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Climate Governance and Federalism in Brazil

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3.1 Introduction

Greenhouse gas (GHG) emissions in Brazil are largely connected to changes in land use and land management practices (SEEG 2018).¹ In 2018 land use and land-cover change contributed to 44 per cent of Brazil's emissions, followed by agriculture, which accounted for 25 per cent. Deforestation has been the main source of land use emissions, representing 93 per cent of the sector's total for the period 1990–2018. In terms of vulnerability to climate change, Brazil is ranked 92 out of 181 countries in the 2020 ND-GAIN Index.² Extreme temperatures, rising seas, as well as the complex challenges of different regions across the country experiencing significant water scarcity and heavy rainfall are predicted to place significant pressure on vulnerable groups, urban infrastructure, the economy and the country's unique ecosystems (World Bank 2021).

While the literature on climate change governance in Brazil has been centred on the multi-level governance framework (Inoue 2012; de Macedo and Jacobi 2019; Setzer 2017), this chapter concerns itself specifically with federalism. It identifies and analyses the main climate change strategies at federal, state and municipal levels in Brazil, focusing on two processes: (i) the favourable context for decentralized policymaking; and (ii) the scope for experimental policymaking and associated learning process among the constituent units.

Two features of Brazilian federalism are highlighted. One is that all levels of government have constitutional responsibilities for climate change policy, with a distinct range of policymaking powers. That is, state and municipal governments can step in and compensate for inaction by the federal government. States and municipalities have been taking the lead in climate governance, especially to compensate for the refusal of federal government to act on climate change. Brazilian states and municipalities have developed climate change policies relating to both mitigation and adaptation. The second is the availability of multiple forums

for ‘experimental’ policymaking triggering processes of policy diffusion among the constituent units. Such forums constitute institutional arrangements that encompass multi-level units as well as agents from different segments of society, such as transnational cooperation networks and agencies, research groups, among others.

3.2 The Practice of Federalism in Brazil

The return of democracy in 1985 (after two decades of military rule) also meant the return of federalism in Brazil. The country became a federal republic under the Constitution of 1988, which established three levels of government: the central government or Union; state governments and the Federal District government; and municipal governments. States and municipalities have autonomous administrations that collect their own taxes and receive a share of the taxes collected by the Federal government. States are headed by a governor and municipalities by a mayor. Both entities have elected legislative bodies. The twenty-six states and the Federal District have their own constitution. The 5,570 municipalities are not governed by states as is the case in most federations (Viswanathan 2014). They are granted the status of federal entities – at the same level as the states and are governed by an organic law, which must comply with federal and state constitutions. There is great discrepancy in the size (geographical area and population), and social and economic indicators among the subnational jurisdictions, but all Brazilian municipalities enjoy the same legal status. In 2015, seventeen municipalities had more than 1 million inhabitants, representing 22 per cent of the population; 44 per cent of municipalities had fewer than 10,000 inhabitants, representing 6.3 per cent of the population (OECD 2016).

The country’s size (over 8.5 million km²) and territorial diversity (physical, social and economic) have justified the choice for a system of government that allows for the decentralization of policies and a focused management of territories. In the context of climate change policymaking, federalism should help the State accounting for the diversity of effects experienced throughout the country, as well as the distinct types of actions that are needed to address the problem (Arretche 2000).

The Constitution assigns the federal government authority to act in foreign policy and international relations; propose and execute the national security and defence policy; conduct the country’s economy and finances, including issuing currency; organize, regulate and provide services in the area of communication; explore nuclear services and facilities. State powers are those outside the federal government’s area of activity and that were not expressly prohibited by the Constitution. Municipalities can legislate on matters of local interest (article 30, I),

in addition to complementing, when possible, federal and state legislation (article 30, II). Metropolitan regions can be created by the States (article 25, paragraph 3).³

The Union occupies a central position in environmental protection. It is responsible for implementing the general environmental policy, as established by Act 6,938 of 1981, which was enacted prior to the Constitution. The Union is also responsible for designing and executing national and regional planning (article 21, IX), which form the basis of environmental protection and climate change policies. But the Union shares authority with the constituent units over several themes related to environmental protection: forests, hunting, fishing, fauna, nature conservation; defence of soil and natural resources, protection of historical, cultural, tourist and landscape heritage; liability for damage to the environment, consumers, goods and rights of artistic, aesthetic, historical, tourist and landscape value; and health (article 24 of the Constitution). Control of sources of GHG emissions is shared between the environmental agencies (Complementary Act 140 of 2011) and subnational governments are allowed to engage in the global climate governance agenda.

3.3 Climate Change in Brazil

3.3.1 Contributions to Climate Change and Its Impacts

Brazilian GHG emissions reached 2,175 bn tonnes of carbon dioxide equivalent (CO₂e) in 2019 (SEEG 2020), placing Brazil as number seven in the ranking of the world's largest emitters. Emissions from the energy sector grew 1 per cent in 2019 compared to the previous year to 413 million tons of CO₂e. Meanwhile, emissions from deforestation increased 19 per cent, to 968 million tons of CO₂e – making this the main contributor to the increase in emissions, responsible for 44 per cent of the country's emissions.

Due to deforestation, Brazil is still far from being a low carbon economy. Emissions per capita exceed 10t CO₂e/inhabitant (2018) and are still higher than the global average of 7t CO₂e/inhabitant (SEEG 2020). The agricultural states of Pará and Mato Grosso are responsible for most of the country's emissions. Livestock activity has contributed to the increase of emissions, in addition to deforestation. On the other hand, the most industrialized state in the country, São Paulo, which represents one-third of the national GDP and has one-fifth of the country's population, occupies fourth place (SEEG 2020).

Despite the economic downturn resulting from the Covid-19 pandemic, GHG emissions in Brazil in 2020 increased by 8 per cent compared to 2019 (SEEG 2020). This was due to the lack of government command and control policy in tackling illegal deforestation and forest fire prevention.

The relevance of Conservation Units and Indigenous Lands for the protection of the Amazon has been extensively documented by numerous studies (Adeney et al. 2009; Barber et al. 2014; Noltea et al. 2013; Soares-Filho et al. 2010), in the sense of reaffirming the fundamental role that these areas play in curbing illegal deforestation and, therefore, in reducing Brazilian GHG emissions (Guetta et al. 2019).

Regarding climate change impact, extreme weather events are predicted to intensify and become more frequent, causing severe impacts on the six Brazilian biomes, coastal areas, the food system and security and water availability. The country's fishing potential may be reduced by 6 per cent over the next forty years, and by 2030 the country could lose about 11 million hectares suitable for agriculture. In turn, food insecurity could increase due to the decrease in subsistence agricultural production, with a consequent lack of food for populations directly exposed to climatic adversity. The effect of climate change will be concentrated mainly in the poorest regions of Brazil and will accentuate social inequalities (PBMC 2013).

