

Introduction: Global Environmental Commons: Analytical and Political Challenges in Building Governance Mechanisms

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The development of the so-called 'new commons' in matters of the environment through the pace of globalization and economic growth raises new challenges both for policy making and for social sciences. The main characteristic of these new commons is their existence at multiple levels: some (such as the protection of the ozone layer) have an entirely global aspect; others (such as clean air) are transboundary; and still others (such as biodiversity) are multilevel in character. This clearly challenges existing governance regimes which are built on nation states and international conventions. Many 'rights' are loosely defined and many 'externalities' generate various and complex 'tragedies of the commons' and social dilemmas. These issues are exacerbated by scientific uncertainties and questions about the design of efficient policies, challenging both natural and social sciences.

Since the publication of path-breaking contributions on these issues in the early 1990's (Young 1989, Ostrom 1990, Carraro and Siniscalco 1993) many political initiatives have been taken, many governance experiments have been run, and a large field of research has opened up at the frontier of environmental and social sciences. The aim of this interdisciplinary book is to address the new challenges in the provision of environmental goods by taking stock of the dispersed knowledge that has been accumulated over the years. Our goal is to contribute to the construction of a common knowledge base about the appropriate governance regimes for different types of global environmental goods.

We start by pointing out the specificity and the nature of global governance challenges. Then we review the state of the art on three main issues. First we address the question of the optimal level of governance, given that, in practice, environmental goods may have very different scopes and can be produced according to various 'aggregation technologies'. This leads us to the problem of multilevel governance and the efficient organization of federal systems. In an international context, it is also worth discussing the economics of treaties and

coalition building. One of the essential lessons highlighted by the literature is the interplay between formal and informal instruments and norms. Second, we point out that the design of governance instruments and regulation should be based on a relevant conception of human motivation and rationality. Too naïve a vision of human rationality and selfishness may lead to incentive schemes, for instance, that deter contributions to the provision of public goods (the crowding-out effect). More fundamentally, the exploration of human motivation, and especially of altruism, raises important questions about the way we should establish targets in matter of the provision of global environmental goods. Today's choices have an important impact in terms of inter-generational transfer, and fairness in this matter is a very complex issue. Third, we revisit the governance toolbox, considering different modes of governance. In particular we point out the costs and benefits of alternative tools — property rights and incentives — by considering not only their characteristics once established but also the economics of their design and implementation. We conclude by briefly discussing the potential of polycentric and networked governance.

1. Global Environmental and governance challenges

Not all environmental goods raise the same challenge with respect to governance. According to the contributors to this book, there are three critical dimensions that need to be taken into account: scale, time, and uncertainty. The many possible combinations of these dimensions impact on the 'cruciality' of the environmental issues at hand, and on the 'difficulty' of their governance.

Let us consider each of these dimensions in turn. Scale refers to whether a given environmental issue can be treated as a set of (linearly) cumulative local problems or as a global issue of linked problems requiring a systemic approach. Timing contrasts processes of rapid systemic — and possibly irreversible — changes and slow, partly reversible, processes of changes. Finally, some environmental issues are characterized by limited uncertainty, where several possible future scenarios can be imagined, but we do not know for certain what will occur. In contrast, there are situations of high uncertainty in which future scenarios are beyond the capability of human cognition because our understanding of the current situation is incomplete, or because future developments are too complex to be predictable. Each of these dimensions, taken in isolation, has an impact on the choice of the mode of governance, and their combination crucially complicates the task of selecting the best way to govern the global commons.

How should we respond to the challenge? Throughout this book, we show that there are three essential dimensions to be taken into account with respect to governance and the management of institutional change. First, we consider the issue of designing governance

solutions: systems of rules, distribution of authority, levels of organization (from local to global), etc. These are the classical ways of tackling governance and institutional issues. However we would like to go a step further by identifying two other crucial dimensions of governance issues, especially in respect of policy making at the global level. Since there is no legally empowered global authority, possible instruments should not be considered only from a design perspective. The negotiation process among stakeholders plays a crucial role in reaching an agreement, and in choosing and implementing a particular policy instrument as a collective action. Third, compliance has also to be taken into consideration in a context where there is no last-resort enforcer. Compliance refers to the actual changes in behavior that are generated by the adoption of an institutional arrangement. It depends on a combination of formal rules, enforced by recognized authorities, and informal obligations, such as social and individual norms, whose violation is typically punished by private actors (Posner, 2007). In particular, the role of social and normative motivations in compliance with environmental regimes has been increasingly recognized in the research literature.

We start by pointing out the specific characteristics of global environmental issues that impact on these dimensions of governance (Section 1.1). Next, we show that some of these characteristics, (e.g. the current changes in the dynamic of the Earth system and its ecology) trigger specific challenges in matters of global governance (Section 1.2)

1.1. Complementarities and Interdependencies governance regimes

It is widely recognized that many global environmental issues borrow from opposing logics — e.g. separability and systemic scaling effects — which call for hybrid solutions in matter of governance. However, it is convenient to analyze how governance solutions fit with the polar characteristics of environmental issues. We discuss this systematically below, starting with scale effects, and then moving on to dynamics and uncertainty.

1.1.1. Scale effects, Polycentrism and Coordination

When an environmental issue tends to be dominated by cumulative (as opposed to systemic) effects, local decision-making and decentralized management is to be preferred, within a framework of coordination on the global scale. Thus, from a design perspective, the main governance implication of local and disjointed environmental problems, such as biodiversity or fisheries, is the important efficiency gains that can be made in a decentralized federalist governance framework. There is no convincing argument to justify centralized provision on a global scale, except for coordination issues which have important economies of scale (such as the organization of research, synthesis of best practice, and advice on appropriate standards).

Institutional bargaining in small groups on local issues, combined with coordination at a global scale should lead to stable agreements. Externalities cannot be avoided, since there are often discrepancies between the scope of an environmental issue and that of a political jurisdiction. Nevertheless, when appropriate, polycentric and decentralized governance is cost-efficient, partly because informal rules and community pressure play a strong role in ensuring compliance at the local level.

On the other hand, systemic interdependencies at the global scale require multilevel governance arrangements, including an independent global entity of last resort. In the case of transboundary environmental problems and international public goods, such as air pollution or climate change, there is a strong need for governance systems organized at the transnational or global scale. The issue, here, is the effectiveness of (generally hard to reach) international agreements. In many cases the global entities/ intergovernmental organizations that result from these processes of negotiation lack their own financial resources and powers of implementation. A second best solution in such cases is to delegate financing and enforcement to the nation states, within the framework of a negotiated multilateral convention. However global agreements (whether leading to a global institution, such as the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), or to framework conventions) raise complex issues.¹ Because of the greater heterogeneity and size of the communities, compliance with the adopted agreements is expected to increase with the presence of formal rules which strengthen the calculated or instrumental motivation for compliance

To determine where the cursor lies on the separability vs. systemic-effects axis, an understanding of aggregation technology is crucial. This refers to how individual contributions to the collective good determine the quality of the good available for consumption (Hirschleifer 1983; Cornes and Sandler 1984). For summation goods, each unit contributed to the public good adds an identical and cumulative amount to the overall level of the good available for consumption. For example, any reduction in the emission of greenhouse gases corresponds to the aggregate (summed) cutbacks of the polluter countries. Other important types of aggregation technologies are: weakest-link public goods, where the smallest contribution fixes the quantity of the public good for the entire group (for example, pest diffusion); best-shot public goods for which the overall level of the public good equals the largest single individual provision level (e.g. finding a cure for a disease); and weighted-sum

¹ The modern theory of coalition formation has shown that even when a global agreement is feasible, a stable equilibrium is one where small coalitions free-ride on larger ones (e.g. Carraro & Siniscalco, 1993, Bloch 1997, Ray & Vohra, 1999). This is a typical anti-Coasean outcome (Maskin and Riley, 2003) which raises important equity and distributional concerns. The size of the stable coalition on a global scale may however be enhanced by policy measures such as negotiation rules (e.g. minimal membership constraints), transfers and issue linkage.

public goods where different contributions can have different impacts (as in the cleanup of polluted sites).

