Polycentrism and climate change policies in Mexico: contributions of the ADI approach to institutional design

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Abstract

Despite important efforts in developing climate change mitigation and adaptation policies, the struggle against global warming has delivered poor results. Part of the explanation of that failure can be found in the weakness of institutional arrangements underlying climate change policies. In this paper, we examine the case of Mexico's climate change policy response through the IAD approach and argue that the concepts of polycentrism and local governance of the commons provide unique tools to explore and design novel, locally customized institutional arrangements with the potential of accelerating the transition to low-carbon, resilient solutions to climate change. However, as our critical review of the IAD approach suggests, the outcome of transition policies will crucially depend on the coordination of institutional arrangements at different levels of action and, more decisively, on aligning key macroeconomic and national level policies to the requirements of local-level institutional arrangements.

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Introduction

Humanity faces an existential challenge, an involuntary product of the unbalanced metabolism of modern society based on the consumption of fossil energy. Almost 30 years after the Earth Summit and the launch of the United Nations Framework Convention on Climate Change (CM), the climate system has rapidly entered in crisis.

The latest report from the Intergovernmental Panel on Climate Change (IPCC) presents indisputable evidence that climate change is accelerating. Global warming is affecting the integrity and resilience of all ecosystems on the planet, more severely than expected (IPCC, 2022). The Amazon basin is in the process of changing from being a sink to becoming a net carbon emitter (Boulton et al., 2022; Gatti et al., 2021), the Arctic is experiencing multiple collapse, and the oceans have stopped to absorb heat to become a net contributor to the increase in average temperature (IPCC, 2021)[1]. The limit of an increase in average temperature of +1.5°C with respect to the average of the pre-industrial era will be exceeded, with high probability, by 2040, liquidating the goal set in the Paris Agreement (IPCC, 2021). This adds up to an accelerated and multidimensional ecological crisis, which includes the loss of biodiversity, overexploitation of aquifers, deforestation, desertification and soil loss, accumulation of toxic waste, overexploitation of fisheries and ocean acidification (Rockström W. Steffen, K. Noone, A. Persson, FS Chapin, III, E. Lambin, TM Lenton, M. Scheffer, et al., 2009). If this trajectory continues, the increase in temperature will put the functioning of the systems that support life on the planet at existential risk.

The challenge for the global society is enormous. Social communities are going to have to explore new routes of ecological transition and at the same time they are going to be forced to respond to increasingly frequent and costly environmental crises. Faced with what seems inevitable, there is no more than insisting that the ambition and goals of the CM must adjust to the new evidence and review its design.

This text examines the response to the problem of climate change for the case of Mexico, focusing on the structure and articulation of the institutional arrangements that define it. The analysis is inspired by a critical review of various proposals of the new institutional economics, particularly Elinor Ostrom and her model of governance of common resources (Ostrom, 2005, 2014). The analysis and institutional development (ADI) perspective allows identifying implementation and design problems in GHG mitigation policies in Mexico: a slow and incomplete deployment of new institutions, lack of coordination, as well as weakness, low ambition and limited scope of economic measures. We also argue that the necessary institutional re-design of these policies requires recognizing and actively

[1]This collapse is manifested in the disappearance of the ice sheet in the Arctic Ocean during the summer (which by reducing the reflection of sunlight increases its absorption, in turn increasing the warming of the atmosphere and the melting of ice), the melting of permafrost with the potential to release astronomical amounts of methane (CH4), as well as the increase in frequency and extension of fires in the tundra, with the subsequent release of carbon dioxide (CO2) and nitrous oxide (NOX).

incorporating collective resource management systems as a necessary complement to the fundamental part of the response to climate change. To conclude, we discuss some limitations of the ADI approach in this specific problem and possible ways to overcome them.

1. Climate change: market, state and collective management of resources

The United Nations Framework Convention on Climate Change (CM from here on), adopted in 1992, is one of the pillars of the multilateral system for the protection of the environment that emerged as result of the Earth Summit (Rio de Janeiro, 1990).[2] The institutional design derived from the CM has been slowly and unevenly built over 3 decades. Its general structure can be separated into three different types of commitments: on the generation of information and scientific analysis (which range from the construction of emission inventories and the generation of national programs to participation in the IPCC), on emission goals and on the flexibility mechanisms that facilitate their mitigation. Although in the first case the CM has generated very important advances, the framework has been ineffective regarding the other two.

The commitment reached in the Kyoto Protocol (ratified in 2001) included emission reduction goals for a small group of countries that, although they were insufficient (even for the forecasts of that time), were mandatory and established the objective of stabilize the GHG concentration at a level that would keep the increase in temperature within a certain limit. This design derailed in the first decade of the century (in particular, from the Copenhagen summit, 2009) and ended at CoP21 in Paris in 2015 in an extensive agreement to all countries but with voluntary emission goals, "determined nationally." Unlike the Kyoto Protocol, the Paris Agreement lacks clear definitions regarding emission goals, baselines or necessary reductions, defining the goal to limit the temperature increase to +1.5°C as much as possible. This design change represents in fact a shift from the original approach based on the precautionary principle, to a risk management approach based on the emissions cost-benefit matrix (Spash, 2016, REF).

Instead, the relaxation mechanisms included in the Kyoto text (focused on developing "market solutions") became the dominant strategy to drive GHG mitigation.[3] These mechanisms were intensely promoted, diversified and spread with different scope, but without having produced a significant reduction in global emissions. Its design is based on the idea that the exploitation of non-renewable natural resources responds to a communal property regime, which is erroneously defined as having free or unregulated access, and

[2]In addition to the CM, the global framework designed in Rio includes the Rio Declaration, Agenda 21, the Convention on Biological Diversity, the Convention against Desertification and the Forest Principles.

