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POLICY BRIDGE

Climate change governance in the anthropocene: emergence of polycentrism in Chile

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Multilateral efforts are essential to an effective response to climate change, but individual nations define climate action policy by translating local and global objectives into adaptation and mitigation actions. We propose a conceptual framework to explore opportunities for polycentric climate governance, understanding polycentricity as a property that encompasses the potential for coordinating multiple centers of semiautonomous decision-making. We assert that polycentrism engages a diverse array of public and private actors for a more effective approach to reducing the threat of climate change. In this way, polycentrism may provide an appropriate strategy for addressing the many challenges of climate governance in the Anthropocene. We review two Chilean case studies: Chile's Nationally Determined Contribution on Climate Change and the Chilean National Climate Change Action Plan. Our examination demonstrates that Chile has included a diversity of actors and directed significant financial resources to both processes. The central government coordinated both of these processes, showing the key role of interventions at higher jurisdictional levels in orienting institutional change to improve strategic planning and better address climate change. Both processes also provide some evidence of knowledge co-production, while at the same time remaining primarily driven by state agencies and directed by technical experts. Efforts to overcome governance weaknesses should focus on further strengthening existing practices for climate change responses, establishing new institutions, and promoting decision-making that incorporates diverse social actors and multiple levels of governance. In particular, stronger inclusion of local level actors provides an opportunity to enhance polycentric modes of governance and improve climate change responses. Fully capitalizing on this opportunity requires establishing durable communication channels between different levels of governance.

Keywords: Climate change; Governance; Polycentrism; Public consultation; Chile

1. Introduction

Climate change is a complex phenomenon that highlights the global interdependencies of sociopolitical and biophysical systems (e.g., see Steffen et al., 2011). Its consequences on multiple planetary boundaries prompted the coining of the term 'Anthropocene' in order to "encourage integrative understandings of global change and sustainability" (Brondizio et al., 2016). The Anthropocene is characterized by human-induced transformations of the geophysical environment, where human activities rival natural processes in terms of their impacts on planetary systems (Crutzen and Stoermer, 2000; Crutzen, 2002; Zalasiewicz et al., 2010; Steffen et al., 2016; Waters et al., 2016; Williams et al., 2016).

An increasingly globalized and interconnected world, and the complex and trans-national effects of climate change necessitate a renewed inquiry into existing

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institutional conceptualizations, structures and operations for confronting climate change (Biermann, 2014; Biermann et al., 2012; Esguerra et al., 2017; Gupta, 2016; Kotzé, 2014; Kotzé, 2016). Climate change governance for mitigation and adaptation involves individual and collective efforts by diverse social actors, within and between different levels. In addition, new institutions, regulations, and structural organizations are required, and normative principles guiding problem solving and institution building need to be defined (Huitema et al., 2016). Effective governance also requires a reassessment of institutional arrangements, communication, and actor roles beyond the mitigation of greenhouse gas (GHG) emissions, in addition to an institutional shift in attention toward long-term planning (Folke et al., 2005; Ostrom, 2010; Plummer, 2013; Gupta, 2016).

The complexity of required climate governance responses increases, given that climate change is a global issue and the Anthropocene is not only a geological period but also a distinct historical, cultural and political era (Benson and Craig, 2014; Kotzé, 2015; Gupta, 2016; Delanty and Mota, 2017). Effective responses to climate change thus require the interaction of multiple actors at different levels, from global to local scales (Keskitalo, 2016). The problem has shifted from a structured, simple issue requiring only a technocratic response, to an unstructured, uncertain, non-linear, ideological, systemic and therefore highly-complex challenge (Gupta 2016). An effective response also requires transformative learning and the ability to combine bottom-up initiatives, top-down and legally binding commitments, and diverse epistemic perspectives. Benson and Craig (2014) propose a shift away from the idea of "sustainability" toward a focus on "resilience", acknowledging uncertainty and the need for adaptation. However, global efforts to address climate change have not produced sufficiently creative or effective solutions. Climate change governance agendas and action strategies are characterized by contradictions between global and local needs, core and periphery understanding, nationally determined versus market-driven motivations, urban and rural contexts, universal versus individual approaches, regional variations, developed and developing socio-economic realities, large and small scales, and approaches seeking integration versus disintegration (Rosenau, 2003). These contradictions have profound implications for governance in societies where existing practices and approaches are inadequate (Ang, 2011). In Latin American countries, such governance challenges include taking into account the entanglement between political regimes and economic models, the vested interests and power dynamics between private and public sector actors, the historical and current asymmetries by which large groups of the population have been isolated from meaningful decision-making processes, and the active and extended presence of social, indigenous and environmental movements that actively contest different forms of territorial interventions (Goldfrank, 2012; Postigo, 2013; Lampis, 2016; Ulloa, 2017; O'Ryan and Ibarra, 2017). There exists, therefore, a pressing need to develop innovative climate change governance responses that integrate analysis of the human-earth system trajectories and the interlinkages between national and international political agendas.

