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Governing Atmospheric Sinks: The Architecture of Entitlements in the Global Commons

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Abstract

This paper revisits key works on the management of common-pool resources under common property arrangements, in order to elicit a broader notion of *collective ownership* and to suggest a model for analysing institutional arrangements that govern the use of large-scale environmental resources such as biodiversity and atmospheric sinks. The paper examines the emerging governance framework for global atmospheric sinks to exemplify the use of the model. The paper indicates how crucial parts of the institutional framework for governing atmospheric sinks are still missing, a shortcoming which maintains the "tragedy of the commons" in the use of atmospheric sinks. The paper suggests that a workable governance solution for global atmospheric sinks has to 1) cap the use of atmospheric sinks; 2) provide for a more equitable benefit sharing; 3) provide for compensation of climate change impacts and assistance for adaptation to climate change impacts; and 4) create institutional solutions for enhancing participation in environmental decisions in order to guarantee progress in and legitimacy of the governance framework.

Keywords

environmental governance, common-pool resources, atmospheric sinks, climate change, institutional analysis

> On the global scale, nations are abandoning not only the freedom of the seas, but the freedom of the atmosphere, which acts as a common sink for aerial garbage.
>
> (Garrett Hardin 1998, 682)

1. INTRODUCTION

Scholars working on small-scale common pool resources such as pastures, forests and fisheries (e.g. Berkes, 1989; Ostrom, 1990), and scholars studying large-scale environmental resources such as high seas, biodiversity and atmospheric sinks (e.g. Miles et al., 2002; Young, 1997) have something in common: an interest in institutions that govern environmental resources. But these two groups of scholars have approached institutions from slightly different angles. The more interdisciplinary scholars working on smaller-scale resources have shed light on the implications of institutional solutions for collective action in user groups, while scholars of international relations and human dimensions of global environmental change working on larger resources have examined how the institutional design of governance solutions and linkages between solutions influence the effectiveness of governance solutions in attaining their intended outcomes.

This paper revisits some of the key works on the management of common-pool resources under common property arrangements (Berkes, 1989; Bromley, 1992; Bromley and Cernea, 1989; McCay and Acheson, 1987; Ostrom, 1990; Schlager and Ostrom, 1992), in order to

elicit a broader notion of *collective ownership* which can be used as an analytical concept to describe and analyse institutional arrangements that govern the use of environmental resources such as water and air quality, biodiversity and atmospheric sinks (Paavola, 2006). Large-scale environmental resources such as these are typically governed by formal legal institutions such as national environmental policies or international environmental conventions. The paper demonstrates that these arrangements can be usefully characterised as particular forms of collective ownership, and that many observations about the design of successful common property arrangements also provide useful insights into the design of these formal environmental governance institutions (see also Keohane and Ostrom, 1995).

The paper examines the governance of atmospheric sinks for greenhouse gases (GHGs) to exemplify the usefulness of conceptualising formal environmental governance institutions as collective ownership arrangements. The paper discusses the attributes of atmospheric sinks for GHGs and their users, indicating that the main challenges in governing these sinks are to constrain resource use, distribute costs and benefits of resource use, and to eliminate free riding. The paper then outlines the main solutions of the international multi-level governance framework for atmospheric sinks of GHGs and contrasts them with the observations made in the literature on the design principles of successful common property arrangements. The paper indicates how crucial parts of the governance framework are still missing and that it has not overcome the "tragedy of the commons" in the use of atmospheric sinks of GHGs (see also Adger et al., 2006; Paavola, 2005a; Paavola and Adger, 2006). Entitlements to the use of atmospheric sinks of GHGs have not yet been adequately formalised and remain based on capture. Other key problems in the governance of atmospheric sinks include unequal distribution of benefits from the use of atmospheric sinks and the inability of affected parties to participate in decisions that affect them (Paavola, 2005).