[3]These mechanisms are the carbon emission trading schemes (CEC), the joint implementation agreements (JI) and the clean development mechanisms (CDM), and, more recently, the agreement on Reducing Emissions from Deforestation and Degradation of forests (REDD+). In a complementary manner, the Global Environmental Fund (administered by the World Bank) and the cooperation agreement for technology transfer were established with the intention of mobilizing additional financial and technical resources to implement mitigation actions.

which presumably leads to the depletion of resources (Hardin, 1968). The matter is presented as a collective action problem in which the absence of individual property rights over a finite resource (in this case, the natural capacity of the atmosphere to recycle and modulate the concentration of GHG through the carbon cycle) generates a global negative externality in the form of an inexorable depletion of the resource.[4]

Market solutions displaced the other policy options in the framework of the CM negotiations, but, in addition to a host of internal problems, the "cap" in cap-and-trade systems has systematically fell short of the required reduction of GHG emissions. For this reason, with exception of what has happened in the European market for two years, both the carbon markets and the other "flexibility mechanisms" have turned out to be insufficient as an effective lever for decarbonization. The inability to negotiate an agreement with mandatory commitments, set according to a physical stabilization goal determined by the precautionary principle (as the Kyoto Protocol was proposed at the time), explains in part the global failure in the task of reducing GHG emissions.

This reduction of the GHG emission problem to an externality misses a key point, the importance of which Ostrom (1990) demonstrated in her critique of the "tragedy of the commons" framework. Similar to goods that are considered public, common goods have characteristics that make it costly to exclude someone from enjoying their benefits. But unlike those, common goods are distinguished by their exclusive use, in the sense that their consumption by one party reduces the availability of the resource for others (and for everyone in the future). This characteristic generates favorable conditions for the overexploitation of the resource and limits private incentives to invest in its recovery, which complicates its regulation through public or private schemes. Ostrom demonstrated the existence of a host of specific experiences of self-regulation in the use of common resources, based on locally generated institutional designs through an evolutionary process of adaptation and maintenance of rules and conflict resolution mechanisms. Two contributions from this perspective are especially relevant to the problem of the institutional response to climate change.

In the first place, this perspective of the commons implies a conceptual displacement of the notion of "natural resources" (as an aggregate of materials and ecological functions that can be converted into an "input" to be absorbed in the productive system and produce "value") to that of natural common goods (the set of elements and functions of the biosphere that support life). This displacement implies substituting the valuation criterion of goods expressed as monetary magnitudes (market value, income, opportunity cost, etc.) to a richer, qualitative, and humanistic matrix of valuation criteria (Bollier, 2007), capable of value creation without abstracting the complex relationship with natural boundaries of access.

Second, the development of institutions and social arrangements for the management of very diverse resources is formulated as a complex problem, in which the criteria of optimality and perfect rationality are too narrow for the initial approach to the problem. Instead, the focus of the analysis is on the conditions of rule formation and development as an endogenous

[4]This symmetry between the economic theory of exhaustible resources and the economics of pollution is clearly explained and argued in Martínez, Alier and Schlüpman, (1991), pp. 218-223.

result of the collective action process. This feature of organizational processes is ubiquitous and central to many formation processes of social structures and introduces a high degree of complexity into the problem of institutional design. In the particular case of common goods, efficiency in resource management depends fundamentally on a participatory, flexible (adaptive) and specific design for each community, social structure and type of resource. This interpretation points to the inexistence of generally applicable solutions, designed in a rigid and vertical way for resource management, and in favor of alternatives that are crafted and implemented gradually and cumulatively, decentralized and with the active participation of the users of the resources. Consequently, institutional schemes to regulate complex systems cannot be designed on the assumption that there is complete knowledge of the relevant factors, since their "large number of components that [are] combined non-additively" implies that "our knowledge about how to design these systems will continue to grow but will never be complete" (Ostrom, 2005).

It seems to us that this double contribution (theoretical and operational) of the ADI framework with a polycentric approach is extremely valuable and stimulating, particularly in the case of the search for solutions to climate change, where resorting to market solutions has been the only point of departure and arrival of institutional design. In the next section we discuss the proposals for adapting this approach and its implications for this problem in general.

2. The ADI approach and the grammar of institutions: arrangements against climate change

Ostrom's basic approach has been improved, expanded and systematized within the framework of Institutional Analysis and Development (ADI). The ADI does not offer a finished theory or a set of universally applicable recipes for the governance of the commons and institutional development in general, but rather a framework that recognizes the specificity, contextuality and contingency in the processes of rule formation to solve complex problems. The ADI and the ADICO model (Ostrom, 2005) essentially express the grammar of institutions and their various forms of expression in diverse situations and arenas of action, with some basic elements:

The case analysis of the ADI offers a series of guidelines to understand the nature of the problem and the difficulty of generating regulatory structures in the case of global warming derived from the increase in GHG emissions and the reduction of natural CO2 sinks. Second, the idea of polycentrism has enormous potential for the design of policies that aim to accelerate the design process.

As mentioned above, the ADI approach focuses on the conditions for the formation of rules (i.e. forms of government or governance) in processes of collective action. These conditions are determined, on the one hand, by the attributes of the "appropriating" resources and agents, and on the other, by more general organization regimes and rules that affect one and the other: "(e) there is a considerable consensus that [certain] attributes of 'appropriating'

resources and agents increase the probability that self-regulatory associations will form" (Ostrom, 2005), and that these arrangements will be robust and durable.

This framework makes it possible to identify specific barriers for a global framework to face the problem of global warming. If we review one by one the characteristics of the resources and agents in a multitude of real cases of very diverse types of common goods and communities, it can be affirmed that both the nature of the resource (the carbon cycle) and the nature of the agents that use it, as well as the links that exist in the form of appropriation of the resource (typically indirect) significantly reduce the possibility that a consistent global regulation system will emerge spontaneously (Ostrom, 2014). Both the deterioration of the resource (the carbon cycle) and its association with the costs of climate change are barely perceptible to users; decisions are socially distributed, asymmetrically and disjointedly; and the modification of the emissions matrix faces strong economic, technological and social barriers.

Here it is necessary to ask to what extent and through what analytical procedure this typology allows considering the necessary elements in the institutional re-design that allow to increase the possibilities of regulation for mitigation and adaptation to climate change, creating more favorable conditions and additional institutional mechanisms that generate them, depending on the specific characteristics of the resource and the agents.