Climate change governance transformations require a review and analysis of current efforts to improve institutional arrangements and integrate the participation of diverse and multi-level actors. Polycentricity is an organizational property that integrates the potential of coordinating multiple centers of semiautonomous decision-making. According to Carlisle and Gruby (2017: 1), if multiple centers for decision-making consider one another and engage in competitive and cooperative relationships, with access to conflict resolution mechanisms, this may be considered a polycentric governance system. This paper seeks to analyze the emergence of new arrangements, processes and actors in the arena of climate change governance. We specifically examine the interaction of different levels of decision-making and the degree of effective, multi-actor participation in Chilean climate change governance; and identify changes in predominant governance models and specific practices that achieve progress toward polycentricism. Increased polycentricism in governance provides improved understanding and supports efforts to respond effectively to climate change by engaging a diverse array of public and private actors in this response (see Ostrom, 2009, 2010).

This paper identifies the extent to which the policy processes, involved in the construction of the National Climate Change Action Plan (*Plan de Acción Nacional de Cambio Climático*, or PANCC) and Chile's Nationally Determined Contribution (NDC) to the Paris Agreement, showed key elements of a proposed polycentric governance framework. We identify gaps between fully evolved polycentric governance and these policy processes, and opportunities to move towards climate change governance where multiple centers of semiautonomous decision-making coordinate with one another. The PANCC is recognized as the first Chilean policy instrument developed in direct response to climate change (CONAMA, 2008). The NDC's relevance emerges as an opportunity to apply an inter-ministerial public policy approach (Gobierno de Chile, 2015). Key opportunities and challenges associated with the co-production of knowledge and the interaction of actors across different levels of governance throughout these processes may therefore be identified.

Chile provides a highly salient focus for our investigation for several reasons. First, it is the most developed and neoliberal economy in the Latin American and the Caribbean (LAC) region. Second, it has a geographically diverse landscape and high exposure to climate variability and change, as evidenced by the severity and extension of the recent mega drought (Magrin et al., 2014; Boisier et al., 2016; Garreaud et al., 2017). According to the Global Climate Risk Index proposed by Kreft et al. (2017), in 2015, Chile was one of the ten countries most affected by climate change worldwide. Third, existing Chilean environmental governance institutions are relatively new and highly hierarchical, and the inclusion of extra-governmental actors in decision-making processes presents an emerging challenge. Ongoing institutional reforms and the engagement of new actors in these processes provide an opportunity to search for evidence of polycentric governance in Chile's recent and evolving development of climate change policies.

The decentralization of Chilean governance has emerged since the 1970s, primarily as a result of neoliberal reforms instated by the Pinochet regime. Market institutions including those responsible for assigning private property rights (such as water use rights) have granted significant autonomy to the private sector (Bauer, 1997), and multiple forms of public-private partnerships in sectors such as mining, infrastructure and energy have enjoyed enormous political influence. At the same time, this concentration of property rights creates environmental inequalities that can impair climate adaptation strategies. The Chilean water code, for example, is being revised to recognize water as a human right rather than a market good (Larrain, 2012). Within this context, it is possible to create spaces for learning, exchange and the development of policy recommendations. Despite the many difficulties associated with these policy processes, such spaces present an opportunity for social transformation toward climate change solutions driven by public knowledge, action and engagement (see O'Brien, 2016).

Section 2 below presents the conceptual framework used to analyze Chilean climate change governance and to determine its primary gaps. Section 3 provides general background regarding the multisector and multilevel actors involved in Chilean governance, as well as the transformations currently taking place, and illustrates two case studies, each of which were constructed based on document review, interviews, and contributions from this study's authors, many of whom have participated in these processes as policy advisors. Section 4 identifies the key factors for promoting better climate change governance. Section 5 presents a final discussion and offers recommendations and conclusions.

2. Conceptual framework for assessing climate change governance

A continuum of environmental governance modes and models has been proposed and implemented; and each reflects norms surrounding societal organization and assumes a position on how to and who should address environmental challenges. Jones et al. (2016) grouped these modes into three categories: centralized, decentralized, and shared. Centralized governance refers to hierarchical governance and is characterized by its monocentricity (state-centric, specifically). Decentralized governance focuses on the involvement of lower levels of government in management. Shared governance is often synonymous with the term co-management, i.e., the sharing of responsibility and authority between government and the community (Pomeroy and Berkes, 1997).

The adaptive (co-) management literature (e.g., Plummer, 2013; Baird et al., 2016) suggests that a management system should have multiple centers of power (polycentricity) rather than one center of control (monocentricity). Polycentric governance occurs when "political authority is dispersed to separately constituted bodies with overlapping jurisdictions that do not stand in hierarchical relationship to each other" (Skelcher, 2005), where decisions are made at different levels, with a certain degree of autonomy, and in interaction with other levels of decision-making. In a modern, polycentric society, coordination among systems facing environmental challenges becomes a complex problem. In this context, polycentric governance represents a good alternative to classic bureaucratic solutions for building resilience because it provides greater opportunities for learning, facilitates social participation, integrates local knowledge, improves connectivity among actors, and increases the diversity of possible responses to challenges such as climate change (Berkes et al., 2003). Polycentric governance offers flexible solutions for self-organization in situations of uncertainty and includes a wide range of stakeholders in decision-making processes (Biggs et al., 2015). These features are essential to generating effective responses to the multiple climate change challenges facing society in the Anthropocene.