1.1.2. Abrupt Changes and Long Term Monitoring Needs

Systems subject to potential abrupt and systemic changes, such as that caused by an invasive species, need an early-warning system, and a balance between mitigation and adaptation measures for dealing with change. Building such management and monitoring capacities in polycentric and decentralized systems is expected to increase the fit with local circumstances, and increase the speed and diversity of available solutions. On the other hand, a global governance arrangement might increase the effectiveness of coordination. However, reaching a global agreement is more difficult in situations of rapid change. Well-designed contractual regimes, with *ex-ante* agreements on negotiation procedures, or strong leadership might be an appropriate way to reach stable agreements in situations of abrupt changes. Hence a formal global collective organization, with clear delegation or a leading political actor (typically the EU) is expected to increase the effectiveness of governance systems.

For environmental problems with a very long time horizon, a global governance arrangement is feasible and should increase efficiency, while a certain level of network governance should increase effectiveness in compliance. Issues such as nuclear waste require investments in governance systems with long-term monitoring capacities. Also, bargaining should be organized to tackle distributional issues that are unlikely to be spontaneously addressed through decentralized mechanisms, even in the presence of a strong altruistic norm towards future generations. Calculated or instrumental motivations tend to be less effective at ensuring compliance, because the exact distributional consequences of compliance with the rules tend to change over time. Hence, to increase compliance, it is worth investing in the building of social norms. Because of the heterogeneity of normative processes and social norms in a global context, polycentric and decentralized governance is preferred.

1.1.3. Risk, Uncertainty and Incomplete Knowledge

The governance of well-defined risks (i.e. situations of limited uncertainty) can be tackled by global governance arrangements within a multi-actor network to reach an efficient risk-sharing arrangement. For specific goods characterized by well-defined risks (e.g. toxic waste, or the International Union for the Conservation of Nature (IUCN) red list species) stringent limitations are required on a transnational scale. These regulations call for the creation of international epistemic communities with a clear institutional mandate, which can provide consensual knowledge on the state of the art to policy makers. Combining regulation, legal liability and social norms is important to ensure effective compliance.

For goods characterized by strong uncertainty or controversy over the level of risk (e.g. climate change or genetically modified organisms), a precautionary approach in a centralized framework has advantages. Strong uncertainty opens the door to value judgments, which therefore play a key role in the bargaining and decision-making processes. In order to reach a stable agreement scientific knowledge needs to be balanced against value judgments. The extended peer-review process therefore implies recourse to polycentric and decentralized arrangements for social learning about values in different local and regional settings. At the same time, the effective governance of these risks requires global independent coordination of scientific and social risk assessment, setting of outcome targets, and rule making. Compliance with precautionary measures will be increased by the specification of formal outcome targets, less so by liability (because of the difficulty of attributing responsibilities) and social norms (which lead to ambivalent results). A decentralized regime of licenses and permits aimed at reaching the outcome targets is expected to result in substantial efficiency gains.

1.1.4. Challenges for the International System of Governance of the Global Commons

The chapter by Charles Perrings digs into the need for new means of coordination and cooperation in the light of the specific features of global environmental problems. It addresses in particular the issue of the development of institutions of governance that fit both the scale of the problems and the characteristics of the alternative environmental goods. The key issue raised is that a single problem of environmental governance can involve multiple goods, each of which might operate at a different scale and lead to a different kind of strategic game. To make these problems tractable, precise knowledge is needed on the biophysical nature of the environmental goods and services, on the supply technology of the related public goods, and on the nature of the bargaining game. For instance, in the case of pathogens, the main focus of international cooperation should be on raising the level of protection offered by quarantine services in the least effective country. By contrast, in other cases, such as carbon sequestration and the conservation of wild living resources, the contribution of every player is simply additive and the focus should be on minimizing the social cost of free-riding. Careful analysis of the public good at stake and of the structure of the pay-offs of alternative strategies is therefore needed to design systems of governance which are better than the non-cooperative status quo.

Taken individually, many of the methodological issues addressed in the chapter by Perrings are not specific to environmental governance. However the particular way in which they are combined gives a specific flavor to this policy domain. The large-scale and encompassing

indirect (involuntary) interdependencies generated by the global connectedness of ecological systems are specific. The global integration of essential issues through webs of dynamic processes calls for alternative ways to institutionally connect actions that normally have no direct relationship or impact on each other. The chapter by Arild Vatn shows that such coupled development of institutional structures is needed, across the boundaries that often separate the state, market and community-based means of coordination. Promising examples, which may form a basis for tackling this difficult problem, are the recent developments in network governance, and the expansion of the role of common property. These and other solutions are of course not a panacea. Understanding natural interdependences is, however, crucial in designing new instruments that will help to address the environmental challenges. The last chapter of the book by Graciela Chichilnisky is based upon precisely this kind of insight.

1.2. The Threat of Environmental Depletion

The stock of accumulated knowledge on the governance of the global environment shows that there is a growing gap between our institutions and the guiding assumptions about ecological systems. Many of our governance tools assume changes that are linear and gradual. Political processes leading to the formation of environmental regimes are slow, and have difficulty dealing with nonlinearities and strong uncertainty. This is in sharp contrast with the reality of ecological systems, and their interactions with the socio-economic systems, which appear to be far more complex and dynamic than anything we have encountered previously. For instance, in the field of climate change, much of the recent scientific interest has focused on rapid climate change, such as the events that would be triggered by the disintegration of major ice sheets or the shutting down of the thermohaline circulation. Another feature of the complexity of ecological systems is the nonlinearities that can cause discontinuities in the normal rate of change. A case in point is species extinction, which occurs when a population reaches a critical threshold or tipping point and then crashes. Many changes in ecological systems are characterized by irreversible change (at least in a reasonable time scale). Abandoned farm land in tropical regions typically reverts to forest in short order, but there is no reason to assume that this allow the species richness that prevailed before the cutting of the forest in the first place to prevail.

The resulting challenge is at the heart of the chapter by Oran Young. This chapter is based on the assumption that many global environmental commons will give rise to changes that are simultaneously nonlinear, abrupt and irreversible. This raises a set of governance challenges that call for institutional innovation. Many of these challenges are related to generating information on how best to find out about the interdependencies, monitoring the evolution of the system, and adapting the solutions to the changing circumstances.

Early warning systems are an example of a governance tool that has been developed in response to this type of challenge, even though it will remain difficult to determine exactly where the thresholds of collapse lie. However, as is also shown in the other contributions to this book, the complex interdependencies between various ecological and social systems at different scales calls for an approach to governance at multiple levels that combines local, national and international initiatives. One point worth noting, is the importance of combining formal and informal arrangements. When changes are nonlinear, abrupt, and irreversible, the case for relying on informal rules and adjustments — at least in the short run — is apt to be compelling.

2. Addressing global issues by articulating local governance frameworks

Environmental federalism points out that the provision of many environmental goods can be performed on a decentralized basis, especially because many natural resources are localized in particular regions. There is therefore a theory (and a practice) of the optimal devolution of the provision of public goods to the right level of governance that depends both upon natural characteristics (watersheds, forests, etc), and societal ones (in particular shared culture, political organization and integration of the economy, see Section 2.1 below). At the same time, for those public goods that have to be provided at the global level, the issue is that no global government exists, and there is not even a strong global political legitimacy. The issue is then to understand how international agreements can be reached and enforced (Section 2.2).

2.1. Environmental Federalism: Scaling Up Local Successes

It is useful to distinguish between local public goods, say a local fishery, and global public goods, such as the general circulation system of the seas. There is an important difference between the two, as local public goods are best provided through local governance mechanisms, while global public goods should be governed at the global scale, whether through a global entity or within the framework of an international convention. This reflects the (European) principle of subsidiarity, which holds that the management of any environmental problem should be at the lowest possible level consistent with capturing the spatial and temporal spread of its effects.

Optimal devolution to various levels of governance depends crucially on aggregation technologies that establish to what extent the various jurisdictions make an independent contribution to the level of aggregated public-good provision. Optimal devolution also depends upon the pre-existing socio-political organization that fixes the conditions under

which alternative governance solutions can be implemented (in particular because solutions based on Bruno Frey and Reiner Eichenberger's concept of functional, overlapping and competing jurisdictions (FOCJ) are often too costly in terms of transaction costs (Frey and Eichenberger 1999; 2001).