3.4 Climate Change and Federalism in Brazil

3.4.1 Climate Change Commitments

Brazil signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the Paris Agreement. Brazil adopted its first voluntary commitment to cut GHG emissions in 2009, as part of the pioneering National Act on Climate Change Policies (PNMC). The legislation committed the country to a deviation in emissions between 36.1 per cent and 38.9 per cent by 2020, compared to projections from a business-as-usual scenario.

The adoption of PNMC meant a significant evolution of the institutional and legal framework on climate change. It was no longer an international agenda alone, but part of the country's development agenda, involving economic sectors, civil society and all levels of government in the policy formulation process (Hale et al. 2018; Senado 2019). The PNMC functioned as a guide for the implementation of decentralized climate policies developed by states and municipalities, based on their exclusive constitutional powers, whether within the scope of command and control of activities that generate GHG emissions (article 23, VI), or in concurrent legislative authority on the environment and pollution control (article 24, VI). Based on this shared power, some states and municipalities, such as the state and the city of São Paulo, had already enacted their climate laws before the Federal government.⁴

The 2010 decree stated that gross Brazilian emissions should be between 2,068 Mt CO₂e and 1,977 Mt CO₂e by 2020, including sectorial plans to cut emissions

economy-wide. The most significant was the Plan for Deforestation Prevention and Control in Amazonia, in which the target was to slash deforestation rates 80 per cent by 2020 compared to the 1996–2005 average. The agriculture sector plan established that Brazil should recover 15 million hectares of degraded pastures – a figure that would be double in 2015 by the NDC for 2030 (Angelo and Rittl 2019).⁵

Brazil achieved impressive results by reducing the deforestation rate in the Amazon by 83.5 per cent from 2004 to 2012. During this period, forest destruction fell from 27,772 km² to 4,571 km² a year. In 2010, the Plan for the Prevention and Control of Deforestation and Burning Practices in the Cerrado Region was also created, resulting in a 33 per cent reduction of deforestation in that biome by 2018. During this period, action was taken to improve land use and land tenure regularization; create more conservation units; create and improve environmental monitoring systems; strengthen environmental surveillance; promote sustainable productive activities; and create economic incentives for forest conservation. Several federal agencies were mobilized to implement and monitor such plans, in addition to the creation of a high-level governance structure (SEEG 2018).

In 2015, Brazil submitted a reduction target under the Paris Agreement, becoming the first major developing country to commit to reduce its emissions in relation to a base year, as opposed to reductions based on projected emissions or per unit of GDP. Its NDC committed the country to a 37 per cent reduction in emissions by 2025 and 43 per cent in 2030 compared to 2005 levels and the publication of a National Adaptation Plan, in 2016 (Brasil 2020).

However, since the election of President Jair Bolsonaro in 2019, this structure has been collapsing. Climate action plans were paralysed and their governance structure extinguished. Likewise, the Amazon Fund, specially created to obtain international financing for mitigation and adaptation to climate change, has been threatened (SEEG 2018). Deforestation in the Amazon increased by 29.5 per cent in 2019, the worst rate in the last eleven years and the third highest in the historical series that began in 1988 (INPE 2020).

3.4.2 Climate Change at State Level

Nineteen out of twenty-seven states have passed a legislation establishing a climate change policy. Most of them, sixteen, were approved between 2007 and 2012. Not all state policies have clear mitigation and adaptation strategies, though. Seven states with a climate policy have defined neither mitigation nor adaptation strategies. In these cases, the climate initiative exists only ‘on paper’. Twelve states have defined their mitigation strategies, with specific foci depending on the emissions profile of each state. In the Amazonian states such as Acre, Amazonas and Rondônia where most emissions come from deforestation, mitigation efforts

focus on environmental services and deforestation prevention and control. In São Paulo and Minas Gerais, mitigation action is more centred in the energy and transportation sectors. Only eight of these states have developed their inventories, which are central to mitigation planning. Regarding adaptation, less than half of the policies (only eight) have defined actions. They are most related to environmental disaster risk management, centred in areas vulnerable to climate related events, such as flooding and landslides. Such strategies do not incorporate future climate change projections for their territories, which is essential to plan the urban space and coastal areas in order to guarantee the best use and occupation of these spaces, the safety of people and economic and social development.

In terms of institutional mechanisms for policy implementation, fifteen states have created a Climate Forum or Climate System, which count on the participation of state secretaries and agencies, municipalities, academia, private sector and civil society organizations. In most cases, these institutional arrangements played a key role in the policy elaboration and approval phases. They were created with the aim of developing a climate change policy in the first place, but after the policy approval not all forums kept active. In some cases, a specific governmental body related to the climate issue has absorbed the policy implementation. Fifteen states have created a climate change board, management, department, superintendence or coordination within their governmental structure. Table 3.1 summarizes states' climate change policies.

3.4.3 Climate Change at Municipal Level

Twelve out of 5,570 municipalities have a specific law establishing a climate policy, corresponding to a population of over 30 million people (IBGE 2010). Between 2003 and 2011, six cities approved their climate change laws (Belo Horizonte, Curitiba, Feira de Santana, Manaus, Palmas, Rio de Janeiro and São Paulo) and five municipalities (Fortaleza, Porto Alegre, Recife, Santos and Sorocaba) approved theirs after 2014, with greater attention to adaptation. Not all municipal policies have clear mitigation or adaptation strategies. Seven out of the twelve municipalities have mitigation strategies and six of them have adaptation actions. Three municipalities have defined neither mitigation nor adaptation actions. Most mitigation strategies include setting or planning to set GHG emission reduction targets. Other actions involve green areas conservation and energy efficiency. The adaptation strategies mainly involve the civil defence and urban planning sectors.

