a 2010				Administração 2 - 2011 a 2014				Administração 3 - 2015 a 2018			
2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
PPA 2008 a 2011				PPA 2012 a 2015				PPA 2016 a 2019			
LOA 2008 base LDO 2008	LOA 2009 base LDO 2009	LOA 2010 base LDO 2010	LOA 2011 base LDO 2011	LOA 2012 base LDO 2012	LOA 2013 base LDO 2013	LOA 2014 base LDO 2014	LOA 2015 base LDO 2015	LOA 2016 base LDO 2016	LOA 2017 base LDO 2017		

Source: Elaborated by the authors based on Garson. (2018)

As of 2002, public spending began to follow the functional classification of the Ministry of Planning, Budget, and Management (MPOG - Portuguese abbreviation) Ordinance No. 42, which changed the functional-programmatic classification of spending. This classification details the budget and budget execution by areas of government action, called Functions of Government, divided into sub-functions related to public policies. This classification allows for identifying the LOA of the PPA program links by four-digit codes (Garson, 2016). Classify the information taken from these official documents: a) mitigation, b) adaptation, c) adaptation and mitigation (in initiatives that concern both dimensions), d) natural disasters, and e) Adaptation and Disasters (Mendes et al., 2017).

Finally in expenditure reviews, which can be of three main types: a) Program reviews: examine specific programs and can provide efficiency gains or savings of outputs, or both. b) Process reviews: closely examine specific business processes used in the production of public services. These reviews help to achieve efficiency gains rather than product savings. c) Organ reviews examine an entire public agency (ministry or other body) and can, in principle, cover all programs and processes of the agency (Boueri et al., 2015).

A program review was chosen, considering that the program approach has better characteristics as it ensures that budget and expenditure data are associated with specific programs, activities, targets, and indicators (UNDP, 2018). Thus, considering these issues of organization of the PPA's, the classification took place in two stages:

- i) Selection at the program level to determine those related to climate change.
- ii) Selection and classification at the level of actions to determine those actions related to climate change and classification according to previously established classes.

4. Results and Discussion

4.1. Review of the Institutional Referential Framework

The referential framework concerns government actions that have a direct or indirect connection. According to the method of Mendes (2017), analyzes the contribution of policies created by the Executive Power of the state (PEEMC/PE - Portuguese abbreviation) (Law No. 14.090/10), PEATER/PE, and PROATER/PE (Law No. 15.223/13), SEUC-PE (Law No. 13.787/09) and PEPSA/PE and PROEPSA/PE (Portuguese abbreviation) (Law No. 15.809/2016) in addressing climate change. First, identifying the strand to which the legal provision qualifies in actions aimed at mitigation, adaptation, or disasters—considering intersections of combined actions between mitigation and adaptation, adaptation, and disasters.

The PEEMC/PE is under responsibility for the Secretariats of Science, Technology, and Environment and Health (SECTMA - Portuguese abbreviation). The division of PEEMC/PE policy is into six chapters, wherein chapter III there are mitigation and adaptation strategies that have thirteen sections: energy; transportation; industry and mining, public sector; agriculture and livestock; biodiversity and forests; water resources; waste and consumption; construction; health; ocean and coastal management; semi-arid and desertification; land use and urban vegetation cover. Analyzing the content of PEEMC/PE, we found 37

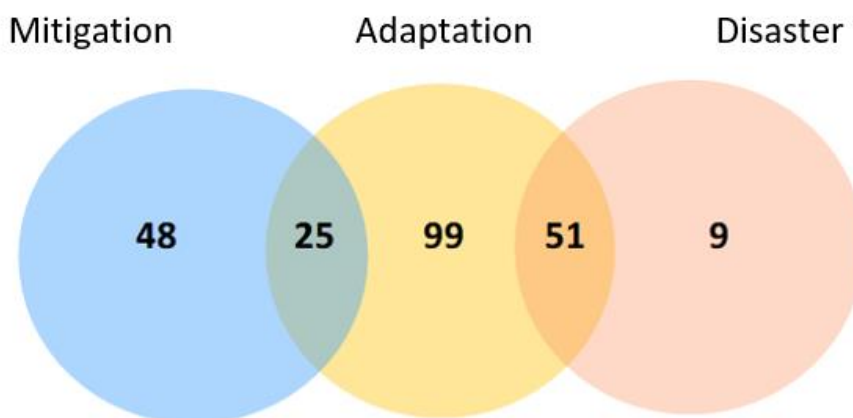
mitigation actions, 55 adaptation actions, 25 actions that correspond to combined actions, eight actions related to disasters, and 34 related to disaster prevention and response.