Building upon Ostrom (2009), we argue that, instead of focusing only on global efforts, multi-level and polycentric climate change governance modes offer an appropriate way to reduce the risks associated with climate change. **Figure 1** illustrates the analytical framework proposed for assessing the current domains and practices underlying climate change governance in a given nation, specifically Chile for this paper. We hypothesize that, while Chile has made significant progress, several gaps exist that impede progress towards polycentrism. We explore these gaps, using the PANCC and NDC as two examples of significant national climate change responses.

The PANCC is a domestic policy instrument, designed to respond to the priorities and objectives of the National Climate Change Strategy, which was adopted in January 2006 by the Chilean Government (CONAMA, 2008). Chile's NDC is a national pledge for an international instrument (the Paris Climate Agreement) and is composed of three key areas: resilience to climate change, control of greenhouse gas emissions, and cross-sectoral support for climate action (including capacity building, technology development and transfer, and financing) (Gobierno de Chile, 2015).

Figure 1 presents four domains that may be used to characterize decision-making processes and policy outputs: (i) relevant governance levels and corresponding roles; (ii) actors and their roles (both formal and informal); (iii) cross-scale institutional linkages between multiple actors; and (iv) knowledge production. By combining these dimensions, different aspects of the relationship between state intervention and societal autonomy can be assessed to construct a continuum of governance modes ranging from state-centric to decentralized, bottom up governing. Within this framework, decentralized decisions can be analyzed in relation to the polycentric approach and by highlighting local knowledge and territorial autonomy.

Figure 1 can guide analysis of different cases to evaluate the presence or absence of attributes that define, in practice, different modes of governance. In turn, the selected cases also allow us to identify opportunities for shifting the governance mode towards polycentrism.

3. Case studies

Using **Figure 1** as a framework for determining if polycentric climate governance is emerging in Chile and how it might further develop. Governance levels, actors, cross-scale and multi-actor linkages, and knowledge production are analyzed in the following sections.

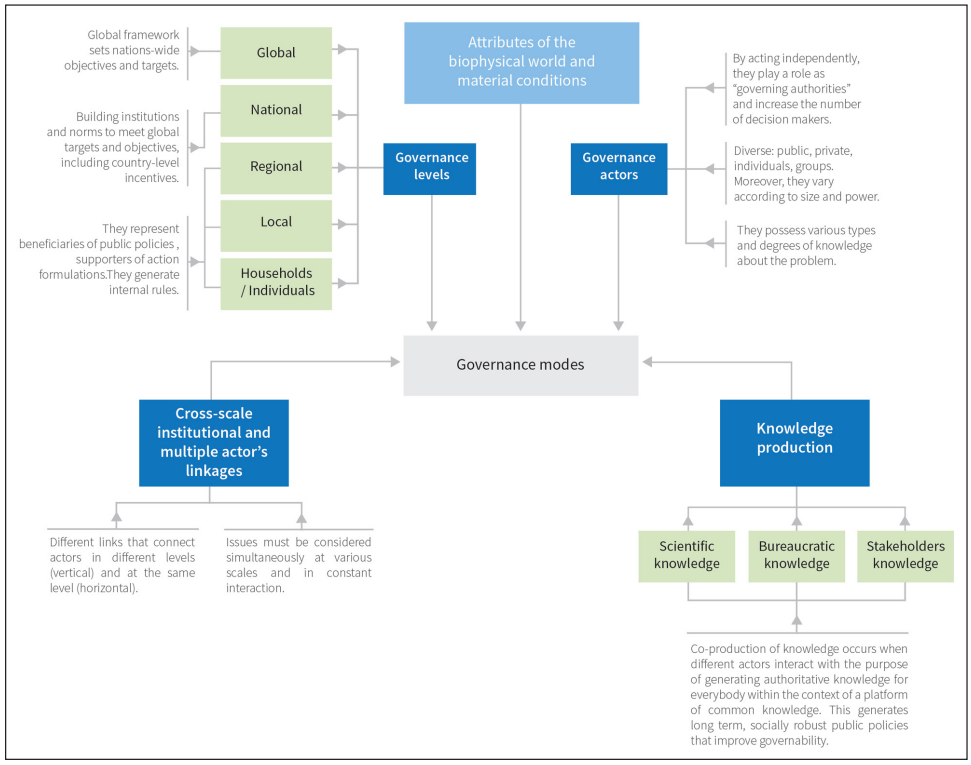

Figure 1: Domains and attributes for analyzing governance modes. Governance levels, actors, cross-scale institutional and multi-actor linkages, and knowledge production represent the domains used to characterize modes of governance from state-centric to decentralized. The combination of the four domains, and functioning of attributes within each domain, affect the options for polycentrism. DOI: https://doi.org/10.1525/elementa.329.f1