Coastal cities represent an important gap in Brazil's local climate policies. They are considered even more vulnerable to climate change for their geographical specificity, their interface between continent, atmosphere and ocean, and because

Table 3.1 *Climate change policies in Brazilian States*

State	Climate act / policy	Year of strategy	Mitigation strategies	Adaptation strategies	Institutional mechanisms for implementation
Acre	Act no. 2,308	2010	State System of Incentives for Environmental Services (Carbon) State Plan of Deforestation Prevention and Control (2010)	Environmental Disaster Risk Management Plan (2012)	Institute for Climate Change and Regulation of Environmental Services (2011)
Amazonas	Acts no. 3,135 and 4,266	2007 / 2015	Environmental Services Management System; State Plan of Deforestation Prevention and Control	Non-existent	Forum on Global Climate Change, Biodiversity and Environmental Services (2009)
Bahia	Act no. 12,050	2011	State Plan on Climate Change to be defined	State Plan on Climate Change to be defined	Forum on Global Climate Change and Biodiversity (2005)
Ceará	Act no. 16,146	2016	State Plan on Climate Change in elaboration	Adaptation Plan in elaboration	Forum on Climate Change and Biodiversity (2008)
Distrito Federal	Act no. 4,797	2012	Mitigation Plan to be elaborated	Adaptation Plan to be elaborated	not defined
Espírito Santo	Act no. 9,531	2010	GHG emission reduction targets to be set for 2025	non-existent	Forum on Global Climate Change, Rational Use of Water and Biodiversity
Goiás	Act no. 16,497	2009	State Plan on Climate Change Mitigation and Adaptation (2012) focused on low carbon agriculture	State Plan on Climate Change Mitigation and Adaptation (2012)	Forum on Climate Change (2016)
Mato Grosso	Complementary Act no. 582	2017	State Plan on Climate Change to be elaborated	State Plan on Climate Change to be elaborated	State Climate Change System (2017)
Minas Gerais	Act no. 45,229	2009	Energy and Climate Change Plan (2015)	to be elaborated	Climate Change Forum (2005)

Table 3.1 (cont.)

State	Climate act / policy	Year of strategy	Mitigation strategies	Adaptation strategies	Institutional mechanisms for implementation
Paraná	Act no. 9,336	2011	GHG emission reduction target of 36.1–38.9% until 2020	Not defined	State Secretary of Environment and Water Resources
Paraná	Act no. 17,133	2012	State Plan on Climate Change in elaboration	State Plan on Climate Change in elaboration	Forum on Global Climate Change (2008)
Pernambuco	Act no. 14,090	2010	State Plan on Climate Change (2011)	State Plan on Climate Change (2011)	State System for Combating Climate Change (2010)
Piauí	Act no. 6,140	2011	State Plan on Climate Change to be elaborated	State Plan on Climate Change to be elaborated	State Secretary of Environment and Water Resources
Rio de Janeiro	Act no. 5,690	2010	State Plan on Climate Change (2012)	State Plan on Climate Change (2012)	Forum on Global Climate Change (2007)
Rio Grande do Sul	Act no. 13,594	2010	Sectorial Plan for Mitigation and Adaptation to Climate Change for the Consolidation of a Low Carbon Economy in Agriculture (2013)	Sectorial Plan for Mitigation and Adaptation to Climate Change for the Consolidation of a Low Carbon Economy in Agriculture (2013)	Forum on Climate Change (2007)
Rondônia	Act no. 4,437	2018	State System of Climate Governance and Environmental Services (2018)	State System of Climate Governance and Environmental Services (2018)	State System of Climate Governance and Environmental Services Management Council (2018)

Santa Catarina	Act no. 14,829	2009	Not defined	Not defined	Forum on Global Climate Change (2009)
São Paulo	Act no. 13,798	2009	Biogas Program (2012); Transportation Program (2014)	Program for the Prevention of Natural Disasters and the Reduction of Geological Risks (2011)	Forum on Global Climate Change and Biodiversity (2005)
Tocantins	Act no. 1,917	2008	Sectorial Plan for Mitigation and Adaptation to Climate Change for the Consolidation of a Low Carbon Economy in Agriculture (2013)	Sectorial Plan for Mitigation and Adaptation to Climate Change for the Consolidation of a Low Carbon Economy in Agriculture (2013)	Forum on Global Climate Change and Biodiversity (2007)

Source: the authors.

they are places with a high concentration of people and structures – which changes these events to the status of disasters, since people and structures can be severely affected. Brazil has a coastline of almost 7,500 km, where many – and some of the most important – cities in the country are located and where most of the population is concentrated. Only five coastal cities (Fortaleza, Recife, Rio de Janeiro, Salvador and Santos) have an adaptation strategy.

In terms of institutional mechanisms for policy implementation, ten out of the twelve cities established a Climate Forum or Committee, with the participation of municipal secretaries and agencies, universities and research institutes, private sector and civil society organizations. A summary of these municipal climate policies is shown in Table 3.2.

3.4.4 Climate Change Policy Construction Process

The development and implementation of climate mitigation and climate adaptation policies at the three levels of government in Brazil relies on several institutions that establish dialogue and coordination, information sharing, capacity development, planning, implementation, monitoring and evaluation across the different levels of government. These institutions and their roles are described in Table 3.3.

However, in recent years, federal institutions at the federal level – the Interministerial Committee on Climate Change, the Interministerial Commission on Global Climate Change and the National Climate Change Fund – have been affected by the climate change denialist position of the current government (dos Santos Estevo 2021). The work of the Brazilian Panel on Climate Change has also been affected by funding reductions, as has the Brazilian Forum of Climate Change.⁶

3.5 Climate Policy and Federalism in Brazil: The Role of the Subnational Level

This section analyses the ways subnational level of government has been taking a leadership in climate governance in Brazil through two processes: (i) the favourable context for decentralized policymaking; and (ii) the scope for experimental policymaking and associated learning among the constituent units.

3.5.1 The Favourable Context for Decentralized Policymaking

As in other countries (e.g., Rabe 2008), decentralized and experimental climate policymaking has emerged in Brazil in a context of bottom-up climate policymaking seeking to fill a void left by federal inaction. The city of Santos,

Table 3.2 *Climate change policies in Brazilian municipalities*

City / State	Climate act/ policy	Year	Mitigation strategies	Adaptation strategies	Institutional mechanisms for implementation
Belo Horizonte (MG)	Act no. 10,175	2011	30% GHG emissions reduction until 2015	Adaptation plan in elaboration	Municipal Committee of Climate Change and Eco economy (2006)
Curitiba (PR)	Decree no. 1,186	2009	Mitigation plan in elaboration	Adaptation plan in elaboration	Curitiba Forum of Climate Change (2009)
Feira de Santana (BA)	Act no. 3,169	2011	Objective to reduce GHG emissions but no target set	To be defined	Municipal Forum of Global Climate Change and Biodiversity (2011)
Fortaleza (CE)	Act no. 10,586	2017	15.5% GHG emissions reduction until 2020 and 20% until 2030	Adaptation plan in elaboration	Fortaleza Forum of Climate Change (2015)
Manaus (AM)	Act no. 254	2010	Mandatory use of equipment aimed at the rational use of energy and water in buildings and tax incentives for sustainable practices	Mandatory use of equipment aimed at the rational use of energy and water in buildings and tax incentives for sustainable practices	Municipal government
Palmas (TO)	Act no. 1,182	2003	Green areas conservation and energy efficiency plan	Not defined	Municipal Department of Environment
Porto Alegre (RS)	Complementary Act no. 872	2020	GHG emission reduction targets to be defined after inventory execution	Resilience Plan (2016)	Municipal Committee of Climate Change and Energy Efficiency (2016)

Table 3.2 (cont.)