The PEATER/PE is under the Secretariat of Agriculture and Agrarian Reform - SARA's responsibility through the Executive Secretariat for Family Farming - ESFF. The ESFF has content related to Article 5, where eighteen sections deal with the objectives aligned to family agriculture, with the primary instrument is PROATER/PE. The PROATER/PE has the function of organizing, executing, and monitoring the services provided to beneficiaries of Technical Assistance and Rural Extension (TARE). In analyzing the content of PEATER/PE, found only nine adaptation actions and eight actions related to disaster prevention and response.

The article 4 of SEUC/PE, created under the Secretariat of Science, Technology, and Environment (SECTMA) responsibility, presents fifteen items focused on conserving natural resources. The System dialogues with PEPSA/PE, whose primary instrument is PROEPSA/PE, establishes five sub-programs. In analyzing SEUC/PE and PEATER/PE contents, found only actions for adaptation and disaster prevention and response, 14 and 1, respectively.

PEPSA/PE and PROEPSA/PE policies are under the State Secretary of Environment and Sustainability and the Executive Committee of the State PES Program, have 11 mitigation actions, 21 adaptation actions, eight disaster prevention and response actions, and one emergency action for vulnerable areas (Figure 2). (Figure 2).

Figure 2 – Analysis of the types of climate change coping strategies present in the legal framework of reference in the state of Pernambuco.



Source: Elaborated by the authors based on Mendes et al. (2017).

Most of the actions analyzed have the purpose of anticipatory/proactive responses before an impact or autonomous/responsive/reactive act after the impact. The adaptive actions encompass a relatively wide range of actions (Andrade, Emilio, & Nunes, 2017), which is why most of the actions in the analyzed policies fall under this classification. Moreover, the PEEMC has 159 actions, of which 56% are adaptation actions, which fundamentally institute actions to promote, stimulate, and create responses concerning climate change to moderate or avoid damage.

These actions explain why there is a more significant provision of adaptation strategies in the policies that make up the legal framework for tackling climate change in the state of Pernambuco. Most of the policies are from the past decade, which explains this distinction between adaptation and mitigation. The balancing of strategies is essential in the fight against climate change because the investment in actions directed both to mitigation and adaptation increases the efficiency of allocating funds for these purposes (Barnett & O'Neill, 2010).

4.2 Identification of the Allocation of Actions to Address Climate Change

After identifying the strategies to confront climate change at the policy level, we sought to identify allocated resources for this purpose in the budget forecast of the state government between 2008 and 2019. In this way, it identifies different government programs and actions according to their functional classification formed by functions and subfunctions to demonstrate in which areas of expenditure the government action will be performed (BRASIL, 2017). This classification serves to aggregate public spending in predetermined thematic areas. The classification represents by a two-digit code and the subfunctions with three-digit codes established by Ordinance No. 42, of April 14, 1999, of the Ministry of Planning Budget and Management.

Found fifty-two programs in 1,080 actions in the state's Budget Balances from 2008 to 2019 and observes an extreme concentration of actions located in the environmental management function (Table 2).

Table 2 - Allocation of actions for climate change in the state of Pernambuco according to the functional classification of the budget.

Function	Action's quantity	Percentage (%)
18. Environmental Management	824	76,29%
20. Agriculture	65	6,01%
17. Sanitation	42	3,88%
04. Administration	40	3,70%
06. Public safety	32	2,96%
15. Urbanism	30	2,77%
23. Commerce and services	21	1,94%
25. Energy	14	1,29%
16. Housing	8	0,74%
26. Transport	4	0,37%

Source: Elaborated by the authors based on data the budget balances of the Pernambuco state government between 2008 and 2019.

Observes the concentration of budget forecast actions in the environmental management function. Due to the characteristics of the theme that affect all areas of governmental action, the expectation is more significant outside the specific area of environmental management.