This is aptly illustrated in the chapter by Elinor Ostrom, which addresses the question of matching scales of governance to the types of collective-action problems under consideration. It starts from the observation that studies of well-established institutions for the governance of natural resources (some of which have already existed for several centuries) have shown that sustainable management of common-pool resources is possible at the local level. Efficient alignment of individual motivations, and the use of specific knowledge, have allowed self-organized communities to consistently outperform public agencies.

The central question is how the principles characterizing these successful decentralized resource-management schemes can be scaled up to address problems on a global scale, and what new principles need to be added. The example of polycentric metropolitan governance, which has a long history of working arrangements that typically range from the very small to large overarching metropolitan governance units, is used in this chapter as a model to draw some lessons which are applicable whenever there is a need to address problems at the largest scale. The main challenge is to establish larger units that do not eliminate the medium- and smaller-size units that help citizens to cope with neighborhood-level public goods and common-pool resources. An important lesson for the global environmental commons is that the strategy of simply recommending a single governance unit to solve global collective-action problems needs to be seriously rethought. A better solution is to encourage experimental efforts at multiple levels. For instance, building a strong commitment to finding ways to reduce individual carbon emissions at the household level can be effectively undertaken in small- to medium-scale governance units. However policies adopted at the global level are more appropriate for agreements on investment in technologies and trade-related aspects of carbon policies. By structuring decision making in this way, the level of public-good provision can be tailored to the specific circumstances — the tastes of residents, the costs of production, and other peculiar local conditions — of each jurisdiction. Difficulties in governing less-than-global public goods generally arise either when one ecosystem supplies services that benefit people at different scales, or when ecological and jurisdictional boundaries do not coincide. Coordination mechanisms at higher levels and new, regional, collective entities may be needed to create the best fit between governance mechanisms and the problems being considered.

2.2. International Agreements among Sovereign Nations

The logic of federalism however shows its limitations when it comes to the international level. In international relations, there is no last resort enforcer and most often no actor overseeing the players and promoting the reaching of agreements. The ability to establish common rules and common (compatible) principles to deal with the provision of public goods at the global level is then submitted to the harsh logic of cooperation among self-interested actors. Depending on the nature of the dilemma (coordination or cooperation), the fact that the global governance game is mediated by organizations with their own logics and strategies means that inequalities in bargaining power are important. Moreover, the fact that crises may threaten players or the system influences their ability to reach agreements and implement solutions.

2.2.1. Why it is difficult to reach an international agreement

In international negotiations, the parties reach an agreement when uncertainty is low, when differences in expected costs and benefits across constituencies are small, and when the aggregate benefits of collective efforts exceed the costs. There are strong free-riding incentives, since it is quite difficult to convince people to give up part of their current wealth for the sake of uncertain gains in the future. All in all, in the raw state of affairs, there are weak political and economic drivers for entering an agreement and for attaining and maintaining its goals.

1. Heterogeneity and the difficulty to share a common burden

When there is considerable cost and benefit heterogeneity among countries with respect to a global externality, reaching an agreement is especially difficult. Stronger inducement mechanisms may be required, e.g. larger transfers or incentives, involving punitive aspects. The underlying problem is always that of agreeing on an appropriate standard for sharing the common burden. For example, it is hardly surprising that developing countries do not regard 1990 emissions as an appropriate basis for allocating rights to the global atmospheric sink; nor that they prefer population-based standards, which are unlikely to be acceptable in a pure form to industrialized nations. These issues will become more and more serious as the global commons problem grows.

Some aspects of heterogeneity can however be helpful: in particular, trading thrives on heterogeneity. When low-cost abatement resources are located outside the system, there is a common interest in making these resources part of the system. This principle is, for instance, at the basis of the Clean Development Mechanism credits employed in the EU's Emissions Trading Scheme discussed in Chapter 7. In this instance, heterogeneity is useful

in setting up the conditions for participation, although it is still important to find an equitable basis for participation to bridge large differences.

2. The negative impact of uncertainty on consensus building

The costs that individuals, firms, and governments have to bear in adjusting their behavior to protect GPGs are very uncertain. Incomplete and imprecise information about the effects of international action, the costs involved, and the compliance all generate uncertainty about the potential results of collective action. The volatility of the estimates depends greatly on variables which are difficult to predict in the long run, such as population, productivity growth, technological improvement, and patterns of consumption. Uncertainty in calculating aggregate net gains and their distribution, together with asymmetric information, result in divergent views of the overall advantages of addressing the externality and sharing the costs. Uncertainty thus complicates the design of compensation schemes and encourages conflicts over the size, nature and direction of compensation. Such conflicts involve a political risk of instability, and increase the dangers for politicians who may doubt the support of their constituents for bargaining about an externality.

3. The limits of enforcement among peers

There are good reasons for skepticism regarding the effectiveness of agreements, since many international institutions charged with overseeing such agreements are weak (Haas, Keohane and Levy 1993). Where monitoring or verification is difficult or impossible, compliance will be harder to achieve. For this reason, most agreements establish obligations that are easily monitored. This is one of the advantages of a treaty focusing on actions (policies and measures) rather than outcomes (emission-level targets) (Barrett 2001).

Enforcement requires punishments. If it is to influence behavior, the threatened punishment must be sufficiently severe. Making punishments both credible and severe is, however, difficult, because the more severe the punishment, the more costly it is. The strongest and most influential countries, such as China and the US, are particularly difficult to deter. Expecting compliance from such countries when their fundamental sovereign interests are at stake is a vain hope.

4. Transaction costs: the negative effects of size and heterogeneity of coalitions

The more agents are involved with a particular global public good the harder it is to achieve cooperation. There are several reasons for this, but one is that the transaction costs of coordination increase with group size. This can be partially overcome by first forming smaller (regional) coalitions that can later join with other regional coalitions to form larger groups. Repeated interactions can also facilitate cooperation.

Heterogeneity, uncertainty, enforcement problems and transaction costs all contribute to the difficulties for reaching international agreements. These issues are discussed in the North-South bargaining context by Ben Groom, Rupert Gatti, Timo Goeschl, and Timothy Swanson who analyze the conditions for the emergence of stable international regimes by considering the joint contributions of countries to the provision of public goods. The chapter is built on a model with two players: northern and southern nations, which are fundamentally qualitatively unequal in the distribution of assets. The North is endowed with (scientific) knowledge and human capital, while the South controls the natural resources (including all types of biological resources from genes to species). The authors shows that such an exchange is fundamentally unequal because cooperation tends to benefit the North more than the South, because the North is more 'productive' in the exploitation of the surplus generated by cooperation and by the public good itself. Compensation payments fail to address this fundamental distributional problem of dividing up the cooperative surplus, because they do not affect the distribution of assets. Not only is the world trapped in an inefficient equilibrium, but this equilibrium tends to be worsened by the game played by the poorest nations to enhance their bargaining positions. It is rational for the poorest countries to threaten to destroy their resources when they are needed by the North to innovate (e.g. reservoir of genes, traditional knowledge, etc.). Strategic destruction can be — and has proven to be in practice — a rational response to an inequitable bargaining solution.

Suicidal strategies leading to the mass destruction of environmental goods, including some non-renewable resources, is threatening the dynamic of international cooperation on their provision. This is why long-term stable regimes should be based on a better recognition of the actual inequalities of the distribution of assets between the North and the South. In the short run, inequalities in the ability to negotiate and to benefit should be taken into consideration, and the South should be overcompensated. In the longer run, the empowerment of nations, and especially the development of their stock of human capital, should be an essential goal of North-South cooperation in the provision of global public goods.

2.2.2...and why some international agreements are successful

Early contributions to the analysis of institutional bargaining about the global commons characterized the interaction among countries as a prisoner's dilemmas (Carraro 2003: xiv), inevitably leading to the establishment of a globally recognized sanctioning authority (Hampton 1987), or its equivalent, a set of global formal contracts (Snidal 1985). However, although the prisoner's dilemma characterizes some of the global commons issues, it is not appropriate for all of them, and in practice there is a wide variety of game structures and related institutional solutions to consider. In addition it is important to recognize that for many

situations unanimity may not be possible. The greater the heterogeneity among the players, the more difficult it is to reach a consensus. At the same time, a consensus is not a necessary condition for action: the actions of specific players, such as the EU, can have a substantial demonstration effect.