City / State	Climate act/ policy	Year	Mitigation strategies	Adaptation strategies	Institutional mechanisms for implementation
Recife (PE)	Act no. 18,011	2014	GHG emission reduction plan with targets by sector of activity (2016)	Adaptation Plan (2019)	Recife Committee of Sustainability and Climate Change (Comclima) (2013) Executive Group of Sustainability and Climate Change (Geclima) (2013)
Rio de Janeiro (RJ)	Act no. 5,248	2011	GHG emission reduction targets: 8% in 2012; 16% in 2016; 20% in 2020	Climate Change Adaptation Strategy (2016)	Forum Carioca of Climate Change and Sustainable Development (2009)
Santos	Adaptation Plan	2016	Not defined	Adaptation Plan (2016)	Municipal Commission of Climate Change Adaptation (2015)
São Paulo (SP)	Act no. 14,933	2009	Guidelines for the City of São Paulo Action Plan for Mitigation and Adaptation to Climate Changes (2011)	Guidelines for the City of São Paulo Action Plan for Mitigation and Adaptation to Climate Changes (2011)	Municipal Committee of Climate Change and Eco economy (2005)
Sorocaba (SP)	Act no. 11,477	2016	GHG emission reduction targets to be defined after inventory execution	Adaptation Plan (in elaboration?)	Local Committee of Climate Change and Working Group on Climate Change (2019)

Source: the authors.

Table 3.3 *Institutions responsible for the development and implementation of climate change policies in Brazil*

Institutional arrangements at federal level	<p>Interministerial Committee on Climate Change: articulates federal government internally among ministries to guide the implementation, monitoring and evaluation of the National Plan on Climate Change; supports the international articulation within the scope of the Climate Convention.</p> <p>Brazilian Forum of Climate Change: main institutional arrangement that enables dialogue, coordination and information sharing.</p> <p>Brazilian Panel on Climate Change: established in the IPCC model, as the technical-scientific extension of the National Policy; interfaces directly with the Brazilian Forum; supported by the Brazilian Network for Research on Global Climate Change.</p>
Institutional arrangements at subnational level	<p>State and municipal forums of climate change, stimulated by the Brazilian Forum.</p> <p>Brazilian Association of State Environmental Entities (ABEMA): promotes political articulation and coordination in Brazilian states.</p> <p>National Association of Municipal Environmental Entities (ANAMMA) and the Forum of Environmental Secretaries of Brazilian Capital Cities (CB27): similar role of Abema at city level.</p>
Capacity development	<p>Transnational networks: mainly ICLEI, 100 Resilient Cities and C-40 play a key role in capacity building opportunities and development of technical knowledge (e.g., elaboration of GHG emissions inventories and resilience plans).</p>
Implementation	<p>National Climate Change Fund: instrument of the National Climate Change Policy to finance projects, studies and enterprises that aim to mitigate and to adapt to the effects of climate change; linked to the Ministry of Environment.</p>
Monitoring & evaluation	<p>Interministerial Committee on Climate Change (CIM): guides and prepares the implementation, monitoring and evaluation of the National Plan on Climate Change.</p>

Source: the authors.

in the state of São Paulo, illustrates this case. In the absence of a national and state adaptation strategy and already feeling the effect of climate change, the local government of Santos started developing its adaptation plan in 2015 and published it a few months after the National Adaptation Plan (PNA) in 2016. As a coastal city, Santos is highly vulnerable to climate change, primarily due to the risks

related to relative sea-level rise; the occurrence of extreme events of rain, storm surges, and storm tides; and the socio-environmental consequences of these events (Marengo et al. 2017; Souza et al. 2019).

The PNA was approved seven years after the approval of the National Policy on Climate Change, which suggests that, at the federal level, adaptation has taken a longer time to be internalized. Furthermore, for Brazilian specialists (Di Giulio et al., 2016a), the PNA falls short of what is needed in relation to adaptation policies. Its implementation has been interrupted by the current federal administration. At state level, only the Federal District developed an adaptation plan, which is currently under public consultation.⁷

In Brazil, the metropolitan level is essential for environmental protection and climate governance. Although climate change effects are localized, they are often linked to transformations and disruptions in ecosystems and ecological processes that include multiple jurisdictions. Therefore, a coordinated response by governments at multiple scales is more efficient in responding to climate impacts (Keskitalo et al. 2016; Nalau et al. 2015). For example, measures involving water management and flood protection systems, such as warning systems that require effective communication and coordination mechanisms, go beyond municipal boundaries. Public transportation also needs to be thought of at the level of the metropolitan region, with the collaboration of municipalities. However, climate change is not considered in any existing political–institutional structures and public policies at metropolitan level (Sathler et al. 2019; Torres et al. 2019). Metropolitan regions along with Integrated Development Regions (RIDEs) concentrate 54.3 per cent of the country’s population (IBGE 2010). Therefore, it is essential that the federal and state governments promote action at the metropolitan scale, acting as interlocutors and encouraging the dissemination of climate policies and the creation of institutional arrangements that enable the construction of an integrated climate agenda at the inter-municipal level.

One example of articulation at municipal and metropolitan scales is the Reconecta Program at Campinas Metropolitan Region, in the state of São Paulo, headed by the municipality of Campinas. While not explicitly a climate change policy, the programme focuses on ecosystem services and supports the integration of conservation and recovery measures for fauna and flora in the twenty municipalities that are part of the metropolitan region. The programme has INTERACT-Bio Project as a partner, it is coordinated and implemented by ICLEI – Local Governments for Sustainability (Interact-Bio 2021).

Due to the localized nature of many climate change effects, it is important that regional and local governments can design their own adaptation policies (Biesbroek et al. 2014; Termeer et al. 2011). For instance, while coastal regions need to enhance their resilience to floods, mountainous regions may need to focus

on landslides. Following tragic landslides in the mountainous region of Rio de Janeiro,⁸ the National Civil Defence and Protection Policy (Act No. 12,608) was approved in 2012, which instituted the National Civil Defence and Protection System. The focus of public policies at the federal level shifted from post-disaster response and reconstruction to preventive actions, which mainly seek to safeguard human life and have been influencing state and municipal policies. This has had a significant impact at the local level, where climate change adaptation planning is strongly related to the civil defence department (Di Giulio et al. 2016b). Decentralized action in Brazil involving risk and disaster management has contributed to the development and implementation of actions with the potential to adapt to the effects of climate change at local level.