On the other hand, there are very adverse conditions with regard to the other attributes. The definition of the limits and extension of the resource (understood as the level of individual access that guarantees its reproduction), as well as its relevance (understood as the set of impacts) and shared understanding are particularly problematic in the case of climate change. In fact, it should be noted that the attributes of the resource are also part of a process of collective action, in which not only "objective" aspects of the functioning of natural variables and phenomena are involved.[5] Despite the fact that there is a broad scientific and, to a lesser degree, political consensus on the nature of the resource, as well as the impacts and sources of its disturbance, the ability to agree on the fundamental principles derived from that knowledge is not reflected in the commitments on the regulatory framework, judging by the setback in international negotiations with reference, for example, to the Kyoto Protocol. There is no clear and unequivocal perception of the relevance of the problem at the level of public opinion, much less in relation to the possibilities of action and its effectiveness criteria.

The application of the different attributes that contribute to a successful design of institutions to govern common goods inside a local community to the definition of arrangements on a global scale in the case of climate change is not straightforward. In the following table (see Table 1) we give an overview to this exercise, that can contribute to a better understanding of the upscaling process to a global level. Specific conditions for scalability emerge.

[5]At this point it should be noted that the underlying idea that the attributes of the resource and the understanding of the agents constitute separable entities is controversial. On the contrary, there is a broad discussion about the "objective" or "socially determined" nature of nature and its phenomena.

Table 1

Conditions for the organization of regulation systems in the use of common goods			
Attributes		**Conditions that increase the possibility of self-organization and strengthen arrangements**	**Conditions in the event of climate change**
Resource Attributes	Possibility of improvement	The conditions of the resource have not reached a degree of irreversible deterioration	The deterioration is increasing rapidly, although the balance between impact and inaction eliminates the latter as a reasonable option
	reliable indicators	They report on the status of the resource in a valid, reliable and affordable way	Increasing availability of indicators, as climate science and its impacts advance
	predictability	Predictable resource flow	Increasing as climate science and its impacts advance
	spatial extension	Resource size is small enough to know its internal and external limits	The resource is global and complex; the very definition of limits on its use is in dispute
User Attributes	Relevance	Users depend on the resource to satisfy basic needs (material, social, religious)	The consensus among the scientific community fluctuates from great to maximum; the public perception of this relevance is not immediate
	shared understanding	Users have a shared image of the operation of the resource and the effect of their actions	There is great diversity of positions between countries; little knowledge of the population in general, with notable exceptions in specific groups (scientists, activists, ...)
	low discount rate	In relation to the future benefits of the resource	It depends on the economic structure and expectations of the basic activities, as well as socio-technical selection criteria.
	Trust and reciprocity	Confidence in the fulfillment of promises and reciprocal relationships	Fragile in the international case; differentiated in the case of local regulation.
	Autonomy	The determination of rules can be carried out without the intervention of external authorities	It does not apply at the global level; differentiated in the case of local regulation
	Organizational experience and local leadership	Users have generated minimal organizational and leadership skills from their participation in other associations or from other experiences	Low but with high potential. The organization at the global level has experienced setbacks (eg the failure of the Kyoto Fr extension); however, there is an accumulation of replicable mitigation and adaptation experiences

As far as agent attributes are concerned, the conditions for collective action are even less conducive to self-regulation. The unrestricted and unconscious use of the recycling capacity of the atmosphere is a condition for the emergence of energy-intensive economic structures based on the expansion of land use. The modification in the parameters of "use" generates an accumulation of differentiated costs between and within the states, which cannot be

immediately identified with the costs of inaction. In addition, the costs derived from the environmental impacts of global warming have a high degree of uncertainty and are deferred over time. Finally, there are enormous asymmetries between the negotiating capacity of the agents involved (both at the state level and within the states), as well as in their ability to react to the demands of mitigation and adaptation actions. This combination of cost disproportion and asymmetries prevents the approximate and gradual alignment of the interests of the agents that characterizes self-organization in the use of common resources and therefore suggests the need to develop regulatory schemes at different levels, which combine both market mechanisms and centralized regulation, but also include collective resource management arrangements.

Ostrom herself has pointed out the importance of organizing activities at different levels and scales of action that can be mutually reinforcing and generate cumulative effects (Ostrom, 2014, 2016). These "polycentric effects" can contribute to reducing the global risks associated with climate change, taking advantage of the differentiated perceptions of the different risks and the local variability of the solutions that can contribute to punctual improvements and to formulate diversified policies based on concrete experiences. Of course, the effectiveness of those solutions depends on local conditions and the nature of the historical arrangements that have shaped the relevant institutions.

The idea of polycentrism can also contribute to increasing the effectiveness of mitigation and adaptation policies by highlighting 1) the need to include flexibility, diversification and contextualization mechanisms in the application of solutions throughout the entire range of problems related to the climate change and that have been condensed into the two large groups of mitigation and adaptation; 2) the decentralization of the agency to multiply experimentation, fine-tune the feedback between local conditions and the design of solutions, strengthen the dissemination, monitoring and enforcement of behavioral rules in the use of resources that contribute to warming (or are affected by the).

In the following section, we broadly examine the performance and institutional structure of the Mexican climate change policy, to identify the criteria and points of articulation between different levels of regulation and types of institutional arrangements.

3. Climate change policy in Mexico: a critique from the ADI approach

In recent years the efforts to design climate change policies, in Mexico and in the world, have made some progress in regard to the creation of a platform for planning and programming actions in the government apparatus at its three levels, to generate information and understanding of the nature of the resource, to the formulation of procedures to calculate private and social costs and benefits of some of the main mitigation actions, as well as in the regulations that establish limits and transition schedules in GHG emissions and energy use in specific activities. Before examining this institutional framework in detail, we first examine the general performance of GHG emissions in Mexico 30 years after the Earth Summit.