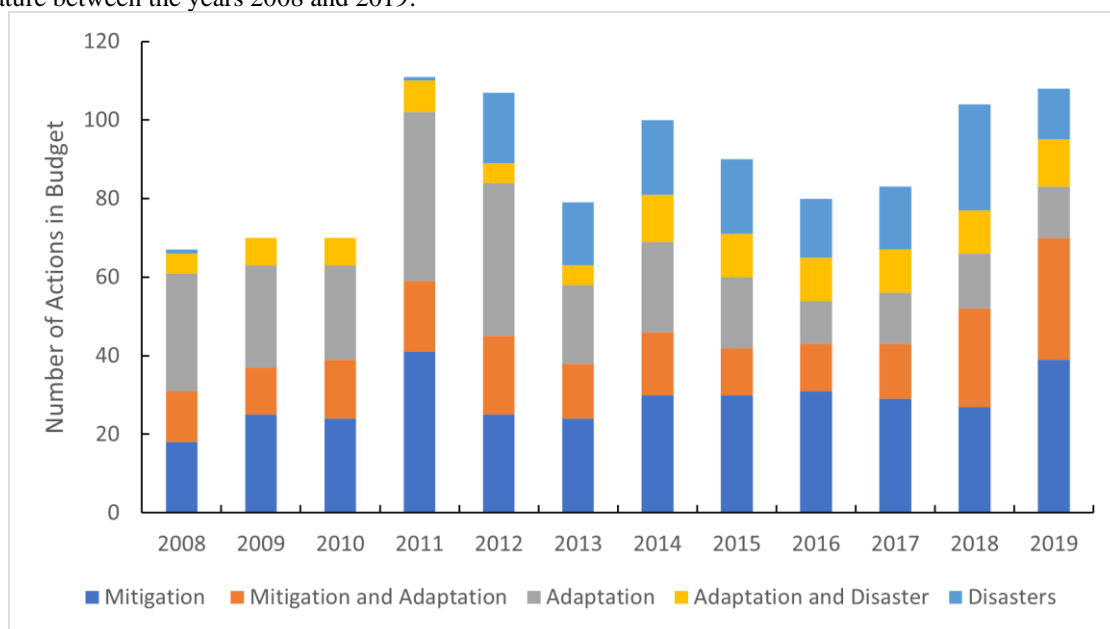
The actions to tackle climate change cannot be isolated, as a strictly environmental problem and development and climate risk management issue that can affect several sectors (agriculture, health, energy, finance, industry, and water resources, for example). For this reason, the lack of coordination of environmental policies can generate inefficiency, lack of speed and coherence in their actions, impacting the organizational and institutional infrastructure that supports decision-making (Castro & Young, 2017).

This aspect underscores the idea that many of the environmental issues addressed by the environmental policy are provoked by unintended external effects of policies that misjudge the interaction with the natural system. This apparent lack of cross-sectoral policy integration supports the need to promote a more integrated approach to policy analysis (LeBlanc, 2015). In this way, it is possible to prevent incongruities between policies from different sectors from compromising development in ways that are appropriate to today's environmental challenges (Timko et al., 2018).

Analyzing the 1,080 climate change actions found in the state government budget between 2008 and 2019 can observe a variation over the years. The year 2011 groups the most considerable actions in the mitigation and adaptation categories, with 41 and 43, respectively. The year 2019 had the most actions in the two combined categories, mitigation and adaptation, and adaptation and disasters, with 31 and 12, respectively.

The year 2014 also had 12 actions dedicated to the adaptation and disaster category, while in 2018, there was a more significant number of actions dedicated to the disaster category, with 27 actions (Figure 3).

Figure 3 – Evolution of the budgetary actions to tackle climate change in the Pernambuco state government according to their nature between the years 2008 and 2019.