However, decentralized and uncoordinated climate action may lead to profound disparities between different regions in a federation, resulting from distinct capacities, resources and assets that local and regional governments have to adapt to climate change (Gordon 2015). That is the case of the municipalities and regions within the state of São Paulo, which have different levels of resilience and capacities. To reduce such disparities, the State launched a programme ('Resilient Municipalities') to support thirteen selected municipalities and the Metropolitan Region of Santos in the design of their adaptation and resilience plans; the pilot phase started in 2021 (São Paulo Governo do Estado 2021).

Moreover, Brazilian cities have faced difficulties when putting such plans into practice. Many climate policies fail to get implemented due to insufficient financial resources (Barbi and de Macedo 2019). Participation in transnational municipal networks (TMNs) is a path taken by most Brazilian cities which have climate policies. Several cities have joined the ICLEI network, whose methodology in the Green Climate Cities Programme includes helping cities find financing for their climate actions. In the case of Santos, the city engaged in the ProAdapta Project, supported by GIZ. Another possibility is to consider climate action budget in the multi-year municipal plan.

The emphasis on decentralization in the cooperative Brazilian federalism model without defined distribution of responsibilities may be a source of tension (Viswanathan 2014). When states or municipalities do not carry out their responsibilities, there is no adequate mechanism for the federal authorities to remedy the situation.

Municipalities with flexibility and capacity to establish their own climate policies can also experiment with innovative solutions for combating climate change (Biesbroek and Lesnikowski 2018) and become a model for other municipalities. This is the case of Santos and Campinas, which are leading the way to climate adaptation in their metropolitan regions, engaging the neighbouring municipalities in climate planning.

3.5.2 The Scope for Experimental Policymaking and Associated Learning

The main mechanism of policy diffusion and social influence in Brazil is policy learning – using established definitions of policy learning as the generation of knowledge on resolving a policy problem and of lessons on best strategies to secure policy adoption (May 1992). Informal institutions such as networks involving officials and experts within and between governments can facilitate policy diffusion processes in a federation, particularly the development and sharing of policy lessons (Butler et al. 2016; Vinke-De Kruijf and Pahl-Wostl 2016). Climate policy diffusion in Brazil is supported by TMNs, mainly ICLEI, C-40 and 100 Resilient Cities, and other institutional arrangements, such as the Brazilian Association of State Environmental Entities (ABEMA) at state level and the National Association of Municipal Environmental Entities (ANAMMA) and the Forum of Environmental Secretaries of Brazilian Capital Cities (CB27), both at local level. By engaging in TMNs and in these other institutional arrangements, it is expected that governments will learn from one another's experiences in designing and implementing climate policies.

The availability of multiple forums for policymaking offers some advantages for combating climate change. Federalism, in particular, makes it possible for state and municipal level to adopt climate policies to compensate for the void left by another level of government's inability or refusal to deal with climate change (Derthick 2010). In the context of federal inaction on climate change by the Bolsonaro administration, multiple Brazilian states and municipalities have engaged in institutional arrangements through which they commit to reduce their carbon emissions. One example is the Brazilian Alliance for Climate Action (ACA), established in 2021 to mobilize state and local authorities, business leaders, investors, academics, the press, religious bodies and civil society organizations to increase climate action (ACA Brasil 2021). Six months after its creation, four states and nineteen municipalities had signed the declaration, assuming the responsibility of meeting the Brazilian NDC and collaborating to make it even more ambitious.

Another example is the 'Governors for Climate' movement, within the framework of the Brazil Center on Climate, which sent a letter to US President Joe Biden signed by twenty-four state governors proposing strategic partnerships between the USA and their states on the eve of the 2021 Leaders' Climate Summit (CBC 2021). With this, they seek to reactivate and create state forums on climate change, attract investments and establish connections between states and international funding agencies, and overall, find opportunities and compensate for the void generated by the national government's refusal to address climate change.

At the same time, at municipal level, the Forum of Environmental Secretaries of Brazilian Capital Cities (CB27) published the Letter in Defence of Biomes, a

document that reinforced the idea that the defence of Brazilian biomes is a necessary condition for the preservation of biodiversity and essential for the climate emergency mitigation and adaptation (CB27 2021). Time will tell whether these mobilizations at state and local levels will be translated into consistent policy mitigation and adaptation strategies.

A well-functioning federal state should facilitate an effective multi-level climate governance system in which all levels collaborate to develop and implement synergistic climate policies based on their experience and resources, thus achieving the balance between centralization and decentralization (Carlson 2009). However, the current administration is hindering multi-level climate governance, essential when it comes to sectors such as land use management, energy, water resources and others. President Bolsonaro was elected and supported by ‘ruralists’, the large rural landowners bloc in Congress, who are interested in agriculture expansion, reduction of conservation areas and authorization for increased use of pesticides (dos Santos Estevo 2021). This situation illustrates what Jordaan et al. (2019) describe as political conflicts and ideological divisions arising from political polarization between different governments in a federation undermining the emergence of effective forms of multi-level climate governance. Overcoming this current political polarization in Brazil is one of the country’s biggest challenges in order to promote multi-level climate governance.

Furthermore, federal structures may enhance climate change resilience through collaborative projects, networks and co-funding arrangements that enable the opening of paths to meet the needs of affected areas, to build capacity at local level for managing climate risks and to address underlying differences between jurisdictions regarding exposure to climate hazards and their adaptive capacity (Pahl-Wostl et al. 2012). In Brazil, some federal funding such as the Climate Fund have been compromised by the federal government, making it difficult to build resilience to climate change.

Federated entities can also act in concert through their own networks, horizontal coordinated climate governance, where they can collaborate and share knowledge with one another (Hanssen et al. 2013). At local level, one example is the participation of 109 Brazilian cities in the Global Covenant of Mayors for Climate and Energy, a global alliance of local governments voluntarily committed to climate change mitigation and adaptation (GCMCE nd). ICLEI has mobilized Brazilian cities and supported the consolidation of a strategic network of institutions committed to the implementation of long-term national strategies, comprising the Brazilian Association of Municipalities (ABM), the National Front of Mayors (FNP) and the National Confederation of Municipalities (CNM) (ICLEI 2021).

Within the multiplicity of forums for the formulation of climate policies, regulatory overlaps and coordination deficits within a federation can hinder

collaboration and generate inefficiencies in the adoption and implementation of climate policies (Jordaan et al. 2019). In Brazil, a sector related to climate governance, such as land use management, is a source of tension between different levels of government.