In practice it can be observed that many large-scale environmental agreements have been signed and are relatively stable through time. Two important differences distinguish these arrangements from the prisoners' dilemma. The first difference is that it is possible to modify the conditions of the game through policy measures (and, similarly, to widen the size of the stable coalition), transfers (side payments), issue linkages, and negotiation rules (for example the minimum number of participants) (Carraro 2003: xvi–xviii). Second, most games are mixed games combining features of cooperative dilemmas (a conflict over the use of the common resources, which means that the cooperation is not stable without external intervention), and coordination dilemmas (cooperation is stable, but is not a dominant strategy in the absence of an appropriate distribution of information).

1. Coalition Building: the better can be the good's enemy

A convenient way to assess the impact of the global scale on the bargaining process is to consider the differing impact of scale on cooperation and coordination games (Snidal 1985). The impact of scale on the prisoner's dilemma has been extensively studied. It is negative, as cooperation is much easier in small coalitions. Cooperation in large groups is self-enforcing only when there is a strong asymmetry between players, and when a benign hegemonic player imposes it on the others. In the absence of a global hegemonic player, increasing the number of players makes cooperation more difficult. Reaching an agreement through voluntary cooperation can only lead to small stable coalitions. A modification of the structure of the game through policy measures (the minimum size of the agreement, side payments, etc.) can nevertheless enhance the size of the possible stable coalition.

By contrast, increasing the number of players enhances the stability of regimes in coordination dilemmas. However, it may inhibit the formation of such regimes. Although some environmental goods should be provided on a local scale, increasing the number of players involved in the bargaining on standards or other coordination issues enhances the intrinsic stability of the regime. Stability requires, however, that sanctions are credible; otherwise exit is always an option. So some form of side-payment might be necessary to ensure stability.

2. Dynamic effects: Let's keep pace with time

Abrupt change, for example in conflicts over the use of resources, generally makes cooperation more difficult (Snidal 1985). Indeed, the need to react quickly diminishes the

possibility of repeated games. Moreover, in this situation bargaining over the exact nature of the new regime tend to be intense. Only well-established governance regimes can orchestrate a successful transition without disrupting the cooperation. Well-designed contracts (including agreements on the negotiation procedures for dealing with adaptation), combined with strong leadership can address these challenges.

In very long time frame, the set of possible game forms to deal with resource conflicts or coordination problems is dramatically reduced. For instance, alleviating collective action dilemma through face-to-face communication or bilateral contracting is impossible in intergenerational conflicts over the use of resources. It has been shown that altruistic norms in favor of future generations are an important motivational factor for the adoption of efficient behavior (Fischer, Irlenbusch and Sadrieh 2004). However, altruistic norms without formal rules can have counterproductive results. When the strategies of the different players are substitutes, the optimistic belief that most people care about future generations diminishes each individual's perceived need to contribute.

These limits on the possible forms of games indicate the need for policies aimed at broadening the possible bargaining equilibriums (rules of equitable contribution, guidelines for decision making, etc.). For instance, voters or members of a collectivity, who may not willing to show restraint if their income is immediately affected, may nevertheless vote for constitutional rights for future generations because there is a strong altruistic norm. In other words, the structure of the situation can be transformed into a coordination problem, with a positive influence on the stability of the efficient equilibrium.

3. The Role of Independent Watchdogs

Though the evidence from game theory suggests that abrupt changes inhibit cooperation, there are instances of cooperation in crisis situations. One recent example is the financial crisis, which, like many environmental problems, is globally systemic. It is important to recognize the conditions underlying cooperation among central banks. Most of them are insulated from, or independent of, the executive and legislative branches of their country's administrations; most individual bankers share a similar view of the way the monetary system works; they have previously interacted with each other, although they have not necessarily coordinated their activities directly; the players frequently meet behind closed doors, which facilitates consensus; they care about their reputations in the group as well as outside; and many are interested in their reputation for the history books, since they do not have to worry about being re-elected. These conditions characterize the role of watchdogs, and therefore

the institutional requirements for establishing analogous environmental agencies with the right incentives and capabilities.

4. Public Opinion

Another player to consider in coordination games is the public at large. Traditional wisdom suggests that the presence of free-riders means that the public has little influence over special interest groups. However competition amongst politicians will cater to the public interest, as it will cause politicians to reach out and discover the values of the public at large (Denzau and Munger, 1986). Citizens' value structures may not be stable, especially under conditions of uncertainty. To the extent that uncertainty exists, the media as well as political leaders have greater scope to shape public opinion (Alston et al. 2008).

5. Mechanisms for reaching consensus: Scientific and Multi-Stakeholders Fora

The problem of the role of uncertainty in decision-making on environmental issues has been addressed by many researchers. Two important general lessons emerge from this literature. First, in order to be effective, scientific assessments should produce knowledge that is legitimate, salient and credible (Clark et al. 2002). Second, the effectiveness of the assessment is enhanced if (1) the assessment body has a clear institutional mandate for knowledge production and (2) if it has a certain independence from the policy arena (Haas 2004).²

Part II of this book addresses the issue of coalition building and consensus mechanisms in the context of climate policy and biodiversity policy respectively. The chapter by Bréchet and Eyckmans analyzes the emergence and stability of coalitions in climate-change negotiations. By using a simulation model developed in the Belgian CLIMNEG research project they show some of the contrasting features of climate agreements and possible ways to mitigate the less desirable outcomes. Agreements bringing together relatively homogenous countries with similar emission-reduction costs and climate-change characteristics tend to be more stable than arrangements among heterogeneous countries. However, they tend to aim for less ambitious greenhouse-gas emission-reduction targets than larger heterogeneous coalitions. This can be addressed by designing appropriate transfer schemes, which stabilize the larger coalitions. Bréchet and Eyckmans also show that working with a multitude of small agreements can yield better global results than limited cooperation in a single large agreement.

Denis Ellerman confirms this finding in the European cap-and-trade system. This system is an example of a governance arrangement which involves a heterogeneous set of national

² Once again, a good example is the role played by the heads of the central banks in the largest economies in the world.

governments in the context of a weak federal structure. Ellerman shows that the first and second trading periods, covering 2005-07 and 2008-12, have been characterized by decentralized cap-setting and allocation systems. He shows that the period of decentralized experimentation and incremental change is an important element of the success of the system, in spite of the need for greater harmonization in the allocation decisions at the firm level in the various EU member countries, and the obvious benefit of centralization in the setting of emission caps to deal with the environmental laggards in the Union. Once the system was operating — and the thankless and cumbersome decentralized procedure had been experienced — agreement on further development of the system appears to have become easier.

3. Pro-social Preferences, Complex Individual Motivations, and the Design of Institutions

The debates about sustainable development and the construction of norms and policies for the provision of environmental public goods are usually set up according to Hardin's (now) standard economic approach to the tragedy of the commons (Hardin 1968). The 'natural' or 'physical' characteristics of certain goods, which are intrinsically considered as desirable by the human community, explain their under-provision because individual selfishness collides with the non-excludability of these non-rival goods. As Ostrom points out, this vision can be mitigated by the fact that many environmental goods have a club character because they are localized. However, this argument draws on a very mechanical vision of how individual and collective preferences are built.

The simplifying assumptions on which the traditional approach to public-good provision relies should not always be thrown out with the bathwater, because they can result in very useful 'babies'; i.e. political recommendations which suggest solutions enabling a better alignment of individual incentives with the collective needs. In particular, the implementation of several types of exclusion mechanisms grounded on 'property rights' (tradable permits, communitarian tradable assets such as bioprospecting rights, etc.) may lead to counter-productive effects. The crowding-out effect is the most famous example: the implementation of incentives to contribute can deter voluntary contributions and action, leading to an overall reduction in the collective effort.

The identification of such problems suggests that the model of the human mental processes underlying most economic reasoning may be too crude to produce a relevant analysis of the issues related to the provision of public goods (and more precisely the provision of environmental goods, which are likely to be impure public goods). More precisely, two sets of issues have been highlighted. First, the organization of collective action to ensure the

provision of public goods requires the definition of collective objectives. The question of the formation of social preferences is therefore raised. Second, once goals have been established, collective action may require the implementation of tools aimed at influencing individual behavior. Aligning individual preferences requires an understanding of them. Thus both sets of issues highlight the fact that understanding individual and collective preferences is central when trying to establish environmental policies. This leads to important research programs and discussions on the relationships between the two. These debates are discussed in the third part of the book and in the three sections below. First, the notion of altruism is developed. Then, its role in the formation of social preferences is raised. Thirdly, the consequences for the design of governance mechanisms are teased out.