3.1. Relevant governance levels and corresponding roles: expression of global agreements at regional and local scales

Chile is a signatory of the most important global climate agreements: the 1992 United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol (signed in 1997 and ratified in 2002), and the Paris Agreement (signed in September 2016 and ratified in February 2017). This international legal context has driven the development of the nation's climate change governance structure, which includes formal rules and structures to promote climate change adaptation and mitigation. **Figure 2** shows the timeline of Chilean responses to climate change in the context of international legal frameworks, the national institutional framework, national legal frameworks, and national policies. Concrete actions included the preparation of national communications on climate change (developed in the context of UNFCC commitments) and public policy instruments such as: the Strategic Climate Change Guidelines (1998), the National Climate Change Strategy (2006), the National Climate Change Action Plans 2008–2012 and 2017–2022 (PANCC I and II, respectively), the National Climate Change Adaptation Plan (2014), Chile's Intended Nationally Determined Contribution on Climate Change (INDC) (2015), and five sectoral adaptation plans: Forestry and Agriculture (2013), Biodiversity (2014), Fisheries and Aquaculture (2015), Health (2016), and Cities (2018, in its final stages of preparation at time of publication).

Chile submitted its INDC in September 2016, proposing a 30% reduction of GHG emissions intensity by 2030 based on 2007 levels, in addition to adaptation and financing measures. Chile ratified the Paris Agreement in February 2017, transforming this INDC into NDC. Emissions intensity may be further reduced (for a 45% total reduction) if international support for additional measures, including capacity building, is available. Chile's NDC is one of few to address short-lived climate pollutants, in particular black carbon, thereby drawing a connection between air quality and climate policy. The development of the NDC would have been much more challenging without the previously-developed Mitigation Action Plans and Scenarios (MAPS) produced by an initiative by the same name founded in 2011 (MAPS, 2013; Calfucoy and Rudnick, 2016), which we further discuss in the following section.

Prior to the Paris agreement meeting, multisector and multilevel public actors, private agents, members of civil society, and other relevant actors in Chile did not have a common understanding of climate change. Additional factors that complicated climate change governance included a lack of information and capacities for understanding the national situation, analyzing historical trends, defining a baseline, making projections, and constructing scenarios to assess policy alternatives. Specifically, it was necessary to forecast expected emissions in a business as usual scenario for 2030 and then propose –and commit to– reductions, assuming possible and expected changes in highly uncertain economic, technological and environmental

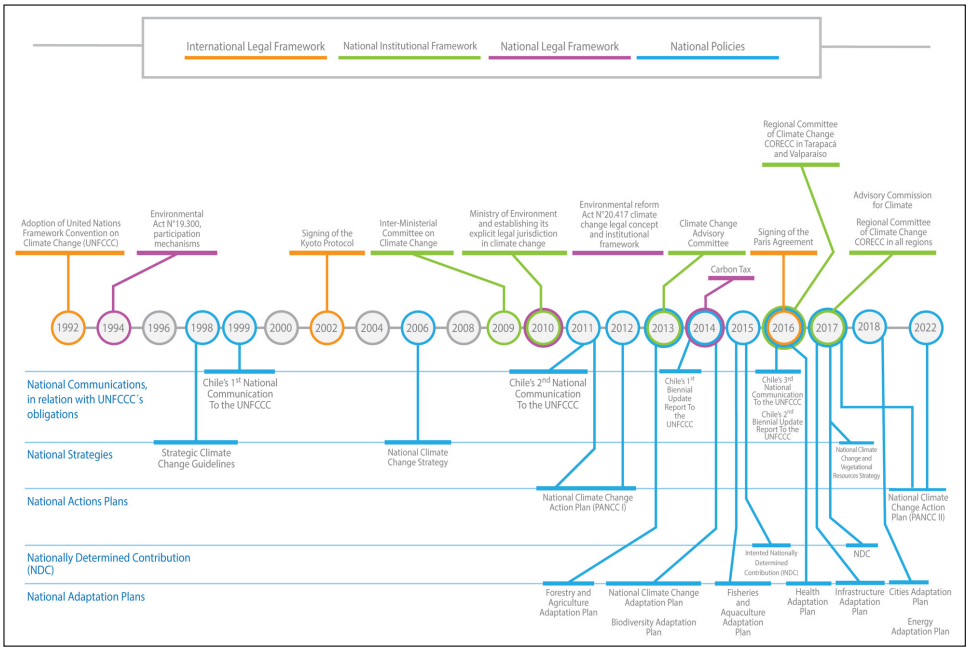

Figure 2: Timeline of legal and institutional aspects of Chilean climate governance since 1992. Chilean policy responses to climate change challenges. Responses have allowed the country to construct national communications, strategies, action plans, NDCs and national adaptation plans. DOI: https://doi.org/10.1525/elementa.329.f2

variables. This type of integrated analysis has not been common to Chile's policy-making practice.

3.2. Actors and their roles (both formal and informal)

According to Cornell et al. (2013), four main actor groups have been involved in the evolution of climate policy in Chile: government agencies, the private sector, civil society and academia. The private sector, civil society and academia relate to the central government through public consultation, within the context of national climate policy often developed from a top-down perspective. Nevertheless, actors beyond government agencies have developed diverse informal efforts to respond to climate change from the bottom-up, comprising a relevant element of the Chilean climate change governance scheme. Despite growing recognition of the importance of participation of these actors in Chilean climate change governance, their role and participation has rarely been studied, with most information scattered among technical reports, working papers and other unpublished documents. According to Paley (2001), new Chilean legislation addressing public participation (Act N°20500) promotes broader public participation in policies, plans, programs, and actions by establishing formal and specific methods and requirements for individuals and organizations. Blanco and Fuenzalida (2013), however, found that local actors were less involved in the preparation of climate change instruments, and that implementation of these instruments presented financial, capacity, and leadership limitations.