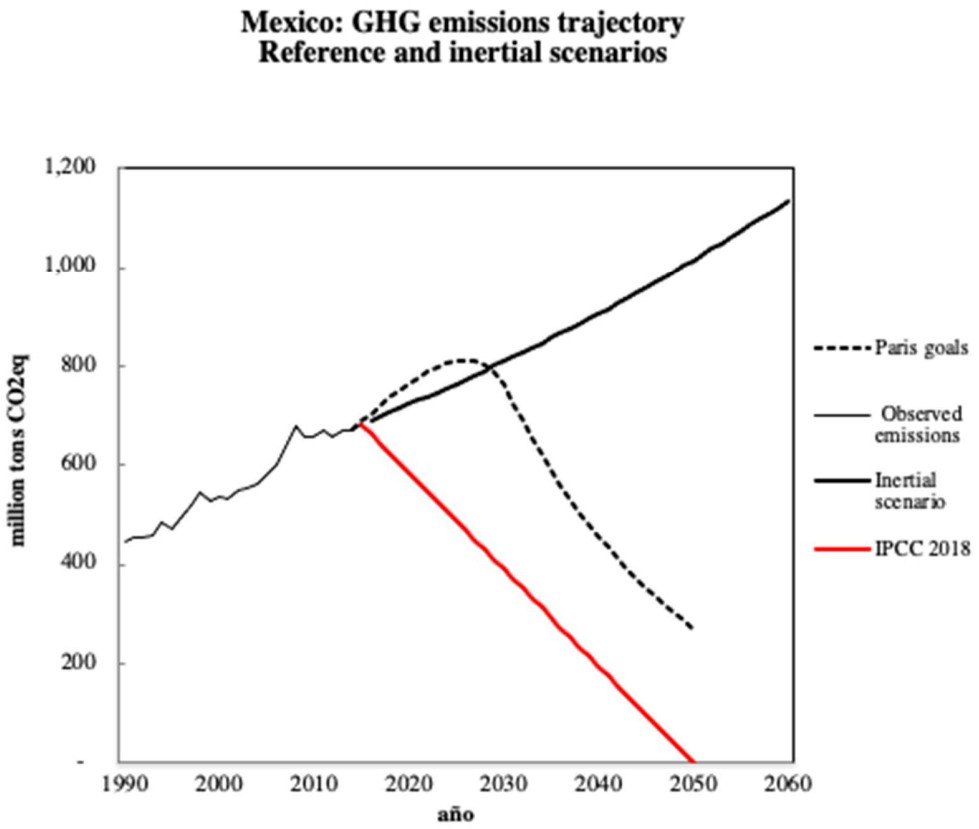
3.1 GHG emissions in Mexico: trends and goals

In Mexico, 1.3% of global GHG emissions are generated, about 650 million tons (in units of CO2, equivalent). This volume of emissions increased by 50% between 1990 and 2015, growing at rates very close to the growth of gross domestic product (GDP), that is, without any evidence of "decoupling" between economic activity and GHG emissions. Although some progress can be detected recently in terms of reducing emissions in some key sectors, these have occurred in relatively simple areas from a technical point of view and with a high degree of centralization (such as the replacement of public lighting and the control of emissions fugitives in the hydrocarbons sector) or related to the disappearance of emission-intensive activities (such as basic petrochemicals)[6]. The rapid increase in the use of natural gas for electricity generation (replacing fuel oil) also contributed to containing the growth of GHG emissions (see Aguayo 2020 for a more detailed analysis).

Within the framework of the Paris Agreement, the Mexican government has committed to reduce GHG emissions by 21% with respect to a baseline calculated according to the inertial scenario until 2030, as well as by 50% with respect to the base year 2000 for the year 2050. These commitments are presented as an effort, with respect to the inertial scenario, but they are totally insufficient from the point of view of reducing climate risk. If we consider the trajectory necessary to keep the temperature increase below 1.5°C, it is necessary to rapidly reduce emissions until they need to be totally eliminated by 2050. Graph 1 (below) illustrates the observed trajectory of emissions and contrasts the inertial trajectory (estimated from the average GDP growth in the period) with the emission levels proposed in the Paris Goals. The red line illustrates the trajectory that would be necessary (according to the IPCC) to keep the increase in temperature below +1.5°C. The goals and actions proposed by Mexico are, in the light of this requirement, critically insufficient.

[6]Official information on emissions from the energy sector should be taken with a grain of salt, especially since they are estimates based on generic emission factors, not specific to the country. Zavala-Araiza et al (2021, REF) found very large discrepancies in total methane emissions from offshore and onshore oil and gas production, concluding that actual emissions are likely higher than the official figure.

Graph 1



Own elaboration based on commitments to mitigate and adapt to climate change 2020-2030 (observed emissions and the Paris goals) and INEGI (GDP, inertial scenario).

The poor performance of the mitigation efforts responds to multiple factors: an economic model riddled with contradictions that produces a mediocre and fragmented growth of the economy (which reduces available resources to carry out the necessary investments), an energy and fiscal policy tied to the fossil fuel production, a messy and rigid electricity sector, and cumulative social deterioration reflected in persistent levels of poverty, marginalization, and violence. In addition, as we argue in the following two sections, there are fundamental coordination and coherence problems between the regulatory system and market mechanisms that reproduce the disconnection between climate change policy and the economic decision-making centers in charge of implementing mitigation actions and adaptation. This also reflects the lack of coherence between the global and national levels of institutional design.

3.2 Institutional arrangements: structure, coordination and design

In this section we examine the set of institutional arrangements underlying Mexico's national climate change policy. As we explained in section 2, in the case of climate change, it involves attributes of the resources and of the users involved that are far from the attributes necessary

for the self-regulated arrangement of a common good. In a theoretical sense, climate change policy can be evaluated based on its effectiveness in generating norms and rules that compensate or resolve these discrepancies between theoretical and real attributes, of resources and users. We conceive from this idea the framework of organizations and specific arrangements as a specialized subsystem that provides a set of public goods and services that are necessary to regulate GHG emissions and direct collective action towards their reduction. Among these assets we can distinguish those that contribute to establishing reliable indicators of the distribution, level and trends of emissions, as well as mitigation pathways. These services are essential insofar as they define the characteristics of the use of the atmosphere, that scientifically and technically proven environmental resource that is elusive and imperceptible in everyday experience. In addition, this subsystem falls on the set of tasks that have to do with the dissemination on a social scale of knowledge about the relevance of climate change,

The development of the National Climate Change Policy (PNCC) currently depends on a network of laws and institutional bodies that go through, in the letter, all levels of government. This legal framework has been the result of the national implementation of international commitments signed by Mexico, such as the United Nations Framework Convention on Climate Change (1992), the Kyoto Protocol (2005), the Doha Amendment (2012) and the Paris Agreement (2015). The current institutional structures are the result of a slow process of development and adaptation of these commitments to government structures (Tudela, 2018).

