

On the Commons and Climate Change: Collective Action and GHG Mitigation¹

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Abstract

Reducing greenhouse-gas (GHG) emissions from anthropogenic activity may be one of the greatest collective-action problems faced by humanity. This poses challenges not only in terms of the institutional configurations to support coordinated governance processes, but equally the information tools and expertise necessary to link GHG mitigation with other policy priorities. This paper theoretically explores how the adoption of a modified theory of collective action based upon a behavioral theory of the individual allows for a reframing of the climate-change policy challenge. As such, it appears important to develop a context within which collective action becomes possible where success is no longer solely tied to incentives, but equally to the provision of information, learning, and interaction between stakeholders while simultaneously fostering trust and reciprocity among actors.

At all levels of government, information plays a key role to both inform and to facilitate communication, as well as to identify and develop the necessary actions and investments and to track changes in conditions. In the case of climate change, greenhouse-gas inventories and other informational tools are necessary components to track an *a priori* intangible emission. As such, it is key to analyze the legitimacy, credibility and saliency of information and expertise integrated into the decision-making process. Further, it is important to recognize that the construction of indicators and other information tools is not *apolitical*, but rather the product of a number of assumptions, interests and decisions concerning what is included and what is excluded shaped by the involved actors.

Keywords: Climate change, collective action, GHG inventories, GHG mitigation

JEL codes: Q54, Q58, R58.

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“I would rather address the question of how to enhance the capabilities of those involved to change the constraining rules of the game to lead to outcomes other than remorseless tragedies.”

Elinor Ostrom 1990:7

1. INTRODUCTION

Reducing greenhouse-gas (GHG) emissions from anthropogenic activity may be one of the greatest collective-action problems faced by humanity. As such, greenhouse-gas mitigation poses a complex policy challenge spanning traditional jurisdictional and sectoral boundaries as well as across time. The reduction of greenhouse gases alone in a single location rarely leads to directly detectable and immediate effects that individual actors can observe or appreciate, given that benefits accrue globally with longtime horizons. As such, GHG mitigation requires significant coordination of actors both between and across levels of government. Often, the only indicator of change are abstract emission-reduction totals and inventories often difficult to take into consideration both in terms of making day-to-day decisions or tackling related policy subjects for decision makers. As such, reducing greenhouse-gas emissions appears to require coherent, coordinated policy decisions across and between levels of governance. This will most likely require the participation of not only elected officials, but also equally the public and private actors involved in sectoral activities. This poses challenges not only in terms of the institutional configurations to support coordinated governance processes, but equally the information tools and expertise necessary to link GHG mitigation with other policy priorities. This paper draws lessons for the governance of climate change and specifically GHG mitigation from the theoretical literature surrounding the management of the ‘*Commons*’¹ and collective action. Given the increasingly recognized necessity to take action at multiple levels of governance – from international to local- this paper will focus specifically on the institutional arrangements and the informational tools necessary to create a context necessary to foster what Elinor Ostrom has termed a ‘polycentric approach for coping with climate change’ (2009).

1.1. The Climate Change Policy Challenge

There are three distinct aspects of the climate-change policy challenge that often render efficient² mitigation action difficult. Principally, climate change poses

¹ *Commons* typically refers to resources that are owned in common or shared between or among communities. These resources are said to be "held in common" and can include everything from natural resources and land to software. The *Commons* is also a way to refer to the larger body of literature treating the governance of these resources

² The author uses a working definition of efficient action as that which achieves real, long-term GHG emission reductions at relatively low-cost.

complex intra- and inter-generational equity problems. First, due to the global nature of the greenhouse effect and the trans-boundary impacts of greenhouse-gases emissions, action on climate change must be coordinated globally with all major GHG emitters participating in the reduction of current and future emissions. This poses significant challenges in terms of coordinating action across nations, heterogeneous in terms of wealth, level of development and current per-capita emission profiles (Newell 2000, Fischer 2004). As such, an intra-generational problem is posed as to what can be expected from different actor groups given their responsibility for emissions as well as the impacts that they will bear. Further, action on climate change is complicated by the need to reduce greenhouse-gas emissions to reduce the severity of climate change while at the same time preparing and implementing the appropriate policies to adapt to both potential and inevitable climatic impacts (Corfee-Morlot et al. 2010). While GHG mitigation and adaptation policy are complementary and must occur in tandem, both require the justification of present costs for uncertain future benefits. Second, climate change poses an inter-generational challenge as choices made today concerning energy generation, transportation, land-use and other activities will influence greenhouse-gas emissions for decades to come. This inter-generational aspect also influences the distribution of costs and benefits that often renders traditional policy-making methods and approaches ineffectual in the choice and implementation of mitigation policies due to present costs for future, often distant and difficult to calculate, benefits (Corfee-Morlot et al. 2010; Corfee-Morlot 2009).

Climate change is a crosscutting problem, calling into question many of the basic social and economic processes, ranging from energy production and food supply, to industrial activity, transportation, etc. Effective action must take a holistic approach, breaching the issue-based “silos” surrounding many of these traditionally insular policy sectors (Corfee-Morlot et al. 2009). A range of actions is often needed that treat multiple facets of the problem at once. This is intimately linked to the fact that in many cases reducing greenhouse-gas emissions will require widespread behavioral change, in terms of both technologies as well as methods of production and consumption.

Further, climate change in many ways presents a “classic” collective action problem resulting from a mismatch of incentives in terms of costs and benefits both across locations and across time. Actors and individuals lack the incentive to take part in collective action as it is possible to ‘free-ride’ on the efforts of others as the benefits of reducing greenhouse-gas emissions can be classified as those from a public good and thus accessible to all. As such, classical, rational-actor theories of collective action would suggest that the participation of individual actors would remain minimal and that action would be focused at the international level where the entirety of costs and benefits can be integrated (Legget 2009). However, this is often contradicted by observations in reality: action has been taken at multiple levels of government by both the public and private sectors. While, as expected, much official policy making is concentrated on international coordination of GHG-mitigation action, the scope for sub-national greenhouse-gas mitigation action is

becoming increasingly visible. Whether this stems from dissatisfaction of the slow nature of international action or from local pressure to take up the subject, it suggests that sub-national collective action on the subject is possible and potentially powerful.

Finally, mitigating future changes in climate requires an understanding of how past, current and planned actions impact greenhouse-gas emissions, and thus the severity of change. Emissions of the six greenhouse-gas emissions recognized by the United Nations Framework Convention on Climate Change (UNFCCC)³ are typically in and of themselves intangible and often go unnoticed unless accompanied by other negative (or positive) effects. As mentioned above, the impact of present-day emissions is not immediate in a single locality (in terms of both time and geographic location). As such, it is necessary to devise and construct means of calculating, monitoring and evaluating not only the sources of greenhouse-gas emissions, but also the direct and indirect impacts of individual actions taken to reduce them. Thus, the development of different forms of expertise, as well as their integration or “mainstreaming” into decision-making, policy implementation and evaluation, must be given careful attention.

This paper reviews the current literature on the “*Commons*” to understand what recent development in theories of collective action can be used to understand better the governance of GHG mitigation in terms of the role of actions across levels of government and the need for specialized expertise and information. Drawing on recent literature, Section 2 explores the noted transition from a theory of collective action based on the assumed rationality of actors to one building on a behavioral theory of the individual. Lessons from decades of research on the collective management of common pool resources that can be applied to the climate-change policy challenge are identified. Section 3 looks at recent developments in how institutional context across levels of government influences the context within which collective action occurs at the local level. Finally, Section 4 reviews recent literature on the role of information and expertise for policy and decision-making, its use, and its production.

2. THE COMMONS AND COMMON POOL RESOURCES

The literature on the *Commons* draws from a wide range of disciplines and traditions, focusing on the management of things held in ‘common’ - typically focusing on natural resources, although it has equally been applied to other types of goods and services. While most non-renewable resources have been privatized,

³ The six UNFCCC recognized greenhouse gases are: carbon dioxide (CO₂); methane (CH₄); nitrous oxide (N₂O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF₆). The United Nations Framework Convention on Climate Change (UNFCCC or FCCC) is an international environmental treaty signed in 1992. Its objective is to stabilize greenhouse-gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

renewable resources are often held in common or public ownership (Stavins 2010). The objective of much of the reflection surrounding the Commons has focused on how to achieve the collective action necessary to ensure the sustainable, productive use of these resource systems (Stavins 2010; Ostrom 1990, 1998, 2009; Poteete et al. 2010). Much of the research on the Commons focuses on ‘Common Pool Resource,’ or “... a natural or man-made resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use” (Ostrom 1990:30). The challenge of the Commons stems principally from situations where users do not bear the full consequences (social costs) of their actions and thus over-exploit resources without investment in their long-term management (Olson 1965; Hardin 1968; Ostrom 1990, 1998, 2009; Libecap 2008; Poteete et al. 2010).

Two overlapping categories of common pool resources are primarily treated in the literature. First, *common property resources* (extensively treated by Elinor Ostrom) are those resources that are collectively owned or held either by a group or that are public property⁴, including fisheries, grazing land, small-scale aquifers, etc. While access may be limited to members of the group, consumption may be non-excludable within the group. Second, ‘*open access common pool resources*’ are those to which no party claims exclusive ownership, such as ocean fisheries, as well as the global atmosphere as a sink for pollutants. These resources tend to be much larger in size, crossing traditional administrative and jurisdictional boundaries; often the costs of developing restrictive boundaries are higher than the apparent historically perceived benefits (Libecap 2008:552). Both categories of common pool resources have two dimensions: first, the management of the *flow* of resources, or the contemporaneous use of the *units* produced by the resource system (fish, trees, liters, metric tons of emissions, etc.). The second dimension concerns the management of *stocks* or the total number of limited units or the capacity of the system to regenerate each year. Often, over-consumption of the resource *flows* can negatively impact the ability of the *stock* to regenerate over time and continue to produce sustainable yields.