Civil society has occupied multiple roles in the formation of Chilean climate change governance, through NGOs, other social organizations, and individual efforts. Among relevant formal initiatives, the Citizens Platform for Climate Change (CPCC), founded in 2014, convenes twenty Chilean NGOs. The CPCC participates in and organizes different activities in response to multiple consultation processes. Nevertheless, despite advances in civil society participation, a relevant gap remains for achieving meaningful participation of these and other actors in climate change initiatives. There is, therefore, a need to increase participation by integrating diverse initiatives and actors within the system of governance (Obreque, 2011; Aldunce et al., 2014; OCDE, 2016).

The private sector, according to the Ministry of Environment (2016), has played a key role in both investment and implementation of innovative measures to mitigate and adapt to climate change. Examples of these efforts include technical reports, the organization of seminars, and participation in public consultations to inform the preparation of climate change policy instruments. The private sector also develops climate change responses within the framework of Corporate Social Responsibility Schemes and Annual Sustainability Reports. Factors limiting the beneficial impact of private sector efforts, however, include a lack of climate change regulation, insufficient capacities at the sectoral level, and the near total absence of incentives to catalyze private sector actions (Ministry of Environment, 2016).

The process of defining the Chilean NDC was intended to be participatory, both during information collection and generation –through the MAPS initiative– and throughout the public consultation on the final proposal. The MAPS project, promoted by the government, represented a comprehensive exploration of multiple scenarios and options for climate change mitigation in Chile. It was a non-binding, largely participatory, inclusive, transparent and constructive process, accompanied by research and modeling efforts. Multiple actors were engaged who had

been included in sectoral consultations coordinated by the Ministry of Foreign Affairs to define Chile's position at previous COPs. These consultations had provided the base for the ambitious, international MAPS Program, founded in 2011 (MAPS, 2013; Calfucoy, 2016; Calfucoy and Rudnick, 2016), which "sought to build national scenarios to inform action toward a lower emissions future in four Latin American countries: Brazil, Chile, Colombia and Peru". Based on the South African experience with mitigation scenarios and financed in large part by international cooperation, MAPS aimed to build "a broad base of support among domestic stakeholders, through the development of sound evidence to support climate mitigation". The MAPS concept established a government-mandated participative process that engaged stakeholders across sectors and partnered them with relevant domestic and international researchers. In January 2012, six Chilean ministries (Foreign Affairs, Finance, Transport and Telecommunications, Agriculture, Energy and Environment) requested that the MAPS project assess and propose the best options for national mitigation of GHG emissions. Central to MAPS was the combination of research and stakeholder interest in policy and planning (MAPS, 2013).

The MAPS process involved 300 experts over a four-year period (2011–2015) throughout three project phases: baseline scenarios, mitigation scenarios and policy options (MAPS, 2015, 2016). Participating actors came from government agencies, academia, the private sector and NGOs. It is important to emphasize that each participant was chosen based on their technical capacities, not as a representative of a sector or interest group, and that their participation was voluntary. Nevertheless, the close links of some experts with particular sectors and their own expectations for the impacts of their recommendations made it difficult to fully respect this distinction (Leal, 2016). The project board included professionals with experience working in seven ministries: Foreign Affairs, Finance, Transport and Telecommunications, Agriculture, Energy, Environment, and Mining. MAPS activities included co-production of knowledge among private, academic and public-sector experts, peer review for quality assurance, and the production of technical data, which was discussed and validated by participating actors (MAPS 2013, 2015 and 2016; Calfucoy, 2015, 2016).

An evaluation of PANCC I implementation was conducted in 2014 and coordinated by researchers from the University of Chile in collaboration with the NGO, Adapt Chile, and a private consultancy firm (http://poch.com/chile) (Aldunce et al., 2014). Based on the proposals emerging from this evaluation, the design of the second PANCC involved increased participation by diverse actors throughout multiple phases of consultation. First, based on the results of the PANCC I evaluation, four workshops were conducted to extend participation to a wider group of organizations, including civil society organizations such as NGOs, private sector representatives, local and national-level government agencies, academia and research organizations. Second, the Office of Climate Change (OCC) of the Ministry of Environment carried out a series of meetings with different actors throughout the country. Third, based on the results of phases one and two, the OCC proposed a first draft of the new plan, which was presented for open consultation. The plan received a record number of comments as compared with other formal instruments within the climate change policy domain in Chile. In its last phase of design, the OCC processed the numerous comments and observations received throughout the consultation process and evaluated their relevance for inclusion. The PANCC II (2017–2022) was presented in July 2017.