Brazilian federalism has provided a favourable context for decentralized and experimental policymaking in climate change governance in the country, especially at local level, where municipalities are leading the way to adaptation strategies. Cooperation between municipalities through transnational municipal networks and international cooperation has collaborated to the policy diffusion of climate strategies in the country. The availability of multiple forums for climate policymaking at the subnational level has played an important role, especially at a time when the federal government is actively dismantling the national climate agenda.

3.6 Conclusion

In recent years Brazilian constituent units have been able to move forward with climate change policies in the absence of effective action by the central government. A favourable legislative framework and the political will of local leaders provided constituent units with the necessary authority and conditions to develop experimental climate policies. State and municipal governments with environmental bodies, financial resources and technical staff have been able to drive local and regional agendas more effectively than the central administration.

However, for key sectors such as land use change and forestry, federal government action is essential. Subnational governments efforts alone are simply incapable of containing deforestation in the Cerrado and the Amazon region and therefore cannot address the main sources of the country's emissions. Given the key role of the land use and forestry sector in Brazil's emissions and the huge global importance of its forests for environmental services, biodiversity and carbon sequestration, the Brazilian government urgently needs to strengthen mitigation action in this sector, as well as to coordinate such action with the constituent units. Our analysis also highlighted an important gap regarding the metropolitan level. This is due to the lack of institutional arrangements that provide metropolitan regions with governance capacity.

When it comes to conflicting interests, the executive and legislative powers have constitutional authority over issues related to climate change mitigation and adaptation at the three levels. However, with the Congress currently dominated by interests that oppose such policies, and the national government adopting a denialist position towards climate change, the Senate has played the role of moderator, often 'locking up' agendas that are not aligned with climate action.

While subnational action in Brazilian federalism has been an important facilitator of climate strategies and policies, it is necessary to monitor to what extent the commitments made and plans designed at subnational level will move forward in a post-pandemic political and economic context.

Notes

- 1 When considering historical emissions, Brazil is the fourth-largest global GHG emitter, responsible for 5 per cent of historical emissions worldwide (Carbon Brief, 2021).
- 2 The ND-GAIN Index¹¹ ranks 181 countries using a score which calculates a country's vulnerability to climate change and other global challenges as well as their readiness to improve resilience (University of Notre Dame, 2022).
- 3 From the second half of the 1990s onwards, a large number of metropolitan regions were created by state governments. There are now more than sixty metropolitan regions in the country (Fernandes, Araújo, 2015).
- 4 Lei nº 12.187, de 29 de dezembro de 2009. *Institui a Política Nacional sobre Mudança do Clima – PNMC*. Diário Oficial da União. Brasília, DF, nº 248, Seção 1, p. 109, 29 dez.
- 5 Decreto nº 7.390, de 9 de dezembro de 2010. *Regulamenta os arts. 6o, 11 e 12 da Lei no 12.187, de 29 de dezembro de 2009, que institui a Política Nacional sobre Mudança do Clima – PNMC*.
- 6 The Brazilian Forum of Climate Change has changed its name to Forum Climate Brazil (Azevedo 2019).
- 7 www.sema.df.gov.br/wp-content/uploads/2021/02/Texto-Consulta-Publica-2021-Plano-de-Adaptacao-Distrito-Federal_publicado.pdf, accessed on 23/06/2021.
- 8 The disaster occurred between 11 and 12 January, 2011, affecting seven cities in the mountainous region of the State of Rio de Janeiro, when heavy rains caused floods and landslides, leaving more than 900 dead, around 350 missing and thousands of people unsheltered, as well as serious damage to the region's infrastructure, economy and geography.

References

- ACA Brasil. 2021. 'Signatários'. <https://acabrasil.org.br/signatarios>, last accessed on 30/06/2021.
- Adeney, J. Marion, Norman L. Christensen Jr., and Stuart L. Pimm. 2009. 'Reserves Protect against Deforestation Fires in the Amazon'. *PLoS ONE* 4 (4): e5014. doi: 10.1371/journal.pone.0005014.
- Albuquerque, Igor (ICLEI), Ane Alencar (Ipam), Claudio Angelo (Observatório Clima) et al. 2020. 'Análise das Emissões Brasileiras de Gases de Efeito Estufa e suas implicações para as metas do Brasil – 1970–2019'. SEEG (Sistema de Estimativas de Emissões de Gases de Efeito Estufa). <https://seeg-br.s3.amazonaws.com/2019-v7.0/documentos-analiticos/SEEG-Relatorio-Analitico-2019.pdf>, accessed on 04/06/2020.
- Arretche, Marta. 2000. *Estado Federativo e Políticas Sociais: Determinantes da Descentralização*. Rio de Janeiro: Revan; São Paulo: FAPESP.
- Azevedo, Ana Lucia. 2019. 'Exonerado por Bolsonaro, Alfredo Sirkis diz que "Brasil precisa de uma Lava-Jato do desmatamento"'. *O Globo Brasil*, 10 May. <https://oglobo.globo.com/sociedade/exonerado-por-bolsonaro-alfredo-sirkis-diz-que-brasil-precisa-de-uma-lava-jato-do-desmatamento-23656390>, accessed on 26/05/2021.
- Barber, Christopher P., Mark A. Cochrane, Carlos M. Souza Jr., and William F. Laurance. 2014. 'Roads, Deforestation, and the Mitigating Effect of Protected Areas in the Amazon'. *Biological Conservation* 177: 203–9. doi: 10.1016/j.biocon.2014.07.004.