2.1. Greenhouse-gas emissions as the use of a Common Pool Resource

While typically not viewed as a natural resource in and of themselves, issues of environmental degradation can be structured as *common pool resource problems* when the global environment is understood as a sink for pollutants (fluvial, atmospheric, etc.). Climate change and the emissions of the six UNFCCC-recognized greenhouse gases is no exception. In this case, the atmosphere is considered as a sink able to stock only a certain flow⁵ of greenhouse-gas emissions before resulting in an increase in the global mean temperature. When the flows into

⁴ Public property is a form of common property owned by all the citizens, but typically controlled by elected officials or bureaucrats, who determine the parameters for access and use (Kondoh 2009).

⁵ The carbon cycle is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth.

the atmosphere outpaces the sequestration of emissions, only so many units of greenhouse gases can be emitted before the defined limit of sustainable use has been attained. Given that greenhouse-gas emissions remain in the atmosphere for an extended period of time (from decades to centuries), management efforts are focused principally on the *flow* of greenhouse-gas emissions that can yet be emitted. As such, much research and international efforts have attempted to identify the quantity (measure in parts per million) of greenhouse gases that the atmosphere can hold in order to achieve the target of limiting the increase of mean global temperature by 2°C before the end of the century.⁶

Further, climate change can be classified as an *open-access common pool resource problem*. As with other environmental and air-pollution problems, the emissions from different source of pollution are spread across a large area, thus distributing the costs of pollution and lessening the direct negative impacts on the polluter. This is equally true in terms of the distribution of benefits from measures taken to reduce pollutants at their source: the majority of the cost is borne by the polluter while the benefits of emission reductions are distributed across a broader area. Therein lays the source of the collective-action problem stemming from a mismatch of incentives, given that the costs and the benefits of reducing emissions are borne by different actors. This problem, often the heart of the Commons literature, will be explored in the following sections as well as the different solutions that have been proposed to achieve collective action. Further, given that greenhouse-gas emissions tend to aggregate homogenously in the atmosphere across geo-political boundaries, theory thus suggests that international, if not global, cooperation is the proper level at which attention should be focused (Stavins 2010; Stern et al. 2006).

2.2. The Theory of Collective Action and the Tragedy of the Commons

The heart of the debate surrounding collective action is the avoidance of inaction and free riding in the management of public goods. Much of the conventional theory of collective action is based on the work of Mancur Olson (1965) and Garret Hardin (1968). Through his work, Olson laid the foundation for much of the modern theory by challenging the then-widely accepted idea that the benefits derived by a group would be sufficient to overcome the temptation for an individual not to contribute to a good benefitting the entire collective.

...unless the number of individuals is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, rational self-interested individuals will not act to achieve their common or group interests (Olson 1965:2)

With what has become known as the *zero-contribution hypothesis*, Olson injected into the debate the idea that without means of excluding an individual from the

⁶ This target, adopted by negotiating parties at the 2010 COP/MOP in Cancun, Mexico, requires that the concentration of GHG emissions in CO₂-equivalent remain below 450 parts per million. Currently, that atmosphere is already estimated to have passed 385 ppm (NOAA 2008).

collective benefit, there is little incentive for a person to contribute to its production.

Garret Hardin and his contemporaries subsequently applied the theory of collective action as presented above to the Commons.

Picture a pasture open to all... A rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another... Each man is locked into a system that compels him to increase his herd without limit — in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in the commons brings ruin to all (Hardin 1968:1244).

Hardin's now famous 'tragedy of the commons' presents a context within which each actor acts in an economically-rational fashion to maximize his utilization of the unregulated common pool resource. An individual receives the full benefit of consuming one more unit of the resource, and shoulders only a fraction of the shared cost spread throughout the entire group. As such, all individuals would maximize short-term benefits and would be highly unlikely to cooperate spontaneously.

Based on the conventional theory of collective action, solutions to the problems plaguing the Commons focus principally on the intervention of an external actor (the State or other) to institute equilibrium and/or take control of the common pool resource (Hardin 1968, Ostrom 1990). In general, two broad categories of solutions that in theory achieve the same results, but through different means are often evoked. As advocated by Hardin, a 'Leviathan' or an external force capable of punishing misbehavior must take control of the resource to ensure its proper use. This external force is able to set the rules and enforce them, in theory ensuring that the full costs and benefits are shared by all parties.

The second approach involves the privatization of the resources, either to the benefit of a single party or by splitting it into units and dividing it among the different actors. As such, in theory and given that the system can be divided in a homogenous fashion, each actor would then bear both the costs and the benefits of his individual actions. In both of these cases, an external force is typically necessary to implement the solutions to the collective-action problem, rather than coming from the individual stakeholders themselves. Thus, there is the potential for action without any real form of the 'collective' (i.e. effected stakeholders) involved. However, as explored further below, the enforcement and monitoring costs required to assure the effectiveness of an external agent may be relatively high without the active participation of stakeholders.

As indicated by a number of authors (Stavins 2010; Ostrom 2009), the conventional theory of collective action can be applied to the problem of reducing global greenhouse-gas emissions. Climate change is caused by billions of individual actors, each emitting greenhouse gases. Each actor stands to bear a portion of the direct cost stemming from a change in daily socio-economic behavior required to reduce his emissions. Equally, each actor will only indirectly

benefit from the shared good of avoiding increases in average global temperature due to temporal and geographical distribution of benefits. Applying Olson's zero contribution hypothesis and Hardin's tragedy of the commons results in the hypothesis that no spontaneous action to limit the use of the atmosphere as a GHG sink would occur. As such, an external authority must necessarily impose and enforce policies at the scale of the externalities (in this case, the planet), without which there would be little incentive to act (Ostrom 2009). Therefore, policies of international scope have received the most attention in the climate-change discussions (Stavins 1997, 2010; Wiener, 2007) as they seem best suited to do this.

2.3. From a rational choice theory to a behavioral theory of the individual

There has, however, been substantial critique of the conventional theory of collective action, focusing particularly on the assumptions made by Olson, Hardin and others concerning individual behavior. "These models [from Olson and Hardin] are extremely useful for explaining how perfectly rational individuals can produce, under some circumstance, outcomes that are not 'rational' when viewed from the perspective of all those involved" (Ostrom 1990:6). However, Elinor Ostrom, one of the foremost critiques of this conventional view, has noted that the zero-contribution hypotheses is often contradicted by what is seen in daily common pool resource management situations (1990, 1998, 2000; Poteete et al. 2010). In her work, she has determined that there is not one type of individual, but many, within different levels of willingness to cooperate (Ostrom 2000). Further, Ostrom and others have repeatedly detailed and analyzed cases where neither privatization nor state intervention has been necessary to allow for the sustainable management of common pool resources, thus calling into question Hardin's tragedy (Dietz et al. 2009; Ostrom 1990, 1998, 2000, 2009; Poteete et al. 2010). While the conventional theory of collective action may be applicable in cases where its strong assumptions holds true, empirical research indicates that collective action is possible (Ostrom 1990, 1998, 2000; Poteete et al. 2010). To understand this better, Ostrom and others have challenged a number of the assumptions surrounding the conventional theory of collective action.

This critique of the conventional theory of collective action can be situated in the New Institutional Economics tradition with roots stemming back to Ronald Coase. While traditional theories of collective action analyze individual actions and behavior, they often fail to consider the larger institutional context behind the need for external intervention. As experience from research demonstrates, even well-planned external intervention can in some cases fail to solve the collective action problem (Dietz et al. 2009; Ostrom 1990, 1998, 2000, 2009; Poteete et al. 2010)⁷. The New Institutional Economic (NIE) theory approach challenges a number of the assumptions made by neoclassical economics and stems from the seminal work of Coase (1937, 1960) emphasizing the role of institutional arrangements in economic

⁷ Much of Ostrom's work is focused on the management of fisheries as well as pasture and other common pool resources.

governance. The principal argument of this theory revolves around the idea that individuals can capture gains from trade by cooperating. However as cooperation is costly and harmed by opportunism, it is necessary to develop “institutions” or formalized interactions to overcome these problems (Gagliardi 2008). While adopting many of the principal neoclassical tenants (rationality [if bounded] of actors⁸, etc.) this strand of theory treats environmental degradation in terms of *interdependencies* between actors rather than unassigned externalities and recognizes the effects of *transaction costs*. Given that different institutional configurations can introduce differing levels of transaction costs, institutional arrangements can thus influence the overall efficiency of policies. NIE theory acknowledges positive transaction costs (Coase 1937, 1960) and how institutional arrangements influence economic outcomes when they are taken into consideration (North 1990).

The conventional theory of collective action based on the work of Olson and Hardin relies on rational choice theory to characterize individual behavior. As such, individuals are theorized to be self-interested “maximizers,” who in one-shot or finitely repeated contexts were unlikely to cooperate when payoff structures brought more immediate gains from self-interested action. Ostrom admits that “[p]redictions from this theory are well supported when applied to the analysis of the provision and production of private goods in a highly competitive environment” (Ostrom 2009:10). In these cases, a highly competitive and dynamic market is able to screen out those actors that do not maximize the cost-benefit ratio. However, it is difficult to explain observed examples of collective action in the management of common pool resources with rational choice theory (Ostrom 1990, 1998, 2000, 2009; Poteete et al. 2010). Rational choice theory assumes that all individuals will have perfect information concerning the full range of costs and benefits concerning every choice. Thus, in the conventional theory of collective action, individuals are assumed to have complete information “...about the structure of the situation they are in, including the preferences of other actors, the full range of possible actions, and the probability associated with each outcome resulting from a combination of actions” (Poteete et al. 2010:217). As such, collective action is reduced to a simple prisoner’s dilemma with little expected spontaneous cooperation, even when repeated.

