



Identifying knowledge gaps in climate adaptation: perceptions by managers and business strategies in Santa Cruz do Sul/Brazil

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Abstract

Since the floods of May 2024 in Rio Grande do Sul, the definition of policies for climate alerts has been accelerated, seeking to provide higher quality and more accurate data. Decision-making by public managers, however, is not in line with business strategies in the interior of the state, far from the centers of power. This research is part of the search for greater quality in climate adaptation decision-making. On a pilot basis, we collected the perceptions and strategies of private managers in the Rio Pardo Valley, starting with the city of Santa Cruz do Sul, regarding the response to climate change. We used a framework applied two decades ago by Kolk and Pinkse with companies in the face of increasing regulations by the European Commission and stimulated self-assessment by managers of small and medium-sized companies active in the city's Commercial and Industrial Association. We identified that managers have been deliberating strategies in a hesitant or defensive way, without (yet) identifying many of the opportunities for innovative services or products in the long term, with limited knowledge of the deliberations on new public policies underway.

Keywords: Global warming. Resilience. Rio Grande do Sul.

Identificando lacunas de conhecimento em adaptação climática: percepções e estratégias empresariais em Santa Cruz/RS

Resumo

Desde as inundações de maio de 2024 no Rio Grande do Sul, vem sendo acelerada a definição de políticas para alertas climáticos, buscando prover dados de maior qualidade e precisão. A tomada de decisão pelos gestores públicos, porém, não ocorre em sintonia com estratégias empresariais no interior do estado, distantes dos centros de poder. Essa pesquisa se enquadra na busca por maior qualidade na tomada de decisão pela adaptação climática no interior gaúcho. Em caráter piloto, coletamos percepções e estratégias de gestores no Vale do Rio Pardo, iniciando pela cidade de Santa Cruz do Sul, acerca da resposta à mudança climática. Utilizamos referencial aplicado a duas décadas por Kolk e Pinkse com empresas face às crescentes regulamentações pela Comissão Europeia e estimulamos a autoavaliação por gestores de pequenas e médias empresas ativas na Associação Comercial e Industrial do município. Identificamos que em sua maioria os gestores têm deliberado estratégias de modo hesitante ou defensivo, sem identificar (ainda) muitas das oportunidades para serviços ou produtos inovadores e sustentáveis a longo prazo, com limitado conhecimento das deliberações sobre novas políticas públicas em curso.

Palavras-chave: Aquecimento global. Resiliência climática. Rio Grande do Sul.

Identificación de brechas de conocimiento en adaptación climática: percepciones y estrategias empresariales en Santa Cruz do Sul/Brasil

Resumen

Desde las inundaciones de mayo de 2024 en Rio Grande do Sul, se ha acelerado la definición de políticas de alerta climática, buscando datos de mayor calidad y precisión. Sin embargo, la toma de decisiones por parte de los gestores públicos no está en consonancia con las estrategias empresariales en el interior del estado, lejos de los centros de poder. Esta investigación se inscribe en la búsqueda de una mayor calidad en la toma de decisiones sobre la adaptación al clima. De forma experimental, recogimos las percepciones y estrategias de los gestores privados del Valle del Río Pardo, empezando por la ciudad de Santa Cruz do Sul, en relación con la respuesta al cambio climático. Utilizamos un marco aplicado hace dos décadas por Kolk y Pinkse con empresas frente a las crecientes regulaciones de la Comisión Europea y estimulamos la autoevaluación por parte de gestores de pequeñas y medianas empresas activas en la Asociación Comercial e Industrial de la ciudad. Identificamos que los directivos han estado deliberando estrategias de forma vacilante o defensiva, sin identificar (todavía) muchas de las oportunidades de servicios o productos innovadores a largo plazo, con un conocimiento limitado de las deliberaciones sobre las nuevas políticas públicas en curso.

Palabras clave: Calentamiento global. Resiliencia. Rio Grande do Sul.

1 Introduction

The floods of May 2024 in Rio Grande do Sul (RS), a disaster of historic proportions, changed public opinion on global warming (Dias, 6/5/2024). “Researchers and politicians from RS interviewed by UOL acknowledge that the current tragedy is unprecedented, but say that more could have been done to prevent it” (Vasconcellos, 25/5/2024). The change in perception has led to new development strategies, as well as consequences in the form of redirected public investments or new organizational formats.

Thus, the levees surrounding the capital city, invisible since their construction in the 1980s to the point of disappearing amid spontaneous occupations became priority. Thirty years late, in 2024, the Porto Alegre city government invested BRL 10 million in removing homes on the levees and rebuilding damaged sections, budgeting an additional BRL 510 million to raise the levee levels by up to seven meters over the next decade (Porto Alegre, 8/10/24).