The current institutional framework of the PNCC is defined in the General Law on Climate Change (LGCC), which establishes the objectives of mitigation and adaptation to climate change, as well as the criteria and requirements for its evaluation every two years. This Law obliges the Federal Public Administration, through SEMARNAT and the Intersecretarial Commission on Climate Change (CICC), to present a Special Climate Change Program (PECC) that establishes six-year planning of the objectives, strategies, lines of action and goals to face climate change. It defines mitigation and adaptation priorities to insert them, in a transversal manner, in all government actions.

Article 40 of the LGCC also establishes that the National Climate Change Policy (PNCC) defined by the PECC has as its coordination nucleus a National Climate Change System (SNCC), made up of three specialized bodies at the federal level and the other levels of government. These three organizations are the CICC, which coordinates the 14 agencies of the federal administration and participates in the preparation and implementation of the PECC), its permanent consultation body, the Climate Change Council (C3)[7]and the National Institute for Climate Change (INECC), which reports to SEMARNAT. This secretariat also coordinates the PECC working group, made up of focal points representing the CICC dependencies, which supports the latter in the implementation and monitoring of actions and facilitates dialogue among its participants. These specialized organizations are related

[7]Made up of at least 15 members from the social, private and academic sectors, who advise the CICC and monitor

through the SNCC with the other government bodies: the Congress of the Union, the Federal Entities, and the Municipal Authorities.

The PECC must be, by law, articulated with the National Development Plan, but the mainstreaming of the PNCC has only partially and superficially permeated the federal public administration. The PECC 2012-2018 included ten indicators to measure the progress of the objectives, 26 strategies and 199 lines of action (77 linked to adaptation, 81 to mitigation and 41 to improving public policy on the matter). However, design problems prevented timely monitoring of the progress of the PECC. For example, most of the lines of action are not related to any indicator and the lack of guidelines, criteria or guides to measure, present and verify mitigation and adaptation measures prevents communication between agencies (INECC, 2017, p. 26). The lack of coordination also contributes to the low institutional effort (the PECC Working Group barely met 5 times between 2014 and 2017) and the lack of clear procedures in the consultation process between the C3 and the CICC. The PECC 2021-2024, currently in operation, establishes 24 strategies and 169 specific actions, but nothing indicates that the design and coordination problems have been resolved.

A more recent evaluation of the PNCC (INECC, 2018) confirms the limited progress in the actual implementation of actions against climate change in economic activities and state planning, identifying coordination problems, lack of follow-up. Coordination problems occur at all levels, between the goals of different dependencies, between dependencies and economic sectors (particularly with the power generation and transportation sectors), and also between the federation and the state and municipal governments. A very important effect is that the penetration of climate change policies is more limited at the state level, and much more restricted at the municipal level. In 2016, only 5 states had their own climate legislation and only a quarter had completed a state climate change program (Tudela, 2018). According to the INECC (2018), in 2019, 23 of the 32 states (71.8%) have a law on climate change, although another 6 (18.7%) had included aspects in their environmental laws (3 did not have a law). specific). In turn, 29 (90.6%) have GHG emissions inventories, and 28 (87.5%) have an inter-ministerial commission or council (coordination body), and 25 states (78.1%) have a state program. In contrast, less than a third of the municipalities have a municipal climate change program.

There is also a set of environmental regulations that regulate aspects related to environmental health, pollutant emissions, energy use, as well as the respective measurement, registration and verification standards. For example, a set of Mexican Official Standards NOM establish maximum permissible levels of pollutant emissions for motor vehicles and other fixed sources of emissions.[8]. In some cases, it is a regulation that establishes goals that are progressively adjusted, as in the case of the one that applies to the emission levels of internal combustion engines.[9].

The NOMs cover a relatively narrow range of activities, which respond to goals that are generally not very ambitious and that do not deviate too much from the inertial scenario. The

[8]This is the case of NOM 041, 042, 044, 048, 050, 076 and 163.

[9]See the draft Amendment to the Official Mexican Standard NOM-163-SEMARNAT-ENER-SCFI-2013, Official Gazette of the Federation, 09-28-2018.

regulations respond to adaptive goals, designed as much as possible within existing structures (in the case of automotive transport or urban dynamics) or to “market-led” transitions (as in the case of the electricity sector); but in general, there is no coordinated purpose of transition actively directed by the state or its agencies. In the case of the fossil fuel sector, a new and more ambitious program for the regulation of methane emissions was recently established (filling a gigantic gap in the previous regulatory system).

3.3 Market mechanisms

Although the subsystem described in the previous section is essential for a GHG emissions regulation regime, short- and long-term actions related to mitigation and adaptation processes are specifically determined by market relations, that is, they respond to independent economic signals and forces. Moreover, given that in the case of climate change there is no generalized social perception of the scarcity of the resource, nor is there a clear link between its use and its consequences, the insertion of generalized and decentralized economic incentives for mitigation and adaptation appears as a necessary mechanism.

As we mentioned, in the framework of the CM adopted by Mexico, the market mechanisms have, at least formally, the objective of facilitating the introduction of new technologies and practices to reduce GHG emissions in the set of economic activities. The main market mechanism is the carbon markets[10], although Mexico has also adopted the carbon tax. These mechanisms do not propose a direct reduction in greenhouse gas emissions. Its immediate objective is to set a "price" or cost for each unit of GHG emitted and, in the case of carbon markets, to establish a system for trading emission rights, which generates incentives to invest in mitigation solutions and At the same time, it allows lowering the costs of reducing these emissions through compensation mechanisms.

The economic policy has not responded to the effort to “mainstream” actions against climate change, but rather, on the contrary, it is oriented towards the unregulated growth of the economic system without including economic mechanisms aimed at “internalizing” the costs of GHG emissions. Proof of this is that the market mechanisms and economic incentives included in the CM have been adopted late and until now in a totally insufficient form.