However, contrary to what rational choice theory predicts, the collective local management of common pool resources has been repeatedly documented (see Dietz et al. 2008; Ostrom 1990, 1998, 2000, 2009; Poteete et al. 2010 for both examples as well as exhaustive bibliographies on the subject). To fit better what they have found through empirical research and through different theories of

⁸ The analysis presented in this paper adopts the idea of the bounded rationality of actors, meaning that decision making occurs under incomplete information due to the high costs of information and that cognitive processing ability is limited.

bounded rationality⁹, Ostrom and her colleagues posit that additional models are necessary to describe individual behavior:

Explanations can no longer rest entirely on the model of the individual facing a particular type of payoff function. Instead...an explanation of cooperation must be based on individual learning and norm-adoption, as well as the influence of micro-situational and broader contextual variables, in generating variable levels of cooperation. (Poteete et al. 2010:220)

As such, a number of researchers have turned towards the development of a *behavioral theory of the individual* to predict better the reciprocal behavior identified between actors, which – to date – has been unexplainable by conventional theories of collective action (Ostrom 1990, 1998, 2009; Poteete et al. 2010)¹⁰. Within this approach, collective exchanges are a process of developing trust, reputation and reciprocity rather than as single-shot or finite prisoner's dilemma (Ostrom 1998). Instead of relying on external “hard” enforcement of regulations and laws to achieve objectives, this approach focuses on the development of an institutional context to foster “soft” methods to increase levels of cooperation.

A behavioral theory of the individual views individuals as adaptive rather than purely rational creatures “...who attempt to do well given the constraints and opportunities of the situations in which they find themselves (or the ones that they seek out)” (Poteete 2010:222), thus learning from one-another as how to do so. This theory for understanding individual behavior is based on three core assumptions:

1. **Actors possess incomplete information** about the structure of the situation in which they are interacting with others, but they may acquire more complete and reliable information over time, especially in situations that are frequently repeated and generate reliable feedback to those involved.
2. **Actors have preferences related to achieving** net benefits for self, but these are combined in many situations with others regarding **preferences and norms about** appropriate actions and outcomes that affect their decisions.
3. **Actors use a variety of heuristics in** making daily decisions that may approximate maximization of net benefits (for self and others) in some competitive situations but are highly cooperative in other situations. (Poteete et al. 2010:223)

⁹ New Institutional Economics has often sided with the neoclassical economic theory concerning the rationality of actors; however, a number of authors question this tenant and, rather, advocate the use of ‘bounded rationality’ (Williamson 1981; Tversky and Kahneman 1974; Ostrom 1998, 2009). While a full review is beyond the scope of this paper, a bounded approach recognizes that the rationality of individuals tends to be limited by their access to information, their cognitive capacities to accept and process new information and the finite amount of time they have to make decisions. Further, it is also accepted that actors often organize their spending into separate mental “accounts” for food, housing, entertainment, general expenses and so on; thus, their logic for each budget line can differ (Kahneman and Tversky, 1974).

¹⁰ Many of the empirical observations upon which Ostrom and her colleagues base their work come from both the analysis of case studies of existing common pool resources management as well as game-theory lab exercises based on their findings. For a complete overview of the game theoretical foundation for her critique of the conventional theory of collective action, beyond the scope of this paper, see Ostrom 1990 Chapter 1.

As such, instead of focusing on the individual, this approach focuses on the contextual or institutional factors involved to understand the behavior of individual actors and actor groups. Given a certain context, Ostrom and her colleagues hypothesize that individuals “try to solve problems as effectively as they can” (Ostrom 1990:25). This does not necessarily mean that individuals do not seek benefits for themselves, but, rather, that there are variations in their preferences regarding other individuals and that are sensitive to normative signals and values concerning what is appropriate behavior in certain settings (Ostrom 2009). This circulates around their capability to gain a reputation of trustworthiness, often leading to the reciprocation of efforts from and by others, leading to potential high levels of cooperation (Poteete et al. 2010). As seen in Figure 1, the development of reciprocity, reputation and trust between actors is an iterative process that directly influences the levels of cooperation and, thus, the net benefits derived through collective action.

Figure 1: Core Relationships in a Modified Theory of Collective Action



Source: Ostrom 1998

Adopting a modified theory of collective action based on a behavioral theory of the individual significantly changes the resulting analysis. Instead of attempting to understand what policy tool is necessary to impose sustainable use of common pool resources from the exterior, it is rather more telling to develop a context within which collective action becomes possible. Success is no longer solely tied to incentives, but equally to the provision of information, learning, and interaction among stakeholders. Implicitly, an analysis and understanding of the associated transaction costs is necessary following the new institutional tradition (Coase 1960, Hall 1993, North 1990, Ostrom 1990, Williamson 1998). The policy ‘metaphors’, as Ostrom has termed the prescriptions of using the leviathan and privatization to solve all collective action problems, are no longer uniformly applicable as a broader range of contextual variables must be taken into consideration.

To achieve its objectives, any policy that tries to improve levels of collective action to overcome social dilemmas must enhance the level of trust by participants that others are complying with the policy or else many will seek ways of avoiding compliance” (Ostrom 2009:11).

While the risk of free riding must still be dealt with, it is the structure of the larger context within which the collective action problem is managed that must be understood.

2.4. Application to a global open-access common pool resource problem: the importance of co-benefits and transaction costs

Can a case be made for treating what has traditionally been framed as an open-access common-pool resource - i.e. the atmosphere as a global sink of greenhouse-gas emissions - as a common-property common-pool resource upon which the management of Poteete and Ostrom's modified theory of collective action is based? This, implicitly, requires that different actor groups accept responsibility for their portion of emissions generated by global economic activity. While both international and national action is important to establish the larger framework for action, this question hinges on the ability of greenhouse-gas emissions to be seen as a local concern once internationally accepted emission-reduction targets have been established. Even with a modified theory of collective action, it would appear that if costs remain local and benefits are global in nature, little incentive exists to act locally. As such, any external mandate to reduce emissions would require extensive compliance-control measures to reduce and limit free-riding (hard enforcement). Furthermore, individual actors and groups face significant information asymmetries and costs concerning the necessary information to link their actions with emissions. Applying the modified theory of collective action, however, requires a number of assumptions to be challenged: (1) that benefits are only global in nature; (2) transaction costs do not affect cooperation, and (3) the focus on action at the national and international level.

2.4.1. Co-benefits

Increasingly, researchers suggest that the double dividends, or the co-benefits, of climate policies can be used to anchor climate policies in a given location (Ostrom 2009; Bollen et al. 2010; Krupnick et al. 2000; OECD 1999; Corfee-Morlot et al. 2009; Corfee-Morlot et al. 2010). In many cases, synergies exist between explicit GHG-mitigation actions and other policies that have indirect impacts on emission levels. For example, many authors have noted that pursuing greenhouse-gas-emission mitigation policies will potentially have significant impacts on local air pollution (see Bollen et al. 2010 for a review of quantified studies). As such, in a scenario where GHG emissions are cut by 50% relative to 2005 levels in 2050, there is a 20 to 40% reduction in the number of premature deaths relative to a Business – as – Usual (BAU) scenario (Bollen et al. 2010:6). Not only can climate policies have local co-benefits, these co-benefits stand to shift the near-term relevancy and 'temporal' nature of the climate-change policy debate. While benefits from GHG mitigation will be most felt in the future and in areas geographically distant from where reductions occur, most co-benefits are experienced in the short to mid-term (Krupnick et al. 2000; Bollen et al 2010). Inversely, what must not be forgotten is that given the priorities of local authorities, GHG mitigation may be seen as a co-benefit of a more 'pressing' policy objective, such as reduction of congestion, local air pollution, urban sprawl, etc. (Corfee-Morlot et al. 2009; Betsill 2001; Betsill and Bulkeley 2004). This often-positive

(although not exclusive) synergy between mitigation and local policies and objectives may serve as a foundation for local-scale action (Ostrom 2009:11).

2.4.2. Transaction costs

Stemming from the seminal work of Coase (1937, 1960) who emphasized the role of institutional arrangements in economic governance, the New Institutional Economic (NIE) theory approach challenges a number of the assumptions made by neoclassical economics. Transaction costs are traditionally defined as the costs of conducting negotiations, seeking information, developing contracts, and monitoring and enforcing compliance (Dhalman, 1979; Barzel, 1985) both from market and non-market transactions. These costs often emerge from the difficulty of obtaining and processing information and, in many instances, can be used to explain why institutions exist in the first place. Given that institutional configurations can introduce differing levels of transaction costs, institutional arrangements can thus influence the overall efficiency of policies (Coase 1960, Hall 1993, North 1990, Ostrom 1990, Williamson 1998).

2.5. A case for sub-national action

It is equally important to challenge the assumption that the international scale or the national scale is the most appropriate for action due to the scope of the issue in question and the ability to internalize all costs and benefits. Taking transaction costs into consideration appears to strengthen the case for complementary sub-national action. First, a number of authors have indicated that waiting for an international agreement to produce a comprehensive plan of action through a process based on unanimity (and thus implying substantial transaction costs related to negotiation, etc.) is in and of itself unrealistic (Fischer 2004; Ostrom 2009; Corfee-Morlot et al. 2009). While international action is critical, given the often-slow process currently in place and the associated transaction costs of negotiation, decentralized action often appears not only feasible, but also potentially necessary¹¹. Second, even when international and national action has been engaged, this does not necessarily mean that all barriers to GHG mitigation are removed. As Ostrom notes:

Before making a commitment that the global level is the only scale on which to address climate change, one should at least reflect on past efforts to adopt uniform policies by very large entities, efforts intended to correct for problems of collective action. The presumption that locals cannot take care of public sector problems has led to diverse policies to place responsibility for local public services on units of government that are very large, frequently lacking the resources to carry out their assignments, and overwhelmed with what they are assigned to do. (2009:22)

For example, the informational costs related to the centralization of a policy subject such as urban planning are high due to the need for contextualized solutions to

¹¹ For example, international negotiations through the United Nations Framework Convention on Climate Change are consensus-based and have, thus, often been blocked by a small number of nations.

problems. In the case of reducing urban passenger transport emissions, this further complicates the implementations of mitigation policies that rely heavily on behavioral changes at the individual level in terms of daily activity. It is important to note that a wide range of policy subjects that can directly influence greenhouse-gas emissions are held at the local level and are able to directly influence individual behavior (ARUP 2011; Corfee-Morlot et al. 2010; Corfee-Morlot et al. 2009; World Bank 2010; Betsill 2001; Bulkeley and Kern 2006; Sippel and Jenssen 2010). As such, it appears that the institutional configurations and the distribution of competencies across levels of government can influence the governance of GHG mitigation.