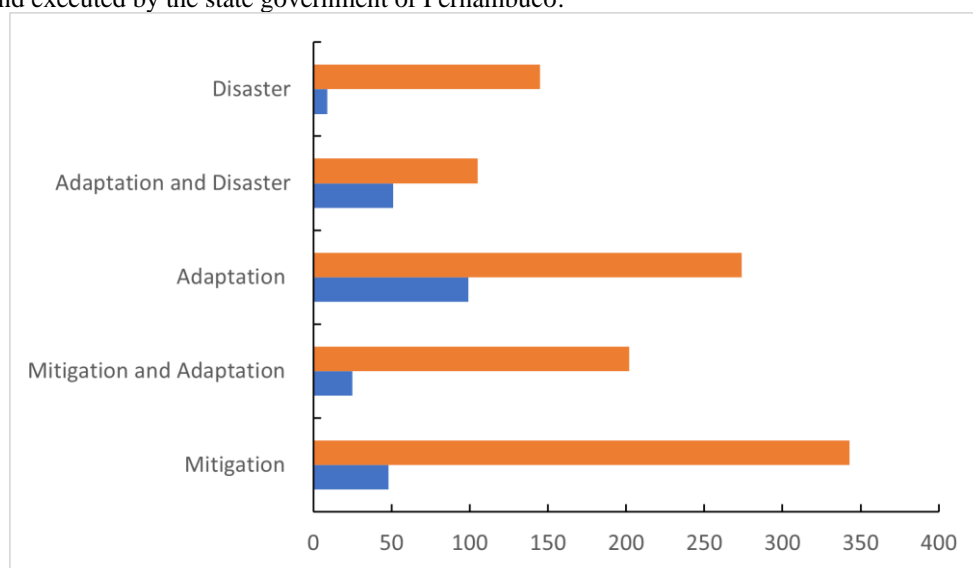
The survey of these data on government programs and actions, in the Multi-Year Plans - (PPA's - Portuguese abbreviation) and Budget Balances also allowed a comparison between the nature of the activities provided for in the analyzed legal framework (Figure 1), with those that the state government executed (Figure 2). In this way, we can compare if the actions of the Pernambuco state government to tackle climate change follow the guidelines provided in the state laws in proportional terms.

Comparing the proportions of the different classes of actions to tackle climate change foreseen in the legal instruments and executed by the state government of Pernambuco in the years 2008 to 2019, we notice asymmetries in the result. In addition to the predominance of actions of an isolated nature (e.g., mitigation only, or adaptation only, or disasters only), it is possible to observe an inversion of policy adaptation strategies. At the same time, in the policy adaptation strategies, those classified as mitigation predominate in the budget actions (Figure 4).

Policy integration is standard in public policy administration because the integration recognizes the possibility of overlapping, restricting, or even suppressing bureaucratic structures. As an example, our analysis presents intersections between mitigation, adaptation, and disasters in distinct policy actions. Utilizing this concept applies environmental criteria in various areas of public policy, such as agriculture, energy, and transportation, to better coordinate them (Donadelli, 2017).

In Pernambuco's climate legislation, adaptation actions are present in more significant amounts, while the budget is more focused on mitigation actions. Explain the divergence by the fact that actions bring benefits and have different political characteristics. In a place without catastrophic events and decision-makers with a strong preference for the present, adaptation actions are undoubtedly the preferred option. Adaptation actions are also preferable in gross benefits when measured by Gross World Product (GWP). However, in terms of net benefits, subtracting policy costs, mitigation is considered more advisable (Bosello, Carraro, & De Cian, 2010).

Figure 4 – Comparison between the proportions of the different classes of climate change actions foreseen in the legal instruments and executed by the state government of Pernambuco.



Inside the Figure 4: Orange/Actions in the budget, Blue/Actions in policies

Source: Elaborated by the authors based on data the budget balances of the Pernambuco state government between 2008 and 2019.

The divergence between the focus of actions in climate legislation and the Pernambuco budget originates because mitigation and adaptation actions are competing strategies. Successful adaptation reduces the marginal benefits of mitigation, and a successful mitigation effort reduces the environmental damage to which it is necessary to adapt (Birkmann & von Teichman, 2010).

However, systematic cost-benefit analyses in the literature show that the setup confirms that integrated implementation of mitigation and adaptation improve societal welfare. The two strategies are strategic complements, and both need to be part of a cost-effective climate change strategy. Both options are necessary because they can reduce vulnerability to climate change through two different but complementary mechanisms (Vijayavenkataraman, Iniyan, & Goic, 2012).

There is a consensus that addressing climate change addresses several sectors of society, such as agriculture, health, and infrastructure. Disaster risk reduction (DRR) includes these sectors, although the relationship between the approaches remains uncertain. Conceptual differences are indeed one of the factors that have so far prevented an effective link between the academic circles of mitigation, adaptation, and that of disasters (Lal et al., 2012).

It is essential to recognize that complex systems involve multiple physical, social, cultural, economic, and environmental variables that cannot be measured using the same methodology. These aspects indicate that a risk weighting or measurement involves the integration of several disciplinary perspectives. An integrated, interdisciplinary focus can more consistently take the nonlinear relationships of parameters, the context, complexity, and dynamics of social and environmental systems, contributing to more effective risk management by the different stakeholders involved in making risk reduction or adaptation decisions (Lal et al., 2012).