In the region Serra Gaúcha, an alliance of business owners, community leaders, and volunteers established the Rebuild Muçum Association, which mobilizes resources to relocate the municipality's urban downtown district to a flood-proof area. This strategy of changing the urban layout through the expropriation of private properties was unthinkable just weeks before the disaster (Laste, 6/2/24) and unprecedented in Rio Grande do Sul, differing from other disaster-prone municipalities, such as Santa Vitória do Palmar, where the destruction of homes leads always to reconstruction in the same location (Brose; Souto and Santos, 2020).

Knutti (2019) explains that scientific research has been producing knowledge about the impacts of climate change at a rapid pace, exemplified by the reports of the Intergovernmental Panel on Climate Change (IPCC). The first IPCC report, in 1990, reviewed approximately 30 references per chapter, while the sixth report records and evaluates more than 1,000 studies per chapter (IPCC, 2022). However, for the author, the decision-making process by public and private managers has not followed the same pace.

Just as scientific production has increased, climate events considered extreme and "unprecedented" have been increasing in frequency and intensity in RS. We argue that, with the floods of May 2024, climate change went from an abstract warning about possible future impacts to a climate emergency experienced daily, affecting families, businesses, and governments, and jeopardizing development processes (Schabach et al., 2024). Among other things, this encouraged the implementation of the 2010 RS Climate Change Policy, which called for the end of subsidies to companies that emit greenhouse gases.

At the 2021 global climate conference (COP 26) in Scotland, the state government committed, a decade late, to the Race to Zero campaign to reduce greenhouse gas emissions by 2050 and prepare the regional economy for climate adaptation. Since 2024, the State Secretariat of the Environment has been accelerating the formulation of a policy to decarbonize production chains, as well as initiating a policy of payment for environmental services.

We argue, however, that beyond citizen engagement or public policies, both greenhouse gas emissions and climate adaptation depend on decisions by the private sector.

In climate adaptation [...] the private sector faces higher costs and shortages of inputs, disruptions in the production and distribution of products and services, impacts on the health of workers, increased costs of accessing capital, and damage to physical assets. Society as a whole is affected by inflation [resulting from disasters], and, once again, the social groups that suffer the most are those with lower incomes and in situations of socioeconomic vulnerability (Nicolletti, 6/19/24).

The State can guide, direct, and regulate mitigation and adaptation, but private sector managers make decisions regarding access to financing, new investments, company relocation, and related actions. This raises the question of this research: What is the knowledge base on mitigation and adaptation among private sector managers in Rio Grande do Sul?

The pioneering research derived from this question, conducted a decade ago with large companies headquartered in Porto Alegre, found:

The results show that the percentage of companies aware of their contribution to climate change is low and, consequently, the number of organizations aware of the risks and opportunities posed by climate change is quite small [...] In general, companies are still in the early stages of developing a climate strategy, implementing low-cost GHG emission reduction actions within the company itself. Most organizations do not take action in their production chains and are unaware of the financial instruments and external actors available to assist them in implementing climate change measures (Leão, 2011, p. 6).

This is the context for the concept of the "knowledge gap" in climate management that we propose here for analysis in the municipality of Santa Cruz do Sul. This refers to both the knowledge or investment gap and the gap in public policies or prevention actions, resulting in a spiral of socioeconomic vulnerabilities, impacts, and increased inequalities. This spiral deepens when investments in infrastructure, technology, or production units disregard climate risks. "It is essential that decision-makers in companies and investors understand the present and future risks, as well as the impacts already caused, to their businesses" (Nicolletti, 6/19/24).

One hypothesis for interpreting this gap lies in climate denial, which has been expanding for a decade, fueled by social media and the support of multiple business entities. In reality, investing in climate risk prevention is excellent business. Stern (2006) estimated that for the global economy, investments of around 1% of Gross Domestic Product (GDP) per year prevent future losses that could reach 5% to 20% of GDP. As stated by the study for the Brazilian economy estimated that, in projected scenarios, by 2050, the impact of climate change will reduce GDP by between 0.5% and 2.3%, preventive investments can reduce (Margulis and Dubeux, 2010).

This research shows that for every dollar invested in adaptation, more than US\$10.50 in benefits can be generated over ten years. These gains don't just refer to avoiding losses from climate disasters: they also result in numerous economic, social, and environmental benefits even when disasters don't occur. We use the 'triple dividend of resilience' approach to group the benefits into three main categories: avoided losses, stimulated economic development, and additional social and environmental benefits. In other words, adaptation is not only an essential response to the climate crisis—it is also one of the smartest investments we can make today (Brandon et al., 3/6/25).

We summarize this argument with the observation that "climate-resilient territories, value chains, communities, and ecosystems form the foundation for a safe and profitable business environment" (Nicolletti, 19/6/24).

We present the results of a pilot study by researchers from the Graduate Programs in Regional Development and Business Management from the University of Santa Cruz do Sul (UNISC), shortly after the disaster in May 2024, in partnership with the Commercial and Industrial Association (ACI) of Santa Cruz do Sul. Over a period of four weeks, a questionnaire in Google Forms format was sent to ACI members, maintaining anonymity, with the aim of mapping knowledge gaps among managers.