The inclusion of a broader spectrum of actors is required to face the complexities of climate governance in Chile and elsewhere, particularly when societal and behavioral changes are needed (see Gallardo et al., 2018). The NDC and PANCC cases provide evidence of an increasing interest on behalf of governmental bodies to include multiple and diverse actors in order to support public participation and the co-production of knowledge (Calfucoy and Rudnick, 2016). However, this transition is in its early stages, and participation remains largely concentrated among expert stakeholders, despite the fact that a participatory approach is common to both cases examined by this study. From the outset, the MAPS initiative included a government-mandated participative process that engaged a range of stakeholders across sectors. Participants in the process expressed a general acknowledgement of its relevance and significance, although its final aim and application was not always clear, and participation was in many cases limited to a relatively small group of experts. The subsequent public consultation, which was opened across the entire country, represented a significant improvement upon traditional participation practices. Likewise, the PANCC II achieved increased diversity of multisector and multilevel actor participation throughout its design. Although PANCC 2017–2022 design was led by one government agency (OCC from the Ministry of Environment), cooperation and collaboration with other actors was ongoing. The actions included in the PANCC II and the responsibilities for their implementation were discussed and agreed upon among the group of actors assigned this responsibility, in order to promote ownership of these commitments and support successful implementation. This coincides with a trend in Latin American countries of increasing transparency and participation of civil society in these processes (Marzano, 2016).

3.3. Cross-scale institutional linkages between multiple actors

From an institutional perspective, numerous government agencies have been responsible for defining relevant policies and providing legal counsel on climate change governance, including the National Advisory Committee on Global Change (1996–2014), the Inter-Ministerial Committee on Climate Change (2009), and the Climate Change Advisory Committee (2013). Act N°20417 of 2010 introduced the reform of environmental institutions, creating the Chilean Ministry of Environment and establishing its explicit legal jurisdiction in climate change while defining the need for collaboration with regional and local authorities. This Act defined climate change as "a change in climate attributed directly or indirectly to human activity which alters global atmospheric composition, and which is in addition to the natural cli-

mate variability observed over comparable time periods". Act N°20417 also established the Council of Ministers for Sustainability and their responsibility for "deliberation of public policy and general regulation on environmental issues". The Council has already approved many of climate change public policy instruments as well as multiple sectoral adaptation plans, the National Climate Change Adaptation Plan, the PANCC I and II, and national communications on climate change.

As described by OECD (2016), the Council of Ministers for Sustainability's ongoing existence and relevance relies heavily upon voluntary engagement and sufficient capacity and commitment by other Ministries. As a result, responsibility for the development of climate change policies rests with the Chilean Ministry of Environment, and implementation requires collaboration with other sectoral Ministries and regional and local government agencies within a framework of cross-scale and institutional linkages. OECD (2016) recognizes that sectoral progress "is being made with an increasing number of ministries now having climate change focal points", but that it is necessary "to provide clear responsibilities for implementation".

Public participation in crafting environmental public policy began with the first environmentally-relevant Chilean legal framework (the 1994 *Ley de Bases del Medioambiente*). This framework was influenced by Principle 10 of the Rio Declaration (1992) and included formal mechanisms for public participation. As a result, the Ministry of Environment invited civil society representatives to review drafts of the National Climate Change Action Plan, the National Adaptation Plan, the Chilean NDC and sectoral adaptation plans. These drafts were prepared in collaboration with other Ministries and in some cases municipalities, linking multiple actors across levels. Nevertheless, public consultation in these cases was non-binding, and not all of the questions, observations and comments raised by participating actors (NGOs, private sector and scholars) or even by public officials (municipalities) were addressed.

Efforts to strengthen cooperation and coordination among different actors represent another factor common to both the PANCC I and II processes. In the case of NDC design, high-level political involvement, together with participative methodology, helped align the mandates and interests of multiple actors. In Chile, relevant political authority for climate change is dispersed among Ministries, whereas investment decisions are mainly controlled by the private sector. These actors do not normally cooperate on environmental issues; however, this case prompted coordination across decision-making bodies, and regular meetings allowed the MAPS' Board to become an effective team. Trust between participating public actors improved, and communication with other sectors became relatively fluent. The participative, multi-actor and evidence-based approach supported the development of a nationally-relevant and appropriate NDC. The process also facilitated coordination among traditionally isolated actors and generated confidence among different stakeholders to support NDC ratification and potentially the development of future, more ambitious proposals and their implementation at the local level.

3.4. Knowledge production

Knowledge co-creation can be defined as a synergetic practice of combining content and process from disciplinary traditions to synthesize new ways of understanding. The MAPS approach resulted in systematic knowledge co-creation, the appropriation of main results and conclusions, and an institutional support base for existing and future mitigation actions (Calfucoy and Rudnick, 2016). In fact, the MAPS board later became the NDC's Technical Round Table and based its recommendations for the NDC on results of the MAPS project. The proposal considers a reduction to 0.70 tons of CO_2 equivalent per Gross Domestic Product (GDP) for 2030, a 4% deviation from MAPS "medium" scenario, and a reduction of 6 million tons for that year as compared to the 2030 emissions projected by MAPS. In this way, the data generated by MAPS provided the basis for the initial proposal for Chile's NDC. This process differed substantially from the preparation of Chile's commitment in Copenhagen in December 2009, where the national government proposed a reduction in 20% of emissions by 2020, a political decision that relied on the limited technical information available at that time (MAPS, 2016).