The pilot model of the Mexican carbon emissions market, established art. 94 transitory of the "General Law on Climate Change" formally began to operate in January 2020 but will only

[10] In detail, carbon markets work as follows. A central entity (a government or a supranational body) establishes an emission cap for a given period and distributes a number of GHG emission quotas to a group of agents. Those agents who pollute above their quota will get a fine. Quota trading seeks convergence of capped emissions at the lowest possible cost. On the one hand, the promise of revenue from the sale of unused quotas creates an incentive to reduce emissions. On the other hand, those agents whose mitigation costs are high can benefit by purchasing permits from those who have access to lower-cost mitigation options. The central entity then sets the emissions cap according to strategic objectives and the market allocates the available resources in the most economical way in accordance with that cap. For a general review of compensation schemes see Hasselknippe, (2003).

begin to operate from 2023. It covers 238 entities in the industrial and energy sector that generate 40% of emissions. However, its design does not imply any economic impact. First, the emission quotas were distributed freely (free allowances), at no cost to the issuers, and second, because the lack of compliance does not generate penalties (only the reduction of unused permits that can be exchanged in the following period).

Since 2014 there has been a tax on carbon emissions derived from energy use, which in 2017 was an average of $43.77 pesos (about $2.2 USD) per ton of carbon.[11]This tax is, on the one hand, too low compared to the estimated costs of emissions, which are not only much higher, but whose estimate is necessarily incomplete (Ackerman & Stanton, 2011). On the other hand, the special carbon tax is in complete contradiction not only with the gigantic subsidies for gasoline prices, but also with energy policy in general.

In the energy sector there is also a knot of interlocking problems that powerfully reinforce the use of fossil fuels. On the one hand, and although oil production in Mexico ceased to be the main productive sector, oil revenues still constitute almost a third of fiscal revenues and the main source of foreign exchange for the public sector. At the same time, as a measure to control inflation and compensate for the deterioration of personal income, there is a general subsidy for the consumption of diesel and gasoline (close to 100%). This perverse economic, fiscal, and financial dependence of Mexico on hydrocarbon production constitutes a "macroeconomic pivot" that enormously raises the short-term cost of actions to mitigate the use of fossil fuels. The contradiction between the economic system and the climate change subsystem is evident: Mexico cannot continue the current logic of exploiting fossil energy resources under the premise of maximizing oil income and at the same time meet its greenhouse GHG emissions reduction goals.

Finally, it should be emphasized that the economic policy as a whole has been oriented towards the unregulated growth of the economy, driven by external demand but based on comparative advantages. This strategy has reproduced the aversion to intervene selectively but actively in industrial and technological development, necessary at multiple levels to transition to production systems with low GHG emissions, nor generating the necessary economic signals to support that transition.

3.4 Sectors and opportunities for polycentrism

There is a very wide range of applications (or reactivations) to collective natural resource management systems directly linked to systems with high GHG emissions whose contribution to mitigation can be enormous. It is true, that as a whole, most of the emissions are generated in highly centralized production and technical systems or whose decision-making structure is fundamentally determined by the market system. However, the participation of sectors with a low degree of centralization of decisions in total emissions is

[11] MEXICO2 Mexican Carbon Platform, http://www.mexico2.com.mx/uploadsmexico/file/artimpuestofinal.pdf.

quite considerable. In Table 1 we attempt a gross estimation of the potential contribution of polycentric management schemes to mitigation efforts.

Table 1

National GHG emissions in the inertial scenario, intended nationally determined targets and opportunities for collective management solutions

(million tons of CO2 equivalent)

	trend 2013	2020	2025	2030	Target 2030	Centralization degree	Proxy of centralization degree
Transport	174	214	237	266	218	low	35.2 million households
Electric power generation	127	143	181	203	139	very high (low for distributed generation)	Hundreds to thousands (management and decision making agents)
Household and commercial	26	27	27	28.5	23	low	35.2 million households and 680,000 private firms
Oil and Gas	80	123	132	137	118	high	Hundreds to thousands (management and decision making agents)
Industry	115	125	144	165	157	high	60,000 industrial firms (INEGI, SIEM)
Agriculture and livestock	80	88	90	93	86	low	2 million agricultural units, 200,000 rural communities
Urban Residues	31	40	45	49	35	very high	2,471 counties
Subtotal	**633**	**760**	**856**	**941**	**776**		
LULUCF[1]	32	32	32	32	-14	low	2,471 counties with thousands of users
Total emissions [2]	**665**	**792**	**888**	**973**	**762**		
By degree of centralization		*million tons*					
high and very high	353	431	502	553.5	449		
low	312	361	386	419.5	313		
low (+ distributed power generation)	439	504	567	622	452		
		% of total GHG emissions					
high and very high	53.1	54.4	56.5	56.9	58.9		
low	66.0	45.6	43.5	43.1	41.1		
low (+ distributed power generation)	66.0	63.6	63.9	63.9	59.3		

Notes: 1 LULUCF: Land use, land use-change and forestry. 2 The sum of sectoral values may not match total due to rounding.

Source: Own elaboration based on "Compromisos de mitigación y adaptación ante el cambio climático 2020-2030", Presidencia de la República.

The condition of strengthening the organization of local government structures for common resources is especially urgent in the agricultural sector. In Mexico, 60% of the land and 75% of the forests are under collective property schemes (Merino, 2005). The agrarian communities that directly manage aquatic, agricultural, livestock and forestry systems in their territories operate under different types of institutional arrangements, which are shaped by a range of key factors highly specific to local conditions. The rules and incentives for the use of resources also depend on institutional arrangements at the federal and state levels, as well as on the restrictions and signals of the economic system.

The processes of deregulation and liberalization of agricultural markets (including land ownership itself), the expansion of international trade and integration into the North American market, essentially modified the set of incentives and restrictions that affect the

management of resources in agrarian communities. The increased level of competition with the international market, in a context of lower urban and rural wages and the dismantling of policies and institutions regulating the market for agricultural products, cornered the peasant economy. The strategies of rural producers have been diverse (from temporary migration to income diversification of rural households, incorporation into contract farming, land abandonment, going through the concentration of land and the emergence of a semi-industrialized platform of export agriculture). To generate and sustain processes that produce mitigation and adaptation actions in rural areas, it depends not only on the design and implementation of specific programs, but also on a parallel process that strengthens the material and technical capacities of agricultural communities.