After this introduction, the next section summarizes the growing debate about the need to improve decision-making processes in risk and disaster management, as significant investments are needed in the present to prevent future risks. In the second section, we present the methodology and related research. In the third section, we present an analysis of the data collected, followed by a brief discussion. In the last section, we present our final considerations.

2 The debate on gaps in climate governance

The existence of knowledge gaps is the driving force behind scientific research. However, the concept in a more strict sense, that is, research on gaps in climate decision-making processes, is of recent origin. This concept has been popularized since 1990 by reports on the state of the art published by the IPCC. In parallel, since 2010, the United Nations Environment Program (UNEP) has published annual reports on gaps in knowledge, financing, and emissions reduction, with the aim of informing public and managers (UNEP, 2023; 2024).

We also notice that research on Climate Decision, the decision-making process on climate by economic agents, has expanded beyond its initial focus on public policy in the 1990s, when international negotiations were priority (Orlove et al., 2020). This field draws on elements from the study of cognitive decision-making processes, such as Herbert Simon's Bounded Rationality or Daniel Kahneman's Framing Effect. We understand the climate decision-making process in the broadest sense, that is, not limited to the definition of public policies, but to any investment that has implications for climate mitigation or adaptation, even if not labeled as such (Magrini, 11/7/22).

In the preliminary negotiations for the Kyoto Protocol for global emissions reduction in 1997, the strategy of large corporations prioritized political influence over negotiators, seeking to avoid regulations that would be detrimental to their respective sectors. Hoffman (2005) notes how this strategy, which resulted in public conflict over whether or not the United States should participate in the agreement, increased uncertainty for private managers. However, given the agreement's approval, Kolk (2000) notes how multinational companies in the Global North altered their strategies, seeking to identify its knowledge gaps to improve production chains and also its marketing strategy, to incorporate emissions reductions.

Furthering this argument based on the responses of more than one hundred multinational companies to an online questionnaire, Levy and Kolk (2002), then Kolk and Pinkse (2004), propose a four-field matrix for interpreting corporate climate adaptation strategies along two dimensions: assertiveness and cooperation. This updates the Conflict Mode Instrument model proposed by Thomas and Kilmann (1974).

The matrix proposed by Kolk and Pinkse (2004) was translated and applied in research conducted with an electricity distribution company in Ceará (Figure 1).

Figure 1: Scenarios for strategic responses by companies to climate regulations

		Identifying opportunities	
		Low	High
Risk of regulation	High	Conformist	Entrepreneurial
	Low	Evasive	Investor

Source: Abreu; Albuquerque e Freitas (2014, p. 581).

The authors summarize this model by characterizing four profiles with varying degrees of information, and therefore, gaps of information:

- Conformist: companies that identify the possibility of being affected by regulatory restrictions and decide to accept the imposed conditions. They do not identify opportunities for a proactive approach to climate change mitigation projects.
- Evasive: companies that recognize few opportunities in the new regulatory framework and seek ways to continue operating in the market without being affected, e.g., by reallocating production.
- Investor: companies that perceive the pressure arising from environmental regulations but identify opportunities for financial or strategic gains, e.g., by approving participation in the carbon market, even though they are not affected by the regulations.
- Entrepreneurial: companies that identify risks posed by regulatory restrictions but attempt to take advantage of this situation to achieve a more favorable position. These companies seek to close gaps and anticipate and influence regulations in order to reduce pressure and improve regulatory efficiency.

Thus, the context and agility for the decision to adopt measures to reduce emissions and adapt to climate change vary between companies. Pinkse and Kolk (2009) compiled a series of factors that influence this decision, differentiating between external and specific (internal) factors of the company. Among the external factors, the authors highlight: physical impacts, environmental regulations, stakeholder pressures, and the structure and growth of the sector. Among the

specific factors of the company, market and supply chain positioning, organizational culture, senior management perception, technological capacity, and risk management stand out.

In reality, many companies engaged in climate adaptation are agnostic about the science of climate change or corporate responsibility to protect the planet's climate. The reason they are deciding to reduce their emissions is essentially strategic. They are looking for ways to prepare for the long term, should emissions reduction become mandatory, and simultaneously obtain short-term economic and strategic gains if regulations are not implemented [...] which implies changing our view of regulatory controls on emissions based solely on environmental criteria or social pressures, to a strategic issue demanded by the market (Hoffman, 2005, p. 22).

As with every disruptive innovation, there are both opportunities and limitations for companies in climate governance. A systematic review of the literature by Orlove et al. (2020) confirms the diagnosis that framing information through negative headlines, or threats of imminent environmental collapse, has not motivated companies to change their production or consumption systems. The ongoing energy and low-carbon transitions are being driven, rather, by decisions about investment opportunities and a positive agenda toward greater sustainability.