3.1. Reciprocity, Preferences for the Future, and Altruism

3.1.1. Altruism and its consequences

Altruism matters in real situations as people are concerned about the welfare of others and the welfare of future generations. For example, most estimates suggest that most of the effects of global warming will be felt after the death of the current generation. This means that actions taken now to deal with global warming will mainly benefit future generations, while the cost of them is sunk for the present generation, who may not even partially profit from any action they take. This raises substantial problems for welfare economics, such as what weight an altruistic society should attach to the welfare of future generations when making collective decisions.

The preferences of individuals are interrelated; altruistic individuals feel good when others are better off, and feel guilty when others are going through a bad phase while they are in a comfortable situation. Altruism is observed in many life situations. One obvious example is the care given by parents to their children. Throughout their childhood and adolescence, parents spend time and money instructing children in order to open up better possibilities for their futures. The value we attach to the wellbeing of our children and their descendents is called dynastic altruism. Donations to charities are another commonly observed form of altruism. Similarly, fundraising for altruistic reasons essentially supports research on rare diseases. However, altruistic societies do not imply anyone is motivated solely by altruistic concerns. Rational altruism is subject to trade offs that may result in selfish actions prevailing over socially motivated ones.

In theoretical terms, this altruistic behavior provides a rationale for spontaneous contributions to privately provided public goods. However, there may be many factors influencing this decision other than altruism. As Olson (1965) noted, 'people are sometimes motivated by a desire to win respect, prestige, friendship and other social and psychological objectives' (p.

60), or as Becker (1974) put it 'apparent 'charitable' behavior can also be motivated by a desire to avoid the scorn of others or to receive social acclaim'. Clearly social pressure, guilt, or sympathy, may play an important role in the decisions of agents. In fact, altruistic motivations may be pure or impure. By pure altruistic preferences we mean that a subject's utility is increased, not only by his or her own payoff from the provision of the public good, but also by the payoff received by the entire group of beneficiaries. Impure altruism or warm-glow preferences mean that the act of contributing, independent of how much it increases group payoffs, increases a subject's utility by a fixed amount. We can also talk about reciprocal altruism when a subject's preferences for the payoffs of others depend on the behavior, motivation, and intentions of those others. 'If somebody is being nice to you or others, you are inclined to be nice to him; if somebody is being mean to you or others, you are inclined to be mean to him.' (Rabin, 1998)³.

3.1.2. Endogenous or Exogenous Altruism?

On this point, two questions arise. First, how can we best understand social preferences and altruism, and how do such preferences relate to individual preferences? Second, is there a link between institutions such as norms and social preferences i.e. do social processes play a role in forming an individuals' social preferences?

There are several different ways of understanding social preferences. One way is to see them as a ranking of different states concerning the welfare of 'the other' that individuals trade off against their individual preferences. Hence altruism and care for others is commensurable with individual preferences. This implies that the utility function includes elements not linked to the welfare of the individual him- or herself. This understanding is rooted in the standard economic model of choice, and does not demand that altruistic choices are necessarily linked to any personal gain such as the 'warm glow' feeling.

An alternative to this interpretation originates in sociology and classical institutional economics. Social and individual preferences are considered as pertaining to different orderings. Social preferences are learned norms. Acting socially is hence following the relevant norm (acting appropriately). On the other hand, private preferences concern the welfare of

³ As Andreoni et al. (2007) suggest, Nagel's (1970) definition provides a good starting point for studying the altruism of individuals' decisions: 'By altruism I mean not abject self-sacrifice, but merely a willingness to act in the consideration of the interests of other persons, without the need of ulterior motives'. According to this definition altruism is neither a desire to sacrifice oneself, nor a desire to satisfy selfish purposes (ulterior motives). Over the past decade, experimental methods have been considerably refined to carefully separate altruistic motives from other motives in social behavior. Experimental evidence about altruistic behavior has therefore been studied in various games — ultimatum games, trust games, voluntary contribution games, etc. — and the importance of altruism in many situations has been demonstrated (e.g. Goeree et al. 2002, Palfrey and Prisbey, 1996; Fischbacher et al., 2001; Fischbacher & Gächter, 2006; Croson, 2007; Andreoni & Miller, 2002). This is not to deny that other reasons, such as a failure of rationality, search for reciprocity, quest for social prestige, or a 'warm glow' may play a role in explaining various 'generous' behavior.

individuals, and utility maximization applies. Not only do these two visions lead to different analytical models, they also correspond to different visions of the interplay between individual and collective preferences. In the first case, individual and collective preferences are independent. In the second case, they are in conflict for a large section of the population, which is an impetus for changing the norm.

The second issue is whether social preferences are individual characteristics or social constructs (i.e., whether they are learned, and hence endogenous). Societies educate their members by emphasizing values and norms that are central to them. These values and norms are embodied in commonly accepted rules about how to treat other people. Hence, they are social constructs that get internalized through the process of socialization. According to the first model above, we are imprinted with motivations to support other people. Our own individual interests have to be weighed against the interests of others. According to the second model, we learn certain ways of acting that apply to specific situations, and following this prescription is actually what gives meaning to the situation.

Institutions such as norms may not only work through establishing social preferences. They may also help us distinguish between different situations. Some contexts are defined as individual while others are seen as social. Hence the market, the firm, the community and the family are all characterized by different expectations concerning the balance between individual and social interests. Shifting between such institutional contexts can be seen as shifting between different preference orderings, which in turn implies changes in the parameters of the utility function.

The paper by Pascual and Ishihara highlights in a critical perspective the fact that individual preferences are not given, and are even not rationally built (e.g. through a neutral learning process), but are the result of social processes impacted by political and social competition. Relying on the work of Bourdieu, Foucault and others, they highlight that neither moral values (e.g. altruism) nor individual rationality (in particular the knowledge on which 'rational' decisions are based) are grounded on individual reflexivity or individual choice; they are merely the product of relationships among the dominant groups in society and the masses. In particular, Pascual and Ishihara insist on the idea that these social relations bias knowledge, including scientific knowledge. As a consequence, individual preferences for environmental goods — indeed, for any public good — cannot be considered as neutral and given. Rather, they are the product of social relationships and they therefore reflect these relationships. While this does not lead to a radical relativism, it does imply that there are no 'natural' or 'physical' imperatives. Preferences for environmental goods (such as biodiversity and clean air) can be balanced against other preferences (such as equality and development for the poorest).

The existence of social preferences as understood above has implications for environmental policy. When formulating policies and choosing between policy instruments to increase the support for the public good, it is essential to specify whether those involved perceive the issue in individual or social terms. Social preferences and norms may encourage individuals to act in ways that take the interests of others into account. In this case, taking the collective interest into account when making collective decisions may result in an under-consideration of the interests of individuals. Introducing instruments that appeal to individual interests may result in confusion in this context, because of the potential 'crowding out' of the social preference. These issues are addressed in the following sections.

3.2. Establishing Norms for Sustainable Development

Social preferences raise a major challenge for preference aggregation and for defining a collective objective function. The central issue is whether people's preferences regarding others' satisfaction should be taken into account in the planner's function, or whether only the selfish part of their preferences should be counted. The standard view is that each generation should be treated equally (if we omit the discounting issue). If the current generation cares about the next generation's well being, the latter's well being will be double-counted in the social planner's objective function. Whether the altruistic component of individuals' preferences is taken into account or not, affects the ranking of options in matters of collective choice. For instance, the aggregation of altruistic preferences increases the weight of future generations in the discounted flow of utility leading to a more patient current generation.

According to critics, the altruistic component should not be counted, since altruists could simply make cash transfers to people they feel altruistic towards. They argue in favor of excluding external preferences on the grounds that including them is inconsistent with utilitarianism. Their main argument is that each person should count for one and only one. Recent critiques of double-counting (e.g. Bernheim, 1989; Bergstrom, Blume and Varian 1986; Milgrom, 1993; Yew-Kwang 1999) have also adopted this point of view. For example, Milgrom (1993) argues against the incorporation of altruism in cost-benefit analysis (CBA) on the grounds of allocative efficiency. Others, such as Weikard (2007), suggest that altruism violates impartiality. Similarly Yew-Kwang (1999) suggests that informed preferences should be used and not actual preferences or happiness. This, he argues, would lead to the exclusion of external preferences. But are altruistic preferences not fully informed?