As the above section indicates, greenhouse-gas mitigation can be seen as a collective-action problem stemming from the management of an open-access common pool resource. Learning from recent work on common-property common pool resource management, the adoption of a modified theory of collective action based upon a behavioral theory of the individual allows for a reframing of the climate-change policy challenge. Instead of focusing solely on what policy tools are necessary to impose sustainable use of common pool resources from the exterior, it is more important to develop a context within which collective action becomes possible. Success is no longer tied only to incentives, but equally to the provision of information, learning, and interaction between stakeholders. Further, given the nature of the policy challenge where local actions can have a significant impact on the global outcomes, it appears that actions and multiple scales of government are necessary. The objective of the next section is to explore how the literature treats the interactions and governance processes linking actions that appear necessary to enable collective action and individual behavioral change to reduce greenhouse-gas emissions.

3. LESSONS FROM THE LITERATURE ON INSTITUTIONAL CONTEXT AND GOVERNANCE PROCESSES

Given that the modified theory takes into account transaction costs as well as the provision of information, learning, and interaction among stakeholders, it is important to define ‘institutions’ and how they shape the context for action. This paper adopts Ostrom’s definition:

‘Institutions’ can be defined as the sets of working rules that are used to determine who is eligible to make decisions in some arena, what actions are allowed or constrained, what aggregation rules will be used, what procedures must be followed, what information must or must not be provided, and what payoffs will be assigned to individuals dependent on their actions (Ostrom 1990:51).

This definition of institutions permits the breaking down of what are often treated as “monolithic” structures into their component parts, allowing for an understanding of how different actors within an institution use information, learn, build trust and act collectively. How institutions are structured influences a number

of different elements typically lumped together as ‘transaction costs.’ Further, as recognized above, it is important to understand that governance processes occur across multiple levels of government and, thus, involve a number of both nested and/or overlapping institutional configurations.

As such, what institutional context can facilitate collective action as defined by the modified theory of collective action described above? While not specifically focusing on climate change, this section reviews first the multi-level governance literature to better understand the relationships and interplay between and within levels of government. The second half of the section will explore how different institutional configurations and decision-making processes that support or undermine the provision of information, learning, and interaction among stakeholders to develop trust and reciprocity, all key to collective action.

3.1. Multi-level and polycentric governance: Conceptualizing relations between institutions

The multi-level governance literature provides a ‘flexible’ framework to conceptualize the relationship between local authorities, national governments, and the increasing number of non-governmental actors. This framework allows for a better understanding of the contextualization and translation of international and national policies into local-level action (Marks, 1993; Betsill and Bulkeley 2004; Corfee-Morlot, 2009; Corfee-Morlot *et. al.*, 2009; Hooghe and Marks 2003). It can be used to analyze processes operating vertically across multiples scales of government (e.g. local to national) and horizontally across governmental departments as well as non-governmental actors (Bulkeley and Betsill 2005). To take action, local authorities cannot typically operate effectively in isolation from other parts of government. Local governmental authority is often hierarchically “nested” in legal and institutional frameworks at a higher scale (Dietz 2003; Hooghe and Marks 2003; Corfee-Morlot, 2009; Corfee-Morlot *et. al.*, 2009; Corfee-Morlot *et. al.*, 2010; Betsill and Bulkeley 2004). For example, while regional and local policies determine the specific details of land use, human settlement patterns and transportation planning, space for action is usually limited by national development paths, technical standards and funding priorities (Sathaye et al. 2007; Corfee-Morlot, 2009; Corfee-Morlot *et. al.*, 2009; Corfee-Morlot *et. al.*, 2010; Betsill and Bulkeley 2004).

3.1.1. Multi-level governance: Horizontal and Vertical Exchanges

Influence and relationships within the multi-level governance framework function across two principal axes: vertically between levels of authority and horizontally within individual levels. The nesting of local-level action within higher-level institutional and regulatory frameworks is just one example of the inter-linkages that exist between the levels of governance. Actors operating at different levels can be dependent upon one another in at least three ways (Pelling 2006):

- Higher-level organizations shape the operating environment for lower-order actors;
- More-localized institutions can influence (block or support) policy received from higher levels; and
- Action at one level can strengthen or weaken action at other levels – by changing the configuration of hazards, vulnerabilities and institutional capacities.

Equally, in terms of horizontal relationships within levels of authority, the multi-level governance framework treats the subject of “issue-based” governance and the creation of issue-specific administrative and jurisdictional arrangements.

Vertical Relationships

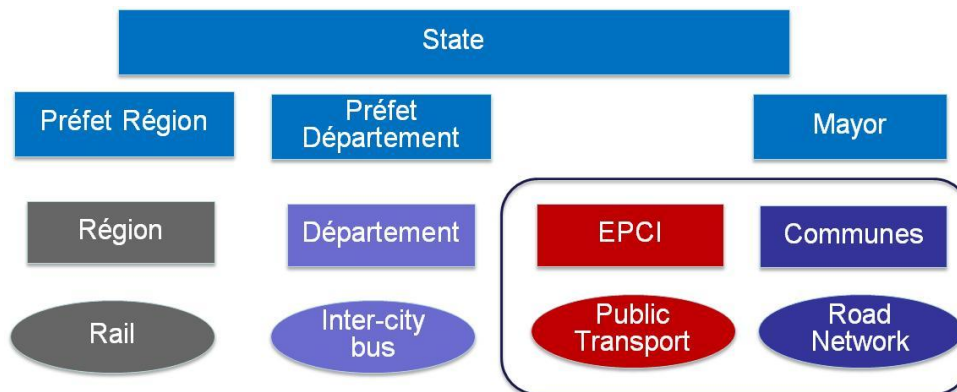
Within the multi-level regulatory environment, a number of top-down and bottom-up processes establish the relationships between the different government levels (see Box 1 for the example of transport planning in France). In most instances, national governments establish the distribution of competencies across sub-national levels (Betsill and Bulkeley 2004; Hooghe and Marks 2003). In the case of climate change, through the UNFCCC, countries have been active at the international level to establish global greenhouse-gas emission targets through a top-down approach, developing an overarching policy framework for the global challenge. Participating national governments, have, in turn, established domestic ‘Policies and Measures’ (PAMs) targeting, in many cases, the private sector or applicable local-level actors (i.e. the European Union’s Emission Trading System; Sweden’s KLIMP program). This has led to the sub-national contextualization and implementation of international objectives through the development of regulations, such as energy efficiency standards, establishment of R and D programs, etc. (Betsill and Bulkeley 2006; Bulkeley and Moser 2007). Within these policy hierarchies, local governments, in turn, apply and adapt the regulation to their own activities, as well as, when applicable, to households and the private sector. While local policy is inscribed by the distribution of jurisdictional competencies as well as national mandates and regulations, in many instances the individual actions and implementation are adapted to local contexts (Pelling 2006; Urwin and Jordan 2007; Jan Corfee-Morlot et al. 2010).

Additionally, a bottom-up process plays an important role in the governance of climate change. Through a process of experimentation, learning and representation, local-level experiences and interests are able to influence national policies equally, within limits. As particularly seen in the area of adaptation to climate change, local experience has been able to re-frame and retool national, and even international, approaches (Corfee-Morlot et al. 2009; Folke et al. 2005; Moser 2006; Vogel et al. 2007). Local governments are not just policy and regulation makers, but are becoming increasingly active in the development of climate-change actions and approaches (Betsill, 2007).

Box 1 : MLG of Transport in France

The French institutional context for governance has traditionally been highly centralized and dominated by the central State. However, since the 1980s, the process of decentralization of competencies and the “deconcentration” of State authority in France has led to a rather complex institutional context involving principally three types of ‘*collectivités territoriales*’ or sub-national units of government (*communes, départements, régions*). While decentralization has increased the responsibilities and competencies of local authorities, there is no direct federalism in the structure as found in other State-Region relationships in other European countries. As such, *there is no direct hierarchy between the different forms of sub-national authorities (régions, départements, communes)*; rather each has its own assigned areas of jurisdiction with representatives of the Central government (regional and departmental *préfet*) to ensure the legality of actions.

Figure 2 : Institutional Hierarchy in France (representatives of the State in blue)



The decentralization process in France has distributed the competencies for transport and urbanism across and between the different levels of governance. Starting in 1982, local authorities have been designated as the *Autorités Organisatrices de Transports (AOT)*¹² for rail, rural and urban-transport services (see Table 1).¹³ Further legislation responded to a growing concern about energy use and local air pollution in the 1990s. As such, a stated goal of local transport policy has been the priority of developing and favoring the use of transport alternatives to the use of personal vehicles as well as reducing energy consumption. This has been further reinforced by later legislation in the 2000s including the *Grenelle de*

¹² Entities charged with the organization and management of transportation services within a defined perimeter.

¹³ It is important to note that individual *communes* and inter-communal structures can choose to manage transport planning and operations themselves (the case of Nantes-Métropole), or can delegate the competencies of the AOT to a *Syndicat Mixte* (as in the case of Grenoble Alpes Métropole and the *Syndicat Mixte de Transports en Commun (SMTC)*).

l'environnement in 2010, which has established a target of reducing GHG emissions from all sectors by 20% of 1990 levels by 2020.