This is the context in which the Secretary-General of the United Nations successfully coined the term "climate emergency" in 2018 to replace the more concise concept of "climate change," followed by the influential British newspaper The Guardian, which popularized the concept (The Guardian, May 13, 2019). Seeking to foster this sense of urgency, the United Nations launched the global Race to Zero campaign in collaboration with researchers from the University of Oxford, aiming to engage subnational governments and businesses worldwide in climate mitigation and adaptation. The Rio Grande do Sul state government accepted this challenge in November 2021, committing to emissions reduction targets by 2050 (RS, 2022).

As stated by this campaign, as national governments are failing to reduce global greenhouse gas emissions, climate science must contribute to supporting and informing managers in the economy and civil society. According to a recent review by the IPCC, "overcoming gaps in climate management is crucial to guiding the transition to a low-carbon, more resilient future, to stimulate consensus and strategic alliances, and to mobilize economic agents" (EC, 2024, p. 86).

A pioneering study in Brazil on gaps in national public policies by Jacobi et al. (2018) was conducted within the scope of the LatinoAdapta project by researchers from the University of São Paulo and the Getúlio Vargas Foundation. A questionnaire consisting of 13 questions was sent to a national email address directory, receiving 30 responses, followed by 14 interviews with federal civil servants in Brasília.

The results found were well aligned and complementary to previous studies, and indicate, above all, that the greatest deficiency does not lie in knowledge production, but in its dissemination, application, and appropriate use. Specifically regarding information gaps, the following stand out: (i) the need for in-depth and refined impact and vulnerability studies; (ii) the creation of parameters and indicators that can guide and prioritize policy development; and (iii) the projection of different georeferenced future climate scenarios at a local scale, capable of

indicating alternatives to decision-makers, so that adaptation actions are integrated into local development and generate benefits independent of climate change (Jacobi et al., 2018, p. 4).

A second nation wide initiative was the private sector consultation process to evaluate the National Policy on Adaptation to Climate Change. Coordinated by the Ministry of the Environment, it received support from the German government for an online survey of large companies in the São Paulo-Rio de Janeiro region. Between October and November 2020, responses were received from 56 companies, with the largest share coming from the oil, gas, and energy sector, accounting for 16% of responses; followed by the forestry, mechanical and electrical engineering, and mining sectors, each accounting for 11% of responses, and services, with 9%.

Regarding how companies approach climate change adaptation, companies predominantly reported senior leadership engagement, accounting for 41% of respondents. Subsequently, 25% of companies reported addressing the topic cross-functionally, 16% within the sustainability department, and 11% in other departments. 7% of companies reported not addressing the topic in their strategies and/or activities [...] Regarding the magnitude of financial losses related to extreme weather events, 26.8% of companies reported financial losses, but these were not measured (Brasil, 2021, p. 19).

Next, a study coordinated by the Brazilian Business Council for Sustainable Development (CEBDS) was implemented by the Boston Consulting Group. Between February and April 2023, 31 interviews were conducted with managers from some of the largest companies based in São Paulo and Rio de Janeiro (CEBDS, 2023). Respondents identified the following risks to private sector inertia:

- Regulatory: Loss of opportunities due to new subsidies; barriers along the value chain due to lack of transparency.
- Market: Loss of relevance in markets subject to carbon pricing mechanisms; consumer pressure for green products.
- Financial: Restricted access to sources of financing and investors focused on sustainability, with potentially lower costs.
- Institutional: Misalignment with the guidelines of the holding company, shareholders, and board regarding the climate agenda; brand devaluation.

Expanding this field of research, studies were conducted by various organizations, such as the global network OECD Watch on gaps in socio-environmental governance in Brazil, expanding the research to civil society organizations (Ingrams et al. 2022), or the annual series of reports by the Talanoa Institute analyzing the progress of decarbonization (Talanoa Institute, 2023), aligned with the online platform Our Decarbonization (nossadescarbonizacao.org).

According to Grizzi (5/12/24), "therefore, is absolutely essential the engagement of the private sector in regulatory development; we need science and academia to lay the foundations and the public sector to organize the steps for building our new environmental and climate regulatory framework." We propose bringing this approach to the business community in the municipality of Santa Cruz do Sul, a significant economic, political, and social hub in the Rio Pardo Valley region, in central Rio Grande do Sul state.

In this way, we seek to prevent a repeat of the ongoing conflict in the region over logistics. For more than two decades, business and political leaders in the Rio Pardo Valley have been mobilized to demand the widening of the RSC-287 highway, which connects to the Metropolitan Region. In 2021, privatization and the first tolls were celebrated as a victory. However, the road project, that started in 2023, has sparked protests from farmers and neighboring residents, as it failed to consider the need to renovate individual access roads, costing up to R\$30,000 per property owner.