Assessments of climate change impacts, vulnerabilities, and risks are changing focus, leading to greater integration between issues. Initial studies focused on analyzing the problem and now, more recently, have begun to combine these assessments to consider specific risk management methods. Thus, collaboration and integration are needed to set appropriate policy agendas and to better understand the topic of interest for the

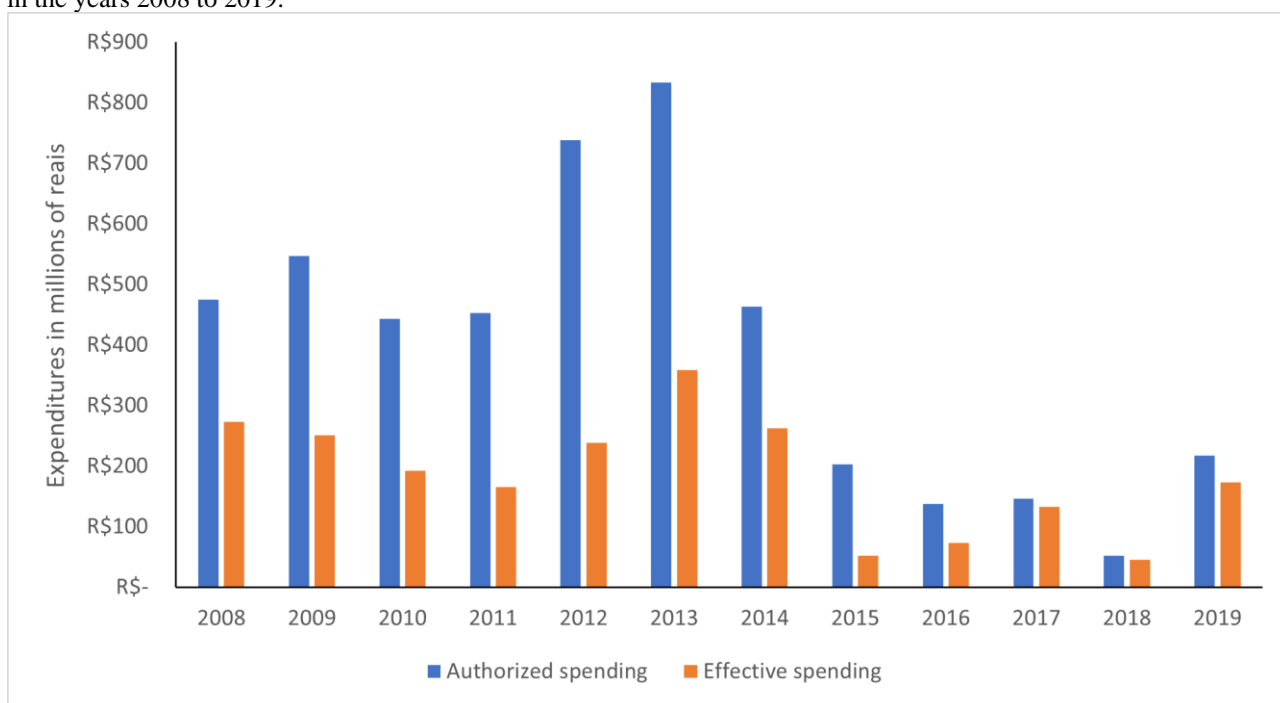
next few decades. Closer integration of disaster risk management and climate change adaptation, along with the incorporation of local, subnational, national, and international development policies and practices, could provide benefits at all scales for all countries around the world (UNDRR, 2019).

4.3 Survey of public expenditures

In this stage, we analyzed the number of resources authorized and effectively spent by the government in the state of Pernambuco on programs related to climate change. Explains the presentation of the first data of a proxy of the size of public spending on climate change.

The first observation to be made is about the significant variation in the amount of money allocated over the years, with reductions at times and considerable increases at others. Observes a decline in the resources effectively spent on climate change in the state of Pernambuco. The historical series analyzed starts with about R\$ 280 million (the year 2008) of effective spending, reaches a peak of R\$ 345 million (the year 2013) and is reduced to a little over R\$ 170 million (the year 2019), reaching values below R\$ 50 million (in 2018) (Figure 5).