- Barbi, Fabiana, and Laura Valente de Macedo. 2019. 'Transnational Municipal Networks and Cities in Climate Governance: Experiments in Brazil'. In *Urban Climate Politics: Agency and empowerment*, eds. Jeroen van der Heijden, Harriet Bulkeley, and Chiara Certomà, 59–79. Cambridge: Cambridge University Press. doi: 10.1017/9781108632157.
- Biesbroek, Robbert, and Alexandra Lesnikowski, A. 2018. 'Adaptation'. In *Governing Climate Change: Polycentricity in action?*, eds. Andrew Jordan, Dave Huitema, Harro van Asselt, and Johanna Forster, 303–19. Cambridge: Cambridge University Press. doi: 10.1017/9781108284646.018.
- Biesbroek, Robbert, Katrien Termeer, Judith Klostermann, and Pavel Kabat. 2014. 'Rethinking Barriers to Adaptation: Mechanism-based explanation of impasses in the governance of an innovative adaptation measure'. *Global Environmental Change* 26 (1): 108–18. doi: 10.1016/j.gloenvcha.2014.04.004.
- Brasil: MMA (Ministério do Meio Ambiente). 2016. *Plano Nacional de Adaptação à Mudança do Clima: Volume II: Estratégias Setoriais e Temáticas*. Portaria MMA nº 150 de 10 de maio de 2016. Brasília: MMA. <https://antigo.mma.gov.br/clima/adaptacao/plano-nacional-de-adaptacao.html>.
- Brasil: MRE (Ministério das Relações Exteriores). 2020. Press release n. 157.
- Carbon Brief. 2021. 'Historical Responsibility for Climate Change is at the Heart of Debates over Climate Justice'. www.carbonbrief.org/analysis-which-countries-are-historically-responsible-for-climate-change.
- Carlson, A. E. 2009. 'Iterative Federalism and Climate Change'. *Northwestern University Law Review* 103 (3): 1097–162.
- CBC. 2021. 'Carta governadores brasileiros a Joe Biden'. *CBC*. www.centrobrasilnoclima.org/acoes/Carta-governadores-brasileiros-a-Joe-Biden, last accessed on 30/06/2021.
- CB27. 2021. 'Regenera o Verde: Capitais Pela Defesa dos Biomas'. *CB27*. <https://cb27.s3.amazonaws.com/port-cb27-carta-regeneracao-verde-port.pdf>, last accessed on 30/06/2021.
- Derthick, M. 2010. 'Compensatory Federalism'. In *Greenhouse Governance: Addressing climate change in America*, ed. Barry G. Rabe, 58–72. Washington DC: Brookings Institution Press.
- Di Giulio, Gabriela Marques, David Lapola, Roger Torres, et al. 2016a. 'Plano Nacional de Adaptação à Mudança do Clima: possibilidades e desafios'. *Jornal da Ciência* 24 (1):1. www.jornaldaciencia.org.br/edicoes/?url=http://jcnoticias.jornaldaciencia.org.br/24-plano-nacional-de-adaptacao-a-mudanca-do-clima-possibilidades-e-desafios, accessed on 16/06/2021.
- Di Giulio, Gabriela Marques, Ana Maria Bedran Martins, and Maria Carmen Lemos. 2016b. 'Adaptação climática: Fronteiras do conhecimento para pensar o contexto brasileiro'. *Estudos Avançados* 30 (88): 25–41. doi: 10.1590/S0103-40142016.30880004.
- dos Santos Estevo, Jefferson. 2021. 'Riscos e Mudanças Climáticas: Os Casos de Brasil e China (2011–2019)'. PhD diss. Unicamp. www.unicamp.br/unicamp/teses/2021/05/04/riscos-e-mudancas-climaticas-os-casos-de-brasil-e-china-2011-2019.
- Fernandes, Antônio Sérgio Araújo, and Suely Mara Vaz Guimarães de Araújo. 2015. 'A Criação de Municípios e a Formalização de Regiões Metropolitanas: Os Desafios da Coordenação Federativa'. *Revista Brasileira de Gestão Urbana* 7 (3): 295–309.
- GCMCE (Global Covenant of Mayors for Climate and Energy). nd. <http://pactodealcaldes-la.eu/en>, last accessed on 30/06/2021.

- Guetta, Mauricio, Antonio Francisco Perrone Oviedo, and Nurit Bensusan. 2019. 'Litigância climática em busca da efetividade da tutela constitucional da Amazônia'. In *Litigância climática: Novas fronteiras para o Direito Ambiental no Brasil*, eds. Joana Setzer, Kamyla Cunha, and Amália Botter Fabbri. São Paulo, SP: Thomson Reuters Brasil.
- Gordon, D. 2015. 'An Uneasy Equilibrium: The coordination of climate governance in federated systems'. *Global Environmental Politics* 15 (2): 121–41.
- Hale, Thomas. 2018. *The Role of Sub-state and Nonstate Actors in International Climate Processes*. London: Chatham House: The Royal Institute of International Affairs. www.chathamhouse.org/sites/default/files/publications/research/2018-11-28-non-state-sectors-climate-synthesis-hale-final.pdf, accessed on 07/07/2020. 2018.
- Hansen, Gro Sandkjaer, Per Kristen Mydske, and Elisabeth Dahle. 2013. 'Multi-Level Coordination of Climate Change Adaptation: By national hierarchical steering or by regional network governance?' *Local Environment* 18 (8): 869–87. doi: 10.1080/13549839.2012.738657.
- IBGE (Instituto Brasileiro de Geografia e Estatística). Censo 2010. <https://cidades.ibge.gov.br>.
- ICLEI (Governos Locais pela Sustentabilidade). 2021. 'Pacto Global de Prefeitos pelo Clima e a Energia'. *ICLEI*. <https://americadosul.iclei.org/projetos/pacto-global-de-prefeitos>, last accessed on 30/06/2021.
- INPE (INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS). 2020. 'Terra Brasilis Taxa de Desmatamento Amazônia Legal 1988–2020'. <http://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal>, accessed on 26/10/2022.
- Inoue, C. 2012. 'Governance of Global Climate Change in the Brazilian Amazon: The case of Amazonian municipalities of Brazil'. *Revista Brasileira de Política Internacional*, 55 (special edition): 170–89.
- INPE (Instituto Nacional de Pesquisas Espaciais). 2021. 'Monitoramento do Desmatamento da Floresta Amazônica Brasileira por Satélite'. www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes, accessed on 04/06/2020.
- Interact-Bio. 2021. Plano de Ação para Implementação da Área de Conectividade da Região Metropolitana de Campinas. <https://americadosul.iclei.org/wp-content/uploads/sites/78/2021/04/60-ly-plano-de-acao-campinas-digital-3.pdf>, last accessed 30/05/2021.
- IPCC (Intergovernmental Panel on Climate Change). 2014. 'Summary for Policymakers'. In *Climate Change 2014: Impacts, adaptation, and vulnerability: Part A: Global and sectoral aspects: Working Group II contribution to the IPCC fifth assessment report*, eds. Christopher B. Field, Vicente R. Barros, David Jon Dokken, et al., 1–34. Cambridge: Cambridge University Press. doi: 10.1017/CBO9781107415379.
- Jordaan, Sarah M., Adrienne Davidson, Jamal A. Nazari, and Irene M. Herremans. 2019. 'The Dynamics of Advancing Climate Policy in Federal Political Systems'. *Environmental Policy and Governance* 29 (3): 220–34. doi: 10.1002/eet.1849.
- Keskitalo, E. Carina H., Sirkku Juhola, Nina Baron, Håkon Fyhn, and Johannes Klein. 2016. 'Implementing Local Climate Change Adaptation and Mitigation Actions: The role of various policy instruments in a multi-level governance context'. *Climate* 4 (1): 7. doi: 10.3390/cli4010007.
- Marengo, Jose A., and Fabio Rubio Scarano, eds. 2017. *Impacto, Vulnerabilidade e Adaptação das Cidades Costeiras Brasileiras às Mudanças Climáticas: Relatório Especial do Painel Brasileiro de Mudanças Climáticas*. Rio de Janeiro: PBMC. doi: 10.13140/RG.2.2.36042.16329.
- de Macedo, Laura Sílvia Valente, and Pedro Roberto Jacobi. 2019. 'Subnational Politics of the Urban Age: Evidence from Brazil on integrating global climate goals in the municipal agenda'. *Palgrave Communications* 5, 18. doi: 10.1057/s41599-019-0225-x.