The contribution of projects for the collective management of natural resources, particularly in rural areas, where more than 20 million Mexicans live, can be even more important. Rural communities face the challenge of responding to drought, the increase in the cost of inputs, less frequent and altered precipitation patterns, increased temperatures and extreme weather events. Lutz-Ley (2020) finds, on the one hand, that adaptation efforts occur in the physical aspect and at the family or household level, and not at the community or regional level; second, that the frequency of adaptive responses at higher levels of aggregation decreases as the need for resources, civil society organization and access to higher levels of decision-making increases.

4. Discussion: climate change and extensions of the ADI approach

The ADI perspective has synthesized a set of useful propositions to frame the problem of climate change, derived from experiences in the design of collective adaptive management systems. Dietz, Ostrom and Stern (2003, REF) propose grouping them into four major lessons: 1) conceive institutional design as a continuous dialogue; 2) keep in mind that the relevant institutional arrangements are complex, redundant, embedded in each other; 3) search not for the optimal arrangement, but for combinations of different types of arrangement; and 4) the design must include mechanisms for continuous change. It seems to us that this heuristic of institutional design constitutes a powerful tool in the case of the climatic emergency. We believe, however, that this heuristic has at least three important limits.

4.1 Limits of the micro-social perspective

A weakness of the ADI approach stems directly from retaining a fundamentally microeconomic perspective on social reality. From a narrow interpretation (which we discussed above), the application of the idea of market failure has the advantage of offering a specific and easy-to-grasp definition, from which a set of “technical” solutions is immediately derived (the 8 principles in institutional design) and a specific agenda. In this sense, there is a dominance of the normative agenda of theory over the explanatory agenda, which to a certain extent can reduce its scientific contribution.

Environmental problems then appear as a result of specific market failures and (to some extent) analytically separable from the broader context of social, economic and political forces that shape the use and distribution of resources (both natural and economic, technological). But the problem with this definition is that it leaves broader institutional arrangements and structures intact, such as the profound tendencies of the economic system to grow without limits and in a cyclically unstable way, the feedback between economic and political inequality, the economic incommensurability of goods and environmental values and cultural, the interrelation between cognitive, organizational and technological structures, etc. (all central problems of positions that from political economy,

For example, an arrangement can be “robust” at the micro-community level (comply with the 8 principles) and yet be completely fragile in the face of the extractive impulse of a state policy. In conditions of social conflict and social, economic and political asymmetries endemic to the socio-economic structure, the IAD approach has rather little to say about existing arrangements. This criticism of course does not invalidate the practical and intellectual usefulness of the IAD approach. Rather, by highlighting its limits we intend to put it in perspective.

4.2 The level of analysis

The relevance of the ADI approach to the problem of climate change crucially depends on defining the appropriate level of analysis in the application of the approach. The ADI requires a very high degree of resolution in the definition of exogenous variables (material and biophysical conditions, rules, nature of the communities, etc.) as well as a clear specification of the components of the arenas of action (the participants and the situation of action). At what level, then, is it possible to expect a more accurate application of the ADI approach? What is the relevant arena for action in the multiple dimensions of sustainability problems arising from global warming? And what are the conditions to relate different levels? In a preliminary way, we can distinguish a set of different interrelated "action arenas" articulated in a more or less hierarchical way from the level of the organizational entities involved: international negotiations for a global framework for regulating emissions, national policies and its configuration, regional, industrial-sectoral issues, local resource management (for adaptation to climate change), etc. By its origin as by the frequency of its application, ADI appears naturally applicable to resource governance problems at the “lowest” level of organization; it is there where the attributes of the resources and agents coincide more closely with those mentioned in Table 1. The ADI approach, however, is at least ambiguous in what refers to the articulation between specific action arenas (delimited based on the definition of a resource and a specific group of agents) and the largest regimes, which determine the degree of autonomy, the level of mutual trust and reciprocity, the presence of generic rules that affect collective action processes, as well as the external variables that act on a certain arena of action.

The application of the principles of polycentrism fails convincingly to discern this lack of definition, since it does not solve the problem of coordination between the different levels and arenas of action. It is important to recognize the existence of possible emergency effects that originate at the local level and can generate important synergies that ultimately contribute

to the construction of collective solutions at the regional or global level. But it is necessary to analyze more clearly the conditions in which this complementarity of processes can occur and the characteristics of aligned processes of this type. This point is of particular relevance given that in the case of climate change it is a phenomenon that is not observed directly and immediately in the affected areas.

4.3 Systemic failures and historicity

This criticism stems from the comment on the micro approach and the interrelated nature of the many "systems" or dimensions that come into play in the case of the causes of climate change and its possible remedies. In the specific case, they highlight, for example, the problems derived from a generalized technological platform (crystallized in a multitude of social functions that satisfy the basic needs of mobility, temperature control, material and food processing) based on the use of fossil fuels, embedded in an economic system whose main purpose is growth. The economy is locked-in a trajectory of high carbon emissions (Unruh, 2001), which has deep implications for policy design.

This feature of the system can be seen at the micro-level as a general bias (or bias) of the price system against alternatives (which, unlike incumbent technologies, have higher learning costs, are less productive, live in marked captives, are more difficult to finance, or face barriers to adoption), even though they may have lower operating costs. This general feature of the system indicates a huge "market failure", which requires a correction in the general level of prices for a wide range of activities. This implies, in the case of Mexico, gradually but decisively reinforcing economic incentives for decarbonization, adjusting economic policy objectives to the transition to low-emission systems, as well as the design of industrial transformation policies in specific systems (mainly energy and food). Finally, the correction of this flaw, as well as its importance in the hierarchy of strategic priorities, should affect the design of monetary and fiscal policy in response to climate change, in the same sense that money market flaws do. and in the labor market.