A second key component of this process was the high level of international political involvement. The United Nations encouraged countries to involve world leaders in their NDC preparations. In September 2014, Chilean President Bachelet, former Executive Director of UN Women, committed to presenting Chile's NDC at the COP21 and announced the launch of the public consultation process. The Chilean Ministry of Foreign Affairs was actively involved in NDC preparation, another highly unusual intervention for an environmental policy and one which signaled the high political priority assigned to this issue.

An initial proposal for the NDC was released for public consultation in December 2014 by the NDC Technical Round Table. In the context of the environmental regulations, plans, and assessments that are legally required to undergo public consultation, the INDC made use of the Ministry of Environment's existing consultation infrastructure to open the draft to voluntary public consultation. The proposal received over 400 observations from 69 organizations and individuals, all of which were analyzed by the Ministry of Environment. As part of this process, the Ministry of Environment sought to involve regions outside of the capital by coordinating a series of seven workshops throughout the country. Unfortunately, the results of consultation were not communicated to the public, and participants were not informed of whether their suggestions had been considered or of how they had been incorporated.

In October 2015, the Ministerial Committee for Sustainability and Climate Change agreed on a final NDC proposal. The decision was largely political, and final contents differed significantly from the initial proposal, with technical considerations raised during the final negotiation process determining the contents of the document. The final proposal also included elements related to climate change adaptation, capacity building, technology development and financing. In this sense, the NDC

represents a climate change policy agenda that will push for commitments within each of these dimensions.

Another key component for the NDC case is the fact that stakeholders at different levels and with conflicting interests and values, diverse decision-making capacities, and significant political and economic influence had different priorities. For example, the Ministry of Foreign Affairs and Ministry of Environment most closely followed the international process and were directly involved in ensuring an adequate NDC preparation process and responding to international requirements. The Energy, Agriculture, Mining and Transport Ministries were mainly concerned with ensuring that any mitigation commitments would be feasible for these sectors in the long-term. The Finance Ministry, as expected, was preoccupied by the impacts of the proposed commitments on economic growth and public finances. In Chile, investment decisions in energy, mining, water, industry, or any other sector are made by private agents. In this context, the private sector, and in particular energy and mining sector representatives, was particularly concerned with the potential impact on costs and the economic competitiveness of climate change initiatives (see for example, Solimano and Schaper, 2015). At the same time, NGOs pushed for increased involvement in determining and fulfilling mitigation and adaptation commitments.

Actors involved in the design of the first PANCC were convened by the National Commission for the Environment (CONAMA), the predecessor of the current Ministry of Environment, in collaboration with various government ministries (CONAMA, 2008). Thus, involved actors primarily represented government agencies, although other actors included participants from civil society, the private sector and academia. Additionally, the process was carried out at the central (national) level of government in Chile, with almost no participation by subnational actors (Obreque, 2011). Participation was also limited as a result of the scant existence of a climate policy domain in Chile at the time. As a result of these limitations, few opportunities for the co-production of knowledge with multisector or multilevel actors were created during the plan's development (Aldunce et al., 2014).

The primary actors responsible for PANCC implementation were also government agencies, coordinated by CONAMA in the plan's first phase and by the Office of Climate Change in its second phase (CONAMA, 2008). The Plan assigned actions and implementation deadlines to specific, central government agencies; in this way, cross-linkages between actors and levels were restricted and, as a result, co-production of knowledge was limited. Learning and exchange occurred during meetings but was generally restricted to the group of actors physically present during discussions. Limited incorporation of scientific knowledge guided the implementation of several investigations that were included as actions in the Plan, but few spaces for effective science-policy interaction were established.

The co-creation of knowledge represents a factor relevant to each of the reviewed policy instruments. MAPS played an important role in providing high-quality technical information as well as a space for all actors to provide feedback. The participatory nature of the process lent relevance, and the initiative was well respected and considered robust, reliable and realistic by most actors. Multiple participants in the NDC consultation process had participated previously in the MAPS process and were therefore already contextualized regarding the initiative and relevant assumptions and models, which facilitated the formulation of comments, suggestions, and reasonable alternatives. In the case of the PANCC I, its hierarchical governance scheme restricted knowledge co-production. However, during the design of PANCC II, diverse perspectives and experiences were included throughout the process.

4. Opportunities for polycentric governance

Social scientists have started to reformulate the orientation of climate governance, which has increasingly moved towards polycentricity, with more diverse, multi-level actors, and much greater emphasis on bottom-up initiatives (Jordan et al. 2015). Chile is taking its first steps toward a more pluralistic view of governance but, as our examination of key instruments reveals, these actions remain markedly state-centric. The Chilean institutional response, as well as that of other countries in Latin America, has been the creation of inter-ministerial spaces for coordination, in many cases located within the orbit of ministries or secretariats of environment such as the Inter-Ministerial Committee on Climate Change in Brazil and the National Commission on Climate Change in Paraguay, among other cases. Another recurring response to the challenge of coordination among different actors and the integration of the climate agenda in sectoral policies is the creation of climate change units or offices in different ministries (Ryan, 2016). These new inter- and intra- ministerial groups have often coordinated PANCC and NDC processes.