Table 1 : Distribution of Transport Competencies in France

	State	Région	Département	Commune & EPCI
AOT	- Inter-regional rail, high-speed rail (TGV)	- Regional road and rail (TER)	- Non-urban road (buses, etc.)	- Urban (AOTU)
Infrastructure	- National roads and railways		- Departmental roads - Portion of national roads	- Communal roads - Urban public transport
Planning Documents	- <i>Schéma national des infrastructures de transports</i>	- <i>Schéma régional des infrastructures et des transports (SRADT)</i>	- <i>Schéma départemental de transports (SDDT)</i>	- <i>Plan de déplacements urbains (PDU)</i>

Horizontal Relationships

Horizontal relationships within the multi-level governance framework include the connections between adjacent local governments, the coordination across function and services within a single government, as well as through formalized networks of authorities. Linkages exist between different local authorities when their jurisdictions overlap or in the governance of a single issue. First, “issue-based” governance, which involves the establishment of task-specific jurisdictions to deal with a single policy area (Hooghe and Marks 2003:10; Foster 1999) demands that appropriate administrative boundaries allow for effective management. These linkages often involve the development of different institutional arrangements, such as separate commissions, boards, metropolitan districts, and informal cooperative mechanisms (OECD, 2010; Walker, 1987; Corfee-Morlot *et al*, 2009) to ensure cooperation between the local authorities on the issue. Second, multi-level governance recognizes that horizontal linkages exist between the different departments and functions within local authorities that must often cooperate to achieve policy objectives. Overcoming the institutional fragmentation where issue-specific services may not communicate or cooperate fully (such as in the context of urban-transport emissions dependent on both transport and urban-planning activities) can characterize the institutional context. Third, learning-information transmission and cooperation also occurs horizontally with linkages increasingly seen between local authorities and regions (Bulkeley and Moser 2007). Taking climate change as an example, horizontal relationships have been created at the local level through the creation of formalized information networks and coalitions (ICLEI, C-40 Cities, etc.) acting both nationally and internationally.

A key part of the horizontal dimension is an open, participatory decision process, a shift from “government” to “governance” as a center for decision making and includes giving greater influence in the policy-dialogue process to business, research and environmental non-governmental organizations (Corfee-Morlot et al 2010; Sathaye et al. 2007:693). This change often facilitates the development of energy and climate policy at any scale as it often requires cooperation across conventional disciplinary and organizational boundaries to bring together sector decision makers, for example in transport, housing or water resources planning, with energy and climate-change experts to consider the implications for sectoral policies and developments. Enabling action at the local level can enhance these participatory processes as decision makers are often in closer contact with local stakeholders and have a better grasp on contextual issues (Corfee-Morlot et al. 2010; Healy 2007; Ostrom 2009). However, in many instances actor preferences may be more homogeneous within a smaller section of the population and, thus, facilitate the development of trust and learning (Ostrom 2009; Corfee-Morlot et al. 2010).

3.1.2. Barriers stemming from a multilevel governance context

Governance of policy issues across multiple levels of government, as well as the encompassing of a broad range of actors, can lead to a number of barriers limiting action. While focusing principally on the vertical relationships between levels of government, recent work by Charbit and Michalun (2009) and Charbit (2011) has identified seven ‘gaps’ or limitations which can result from the macro, multi-level context, including: *Administrative gap* – geographical mismatch between policy issue and administrative boundaries; *Information gap* – asymmetries of information between policy making and/or implementation authorities and between public and non-governmental actors; *Policy gap* – sectoral fragmentation of issue-related tasks across ministries and agencies (also at a local scale between different entities); *Capacity gap* – Insufficient scientific, technical, and implementation capacity on the part of local-issue management actors (size and quality of the infrastructure and resource they must manage); *Funding gap* – Unstable or insufficient revenues undermine effective implementation of issue responsibilities at the sub-national level; *Objective gap* – Different rationalities creating obstacles for adopting convergent targets; and *Accountability gap* – Difficulty to ensure the transparency of practices across the different constituencies. These gaps are useful in establishing the bases for a framework for analysis to assist in the identification of different actions (the modifications of institutional arrangements, the use of different policies such as contractual tools) to reduce difficulties that stem from issues of coordination and capacity challenges (Charbit and Michalun 2009).

Table 2: Key obstacles to local greenhouse-gas mitigation action

Jurisdictional and institutional	<ul style="list-style-type: none"> - lack of mandate to address climate issues - national or regional laws, rules or regulations that lead to increased GHG emissions over time - ill-adapted institutional designs to convene or coordinate across relevant issues (vertically and/or horizontally)
Economic and budgetary	<ul style="list-style-type: none"> - Distribution of perceived and real costs and benefits - Lack of resources or funding to address the problems identified - Reliance on internal and existing funding mechanisms to augment cost of action
Political	<ul style="list-style-type: none"> - Local authorities “too close” to different interests - Pressures of short-term electoral cycles on effective risk management and long time lag to reap full adaptation benefits - Lack of willingness to accept costs and behavioral change - Pressure to maintain BAU development pathways
Technical or scientific	<ul style="list-style-type: none"> - Scientific uncertainty - Inadequate understanding or ignorance of climate-change risks - Lack of technical capacity or access to expertise - Lack of scale-relevant scientific or technical information

Source: After Corfee-Morlot et al. 2010

Box 2 Basic assumptions of polycentric approach

As developed by Ostrom (2009:33-34), a number of principals underlie and structure the polycentric governance approach:

1. Public goods and services differ substantially in regard to their production functions and their scale of effects.
2. Policy preferences tend to be more homogeneous within smaller units than across an entire metropolitan area.
- 3 Citizens who live in areas served by multiple jurisdictions learn more about the performance of any one jurisdiction by seeing or hearing about how problems are handled in other jurisdictions.
4. The presence of large numbers of potential producers of urban goods and services in a metropolitan area allows elected officials a more effective choice of producers.
5. Multiple jurisdictions with different scopes and scales of organization allow citizens and officials more choice in selecting modes of providing and producing public goods to try to utilize the best available technology, to achieve economies and avoid diseconomies of scale, and improve performance over time.
6. Producers who must compete for contracts are more likely to search for innovative technologies, to encourage effective team production, as well as citizen coproduction, so as to enhance their own performance.

Additionally, it is necessary to address the specificities that surround the climate-policy challenge. In the specific case of climate change, the literature confirms that barriers are exacerbated from a system spanning multiple levels as well as integrating a heterogeneous mix of actors and stakeholders. While focusing on the climate-change adaptation challenge, the obstacles to local governance of

climate change identified by Corfee-Morlot et al. (2010) equally appear to apply to the greenhouse-gas mitigation challenge. As seen in Table 2, barriers stemming from jurisdictional, political, budgetary and technical issues can limit the capacity of local actors to implement policies. For example, the jurisdictional competencies and boundaries of local actors are traditionally determined by larger national-scale processes. Often, the distribution of competencies and or the alignment of administrative boundaries with that of the policy issues at hand can limit the capacity to act. This can be seen in France, as in many other countries, where the boundaries of urban planning districts may not encompass the entire commuting area.

The next section will explore the literature on analyzing institutional structure and identifying the principles from the “environmental governance” of common pool resources potentially applicable to greenhouse-gas mitigation.

3.1.3. Towards a Polycentric Governance of Climate Change

Recognizing that the governance of climate change, and more specifically greenhouse-gas mitigation, occurs across multiple levels of governance, administrative jurisdictions and groups of actors prescribing a single institutional configuration is difficult, if not impossible. Nevertheless, decades of research on similar collective-action problems suggest that a “polycentric” order may be of use (Ostrom 2009). Allowing for the linking of diverse systems functioning at both different levels and scales, a polycentric order has been defined as “...*one where many elements are capable of making mutual adjustments for ordering their relationships with one another within a general system of rules where each element acts with independence of other elements*” (V. Ostrom 1999:57). While applied to a larger range of provision of public good (principally education and public safety), the polycentric approach stresses that instead of a single best design, governance should be based on a set of core principles to structure local institutions (Ostrom 2009). This approach is well structured for dealing with climate change in the cases where mitigation action is required across multiple levels and sectors, with regrouping activities functioning at different scales. As Ostrom notes, the polycentric approach “...encourages experimental efforts at multiple levels, as well as the development of methods for assessing the benefits and costs of particular strategies adopted in one type of ecosystem and comparing these with results obtained in other ecosystems” (2009:39).

3.2. Analyzing Institutional Structure and Principles for Decision Making

While multi-level governance literature elucidates the play between and within different institutional levels, it has not examined how different institutions support or undermine the provision of information, learning, and interaction between stakeholders to develop trust and reciprocity (Ostrom 1998), two key elements to support collective action. As such, it is important to look at the horizontal interaction between ‘micro-scale’ settings within which cooperation can occur, as

well as their vertical relationship with other government levels. Through their work on collective action problems, empirical researchers have begun to identify the characteristics of a setting where collective action is possible:

1. Many of those affected have *agreed on the need for changes* in behavior and see themselves as *jointly sharing responsibility* for future outcomes.
2. The reliability and frequency of *information* about the phenomena of concern are relatively high.
3. Participants know who else has *agreed to change behavior* and that their compliance is being *monitored*
4. *Communication* occurs among at least subsets of participants. (Ostrom 2009:13)

In a setting where collective action becomes possible, individual actors must have a common framing of the collective-action problem and, thus, an agreement on how to treat the problem in a shared way. This is facilitated through sufficient information on the issue at hand and the means of monitoring those who have equally agreed to change their behavior. As such, continued communication between the different actors is an essential component of collective action.

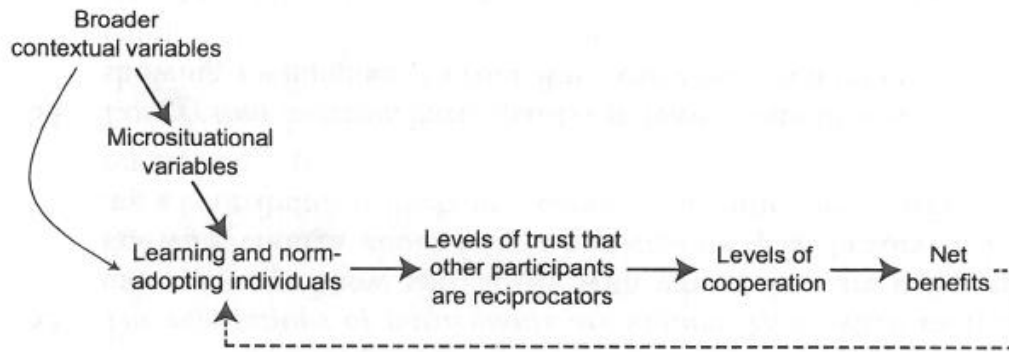
3.2.1. Micro-situational variables

Through their empirical research, Poteete et al. (2010) and Ostrom (2009) have identified what they term as the ‘microsituational variables’ that influence the context and allow for the type of setting described above to achieve collective action. Among the most important are:

- (1) reliable information is available about the immediate and long-term costs and benefits of actions;
- (2) the individuals involved see the common resource as important for their own achievements and have a long-term time horizon;
- (3) gaining a reputation for being a trustworthy reciprocator is important to those involved;
- (4) individuals can communicate with at least some of the others involved;
- (5) informal monitoring and sanctioning is feasible and considered appropriate; and
- (6) social capital and leadership exist, related to previous successes in solving joint problems.