Figure 5 - Comparison between the amounts authorized and paid for climate change programs in the state of Pernambuco in the years 2008 to 2019.



Source: Elaborated by the authors based on data the budget balances of the Pernambuco state government between 2008 and 2019. Values updated based on the National Wide Consumer Price Index

Observes the difference between the authorized expenses and the effective expenses when comparing year to year. There is an average difference of 54% between the amounts authorized for spending on climate change policies and those paid. In terms of difference, 2015 was the most critical, being effectively paid only 26% of the authorized amounts for policies to tackle climate change and (the year with the lowest absolute value, just over R\$ 52 million). Thus, it observes a tendency to reduce spending with a considerable difference between what planning-execution.

The differentiation of the amounts between authorized and paid is since the public budget follows steps.

The financial execution of expenses must always have as a defining framework the authorizations contained in the budget. Thus, the financial behavior of public institutions is a result of the execution of the budget programming (Giacomoni, 2017). Therefore, it is essential to evaluate all stages of the budgeting process since if there are no legal bindings, the resources, although budgeted, may not be executed. Thus, the expense presents in the LOA (Annual Budget Law, Portuguese abbreviation) may not be realized, with prejudice to the implementation of the policy (Garson, 2018).

This difference between the amounts authorized and the amounts paid may be due to several factors: the need for contingency, reallocation of resources to other areas of government action, the inability of the executing agency about the procedures for the execution, and the payment of the foreseen activities. These reasons mentioned above can be the motivations for the problematic execution of the policies to tackle climate change and the efficient execution and transformation of public spending into efficient climate policies.

According to Afonso, Schuknecht, & Tanzi. (2006) for analyzing the efficiency of expenditures in production, in general, should base oneself on the relationship between the number of inputs and products or the relationship between costs and benefits. However, collecting such data can be uncertain, especially about environmental policy issues. Thus, most empirical studies focus on the efficiency of revenue use or the technical efficiency of public spending (Mattos & Terra, 2015). Therefore, it observes the dimension of spending on climate change (GMC - Spending on Climate Change - Portuguese abbreviation) in Pernambuco. Concerning the Gross Domestic Product (GDP) and the total Government Spending (GS), the climate change expenditures represent a small share in the comparison (on average 0.16% of GDP and 1.08% of the total state government expenditures) (Table 3). Between 2002 and 2012, the Pernambuco state government spent estimated monetary losses due to natural disaster-related damages in the state, equivalent to 15.73% of its GDP, being the eighth state in the country with the highest proportional impact in the period (Young, Aguiar, & Souza, 2015).

The few references on climate change spending survey in Brazil are in a national survey referring to 2015 to 2018 that show a 67% reduction in climate change budget spending (WWF-Brazil, 2018). Tozato et al. (2019) explain that despite the urgency of the climate issue and even after more than ten years of the launch of the National Plan and the National Policy on Climate Change - PNMC, there are still few studies with Brazilian public spending on climate change.

Table 3 – Comparison of spending on climate change with the total spending and GDP of the state of Pernambuco between the years 2008 and 2018

Year	GPD (R\$)	GT ¹	GMC ²	GMC/GPD (%)	GMC/GT (%)
2008	70.440.859.000,00	10.090.961.799,42	273.330.168,82	0,39	2,71
2009	78.428.308.000,00	16.309.787.575,17	250.720.077,32	0,32	1,54
2010	97.189.760.000,00	13.826.613.032,94	192.524.943,92	0,20	1,39
2011	110.161.559.000,00	14.233.472.603,82	164.887.713,00	0,15	1,16
2012	127.989.043.000,00	18.048.135.496,14	238.527.240,07	0,19	1,32
2013	141.150.252.000,00	19.741.268.966,19	358.900.740,63	0,25	1,82
2014	155.142.648.000,00	19.930.393.012,94	262.190.963,30	0,17	1,32
2015	156.963.667.000,00	11.366.016.002,97	52.165.415,46	0,03	0,46

2016	167.345.031.000,00	20.604.414.072,04	72.994.568,70	0,04	0,35
2017	181.550.642.000,00	48.734.044.799,71	132.345.824,49	0,07	0,27
2018	182.800.000.000,00	39.964.557.707,26	44.961.243,96	0,02	0,11
2019	205.000.000.000,00	37.179.997.587,88	172.723.749,16	0,08	0,46

Source: Prepared by the authors based on data from the state government and Condepe-Fidem, and the budget balances. 1. GPD: Gross Domestic Product. GT: Total Government Expenditure (R\$). 2. GMC: Climate Change Expenditure (R\$).