For example, one of the most relevant features emerging during PANCC I implementation was the cooperation and collaboration between government agencies. For the PANCC II (2017–2022), although the design process was headed by one government agency (OCC of the Ministry of Environment), cooperation and collaboration with other actors was ongoing. The actions included in the PANCC II and the responsibilities for their implementation were discussed and agreed upon among the group of actors assigned this responsibility, to promote empowerment of these commitments and support successful implementation.

Advancing toward a more polycentric approach to climate change governance requires assessing existing institutional and procedural weaknesses. Despite increased participation, the knowledge incorporated within the Chilean NDC remained largely formal and technical, with limited inclusion of alternative knowledge sources (e.g., local and indigenous). Despite the multi-actor and participative character of the process, the participation of civil society and other relevant stakeholders was relatively weak and limited to a rapid consultation process, with practically non-existent linkages to regional and local levels of decision-making. Coordination occurred mainly horizontally and between previously established centers of power. The final approval of the NDC did not properly respond to whether or how comments submitted by different actors were considered. A lack of clear steps to

ensure continuity and the ongoing involvement of participants in NDC implementation was also notable.

The first PANCC had several weaknesses including financial constraints, changes to the institutional environment, short-term vision related to change in government administrations, the constant turnover of public servants, a limited sense of commitment by some decision-makers, and weak participation. An observed lack of accountability, due to the absence of adequate indicators and permanent monitoring of the plan's implementation, also restricted the plan's effectiveness. Throughout the plan's second phase, important actions were undertaken to address these weaknesses, and these actions produced positive results.

In summary, the PANCC and NDC processes represent contributions to increasingly participatory climate change governance in Chile. However, neither process effectively manages the needs, challenges and opportunities emerging simultaneously from local and central levels. Additionally, efforts are needed to move past traditional information delivery toward spaces for broader and more collaborative multilevel and multi-actor knowledge co-production. By doing so, different points of views, expertise and concerns can be incorporated and will help to produce a more comprehensive and complete picture of the Chilean reality and support effective responses in the face of the complexity and uncertainty of climate change.

5. Conclusions and recommendations

We assert that polycentrism encompasses the governance domains needed to face the many challenges of governance in the Anthropocene, particularly when dealing with the multi-national, multi-level issues and challenges related to climate change. This paper identifies the ways in which existing Chilean initiatives involve multisector, multilevel actors and are moving toward improved institutional arrangements to better address these challenges. We examined two case studies, the PANCC and Chile's NDC, to assess the role each has played as a process and policy tool for achieving robust, multi-stakeholder engagement for effective climate change governance. We identified evidence (or lack) of emergence of polycentric governance by drawing on a conceptual framework of four domains of polycentrism: (i) relevant governance levels and corresponding roles; (ii) actors and their roles (both formal and informal); (iii) cross-scale institutional linkages between multiple actors; and (iv) knowledge production (see **Figure 1**).

These case studies reveal a political commitment to open, participatory processes aiming to legitimize decision-making, avoid conflict, and produce robust commitments to international agreements by moving from often-symbolic social participation toward more active multi-stakeholder involvement. This study also reveals a need to strengthen participatory processes and integrate multisector and multilevel actors throughout the entire political cycle, from policy design to implementation and evaluation. Processes surrounding the design, implementation, and evaluation of formal instruments such as the PANCC can present opportunities for social learning which is the process by which individuals copy in some sense and to some extent the behavior of other individuals within their observational range (Bandura, 1977; Heyes, 1994; Flinn, 1997; Boyd and Richerson, 2009). Multiple stakeholders, including civil society, NGOs, and academic actors, played key roles in policy implementation and re-formulation processes, in part because they filled the knowledge gap confronted by many public institutions when dealing with climate change.

In terms of knowledge production, emerging institutional arrangements intend to build knowledge within the context of uncertainty and establish a common understanding of problems. For the case of Chile's NDCs, knowledge production allowed the proposal and key assumptions to be understood and shared by most stakeholders, facilitating its acceptance. However, it is necessary to institutionalize knowledge production and co-creation, and document the strengths and weaknesses of this process to achieve adaptive management that learns from previous experiences, avoids mistakes, and effectively addresses knowledge gaps.

In summary, efforts to overcome the weaknesses of the climate change policy arena in Chile should focus on strengthening current institutional structures for climate change response, encouraging institutional reform, fortifying communication channels and promoting decision-making that incorporates a wider group of organizations and social actors, as well as multiple levels of governance. Inclusion of local level actors presents an opportunity for enhancing polycentric governance modes, especially considering local administrations' unique role as key sources of knowledge, both directly affected by climate change and at the front lines of the climate change response. Nevertheless, case studies suggest that the central government also plays a key role in developing and implementing an effective and coordinated response to climate change.

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- Contributed to acquisition of data: PA, CI, PM, RO.
- Contributed to analysis and interpretation of data: RA, PA, GB, CI, PM, LN, RO, AI, LG.
- Drafted and/or revised the article: RA, GB, CI, LN, LG.
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