To prevent a similar experience from happening again, private managers in the interior regions of Rio Grande do Sul need to be informed about ongoing innovations in climate adaptation legislation, their costs, limitations, and opportunities. This approach, known as "due diligence," translates into companies' efforts to identify, prevent, and mitigate socio-environmental damage, "beyond compliance with the law" (ILAJUC, 2023).

3 Research Method

The research is being conducted through a partnership between researchers from the Graduate Programs in Administration (PPGA) and Regional Development (PPGDR) at UNISC. We designed this survey in 2024 as the starting point for a longitudinal study to be conducted throughout the period of the 2024-2027 Quadrennial Evaluation of graduate programs by the Ministry of Education. The purpose is to support regional development promotion efforts in the municipalities that make up the Vale do Rio Pardo Region with information on climate adaptation for companies in this micro-region.

The research group consists of private companies, more than 90% small and medium-sized, family-run, located in the 23 municipalities that make up the Vale do Rio Pardo microregion. As a pilot project, this first stage of the research began in June 2024 with companies headquartered in the municipality of Santa Cruz do Sul, which accounts for approximately 45% of the region's Gross Domestic Product (GDP).

As part of the partnership between the university and small business board, the questionnaire was planned to be distributed using Google Forms to a group of 100 companies recognized for their sustainability strategy disclosures in the last week of April 2024, following its launch at the *Business Café* (Lara, 6/25/24). A research instrument adapted from the studies by Hoffman (2005) in California, and Leão (2011) in Rio Grande do Sul, was used. The questionnaire consists of 15 questions, a limited number to allow greater adherence by companies, with 13 closed questions and two open questions.

One limitation of the selected methodology is that the start of the survey coincided with extreme weather events involving heavy rainfall in the Serra Gaúcha region between April 27 and 30, 2024, followed by flooding throughout May in the metropolitan region, which turned into a catastrophe with national repercussions.

The launch of the survey was postponed and presented to the public at the *Business Café* event held on June 25, 2024, attended by 47 people at the auditorium located downtown Santa Cruz do Sul. The event, as well as the launch of the survey, received prior publicity in the regional media, reinforced later by interviews with our team on local radio stations. The survey was conducted between June 25 and July 26, 2024. The presentation of the preliminary results took place as part of the ESG

Experience event on August 15, 2024, held at an auditorium at the university UNISC and attended by 117 participants from companies and business in the region.

4 What are the priorities for mitigation and adaptation?

In this pilot stage of the survey, the questionnaire return rate was 25 responses, or 25% of the selected sample. The majority of respondents, 22 in total, represent companies based in the municipality of Santa Cruz do Sul. The profile of the companies was mostly small businesses (9), followed by micro-enterprises and startups (6), medium-sized (4), and large (4) organizations. In addition, the companies are from various sectors: Financial Services, Education and Health (6), Professional Services and Other Services (5), and Technology, Information, and Communication (4), which highlights the heterogeneity of the responses.

Regarding senior management engagement, most companies stated that they do not have part-time or full-time professionals dedicated solely to promoting sustainability (15), but that they nevertheless actively participate in sustainability initiatives (14). The following examples were listed: planting trees; using clean energy sources; harvesting rainwater; recycling waste; reducing waste generation; social investments in the community; environmental initiatives; reducing emissions; reusing construction waste; preparing and monitoring CO₂ inventories; and monitoring carbon footprint reduction with customers. Thus, we understand they are following the advice that "instead of waiting for approval from the regulated carbon market, companies should be ahead of the curve with sectoral targets to advance toward net zero" (Grizzi, 6/3/24).

Regarding the perception of opportunities and risks in management, we found that in most companies, senior management has information or basic knowledge about the impact of climate change on the economy of Rio Grande do Sul. These companies' growth strategies consider some climate risks (e.g., future floods and droughts) and the opportunities generated by climate change. However, the responses indicate that senior management is not adequately monitoring the decarbonization strategies implemented by the state or federal government.

With regard to the measurement, certification, and disclosure of emissions, we found that most companies do not conduct annual greenhouse gas inventories (19) and do not have emission reduction targets. In addition, the vast majority do not have internal decarbonization targets (13). In companies that have adopted targets, these are related to energy efficiency (7) and tree planting (7).

Most companies (16) do not have representatives in associations or professional organizations related to climate change (such as the Rio Grande do Sul Climate Change Forum, Municipal Board, or similar). In addition, the topic of climate change is not part of the internal training program for employees at most companies (12).

In the self-assessment question, using the Kolk and Pinkse matrix, the companies classified themselves as being mostly hesitant or defensive:

- Entrepreneurial or proactive (9),
- Conformist or hesitant (8),
- Evasive or defensive (6), and
- Investor or reactive (2).

Entrepreneurial/proactive companies highlighted that they pursue actions to promote sustainability, anticipate innovation activities, acknowledge that climate change is impacting the region, care for the environment, ensure energy efficiency and sustainability, conduct GHG inventories, and seek to minimize and offset emissions.