The paper suggests that the governance solution for global atmospheric sinks has to 1) cap the use of atmospheric sink – instead of only prescribing relative cuts in its use as in the Kyoto Protocol – in order to create a basis for exclusion; 2) provide for a more equitable benefit sharing by introducing responsibility for the adverse impacts of greenhouse gas emissions through carbon taxation or other means; 3) provide for compensation of climate change impacts and assistance for adaptation to climate change impacts; and 4) create institutional solutions for enhancing participation in environmental decisions, particularly across the levels of governance, in order to guarantee progress in and legitimacy of the governance framework (see Adger et al., 2006; Paavola, 2005; Paavola and Adger, 2006).

In what follows, the paper will first forward a notion of collective ownership. Then the paper will suggest a way to examine the institutional design of all governance solutions. The following sections will discuss atmospheric sinks as resources and examine the framework that exists for their governance. The paper concludes with a discussion on the shortcomings and development needs of the governance framework.

2. FROM COMMON PROPERTY TO COLLECTIVE OWNERSHIP

As I have explained in greater detail elsewhere (see Paavola and Adger, 2005; Paavola, 2006), environmental governance should be understood broadly so as to include all institutional responses that are used to resolve conflicts over environmental resources. This definition eliminates the distinction between "governance" and "government" in environmental matters which is prevalent in the contemporary literature. The broader conception of institutional responses that are available for resolving environmental conflicts

invites us to explain why solutions not involving the state are used to respond to some environmental conflicts, and why solutions based on the central role of the state prevail in others. The key conceptual argument that I seek to advance in this paper is that all environmental governance solutions from common property to national environmental and natural resource policies and international environmental conventions can be understood as forms of ownership, and that doing so helps to appreciate the full range of state-based and other solutions and to examine their implications for governance outcomes.

Debates on property regimes offer the best starting point for my argument. For two decades after Hardin's (1968) damning analysis of the commons, the nationalisation or privatisation of natural resources seemed as the only alternatives in resource tenure. In the 1980s scholars working on common property arrangements made counter-arguments to Hardin's analysis which, together with the accumulating empirical evidence, legitimated common property as a viable form of resource tenure (Bromley and Cernea, 1989; Ostrom, 1990; Runge, 1986; Wade 1987, 1988). The established view became that four property rights regimes exist for governing the use of natural resources: open access or *res nullius*, common property, state property and private property (Bromley and Cernea, 1989; Bromley, 1992b; Hanna, Folke and Mäler, 1996). At this juncture, *res nullius* and ineffective state property regimes became the culprits for resource degradation and depletion.

However, many common environmental governance solutions such as national environmental and natural resource policies do not fit conveniently to the typology of property regimes. Moreover, "state property" does not have a clear meaning. On one hand, the state can hold private property rights to some resources and alienate them at its will. On the other hand, the state can manage certain resources on behalf of people as if holding them in public trust, without legitimate authority to alienate them (Sax, 1970; Rose; 2003). This is an example of collective ownership not unlike common property. Thus the concept of "state property" should be abandoned. The concept of "common property" should in turn be understood broadly so as to include all forms of collective ownership, including environmental governance regimes constituted by national environmental and natural resource policies and international environmental conventions.

Thus a typology of governance regimes should distinguish between *res nullius*, collective ownership and private ownership. Private ownership vests comprehensive decision-making authority in the owner, who can alienate the owned resources on the market (see Cole, 2002). Forms of collective ownership do not usually constitute a right to alienate the resource at all and lesser rights are often inalienable collective or individual rights. However, the distinction between private and collective ownership is often far less stark. Private ownership can be vested in "collectives" such as firms, which face the same collective action problems as communities or other organisations as collective owners. Moreover, rights created by collective ownership can be held individually and sometimes are transferable. For example, usufruct rights, under which agricultural land has often been held, can frequently be bequeathed across generations. Some rights, such as water rights under the Spanish *Huerta* arrangements described by Ostrom (1990: 69-82) or land rights among the Waluguru in Tanzania (Young and Fosbrooke, 1960), can also be transferable within the community.