Further, when individuals and groups face inevitable rules and sanctions imposed by external authorities, these are viewed as legitimate and enforcement is seen as equitable (Ostrom 2009:14). What is striking is that information has a key role not only formulating individual actions, but also in communicating and situating one’s actions in relation to other actors. Within this context, the group is able to sanction, both formally and informally, those individuals who have committed to act but are not doing so. As such, active participation within the group takes on a normative quality and influences how individuals are expected to act within the given situation.

Figure 3: Effects of Broader Contextual Variables and Micro-situational Variables on Collective Action



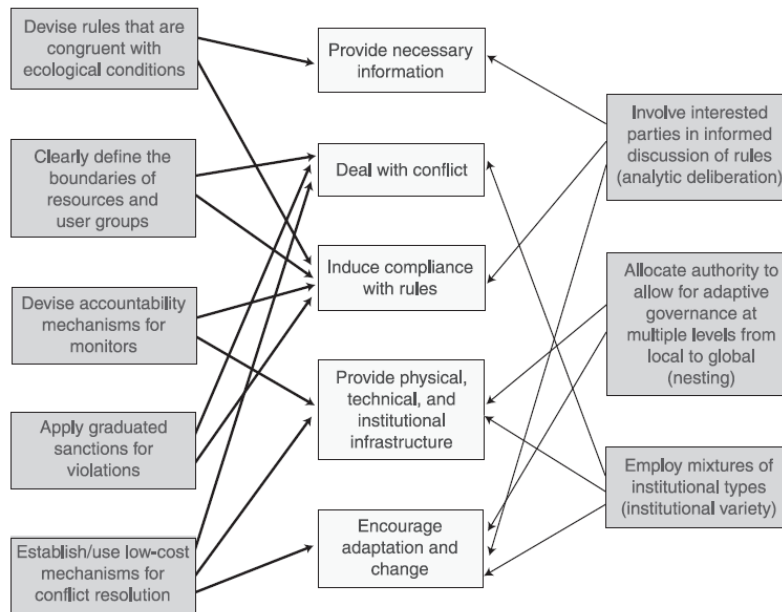
Source: Poteete et al. 2010

As outlined in Figure 3, the broader contextual variables stemming from the position of the different institutions within a larger multi-level governance context combine with the micro-situational context to influence the learning and norm-adoption of individuals. This influences the level of trust of other actors who have engaged within the collective-action problem and, in function of the levels of demonstrated effort and information available, pushes them to reciprocate efforts and cooperation in producing net benefits for the entire group. In turn, this increase in net benefits reinforces the learning and norm-adoption of individuals, thus creating a reinforcing cycle for further collective action (Ostrom 2000; Poteete et al. 2010). As noted by Poteete et al., “the core problem that needs to be solved in order to increase cooperation is creating trust among participants that others are reciprocators, and that cooperating will not make an individual a sucker” (2010:229).

3.2.2. Towards a Governance Framework

While recognizing the importance of institutional configurations to foster collective action, Dietz et al. have cited increasing pressures of globalization of commerce and production as well as the decreasing levels of face-to-face contact (particularly in large urban areas), “[f]ew settings in the world are characterized by all of these conditions... The challenge is to devise institutional arrangements that help to establish such conditions or... meet the main challenges of governance in the absence of ideal conditions” (Dietz et al. 2008:612). This does not mean, however, that it is not possible to develop governance institutions that treat the important questions of mutual trust, reciprocity and reputation. Instead, they suggest that a number of ‘general principles for robust governance of environmental resources’ corresponding to a certain number of governance requirements can be identified (as seen in Figure 4).

Figure 4: General Principles for robust governance (right and left) and governance requirements (center)



Source: Dietz et al. 2008

First, providing information on environmental resources is a key to the governance of the different stocks, flows and processes. It is important to identify the impacts of human actions on the environment as well as link them with different types of policies that can be taken to reduce negative impacts. Dietz et al. stress that “Information also must be congruent with the decision makers’ needs in terms of timing, content and form of presentation” (2008:614) as well as meet high scientific standards to ensure credibility. This information can serve as a valuable indicator or signal with which to plan and evaluate action. Second, different mechanisms must be developed to deal with conflict stemming from different perspectives, interests and fundamental disagreements concerning the use of resources (2008:615). Third, conflict-resolution mechanisms should be paired with a means of inducing rule compliance through different forms of graduated sanctions to incentivize both compliance as well as learning (2008:616). Fourth, investments in the necessary ‘infrastructure’, both in physical (roads, rails, etc.) and institutional terms¹⁴ are important to create the context within which the issue can be managed (and monitored). Finally, Dietz et al. emphasize the necessity of designing institutions in a manner that allows for change or ‘adaptation’ to changing states of knowledge, conditions, etc. (2008:616).¹⁵

¹⁴ Institutional infrastructure in this context refers to research, social capital, and multi-level rules, to coordinate between local and larger levels of governance (Dietz et al. 2008)

¹⁵ While Dietz et al. present a model for robust government, it is important to note that the debate, as Foster (1999) remarks, is not as much about the *optimization* of a system towards a given institutional design as finding the necessary institutional arrangements to facilitate the governance of an issue given the local context.

Drawing on both the multi-level governance literature and the work of Elinor Ostrom and her colleagues, this framework for the governance of environmental resources lays out the general principles to structure the analysis of how local authorities govern greenhouse-gas emissions mitigation. Within the above framework, information plays a key role both to inform and to facilitate communication, as well as to identify and develop the necessary actions and investments and to track changes in conditions. In the case of climate change, greenhouse-gas inventories, marginal abatement-cost curves, emission projections and other informational tools are necessary components to track *a priori* intangible emissions, their sources as well as the performance of mitigation actions. However, a number of issues are raised concerning how information is developed and integrated into the decision-making process by both public and private actors. As such, the following section will explore the literature on the sciences-policy interface and the production of knowledge to inform the decision-making process.

4. INFORMATION AND THE DECISION-MAKING PROCESS

In the above sections, information has been frequently identified as a key element in the management of collective resources. The modified theory of collective action emphasizes the role of information in supporting decision making, learning and building trust. Removing the assumption of perfect information introduces a layer of complexity to reflections on common pool resource problems and collective action. Instead of actors being fully aware of the costs and benefits of their actions, they are rather constrained in terms of how problems and possible solutions are perceived and constructed. Information, whether formalized in the policy processes as an indicator or leveraged through targeted studies, cannot be taken as an *apolitical* technical tool (Dietz et al. 2008; Cash et al. 2003; Cash et al. 2006; Lascoumes et Le Galès 2004; Zittoun 2009). Rather, it is more important to understand what is *not* included than what is contained within a measure. As such, it is key to understand the choices surrounding the development of an information ‘instrument’ or tool, its functioning as well as how it is used within decision making. As such, a number of questions are raised about the creation and use of information. While policy change can occur for a wide range of reasons, whether based on the interests of politicians and bureaucrats to preserve their position or due to changes in problem definition or the pressures of interest groups (Kingdon 2002), information plays a key role in establishing a common language and framework to discuss a policy issue.

Drawing from the literature on the role of information in governance processes, the following section will focus on how information is produced and used for both public and private actors. The focus is particularly on how information is used in the decision-making process, thus purposefully setting to one side the issues of communication and engagement with the larger public, although this will become an increasingly important issue that merits further attention.

4.1. Information in governance and the decision-making process: informing and guiding debate

In his seminal work decrypting governance processes and how changes in policies occur, Kingdon lays out the key roles of two inter-related processes: problem definition and identification of feasible actions (Kingdon 2002). This interpretation of March and Olsen's 'garbage can model,' considers that policymaking and organizational choice is often used to understand the intersection of actors, a policy problem and different ideas and information at a given moment (March and Olsen 1984). Both Kingdon and Hall identify ideas and information as key means of understanding how issues are framed and how different actions and policies enter into the range of possibilities (Kingdon 2002; Hall 1993). Hall notes that "Policy making in virtually all fields takes place within the context of a particular set of ideas that recognize some social interests as more legitimate than others and privilege some lines of policy over others" (1993:292). As such, it is important to understand how ideas concerning a different policy subject evolve and gain influence. This can often occur through the type(s) of information available used to frame a particular policy problem. Within a *social learning perspective*¹⁶, consistent with the modified theory of collective action laid out above, actors are able to learn from both information and each other, leading to an evolution of the ideas that structure and frame a given issue (Hall 1993:289). As such, it is important to analyze how information enters into decision-making processes, as well influencing both the evolution of larger social norms and influencing policy decisions and outcomes.

The availability of information is a key factor in how issues are taken up and framed. While simplistic, there is a ring of truth to "what gets measured gets managed."¹⁷ To be taken up, a subject or issue must be given attention and prioritized in comparison to other pressing concerns. While the availability of information on an issue is often not enough to ensure attention (focusing on events such as a crisis and feedback concerning policy failures can have an equally important impact), it can play an important role in getting it on the agenda (Kingdon 2002). For action to occur and an issue to move upwards on the policy agenda, it is important to be perceived as a 'problem' rather than a simple 'condition.' When seen as a problem, the necessity of taking action becomes implicit. This is often linked to how the issue is framed and defined, as well as influencing what data is collected and how it is processed and interpreted. As Kingdon notes: "There are great political stakes in problem definition. Some are helped and others are hurt, depending on how problems get defined" (2002:110). Within this process, values, comparisons to other issues, and existing categories often influence problem definitions (is government intervention necessary, what are others doing about the issue, etc.) How issues are framed will influence who is

¹⁶ Social learning is defined as experience-based learning within a given local context for policy (Hall 1993).