Conformist/hesitant companies stated that they are essentially complying with applicable legislation and indicate that they take additional steps: they evaluate within the context in which they operate and review processes to reduce CO₂ emissions, for example, the need for a change in mindset, there is a lack of information, and that they are deepening their company culture to study the topic with their team.

Companies that classify their strategies as evasive or defensive argue that rising operating costs, the risk of new taxes, uncertainty regarding the allocation of funds raised through carbon credits, distrust in government action, and doubts about the alternatives presented have been holding back decisions to innovate in climate adaptation.

Companies with investor/reactive strategies emphasized that the high cost of capital for cash flow related to changes, in addition to existing legal obligations, impedes new investments. In one case, the company argues that there is currently no viable alternative to the current production model and that global warming is possibly more of an economic game than a reality.

Finally, respondents had the opportunity, through open-ended questions, to identify knowledge gaps and list the topics on which companies need more information in the short and/or medium term, naming seven priorities:

- (i) carbon credits and decarbonization;
- (ii) current legislation and potential changes;
- (iii) sustainability in import and export;
- (iv) ESG and environmental responsibility;
- (v) municipal and state strategies with examples of good practices and actions for climate change with real impact;
- (vi) community engagement; and
- (vii) if there is a tax increase, where the government at different levels will use it and how it can be discussed with society.

This list of seven topics suggests a priority agenda for information and dialogue in the Vale do Rio Pardo region with business entities, ranging from basic elements such as “corporate environmental responsibility” to more complex topics such as “carbon credits.” However, challenges such as the social cost of carbon in the new sustainability accounting that will be mandatory for publicly traded companies from 2027, according to Resolution 193/2023 of the Securities and Exchange Commission, were not even mentioned by respondents.

5 Discussion

Despite the relatively broad number of environmental initiatives listed in the survey, we concluded that few companies in the sample recognize and quantify their contribution to climate change, as only six companies report conducting greenhouse

gas inventories. Conducting inventories is crucial because it enables the identification of options for reducing emissions and the carbon intensity of products and services.

Some managers involved in this survey had questioned: Is it worthwhile to change the company's strategy and invest in climate adaptation? For two decades, Sebrae has made this statement, arguing:

Small businesses are important economic agents for inclusive and sustainable development. By investing in improving their production systems for the generation and consumption of cleaner energy, small businesses make a positive contribution to reducing greenhouse gas emissions [...] Sebrae's role is focused both on raising awareness of entrepreneurs' collective responsibility for the future and on identifying business opportunities in this new market segment (Sebrae, 2008, p. 5).

Despite the optimistic tone of this statement, two decades later the context for management in small and medium-sized enterprises in large parts of Rio Grande do Sul has not yet been changed by Sebrae's actions. Managers in the private sector are making decisions on their own, and laws are being changed by public managers. "Domestic and international regulations are knocking on the door, and the planet waits for no one; business as usual no longer seems like a reasonable strategy" (Grizzi, 12/5/24).

There are enough studies available to show that it is not necessary to choose between growth and decarbonization, these paths are complementary, and making the ecological transition does not imply sacrifices for the economy, as evidenced by the energy transition underway in this state. More than that, it is desirable for Rio Grande do Sul to make a transition to low carbon as soon as possible, in order to qualify its development and become more competitive in responding to the climate emergency.

Regarding respondents' perceptions that inform decision-making, in most of the companies represented here, managers have information or knowledge about both the causes and the impact of climate change on the regional economy. The growth strategies of these companies mostly consider climate risks such as future floods or droughts, and they seek to capitalize on early opportunities generated by climate change in their business strategy.

It is possible to conclude that most of the companies in this sample are in an incipient, or initial, stage of building a climate agenda. They are adopting initial steps, preferably at low cost, such as occasional tree planting or purchasing energy from renewable sources. Support for projects with potential for regional scale, such as payment for environmental services, is still in the experimental phase.

Managers' limited knowledge of the carbon intensity of their production chain limits the scope of ongoing business initiatives and poses a challenge in view of the federal government's authorization of carbon credits for the domestic market and the state government's promised implementation of a decarbonization policy.

Professional associations, such as employers' unions and state federations, did not stand out in the responses. There still seems to be a lack of qualified communication with small and medium-sized companies in the region on climate adaptation, even considering the municipality of Santa Cruz do Sul as a representative market in the region. This contrasts with recurring statements by

state political leaders to the media about the participatory and transparent nature of the regulations being developed by the state's government.

6 Final thoughts

Corporate actions to address the impacts of global warming have been adopted across the globe, whether by regulatory mandate, as in the major economies of California, China, or the European Union, or by voluntary initiative, as in multiple companies in Rio Grande do Sul. This study focused on understanding and analyzing the responses of companies based in the municipality of Santa Cruz do Sul to climate change, identifying knowledge gaps that point to the potential for future scientific dialog and outreach initiatives.