On the other hand, there is no reason why altruistic preferences should not be compatible with standard CBA techniques. The Kaldor-Hicks principle simply states that a given change is desirable whenever the benefits of the winners can (potentially) compensate for the losses

of the losers. This principle can easily account for altruistic benefits and losses as well as direct benefits and losses. On this basis, external preferences should be taken into account.

Another issue raised by external preferences is the existence of 'evil' preferences. If we are trying to include different kind of preferences, shouldn't we consider evil preferences as well? Or should we include good preferences and exclude bad ones? If we take a positive and impartial view of aggregation, we should of course be fair to everyone: all preferences should count, even the selfish ones. This position might be objected to, on the basis of freedom of choice. Take the case of envy, which is a negative feeling about others' wellbeing. Envious people would be better off if the endowments of the people they envy were reduced. In other words they would feel better if others' freedom were reduced. Altruists have exactly the opposite feeling: they feel better if others' freedom is increased. If we agree on some moral principles, such as that others' freedom should never be reduced, than evil preferences will be filtered out in the aggregation. The question becomes 'which principles should be adopted in carrying out the aggregation?', rather than 'which part of people's preferences should be counted?'.

Choosing an aggregation technique for individual preferences helps us to disentangle selfish and altruistic preferences, and to discount the altruistic preferences so as to avoid the dictatorship of the future. Some techniques overweight the well-being of future generations as compared to the well-being of the present generation. However other techniques allow the interests of the various generations to be balanced. This raises the issue of the right of the social planner to decide which generation, if any, should be sacrificed. Research on these issues is still in its infancy, and better prediction models should permit more accurate discounting and aggregation techniques.

Nunes and Onofri point out in their paper that a warm glow, altruism and other non-selfish motivations exist and matter. According to them, these have normative consequences, since they cannot be interpreted as deviations from rationality. If individuals express preferences for public goods, their altruistic motivation should be discounted on the basis of the double-counting argument. However this argument reflects the ideological *a priori* view that individual selfishness is superior to altruism. This is debatable. It has in any case a double impact, both on the choice of aggregation technique and on the social discount rate, which should reflect the relative weight given to each generation's preferences. The paper by Richter and Van Soest makes a similar argument. These authors provide a review of the evidence, gathered from both the laboratory and the field, about the fact that widespread voluntary contributions to environmental goods exist. The micro-foundations of such behavior can be grounded in the reputational benefits coming from signaling pro-social attitudes to the community, and in its impact on the beliefs in the community about the value of cooperation.

There is no reason, then, to dismiss this fundamental orientation of human beings in favor of their community when actual decisions have to be made.

3.3. Complex Individual Motivations and Institutional Design

Social preferences represent a major challenge to the design of environmental policy instruments. The current instruments and targets were designed using the standard behavioral assumptions of welfare economics, i.e. selfish preferences. If altruistic preferences are widespread, and if this component of individual preferences is non-negligible, standard policy instruments will usually fail to reach their objective, since private costs and benefits will be misrepresented. For example an agent with a strong altruistic orientation will bear costs and enjoy benefits in excess of those deriving from the selfish dimension of his or her preferences. Misrepresentation of social preferences can lead to adverse outcomes from policy implementation, such as lower contributions to the provision of a public good from incentives which were designed to increase them (Section 3.3.1). Such a crowding-out effect, is, however, often mitigated because the motivations that lead individuals to contribute to environmental public goods, and the systems that influence their behavior, are much more complex than those considered in the theory or the laboratory (Section 3.3.2).

3.3.1. The Threat of Crowding Out

The idea behind crowding out is that government spending on public-good provision may, partially or totally, squeeze out private contributions. This type of effect sometimes shows up even with altruistic preferences. Indeed, a standard result on the voluntary provision of public goods (Warr 1983), states that, for any arbitrary exogenous income, any redistribution among contributors has no influence on the aggregate supply of public goods. This neutrality theorem has been extended by Bergstrom, Blume and Varian (1986) and Iritani & Yamamoto (2004). Bergstrom et al. showed that redistribution from the rich to the poor might even decrease the total amount of public goods provided. Another neutrality result, public-debt neutrality, also known as the Ricardian equivalence theorem, applies to intertemporal resource allocation. The idea, developed by Becker (1974) and Barro (1974), is that any attempt by the government to reallocate resources across generations is neutralized by an opposite reshuffling by households through their altruistic bequests. Considering a society consisting of altruist and non-altruist households that all contribute to the public good, Jovet et al (2000) show that neutrality still holds for any intra- and inter-generational redistribution of income by public authorities.

What happens to private contributions under altruistic preferences? Do altruistic agents provide more public goods because they care about the impact of the public-good provision

on others' well being? The tentative answer is 'yes'. If agents have altruistic preferences, their marginal utility from providing the public good is greater, and therefore they will make a larger contribution to the public good. But complete crowding-out still occurs. In a more general setting, this is because an increase in other's income (and utility) is compensated for by a reduction in individual contributions, since the agent equalizes his or her own marginal utility to the altruistic part of others' utility.

If crowding out is complete, any policy designed to increase a global public good, based on income transfers between agents, will fail to achieve its objective. The question is therefore, when can we neglect crowding out? There are at least two situations in which crowding out will be limited: when impure altruism or warm glow is a factor, and when there are non-linearities in the production of the public good. The first situation has been extensively investigated in the theoretical and experimental literature (see Andreoni 1989, 1990, 1993; Bolton and Zwick 1998; Eckel, Grossman and Johnston 2005). Impure altruism means that agents derive utility from the act of giving: they do not care about others' utility, but about their own utility gain from giving (which can be therefore interpreted as a private good). Therefore, even if they have a low income and others have more, they still contribute to the public good, because they get utility from giving. Such impure altruism leads to partial crowding-out, an outcome which is compatible with most empirical findings, both from the field and from various types of experiments.

The second reason is non-linearity in the production of the public good. Take the example of a step-level public good or an open-access renewable resource with a critical reproduction threshold. Income redistribution might reduce some agents' contributions, and therefore prevent the total contribution reaching the level it attained before the redistribution.

The chapters in the third section of this book provide useful insights into how an understanding of the complexity of the determinants of human behaviors may help in the design of appropriate policy tools to get individuals involved in the production of environmental goods. Nunes and Onofri point out that warm glow, altruism and more generally not purely selfish behavior lead us to recognize that there is no systematic tragedy of the commons. Public goods might be produced because individuals contribute spontaneously, even in the absence of the social pressures highlighted by Ostrom. Of course the efficient level may not be reached in this situation. The question then becomes whether incentive policies would be better or worse than the *laissez faire* situation. At least, incentive policies should avoid crowding-out. Van Soest and Richter discuss this extensively in their chapter.

From the perspective of the implementation of environmental policies, the chapter by Richter and Van Soest has two implications. The first is that, when formulating policies, the impact of

various incentive schemes and regulations on the costs of signaling, and on the beliefs that prevail in the community, must be acknowledged. They show that policies that are perceived to be legitimate and supported by the community tend to favor the mutual reinforcement of formal and informal institutions in the provision of public goods. This leads us to reconsider, in a more favorable light, the potential benefits of the participation of communities and stakeholders in the design of environmental policy. The second implication is that the choice of policy institutions may, through its impact on the development of belief systems, have implications for the extent to which environmental policies are supported by communities and stakeholders. Acknowledging this is particularly important in situations where voluntary behavior by individuals and organizations makes an important contribution to the effective provision of environmental goods.

Richter and Van Soest's contribution is followed by Pascual and Ishihara's, which questions the legitimacy of incentive policies. If individuals do not spontaneously contribute to public goods, who is entitled to encourage them to do so? What is the basis for the 'collective interest' that is apparently being pursued? This chapter suggests that the formulation of objectives cannot be separated from the implementation of the resulting policy. Formulation and implementation should, in a sense, be jointly negotiated, since it should be clear that conflicting interests are at play at both stages, and that the identifications of issues and the possibility of collectively enhancing solutions cannot logically be separated and dealt with independently from each other.