¹⁷ Attributed to Peter Drucker.

involved in addressing a problem, what solutions are proposed to solve them, how different actors engage on the issue and what scarce resources are made available (Kingdon 2002). While some values and frames may change, this can be a slow process: Kingdon stresses that “Old categories and old means of classifying subjects into those categories tend to persist” (2002:112). As such, new informational tools or indicators may be key to what and how issues are framed, interpreted and placed on the decision-making agenda.

In terms of greenhouse-gas mitigation, how information is framed can equally influence not only the scope of action and effort, but also the individual solutions deemed acceptable. For example, when GHG mitigation is framed as an energy problem, solutions may focus principally on energy efficiency (technology changes) and fuel switching. However, when framed as an air-pollution problem or part of the larger issue of sustainable development, not only does the scope of solutions (behavioral change, etc.) expand, but also equally a number of individual solutions becomes less acceptable. For example, when the impacts of the fuel-switching focused solutions of diesel vehicles or nuclear-power generation are examined with a larger set of criteria than just GHG emissions, they are rapidly less acceptable to a number of actors. Further, normative ideas concerning how responsibility is attributed, whether it is the consumers or producers of energy, services and products that are responsible for the resulting emissions, can affect how measurements are conducted.

4.2. Information in the Decision-Making Process: Constructed Indicators reflecting preferences, priorities and constraints

One form of information that has been widely treated in the literature is the use of quantified indicators in both public and private decision-making processes. Many authors have noted that indicators are powerful instruments in focusing attention on issues (Kingdon 2002; Zittoun 2009; Lascoumes and Le Galès 2004; Riveline 1991, 2005). An indicator is capable of presenting a complex subject in a ‘digestible’ form that allows decision makers to grasp a problem better. Each indicator functions in reference to a certain ‘norm’ of what is an acceptable value or level and, thus, allows changes or an existing condition to be compared to a ‘latent’ or business-as-usual state. As Zittoun notes “*Dans certaines situations, l’indicateur non seulement identifie un problème, mais le relie à une cause, à une victime, à un coupable, à un acteur légitime ou encore à un territoire*” (2009:235)¹⁸. Indicators serve to translate information on a problem into a value or concept not only to indicate that a problem exists, but also to ‘problematize’ it, thus framing it in terms of a set of actors or a set of solutions. As such, the victims of the policy problem can be more clearly identified, as well as the assigning of responsibility for the problem, and often who should bear the costs of action. Often, by anchoring a problem through the identification of both victims and

¹⁸ “In some situations, the indicator not only identifies a problem, but connects it to a cause, a victim, a responsible party, a legitimate actor or a territory.”

responsible parties, the issue can be pushed upwards on the policy agenda and appropriate courses of action identified (Zittoun 2009:236). Further, and perhaps most importantly, indicators allow for the creation of a common language to discuss what may often be an abstract policy problem and thus “*Il offre une capacité d'abstraction et de circulation qui fait que dans n'importe quelle salle de réunion (donc loin spatialement et temporellement du phénomène lui-même), il est possible de discuter du problème, de son ampleur, de sa nature ou des solutions à apporter*” (Zittoun 2009:240).¹⁹ The creation of a common language, particularly in the context of a complex, transversal policy problem such as climate change, is important to facilitate coordination.

There are, however, a number of limitations placed on indicators, both technical and political in nature. First, Kingdon notes that problems, subjects and aspects that are easily ‘countable’ often receive greater attention than those that are not easily quantified. As such, different indicators - such as ridership in the case of public transport - receive priority while perhaps equally consequential issues, such as quality of service (which is more qualitative and, thus, more difficult to summarize, are not as well incorporated). Thus, the framing and definition of specific issues can be heavily dependent on the quantifiable with the qualitative placed to the side (Kingdon 2002). Second, as for both the private and public sectors, typically only a limited number of indicators are actually used to dissect a problem and influence decision making, with research suggesting no more than three or four (Riveline 1991, 2005). As such, particularly in environmental problems where actions are weighed using environmental, economic and social considerations, there are clear limits to multi-variable analysis and the cognitive capacity of individual actors to use such a wide range of information effectively.

Further, it is important to recognize that an indicator is a process of translating data into a usable fashion, which means that it is not an *apolitical* technical tool. Rather, indicators are based on assumptions that are able to influence the framing and presentation of a policy problem. This is in line with the work of Lascoumes and Le Galès, who have analyzed how different governing instruments, such as indicators, can structure action around a policy problem (2004). When indicators are seen as specifically designed governance instruments, it becomes clear that they are much more than only a technical solution. As such, indicators, just as other instruments, can be structured to offset external forces and challenges; produce a particular representation of the relationships between stakeholders; as well as the ability to introduce a hierarchy into the variables surrounding the policy subject and, thus, giving meaning to a particular definition (Lascoumes and Le Galès 2004:31).

¹⁹“ It has the capacity of abstraction and circulation of information which means that in any meeting room (distant in both space and time from the phenomenon itself), it is possible to discuss the problem, its extent, nature or identify possible solutions.”

Box 3: Information tools, indicators and GHG mitigation in France

Informational tools have multiple roles to play, particularly in the case of governing GHG emissions. Different studies, indicators, inventories and other “tools” aid in a number of decisions-making processes including:

- *Diagnostic and baseline*—profile of GHG emission sources within the area of study to identify principal sources and understand evolution over time without intervention;
- *Analysis of actions*—analysis of the direct and indirect impacts of emission–reduction policies, often linked to analyzing their cost efficiency in terms of cost per ton CO₂e;
- *Scenario analysis*—analysis and comparison of the mitigation (both direct and indirect) of potential policy “packages”;
- *Tracking progress*—deployment of periodic or punctual indicators to track progress towards emission reduction goals;
- *Ex-post evaluation*—analysis of actions taken and identification of their effectiveness.

Thus, information tools are expected to perform a range of functions within the decision-making process.

A second set of tools are increasingly used to integrate or “mainstream” concerns for greenhouse gas emissions into individual decision-making processes. In France, in the case of the *Plan de déplacements urbains*, the principal planning document for urban passenger transport, a number of informational tools have been deployed. Steps have been taken in mainstreaming GHG mitigation into decision making through a range of information tools calibrated for different parts of the process. These tools have been used to introduce GHG evaluation criteria and analysis into the diagnostic stages of the process as well as in the construction of emission previsions related to specific scenarios and the evaluation of individual actions.

Methodological approaches chosen and the hypothesis made when developing GHG information tools can structure the results given. These choices concern a number of basic elements of the methodological approach taken. This includes *what* is being measured, *how* emissions are quantified and the normative question of how *responsibility* for the greenhouse gas emissions are attributed to different actors and groups. These choices can significantly influence results of a given quantification of emissions, as well as inhibit comparability among tools.

Many of the methodological choices touch upon larger, normative questions concerning how responsibility for GHG emissions is assigned.²⁰ Clearly assigning responsibility for GHG emissions is key in resolving a number of methodological issues, such as double counting. However, it is rooted in a number of complex normative issues, as it requires a judgment as to whether consumers or producers are primarily responsible for the emissions stemming from the goods and services. Often, a pragmatic “middle ground” can be found when the capacity of actors to mitigate is taken into consideration. As such, a number of normative, often politically and exogenously determined, variables have a central role in the structuring of inventories.

This has been further reinforced by the work of Philippe Zittoun (2009). The conclusion of his analysis of a number of case studies looking at the institutional and political context around the elaboration of local-scale indicators in Europe focuses primarily on the fact that “*Les indicateurs forment un instrument particulier qui n'a rien de neutre. Sa fabrication ou sa sélection parmi de nombreux possibles par les acteurs, enferment une série de caractéristiques sociales et politiques...*”²¹ (2009:239). As such, their construction can be used to legitimize certain instruments, policies and approaches. Equally, as indicators are often used to trace future scenarios and trends, they offer different actors the possibility to manipulate different parameters, thus creating different visions of the future that can be used to support certain agendas (Zittoun 2009:238). This indicates that indicators can be and are used as a political tool to construct different strategic positions supporting specific actions. This can lead to conflict between different groups of actors, either within or across scales of governance, as different choices in, and in terms of the construction of, indicators can potentially support very different policy options and outcomes (Zittoun 2009; Lascoumes and Le Gales 2004).

Given that indicators are not “...straightforward recognition of the facts...,” it is important to understand how decisions are made concerning their construction and the actors there involved (Kingdon 2002:94). The next section will pull from the literature how this process can occur and attempt to identify what institutional configurations can limit their politicization and improve their relevancy.

²⁰ The principal approaches for attributing responsibility can be divided into either production-based or consumption-based. A *production-based* approach allocates the accounting (responsibility) of emissions to the place where they are produced. As such, only emissions generated in a given territory are attributed to the city in its inventory. Conversely, a *consumption-based* approach of accounting and responsibility allocates emissions to their point of consumption. The scope of this accounting method is variable in application, ranging from a limited portion of upstream emissions to a full life-cycle analysis.

²¹ “Indicators are instruments that are not neutral. Their creation or selection from among the many possible by the actors embodies a series of social and political characteristics.”

4.3. Information for ‘Learning’ and Decision Support: Importance of the Credibility, Legitimacy and Saliency of Information

A body of research attempts to characterize the use of information in the decision-support process, whether discussing the decision making of individuals or those made by elected officials. Complementary to Hall and Kingdon’s writing on the importance of information in problem definition and agenda setting (Dietz 2003; Cash et al. 2003; Tribbia and Moser 2008; Corfee-Morlot et al. 2010), a number of authors have focused on the importance of knowledge, information and learning within the decision-making process. These studies treat information and knowledge as a constructed part of the policy process and, thus, attempt to characterize how it is perceived by those involved. Cash et al. (2003; 2006) have attempted to identify the criteria by which information used in the decision-making process will be judged. They posit that the saliency, the credibility and the legitimacy of the information:

...is likely to be effective in influencing the evolution of social responses to public issues to the extent that the information is perceived by relevant stakeholders to be not only credible, but also salient and legitimate. In the sense used here, *credibility* involves the scientific adequacy of the technical evidence and arguments. *Saliency* deals with the relevance of the assessment to the needs of decision makers. *Legitimacy* reflects the perception that the production of information and technology has been respectful of stakeholders’ divergent values and beliefs, unbiased in its conduct, and fair in its treatment of opposing views and interests. (2003:8086).