We identified only one related study with companies headquartered in Porto Alegre a decade ago, an indicator of the lack of research on corporate climate adaptation strategies in Rio Grande do Sul. This study sought to identify which initiatives are underway, and which have not yet begun, based on a sample of companies based in Santa Cruz do Sul.

The research did not identify climate denial as a corporate action strategy, despite this approach being favored by a significant portion of the Rio Grande do Sul electorate. It was possible to identify a set of seven topics, of varying complexity, that comprise a future research and outreach agenda at the regional level. Thus, in this pilot collection, it was possible to identify a knowledge gap in climate adaptation, to be consolidated by repeating this research at regular intervals.

REFERENCES

ABREU, M.; ALBUQUERQUE, A.; FREITAS, A. Posicionamento estratégico em resposta às restrições regulatórias de emissões e gases de efeito estufa. **Revista de Administração USP**, São Paulo, v. 49, n. 3, p. 578-590, 2014. DOI: 10.5700/rausp1169

BRANDON, C.; KRATZER, B.; AGGARWAL, A.; HEUBAUM, H.; NOVENARIO, H. Investimentos em adaptação climática podem gerar retorno pelo menos dez vezes maior em benefícios. **WRI**, 03 jun. 2025. Disponível em: <https://www.wribrasil.org.br>. Acesso em: 04 jun. 2025.

BRASIL. Ministério do Meio Ambiente. **Relatório final de monitoramento e avaliação do Plano Nacional de Adaptação à Mudança do Clima Ciclo 2016-2020: Síntese e análise dos resultados do levantamento realizado junto ao setor empresarial**. Brasília, nov. 2021.

BROSE, M.; SOUTO, A.; SANTOS, C. Percepções e adaptação aos riscos climáticos no litoral: a reconstrução pós-ciclone de 2016 do Balneário Hermenegildo, RS. **Revista Política e Planejamento Regional**, Rio de Janeiro, v. 7, n. 3, p. 267-284, 2020.

CADONÁ, A. Qual Reconstrução do Rio Grande do Sul? enchentes de 2024 e o projeto político de reconstrução da burguesia industrial. **Revista REDES**, Santa Cruz do Sul, v.29, 2024. DOI: 10.17058/redes.v29i1.19707

CONSELHO EMPRESARIAL BRASILEIRO PARA O DESENVOLVIMENTO SUSTENTÁVEL (CEBDS). **Desafios do setor empresarial brasileiro na jornada Net Zero**. Rio de Janeiro; São Paulo: BCG, 2023.

DIAS, T. Enchentes no RS: leia o relatório de 2015 que projetou o desastre – e os governos escolheram engavetar. **Intercept_Brasil**, 06 mai. 2024. Disponível em: <https://www.intercept.com.br/2024/05/06>. Acesso em: 27 mai. 2025.

EUROPEAN COMMISSION (EC). **The next frontier for climate change science**. Independent Expert Report. Brussels, 2024.

GRIZZI, A. Os conselhos estão preparados para a governança ambiental e climática? **Reset**, 5 dez. 2024. Disponível em: <https://capitalreset.uol.com.br>. Acesso em: 3 jun. 2025.

GRIZZI, A. Onde estão os planos de mitigação e adaptação do setor privado? **Reset**, 6 mar. 2024. Disponível em: <https://capitalreset.uol.com.br>. Acesso em: 3 jun. 2025.

HOFFMAN, A. Climate change strategy: the business logic behind voluntary greenhouse gases reduction. **California Management Review**, v. 47, n. 3, p. 21-46, 2005.

INGRAMS, M.; ALEIXO, L.; NAKAHARADA, C.; EDUARDO, C.; PINHEIRO, F.; LOBATO, M.; ARIMA JR., M. **Lacunas de governança socioambiental no Brasil**: Utilizando o processo de acesso à OCDE para fortalecer os direitos humanos e a proteção ambiental. Amsterdam: OECD Watch, 2022.

INSTITUTO LATINOAMERICANO DE JUSTIÇA COLETIVA (ILAJUC). **Devida diligência**: para além o cumprimento da lei. São Paulo, 2023.

INSTITUTO TALANOIA. **Política Climática por Inteiro 2023**: Um balanço dos avanços e lacunas da agenda de mudança do clima no Brasil. Rio de Janeiro, 2023.

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC). **Climate Change 2022**: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the IPCC. New York: Cambridge University Press, 2022.

JACOBI, R.; CÔRTEZ, P.; TORRES, P.; MONZONI, M.; NICOLLETTI, M.; LEFEVRE, G.; PERES, E.; POZZAN, M. **Lacunas de conhecimento em adaptação às mudanças climáticas**. Relatório Diagnóstico Brasil. Montevideo: Red Regional de Cambio Climático y Toma de Decisiones, 2018.