3.3.2. Altruism, Long-Term Thinking and Compliance

More generally, taking the complex motivations of individuals into account leads to a better understanding of how actual policies should utilize various imperfect tools to manage the processes of institutional design. For instance, the presence of a strong altruistic norm in favor of future generations might be used to establish constitutional rights for future generations. Voters or members of a collectivity, who might not be willing to show enough restraint when their income is immediately affected, might — as survey data indicates — nevertheless vote for a general rule. In other words, because of the presence of the altruistic norm, it may be possible to change the structure of the situation into a coordination problem. Institutions that positively value the altruistic norm (churches, etc.) will have a positive influence on the stability of the coordination equilibrium. Compliance with principles derived from the logic of sustainable development, can only be achieved by combining the enforcement of formal rules with adherence to informal norms of behavior. The adoption of new institutional arrangements frequently requires an actual change in behavior. But characterizing compliance as pure obedience would miss the broader point that actors commonly share and accept the rules, and so make the rule their own. This internalization of

the norm encourages actors to accept the primacy of the common good over their individual objectives (Tyler 1998: 271).

There is an important distinction to be made between calculated motivations for compliance and normative motivations (Burby and Paterson 1993; Winter and May 2001). In the first case, compliance is determined by calculating the expected positive or negative outcomes from following or disobeying a rule. The main drivers of this expectation are the likelihood of being detected breaking the rule, the size of the punishment or reward, and the credibility of the threats of punishment. There is overwhelming empirical evidence that strengthening enforcement produces higher compliance (Nadeau 1997). More formal rules generate greater compliance, as they increase both transparency and the probability of being convicted (Almer and Goeschl 2010). Concern about incurring respect or opprobrium from other members of a group also plays a role.

4. Designing Incentive Mechanisms under the Constraints of a Socio-Political Game

As has already been shown in section 2 previously, letting countries decide on their own results in a situation where each tends to ignore its impact on the others has important consequences for the design of appropriate incentive mechanisms. Two positions to address this issue can be envisioned. One is to try the property-rights solution. The other is to design a mechanism so that a market for GPGs is created. The role of complex motivations and the logic of socio-political games highlighted above further constrain the possible choices in the design of incentives.

4.1. The Difficulties and Dilemmas When Creating a Property Right System

Because they internalize externalities and potentially eliminate them, property rights can be a viable way of solving some of the problems of the global commons. If perfectly defined and enforced, they match the social benefits and costs of the decision maker so that excessive extraction, pollution or harvesting does not take place. They can evolve bottom-up under international law; however, where transaction costs preclude this process, property rights can be created top-down. Property rights involve issues of allocation, measurement, boundaries and enforcement; these factors can be used as an instrument to address global externalities.

The assignment of property rights to address open access entails the most direct and transparent assignment of benefits and costs, but requires costly allocation, boundary and enforcement policies. Any meaningful property right involves exclusion, potentially producing distributional conflicts. Further, the right may become more valuable for any number of

reasons, so that ownership brings new wealth, status, and political influence to those who secure the property rights, changing existing social and political positions and inciting controversy that may be costly to politicians. Finally, constituencies that benefited from the previous regulatory arrangements are likely to be disadvantaged by any new rights system. Inefficiencies generate their own constituencies for keeping things as they are. Demsetz (1967) suggested a smooth process of the emergence of property rights as resource values rose, offsetting the costs of definition and enforcement. But experience suggests that the process of institutional change is more complex than he envisioned. Allocation is contentious because of the assignment of wealth and political influence associated with exclusive property rights. Political conflicts and negotiations determine the arrangements that ultimately emerge, their timing, and their effectiveness. Therefore, the political creation of property rights attracts rent-seeking efforts to influence their distribution. Such efforts can be costly in themselves.

As Coase (1960) emphasized, allocation rules are always important for distribution and they affect efficiency in the presence of transaction costs. Prior use is the dominant method worldwide of establishing property rights. It assigns ownership to the entities that implicitly and freely exercised the right prior to the introduction of the policy that created scarcity. Prior-use rules are attractive because they recognize incumbent parties, who will be important constituents in any distribution of property rights, if for no other reason than their concern about past investment in specific assets, which could not otherwise be deployed to any other use. The incumbents will also inevitably be the highest-valued users after the initiation of the policy (as shown in chapter 12 grandfathering in the allocation of initial pollution permits has been a necessary ingredient in building political support). Moreover, prior-use rules do not undermine efficiency. They create opportunity costs that will lead recipients to treat these rights as a valuable asset and to use them judiciously, including innovation and experimentation with ways to use the resource efficiently in response to the new cost. Further, under prior-use arrangements the pre-policy market determines the optimal claim size, whereas under other allocation systems bureaucratic or political objectives define the assignments. If these are not consistent with optimal production size then further trade is required, and if transaction costs are high, such exchange may be limited.

Equal-sharing rules avoid the distributional concerns associated with prior use and reflect egalitarian goals better. If there are no restrictions on the subsequent exchange of property rights, and transaction costs are low, there are few efficiency implications. The resource still migrates to high-value users. Uniform allocations also avoid the measurement costs of verifying claims of past production or use, and of documenting precedence claims that are part of prior-use assignments. They can also avoid the inefficiencies caused when prior use

is known to be the allocation rule. Lotteries are examples of uniform allocations because each claimant is given an equal, random chance in the assignment of rights to the resource, and the allocation is generally partitioned equally among the lottery winners. Uniform allocations via lotteries are most effective when applied to new resources where there are no incumbent claims and all parties are relatively homogeneous. They can also be used when the access and use rights granted are short-term, such as with lotteries for annual hunting licenses.

A third allocation mechanism is auction. Auctions can place assets directly into the hands of those who place the highest value on the asset. It thereby avoids the transaction costs of re-allocation. Auctions also generate resources for the state and avoid the windfalls that might be considered unearned and divisive. Auction returns can be used to cover the costs of defining and enforcing property rights and other costs of resource management, as well as a wide range of other social uses including the reduction of distortionary taxes on factors of production. As with lotteries, auctions work best for new, unallocated resources where there are no incumbent claimants. Incumbents naturally resist auctions for the allocation of rights, because they are forced to pay for something they believe they are already entitled to because of their prior use. For this reason auctions have not been used as often as recommended by economists. Auctions can be used in conjunction with other allocation arrangements to provide an adjustment margin when some parties are not allocated sufficient property rights for efficient production, and the transaction costs of gaining additional increments from others are high.

This discussion of allocation mechanisms suggests that there is an underlying collective action problem associated with the definition and assignment of property rights. The main issue is that they involve high resource and political costs relative to their expected gains. These issues become even more problematic when there are multiple parties claiming a stake in the resource. Open access is then often a self-sustainable equilibrium from a political standpoint, even when it entails inefficiencies and resource depletion.

Collective action, which may have previously been impossible, can become more likely when a crisis occurs. New information emerges about the severity of the problem, reducing uncertainty and measurement costs, and eliminating information asymmetries; the resource becomes more valuable (perhaps due to its greater depletion), increasing the benefits of action; new technologies or techniques are developed to lower the costs of closing the externality; and the number of parties declines as the private returns to exploitation fall.

For these reasons, just as in the national political arena, politicians have incentives to delay action until there is a crisis, and the open-access problem is serious enough to generate the information needed to make the distribution of costs and benefits across and within countries

and constituencies clear. At that time politicians are better able to mobilize political support for international action that entails both costly production adjustments as well as paying (or receiving) internal and external transfers to mobilize collective efforts.

Garry Libecap's chapter elaborates these issues. It shows that even in some of the simplest problems (local common-pool resources), the establishment of property rights results in serious shortcomings. There is often a war of attrition between the various stakeholders who all want to have the other pay the cost of the privatization process. Thus the establishment of property rights is late, in the sense that over-exploitation and mismanagement of the resource have already happened. Sometimes, property rights are implemented too late to prevent resource depletion. Moreover, to build political support, politicians mold the assignment of property rights in a manner that achieves other distributional objectives or meets the demands of those who claim to be harmed. These adjustments, which attenuate the property rights that are granted, weaken the ability of the rights regime to reduce the losses due to the over-exploitation and mismanagement of the open access resources.