These two spheres are focal points for the determination of social activity that, in the language of the ADI, are similar to "constitutional rules". These rules profoundly determine the generation and change of operational rules and their characteristics make them persistent over time. The ADI approach, however, refers to rules of a constitutional nature when it considers a very different type of regulatory sphere, such as the level of democracy or verticality in a macro-regime. However, there is no reference or explanation in the ADI approach to the causes of persistence of these rules. The possibility that it is the extension of the process of collective action necessary to re-generate them offers, in light of the two processes mentioned above,

5. Conclusions

The analysis framework proposed by Ostrom opens the discussion on the types of institutional arrangements necessary to face a problem such as climate change and on the conditions to achieve their adequate formation. It achieves this in the first place by

recognizing that problems such as global warming are the cumulative result of individual actions and that at the same time its solution can only lie in collective actions at different levels. To face a social dilemma of this type, it is essential to create clear incentives and enforceable rules at the local level, but compatible at the global level. Only local arrangements make it possible to break existing resistance through broader access to information, the introduction of trust and reciprocity, and decentralized decision-making.

But Ostrom's model also leaves a series of problems to be solved. In the first place, that of the construction of rules in conditions of asymmetry between the agents, and in which there is compatibility between them and the existing institutional framework. This problem involves not only examining the plausibility of using the IDA to understand the governance of contested commons, but also rethinking the role of the state in creating conditions for decentralized organization. Secondly, the problem of the rapport between the activities of exploitation of common goods and the rest of the social regimes; in the case of mitigation and adaptation problems,

It seems to us that these problems, which we have dealt with preliminarily in this text, offer a very fertile field of discussion that deserves to be deepened and expanded.

References

Ackerman, F., & Stanton, EA (2011). Climate economics: state of the art. Stockholm Environment Institute-US Center.

Aguayo, Francisco (2020), "La política comercial: estrategias de desarrollo y estructura productiva", in A. Nadal, "Pensar fuera de la caja: la economía mexicana y sus posibles alternativas", series Estudios y Perspectivas-Sede subregional de la CEPAL en México, N° 182, Mexico City, Economic Commission for Latin America (ECLAC), 2020. https://www.cepal.org/es/publicaciones/45550-pensar-fuera-la-caja-la-economia-mexicana-sus-posibles-alternativas.

Bollier, D. (2007). The growth of the commons paradigm. In C. Hess & E. Ostrom (Eds.), Understanding knowledge as a commons. MIT Press.

Boulton, CA, Lenton, TM, & Boers, N. (2022). Pronounced loss of Amazon rainforest resilience since the early 2000s. Nature Climate Change, 12(3), 271–278. https://doi.org/10.1038/s41558-022-01287-8

Gatti, L. V, Basso, LS, Miller, JB, Gloor, M., Gatti Domingues, L., Cassol, HLG, Tejada, G., Aragão, LEOC, Nobre, C., Peters, W., Marani, L., Arai, E., Sanches, AH, Corrêa, SM, Anderson, L., Von Randow, C., Correia, CSC, Crispim, SP, & Neves, RAL (2021). Amazonia as a carbon source linked to deforestation and climate change. Nature, 595(7867), 388–393. https://doi.org/10.1038/s41586-021-03629-6

Hardin, G. (1968). The tragedy of the commons. Science, 162, 1243–1248.

Hasselknippe, H. (2003). Systems for carbon trading: an overview. Climate Policy, 3(2), 43–57.

INECC. (2017). Strategic Evaluation of the Special Climate Change Program 2014-2018. https://www.gob.mx/cms/uploads/attachment/file/261388/Informe__evaluacion_PECC_final_limpio_1_.pdf

INECC. (2018). Strategic evaluation of the subnational progress of the National Climate Change Policy. https://changeclimatico.gob.mx/wp-content/uploads/2021/05/EVALUACION_ESTRATEGICA_AVANCE_SUBNACIONAL_PNCC.pdf

IPCC. (2021). Climate Change 2021 - The Physical Science Basis - Full Report. In RY and BZ

Masson-Delmotte, V., P. Zhai, A. Pirani, SL Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, MI Gomis, M. Huang, K Leitzell, E. Lonnoy, JBR Matthews, TK Maycock, T. Waterfield, O. Yelekçi (Ed.), Climate Change 2021: The Physical Science Basis. Cambridge University Press. https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/

IPCC. (2022). IPCC working group sixth assessment report: Technical Summary.

Lutz-Law, A.N. (2020). Human adaptation to global change in rural communities of Mexico. Current Opinion in Environmental Sustainability, 44, 85–92. https://doi.org/10.1016/j.cosust.2020.08.011

Martinez-Alier, J., & Schlüpman, K. (1991). ecology and economy. Fund of Economic Culture.

Ostrom, E. (1990). Governing the commons: the evolution of institutions for collective action. Cambridge University Press.

Ostrom, E. (2005). Understanding institutional diversity. Princeton University Press.

Ostrom, E. (2014). A polycentric approach for coping with climate change. Annals of Economics and Finance, 15(1), 97–134. https://doi.org/10.2139/ssrn.1934353

Ostrom, E. (2016). Nested Externalities and Polycentric Institutions: Must We Wait for Global Solutions to Climate Change Before Taking Actions at Other Scales? (pp.259–276). https://doi.org/10.1007/978-3-319-31943-8_13

Rockström W. Steffen, K. Noone, Å. Persson, FS Chapin, III, E. Lambin, TM Lenton, M. Scheffer, J., C. Folke B. Nykvist, CA De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P., HS, K. Snyder U. Svedin, M. Falkenmark, L. Karlberg, RW Corell, VJ Fabry, J. Hansen, B., RC, & Walker K. Richardson, P. Crutzen, and J. Foley. , D.L. (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity. Ecology and Society, 14(2), 32.

Rosenberg, N. (1982). Learning by using. In Inside the black box: technology and economics (pp. 120–140). Cambridge University Press. hard

Tudela, F. (2018). Sustainable development, climate change and energy. In EM Priego & R. Díaz (Eds.), New energy and climate model in Mexico. Chamber of Deputies, LXIII Legislature - Miguel Ángel Porrúa.

Unruh, G. C. (2000). Understanding carbon lock-in. *Energy Policy*, *28*(12), 817–830.