This suggests that the value of the information is not only in its technical exactness, but is equally influenced by how the information is produced as well as how it is integrated into the larger decision-making process. This section looks at the difficulties identified in the production of knowledge and information as well as the role of ‘boundary organizations’ that are able to negotiate the demands between the scientific and the political in the production of information for decision making.

Often, the idea that with ‘more’ and ‘better’ information actors will be able to produce ‘better’ and more ‘informed’ decisions dominates debates on the role of information in decision-making processes. However as Tribbia and Moser have identified, more and better information will not necessarily lead to ‘better’ decisions:

Many environmental policy initiatives fall short of expectations because experts simply believe that ‘better science will lead to better decisions’ without fully understanding the decision situation and institutional context within which scientific information could be used... or what a decision-maker could really use (Tribbia and Moser 2008:317).

Further, often the definitions of what ‘better’ information entails can vary. Experts and scientific researches may associate that ‘better’ knowledge is about ‘getting it right’, which can significantly reduce the saliency of information due to time constraints and the need for ‘timely’ expertise. (NRC 2009; Tribbia and Moser 2008). However, for decision makers, ‘better’ information may be associated with reducing the margin of uncertainty within the constraints of time and cost. Given that much of the information and expertise used in the decision-making process

around environmental subjects tends to include a large margin of uncertainty concerning the scope of impacts, cost, time horizons, etc., conflicts can arise as those providing the information are torn between producing something that is salient, credible and legitimate. This larger “opening-up” (Corfee-Morlot 2009) of the policy process can, however, conflict with an information user’s search for a simplified response to a specific, pressing problem.

To overcome these issues, a number of researchers have framed the production of information and expertise as a ‘system’ rather than a one-way transmission of information from scientists to decision makers who are expected to use it to make better decisions (Cash et al. 2003; Tribbia and Moser 2008; Corfee-Morlot et al. 2011). Within such a system, exchanges between the expert or scientific community and decision makers foster the ‘co-production’ of knowledge which is viewed as salient, credible and legitimate for all parties involved (Tribbia and Moser 2008). Cash et al. attribute three important tasks critical to the effectiveness of information systems: communication, translation and mediation (2003:8086). First, an information system for decision support must foster active, iterative and inclusive *communication* between the different involved groups. Second, there must be a process of *translating* the scientific information into terms that can be easily accessed and understood by decision makers. Similarly, it is important that the requirements of decision makers be translated into a format that experts can understand in relation to their research. Finally, given the differences in expectations, accountability and priorities among the different actors (experts, decision makers, citizens, etc.) involved in the information development process, *mediation* is important to enhance the legitimacy of the process. This can occur through the “increasing transparency, bringing all perspectives to the table, providing rules of conduct, and establishing criteria for decision making” (Cash et al. 2003 :8086).

4.4. Institutional Context for Information Systems: Boundary Organizations

Finding an institutional form to foster an iterative exchange among scientists, experts and decision makers, however, may not be an easy task. A number of researchers (Cash et al., 2003; Guston, 2001; Gieryn, 1999; Tribbia and Moser 2008; Corfee-Morlot et al. 2011) have suggested that ‘*boundary organizations*’ “...can help improve the end-to-end process of knowledge co-production and application by enabling scientists and decision-makers to increase mutual understanding of capacities and needs while remaining within their respective professional boundaries” (Tribbia and Moser 2008:317). The idea of boundary organizations was first introduced in the 1980s through the work of Gieryn (1983). In the climate-change literature, boundary organizations have principally been applied to the context surrounding the adaptation to a changing climate (Vogel et al. 2007; Tribbia and Moser 2008; Corfee-Morlot et al 2010); however, they equally appear relevant for questions related to greenhouse-gas mitigation. Boundary organizations are agencies or entities that “...have the overall

dual purpose of protecting but also transcending the divide between science and practice (e.g., protection from the politicization of science, transcending for improved information flow)” (Tribbia and Moser 2008:317). As such, they are able to treat the concerns raised above related to the politicization of information and indicators, but also the saliency, credibility and legitimacy of the information produced.

Boundary organizations serve two principal purposes in the co-production of information and knowledge. They first facilitate the collaboration between experts and decision makers on different subjects. Second, they are able to produce what has been termed as ‘boundary objects’ or “...information and things used by both scientists as well as by politicians for different objectives, but without compromising the things themselves” (Guston 2001:401). In the case of climate-change mitigation, greenhouse-gas inventories are clear examples of a co-produced boundary object that is useful to both the scientific community, and decision makers. To achieve these objectives, boundary organizations fulfill a number of functions: *convening*, *translating*, *collaboration* and *mediation* (Tribbia and Moser 2008; Guston 2001; Corfee-Morlot et al. 2011). First, boundary organizations have a *convening function* to bring the different stakeholders together on the issue. Second, as mentioned above, the organization works to *translate* the subject being treated into terms that the different parties are able to understand and then discuss. Third, the boundary organization facilitates an ongoing *collaboration* process, involving frank and transparent exchanges, to co-produce “relevant and scientifically credible, applied knowledge” (Tribbia and Moser 2008:317). Fourth, these organizations play a *mediating* role to ensure the fair representation of the different stakeholder parties involved.

The need for interaction in the production of information and cooperation fits well with the behavioral theory of the individual: individual actors do not have perfect information, but they are able to learn and build trust (Ostrom 2008; Poteete et al. 2010). The above section has laid out how information and knowledge are important in the decision-making process. Information has a key role in what issues make it onto the agenda, their relative priority and how they are framed. This process of framing decisions can have a larger impact on what solutions are identified as feasible and acceptable. Information within decision-making processes often takes the form of a variety of indicators and other informational tools. It is important to recognize their construction, particularly that they are not *apolitical*, but, rather, the product of a certain number of assumptions, interests and decisions concerning what is included and what is excluded. Therefore, it is important to understand how information is produced so that it is perceived not only as credible, but also as salient and legitimate within the decision-making process by involved actors. In many instances, there appears to be a role for boundary organizations, liable to both scientific experts as well as decision makers, in the production of information and knowledge. Through a process of ‘analytic deliberation’²² and the

²² Well-structured dialogue involving scientists, resource users, and interested publics, informed by

fostering of exchanges between the range of actors involved, they are able to treat the concerns related to the politicization of information and indicators as well as the ‘co-production’ of salient, credible and legitimate information.

5. CONCLUSIONS

Climate change may very well represent one of the most challenging collective-action problems facing humanity to date. Framing the atmosphere as a sink able to stock only a certain concentration of greenhouse gases before resulting in an increase in the global mean temperature, climate change can be classified an *open-access common pool resource problem*. As such, greenhouse-gas mitigation poses a complex policy challenge spanning multiple levels of government, across traditional sectors and presenting difficult inter- and intra-generational challenges. This paper has reviewed the current reflections on the *commons* to understand what recent developments in theories of collective action can be used to foster what appears to be the collective action necessary to address such a cross-cutting problem. Drawing from recent work on common-property common pool resource management, this paper has shown how, in theory, the adoption of a modified theory of collective action based upon a behavioral theory of the individual allows for a reframing of the climate-change policy challenge. Instead of attempting to understand only what policy tool is necessary to impose sustainable use of common pool resources from the exterior, it is equally important to develop a context within which collective action becomes possible. Success is no longer solely tied to incentives, but equally to the provision of information, learning, and interaction between stakeholders while simultaneously fostering trust and reciprocity among actors.

Given the nature of the policy challenge where local actions have a significant impact on the global context, it appears that actions’ multiple scales of government are necessary. As such, this paper has analyzed the body of literature on multi-level governance as well as on how different institutions support or undermine the provision of information, learning, and interaction among stakeholders to develop trust and reciprocity, key comments to collective action. To take action, authorities cannot typically operate effectively in isolation from other parts of government. Local governmental authority to act is often hierarchically “nested” in legal and institutional frameworks at a higher scale. Additionally, it is necessary to take into consideration a number of micro-scale characteristics of institutions that serve to foster a context within which collective action can occur. Drawing on work from Dietz et al. (2003), a framework for the governance of environmental resources was identified that lays out the general principles to

analysis of key information about environmental and human-environment systems, appears critical. Such analytic deliberation...provides improved information and the trust in it that is essential for information to be used effectively, builds social capital, and can allow for change and deal with inevitable conflicts well enough to produce consensus on governance rules. (Dietz et al. 2008 :616-617)

structure the analysis of how local authorities are structuring the governance of greenhouse-gas emissions.

Within the above framework, information plays a key role to both inform and to facilitate communication, as well as to identify and develop the necessary actions and investments and to track changes in conditions. In the case of climate change, greenhouse-gas inventories and other informational tools are necessary components to track an *a priori* intangible emission. The final section of this paper analyzed the role of information and knowledge in the decision-making process. Information has a key role in what issues make it onto the agenda, their relative priority and how they are framed. This process of framing decisions can have a larger impact on what solutions are identified as feasible and acceptable. Information within decision-making processes often takes the form of a variety of indicators and other informational tools. As Cash et al. (2003; 2006) suggest, it is key to analyze the legitimacy, credibility and saliency of information and expertise integrated into the decision-making process. As such, it is important to recognize their construction, particularly that they are not *apolitical*, but rather the product of a certain number of assumptions, interests and decisions concerning what is included and what is excluded shaped by the involved actors. Therefore, it is important to understand how information is produced so that it is perceived not only as credible, but also salient and legitimate within the decision-making process by all actors. In many instances, there appears to be a role for “boundary organizations”, liable to both scientific experts as well as decision makers, in the production of information and knowledge. Through a process of ‘analytic deliberation’ and the fostering of exchanges between the range of actors involved, they are able to treat the concerns related to the politicization of information and indicators as well as in the ‘co-production’ of salience, credibility and legitimacy information.

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