In other parts of the world, most notably the Asian continent, initiatives to identify climate change spending are present. Between 2008 to 2012, Bangladesh spent an average of 1.1% of its annual GDP on climate change (O'Donnell et al., 2013). South Asian countries spend about 1% of their GDP on climate change (Gogoi, 2017). These values allow an initial benchmark for superficial comparison of current spending in the state of Pernambuco (Table 4).

In comparison to Brazilian information, Pernambuco spending is considerably lower than in the state of Santa Catarina. Analyzing the financial data that correspond to planned resources (not necessarily executed) (Kabilio, 2017), the state of Santa Catarina had between 2002 and 2012 economic losses related to natural disasters of the order of 20% of its GDP, being the fourth most affected state in Brazil (Young et al., 2015). These two factors may partly explain the reason for higher spending in this area. About the spending at the federal level being lower than states, it may point to the methodology since the survey only considered spending at the level of action regarding climate change within the Ministry of Environment (WWF-Brazil, 2018).

Table 4 – Comparison between climate change expenditures in the state of Pernambuco (PE), Santa Catarina (SC), and other regions of Brazil and the world, such as Bangladesh (BGD), Cambodia (KHM), Nepal (NPL), and Samoa (WSM).

Indicators /Local¹	PE	SC	BR	BGD	KHM	NPL	WSM
GPD ²	139.513,48	277.192,03	11.193.525,56	700.148,67	60.660,14	79.168,17	3.279,62
GT ³	22.502,47	34.260,51	2.173.808,23	108.436,01	11.569,19	18.456,80	1.289,48
GMC	184,69	4.812,59	98,42	7.053,78	652,81	1.258,22	177,53
GMC/GPD	0,13%	1,74%	0,001%	1,01%	1,08%	1,59%	5,41%
GMC/GT	0,82%	14,05%	0,005%	6,51%	5,64%	6,82%	13,77%
Area (Km ²)	98.312	95.346	8.516.000	147.570	181.035	147.516	2.842
GMC/km ² (R\$)	1.878,60	50.474,96	11,56	47.799,56	3.605,99	8.529,37	62.466,68

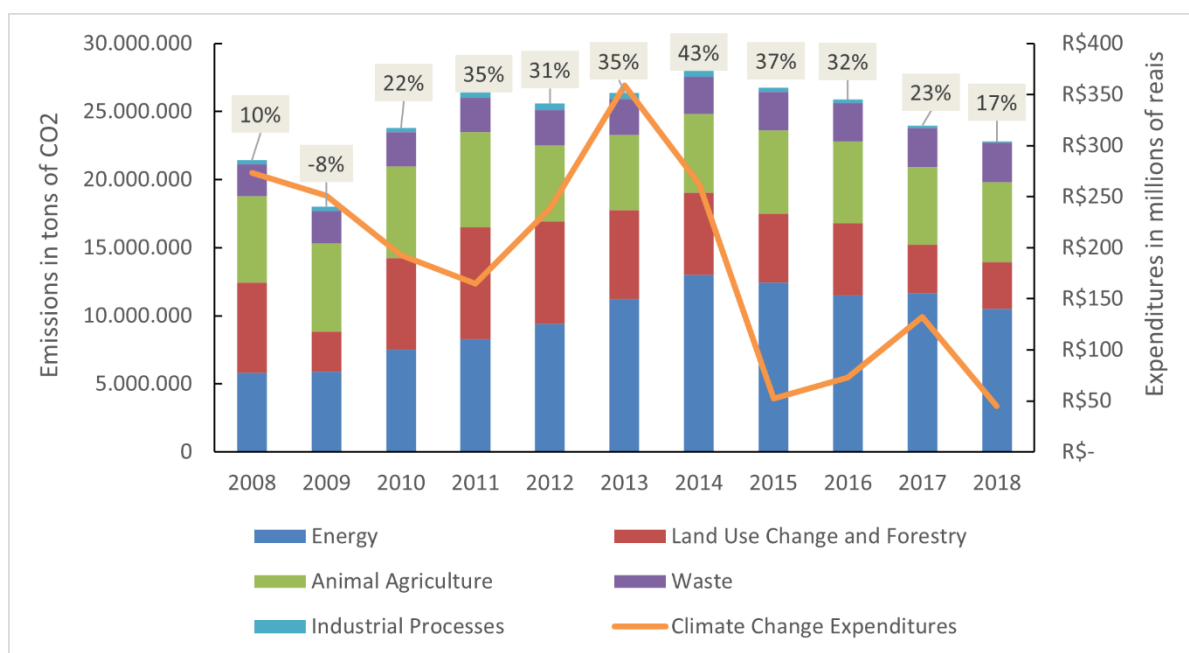
Source: Prepared by the authors with data from (<https://www.climatefinance-developmenteffectiveness.org/CPEIR-Database>), IBGE; State Budget Balances from 2008 to 2015; (Kabilio, 2017).1. Each location has arithmetic averages of certain periods: Pernambuco (2008-19); Santa Catarina (2016-2019); Brazil (2011-17); Bangladesh (2010-14); Cambodia (2009-12); Nepal (2008-12); Samoa (2007-12).2. Million R\$. 3 GPD: Gross Domestic Product. GT: Total Government Expenditure. 4 GMC: Climate Change Spending.