4. 2. Mechanism Design: Playing off the cushion

The property-rights approach rests on the possibility of excluding agents from the benefits of a commodity, unless they have a specific right to enjoy it. But sometimes excludability is not possible or is too costly or difficult to implement. In these situations an outside intervention is necessary. Since an externality can be viewed as an unpriced commodity, another possibility would be to create a market for this externality. This second position has been termed the mechanism-design solution.

This idea has led to a broad literature on the use of economic incentives to reach environmental goals. The term 'economic' is usually reserved for incentives that specify a particular goal, but leave it to market participants, via financial incentives, to decide how that outcome is to be reached. This is why environmental taxes and emission trading are traditionally considered as examples of market- or incentive-based instruments. However, if this notion is taken literally, more traditional legal policy instruments, such as liability rules and regulation are also incentive-based in the sense that they provide incentives to market participants to reach a particular policy goal (such as reducing specific emissions). The main difference is usually in the amount of flexibility allowed and in the sanctions applied if the particular goal is not reached. This is addressed in the chapter by Michael Faure, which presents a cost/benefit analysis of the various instruments of regulation in the hands of public authorities. His analysis of the toolbox shows that none of the instruments is perfect, and a combination of them is therefore needed.

In Chapter 13, Graciela Chichilnisky proposes the creation of global and sustainable funding mechanisms to provide global public goods. This is in fact an extension of the Kyoto Protocol's carbon market, and it is based on the same assumption as Ben Groom, Rupert Gatti, Timo Goeschl and Timothy Swanson employed: environmental resources are less a patrimony to be preserved, than a public good to be produced. Therefore she develops the idea of devising mechanisms to produce these goods. Chichilnisky's propositions are founded on the fact that environmental public goods can often be produced jointly with other goods. This is well illustrated by the biodiversity issue. The provision of clean and drinkable water to an increasing urban population can be based on natural filtration techniques, which require natural spaces, and especially forested areas. Forests are both carbon sinks and biodiversity reservoirs. Thus the revenues generated by the provision of water to cities (and to agriculture) can be socialized to fund re-forestation and to support the populations leaving in forested areas. The same types of synergy apply to the provision of many global resources — forests, water, biodiversity, the hertzian spectrum, etc. — so that several mechanisms have to be employed to ensure that they are exploited in a sustainable and risk-free manner. Setting aside the diplomatic and political difficulties of reaching a global agreement on this, Chichilnisky, focuses on the technical issues. She suggests the creation of public-private corporations to exploit the various services she identifies as marketable. The distribution of bonds and shares in these corporations should allow the distribution issue to be managed (e.g. by granting shares to indigenous communities), while their sale will provide revenue for the huge investments in infrastructure and R&D that will be necessary. Thus new types of international organization, grounded on a market and property-rights logic, should emerge to allow the self-funded and sustainable provision of global public goods, and to effectively recognize the legitimate and current property of all nations, large and small.

However such mechanisms can be subject to several failures due to, for example, the interplay between different levels of governance or insufficient consideration of the social norms that can play a critical role in a government's decision about whether or not to comply.

4.2.1. Vertical integration of policy instruments

One key issue that must not be overlooked in considering multi-layered governance is the potential interplay between policy instruments that may be implemented at different levels. These instruments may conflict with each other, and potentially destroy each other's effectiveness. The solution is multi-level coordination. This issue has been partially addressed in the literature, and there are three main strands. The first concerns policies that have a harmful impact on the environment. This usually results from the fact that their impact on pollution has been completely ignored (OECD 2007). The second strand is devoted to fiscal policy and explores how implementing a carbon tax without taking pre-existing taxes

into account may be sub-optimal (Goulder and Wendner 2008). Lastly, recent studies have paid attention to the interplay between supra-national regulations, such as markets for tradable permits, and national fiscal policies. They have shown that such interactions are sources of inefficiencies and that promoting higher-level regulation without lower-level harmonization may not be optimal (e.g. Santore et al. (2001) for the US sulfur-dioxide market and Bréchet et al (2007) for the EU's emissions trading scheme).

4.2.2. Social norms

One question refers to the motivation for engaging in international environmental policy. Social norms may play an important role not only in the explanation of individual behavior, but also in the decisions of national governments in the diplomatic arena (Hoel and Schneider, 1997). Governments may fear being labeled as opportunistic and non-cooperative, and therefore sign and stick to an environmental convention, even when, in purely economic terms, free-riding pays off. Formally speaking, taking such motivations into account amounts to expanding the set of arguments in the utility (or welfare) functions of the players. This non-environmental cost is likely to be higher the larger the number of cooperating countries. Psychosocial interventions are essential to deliver the widespread changes in social norms needed to initiate the changes in the economy and in life styles that are essential to address global environmental issues.

The chapters in this last part of the book show that the various mechanisms and allocation rules for collective action all have some imperfections. Regular assessment of the contributions of the various implementation mechanisms is important, as is democratic debate about these evaluations, and forms of reflexive governance involving communities and social networks in the implementation frameworks.

Conclusion: The Challenges of Polycentric and Networked Governance

Taken together, the distinctive features of the governance of environmental issues analyzed in this book call for innovation in the nature of systems of governance. We have explored the character of two promising trends which have been developed as an answer to the shifting demands on for governance — decentralized networked governance in federal systems and global environmental governance — and asked a series of questions about the capacity of these forms of governance to handle a range of concerns relating to scale, time, and uncertainty.

Decentralized (or polycentric) networked governance has been extensively studied (Haas 2004; Ostrom 2001; Reinicke and Deng 2000; Hajer and Wagenaar 2003; Slaughter 2004). It

can be characterized as an attempt to take into account the increasing importance of NGOs, the private sector, scientific networks and international institutions in performing various governance functions. The aim of networked governance is to foster synergy between different competences and sources of knowledge in order to deal with complex and interlinked problems. In this perspective, governance is accomplished through decentralized networks of private and public actors associated with international, national and regional institutions.

However, as we have seen, such a mode of governance is insufficient in cases of systemic change. Here, individual networks may act in ways that run counter to the actions of others, because of the interdependencies. For example, under the Montreal protocol, China could start producing CFCs, while other countries were cooperating to reduce their production. Global environmental governance is the answer to the problems raised by functional interdependencies on the global scale.

A particular interesting example of global governance illustrating these trends is the Earth System Science Partnership (Bierman 2007). In 2001, four global change programs — DIVERSITAS, the International Geosphere-Biosphere Programme, the World Climate Research Programme, and the International Human Dimensions Programme on Global Environmental Change — joined forces to intensify their cooperation through the establishment of an overarching Earth System Science Partnership. The research communities represented in this partnership contend that the earth system now operates ‘well outside the normal state exhibited over the past 500,000 years’ and that ‘human activity is generating change that extends well beyond natural variability — in some cases, alarmingly so — and at rates that continue to accelerate’ (*Ibid.*). To cope with this challenge, the four global change research programs have called ‘urgently’ for ‘an ethical framework for global stewardship and strategies for Earth System management’ (Steffen et al. 2004).

Decentralized or polycentric networked governance and global environmental governance are emerging as innovative responses to the collective action problems raised by environmental goods and the need to address them by the creation of a global order. They share two important features: the recognition of the role of hybrid networks composed of state and non-state actors (civil society, community organizations, non-profit organizations, industry associations) in the provision of different types of collective goods, on the one hand, and the attribution of a new role to the government, on the other (Delmas and Young forthcoming).

In the case of decentralized or polycentric networked governance, the new role of governments can be understood as a facilitator of network dynamics. In the past, the role of the government in the regulation of networks was mainly restricted to the management of

negative externalities, generated by the capture of rents in network industries, for example. The rents and the externalities are still there, but the activities of networks have to be increasingly situated in a complex web of interdependencies with both positive and negative impacts. In this new context, governments have to both manage negative externalities and facilitate the generation of positive network effects such as the provision of collective goods. As a consequence, governments have been increasingly involved in activities such as the stimulation of social learning, the building of adaptive capacities, support for research into standardization, and other issues of common concern. In the case of Earth system governance, global governance arrangements are created which place new constraints on member states. These can take the form of new independent authorities of last resort, such as independent dispute resolution authorities, global funding schemes, or a set of coordination and information instruments. In this context, states become intermediary players between demands and constraints from lower level constituencies on the one hand, and the global order composed of different state and non-state actors on the other. This leads to a more differentiated global governance system, where collective the preferences of states play an increasing role in various forms of common, but differentiated, responsibility.