- May, P. J. 1992. 'Policy Learning and Failure'. *Journal of Public Policy* 12 (4): 331–54.
- Nalau, Johanna, Benjamin L. Preston, and Megan C. Maloney. 2015. 'Is Adaptation a Local Responsibility?' *Environmental Science and Policy* 48: 89–98.
- Noltea, Christoph, Arun Agrawal, Kirsten M. Silvius, and Britaldo S. Soares-Filho. 2013. 'Governance Regime and Location Influence Avoided Deforestation Success of Protected Areas in the Brazilian Amazon'. *PNAS* 110 (13): 4956–61. doi: 10.1073/pnas.1214786110.
- Observatório do Clima. 'The Worst is Yet to Come: A year of environmental havoc under Brazil's far-right President Jair Bolsonaro'. www.oc.eco.br/wp-content/uploads/2019/12/Relato%CC%81rio-COP25-v3.pdf, accessed on 17/06/2020.
- OECD. 2016. 'Country Profile: Brazil'. www.oecd.org/regional/regional-policy/profile-Brazil.pdf.
- Pahl-Wostl, Claudia, Louis Lebel, Christian Knieper, and Elena Nikitina. 2012. 'From Applying Panaceas to Mastering Complexity: Toward adaptive water governance in river basins'. *Environmental Science and Policy* 23: 24–34. doi: 10.1016/j.envsci.2012.07.014.
- PBMC (Painel Brasileiro de Mudanças Climáticas). 2013. 'Executive Summary: Impacts, vulnerability and adaptation to climate change: Contribution from Working Group 2 to the Primeiro Relatório de Avaliação Nacional sobre Mudança Climáticas of the Painel Brasileiro de Mudanças Climáticas (GT2 RANI PBMC)'. [Eduardo Delgado Assad, and Antônio Rocha Magalhães, eds.]. COPPE. Rio de Janeiro: Universidade Federal do Rio de Janeiro.
- Rabe, B. 2008. 'States on Steroids: The intergovernmental Odyssey of American climate policy'. *Review of Policy Research* 25 (2): 105–28.
- São Paulo Governo do Estado. 2021. 'Municípios Paulistas Resilientes'. *Infraestrutura e Meio Ambiente*. www.infraestruturameioambiente.sp.gov.br/municipiosresilientes, last accessed on 14/07/2021.
- Sathler, Douglas, Julio Cesar Paiva, and Sandra Baptista. 2019. 'Mudanças Climáticas: Planejamento urbano e governança ambiental nas sedes das principais regiões metropolitanas e integradas de desenvolvimento do Brasil'. *Caderno de Geografia* 29 (56): 262–86. doi: 10.5752/P.2318-2962.2019v29n56p262.
- SEEG. 2018. 'Emissões de GEE no Brasil e suas implicações para políticas públicas e a contribuição brasileira para o Acordo de Paris'. https://seeg-br.s3.amazonaws.com/Documentos%20Analiticos/SEEG_5/SEEG5_DOC_Analiticos_1990-2016.zip, accessed on 26/10/2022.
- SEEG. 2020. 'Nota Técnica: Impacto da pandemia de Covid-19 nas emissões de gases de efeito estufa no Brasil'. https://seeg-br.s3.amazonaws.com/OC_nota_tecnica_FINAL.pdf, accessed on 04/06/2020.
- SEEG. 2022. 'Emissões Totais'. http://plataforma.seeg.eco.br/total_emission# accessed on 22/04/2021.
- Setzer, J. 2017. 'How Subnational Governments are Rescaling Environmental Governance: The case of the Brazilian State of São Paulo'. *Journal of Environmental Policy & Planning* 19 (5): 503–19.
- Soares-Filho, Britaldo, Paulo Moutinho, Daniel Nepstad, et al. 2010. 'Role of Brazilian Amazon Protected Areas in Climate Change Mitigation'. *PNAS* 107 (24): 10821–26. doi: 10.1073/pnas.0913048107.
- Souza, C. R. G., Souza, A. P., and Harari, J. 2019. 'Long Term Analysis of Meteorological-Oceanographic Extreme Events for the Baixada Santista Region'. In *Climate Change in Santos, Brazil: Projections, impacts and adaptation options*, eds. Lucí Hidalgo

- Nunes, Roberto Greco, and José A. Marengo, 97–134. Cham: Springer Nature Switzerland. doi: 10.1007/978-3-319-96535-2.
- Termeer, Catrien, Art Dewulf, Helena van Rijswijk, et al. 2011. ‘The Regional Governance of Climate Adaptation: A framework for developing legitimate, effective, and resilient governance arrangements’. *Climate Law* 2 (2): 159–79. doi: 10.3233/CL-2011-032.
- University of Notre Dame. 2022. ‘ND-GAIN: Notre Dame global adaptation initiative: Country index’. <https://gain.nd.edu/our-work/country-index>.
- Vinke-De Kruijf, Joanne, and Claudia Pahl-Wostl. 2016. ‘A Multi-Level Perspective on Learning about Climate Change Adaptation through International Cooperation’. *Environmental Science & Policy* 66: 242–49. doi: 10.1016/j.envsci.2016.07.004.
- Viswanathan, R. 2014, 14 August. ‘Federalism, Swaraj and Brazil’. *Gateway House*. www.gatewayhouse.in/federalism-swaraj-and-brazil, accessed on 24/04/2021.
- Volden, Craig, Michael M. Ting, and Daniel P. Carpenter. 2008. ‘A Formal Model of Learning and Policy Diffusion’. *American Political Science Review* 102 (3): 319–32. www.jstor.org/stable/27644523.
- World Bank. 2021. ‘Climate Risk Profile: Brazil’. *The World Bank Group*. https://climateknowledgeportal.worldbank.org/sites/default/files/2021-07/15915-WB_Brazil%20Country%20Profile-WEB.pdf.
- WWF-Brasil. 2017. ‘Guia de Adaptação às Mudanças do Clima para entes federativos. Brasília’. www.wwf.org.br/?62222/Guia-de-adapcao-s-mudanas-do-clima-para-entes-federativos.