In Asian countries, the methodology is similar (the countries use the CPEIR). The differences may be related to greater exposure of these countries to the consequences of climate change, such as intensification of

monsoon and typhoon regimes, flooding, and sea-level rise. The analysis of the state emissions data shows that there is no correlation between the level of spending and GHG emission levels. In the period analysis, the estimated emissions for the state of Pernambuco grew and then declined. Meanwhile, the expenditures on climate change varied more and with a sharp decline since the middle of the period in question (Figure 6).

The Brazilian Nationally Determined Contribution - BNDC, established after the Paris Agreement, proposes to reduce GHG emissions by 37% in 2025 and 43% in 2030, regarding the year 2005, which is equivalent to a ceiling of emissions of 1,300 and 1,200 MtCO₂ and in 2025 and 2030, respectively (BRASIL, 2015; MCTIC, 2017). Data from the state of Pernambuco show that only in 2009 was there a reduction (of 8%) in GHG emissions compared to the year 2005. Therefore, it observes an increase in emissions by an average of 25% in the period analyzed.

Figure 6 – Comparison between spending on climate change and CO₂e emissions in Pernambuco between 2008 and 2018 (and the variation concerning the year 2005).



Source: Prepared by the authors based on data from the state government and SEEG.

Analyses made in the years 2010 and 2011 emphasized that Brazil was advanced about climate policies and revealed the states of the Federation that adopted laws that had the proposal to: a) encourage the reduction of emissions; b) stimulate the protection of forests; and c) promote the development and adoption of less intensive technologies (IPEA, 2010).

Observing the year 2019, Brazil is going to the opposite about the goals established in its BNDC. The basis of information is that Brazil is not pursuing its National Climate Change Policy goals, nor has the policies and governance structure to achieve the goals set out in the BNDC (Angelo & Rittl, 2019). Judging by the current GHG emissions data and the drastic reduction in climate change spending, the state of Pernambuco is also not moving towards making its emissions reduction contribution towards the national target set in the BNDC.

5. Conclusion

Observes that during the period in analysis, there was no compatibility between the guidelines expressed in the policies related to climate change and the government's programs and actions. These policies may mean that the state laws are in force but are not guidelines for executing its actions.

Pernambuco's state lacks a balance between executing different strategies to face climate change, such as adaptation, mitigation, and disaster reduction. Besides this, it observes that confrontation to climate change seems to be considered an attribution only of the environmental area of the government.

Notes the variation in the planning of budgetary resources and variation in the resources paid out. These two elements can indicate inefficiency in public spending and even an inability to execute the planned budget, or the non-prioritization of this area by the government, with contingency or reallocation of resources.

Even though some aspects related to climate change are unpredictable (such as disasters), other aspects should follow a budget execution schedule. This inobservance can demonstrate the absence of planning, or the disregard of the guidelines established by law.

Finally, even though there is no clear definition of what should be considered expenses for facing the consequences of climate change. The data lead us to believe that the actions of the state government of Pernambuco are inadequate to tackle climate change, and consequently, public spending could be more efficient.

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