KNUTTI, R. Closing the knowledge-action gap in climate change. **One Earth** 1, Commentary, p. 21- 23, 2019. DOI: 10.1016/j.oneear.2019.09.001

KOLK, A. **Economics of Environmental Management**. Harlow: Financial Times/Prentice Hall, 2000.

KOLK, A.; PINSKE, J. Market strategies for climate change. **European Management Journal**, v. 22, n. 3, p. 304–314, 2004. DOI:10.1016/j.emj.2004.04.011

LARA, E. Café empresarial debate preparação das empresas diante das mudanças climáticas. **Portal Arauto**, 25 jun. 2024. Disponível em: <https://portalarauto.com.br>. Acesso em: 3 jun. 2025.

LASTE, M. Projeto Recupera Muçum: comunidade e empresários unem forças para realocar cidade. 02 jun. 2024, **A Hora**. Disponível em: <https://grupoahora.net.br/conteudos>. Acesso em: 28 nov. 2024.

LEÃO, E. **As respostas das empresas localizadas no Rio Grande do Sul frente às mudanças do clima**. 154 f. Dissertação (Mestrado) Administração. Universidade Federal do Rio Grande do Sul, Porto Alegre, 2011.

LEVY, D.; KOLK, A. Strategic responses to global climate change: conflicting pressures on multinationals in the oil industry. **Business and Politics**, v. 4, n. 3, p. 275-300, 2002. DOI: 10.1080/1369525022000047073

MAGRINI, L. Ecólogo David Lapola comenta lacunas científicas sobre conservação, captura de carbono, emissões por degradação florestal e adaptação. 07 nov. 2022, **ComCiência**. Disponível em: <https://www.comciencia.br>. Acesso em: 02 dez. 2024.

MARGULIS, S. e DUBEUX, C. (eds.) **Economia da mudança do clima no Brasil: custos e oportunidades**. São Paulo, USP; UFRJ; Banco Mundial, 2010.

NICOLLETTI, M. Adaptação climática, uma agenda de negócios. 19 jun. 2024, **FGV**. Disponível em: <https://portal.fgv.br/artigos>. Acesso em: 28 nov. 2024.

ORLOVE, B.; SHWOM, R.; MARKOWITZ, E.; CHEONG, S. Climate Decision-Making. **Annual Review of Environment and Resources**, v. 45, p. 271-303, 2020. <https://doi.org/10.1146/annurev-environ-012320-085130>

PINKSE, J.; KOLK, A. **International business and global climate change**. New York: Routledge, 2009.

PORTO ALEGRE. Secretaria de Comunicação. Dmae inicia obras de reforço em diques do bairro Sarandi. 10 ago. 2024, **DMAE**. Disponível em: <https://prefeitura.poa.br/dmae/noticias>. Acesso em: 28 nov. 2024.

RIO GRANDE DO SUL. Secretaria do Meio Ambiente. Estratégias para o enfrentamento das mudanças climáticas. **Decreto N° 56.347, de 26 de janeiro de 2022**. Disponível em: <https://www.proclima2050.rs.gov.br>. Acesso em: 29 nov. 2024.

SCHABBACH, L.; RAMOS, M.; LIMA E CUNHA, L. MARX, V. As enchentes de 2024 no Rio Grande do Sul e a capacidade de resposta dos municípios às inundações. **Revista REDES**, Santa Cruz do Sul, v. 29, 2024.

SERVIÇO BRASILEIRO DE APOIO ÀS MICRO E PEQUENAS EMPRESAS (SEBRAE). **Mudanças climáticas e oportunidades de negócio para pequenas empresas**. Brasília: Sebrae Nacional, 2008.

STERN, N. **Estudo Stern**: Aspectos Econômicos das Alterações Climáticas. Resumo das conclusões. Tradução online. São José dos Campos: INPE, 2006. Disponível em: <http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/destaques>. Acesso em: 28 nov. 2024.

THE GUARDIAN. Why the Guardian is changing the language it uses about the environment. 15 mai. 2019, **The Guardian**. Disponível em: <https://www.theguardian.com/environment>. Acesso em: 29 nov. 2024.

THOMAS, K.; KILMANN, R. **Thomas-Kilmann conflict mode instrument**. Reimpressão 1997. Tuxedo: Xicom, 1974.

UNITED NATIONS ENVIRONMENT PROGRAMM (UNEP). **No more hot air...please!** Emissions gap report 2024. Kenya, 2024.

UNITED NATIONS ENVIRONMENT PROGRAMM (UNEP). **Underfinanced, Underprepared**. Emissions gap report 2023. Kenya, 2023.

VASCONCELLOS, H. Na tragédia do RS, culpa recai sobre prefeitos, governador e União. **UOL**, 25 mai. 2024. Disponível em: <https://noticias.uol.com.br/cotidiano/>. Acesso em: 27 mai. 2025.

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