Many environmental and natural resource policies can be understood as forms of collective ownership. For example, water and air pollution control regulations determine to what extent polluters can use air basins and watercourses for depositing wastes. At the same time, they define the right of other users to be free from greater pollutant concentrations. These

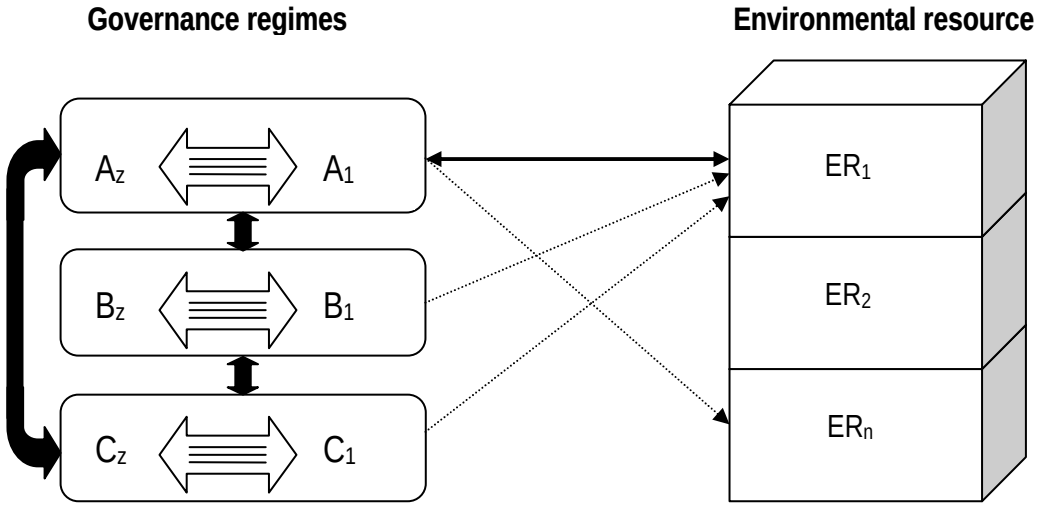
entitlements resemble usufruct rights of common property arrangements in that both are attenuated and non-transferable. Environmental taxes and charges constitute collective ownership where administrative prices are used to allocate environmental resources. Trading systems, such as the one established in the United States to govern SO_2 emissions under the Clean Air Act, constitute a form of collective ownership (Rose, 2002; Tietenberg, 2002) which is not fundamentally different (apart from obvious differences in scale and formality) from trading irrigation water within common property arrangements (Ostrom, 1990).

But all environmental policies are not constitutive of collective ownership: private ownership also plays an important role. Payments for ecosystem and conservation services confirm private ownership of environmental resources that generate sought-after benefit streams. These payments are not subsidies although they are often mistakenly considered as such: they are prices paid on the market for the private provisioning of environmental goods and services. Other policies, such as those requiring insurance coverage for oil spills and other environmental hazards, in turn confirm these risks as private property and create a market for pricing and exchanging them. Many new informational and voluntary policy instruments such as eco-labels and certified management systems (see Dietz and Stern, 2002; OECD, 2003) constitute good environmental performance as intangible private property.

The revised typology of property regimes still fails to capture the complexity of contemporary environmental governance solutions. One reason for this is that property rights are usually understood as bundles of rights held by the owner(s) vis-à-vis other agents. This viewpoint is appropriate for understanding how institutions structure human behaviour but it does not characterise institutional solutions that govern the use of particular environmental resources. Many environmental resources such as bodies of water facilitate multiple uses, and a variety of agents can hold entitlements to different aspects of the same resource simultaneously (Figure 1). For example, in India complex systems of land rights have distinguished the rights of farmers to cultivate land from the rights of pastoralists to grazing after the growing season (Chakravarty-Kaul, 1998). In many parts of Africa, ownership of land is distinct from the ownership of trees: land belongs to clans but fruit and other trees planted and tended by individuals belong to them (e.g. Young and Fosbrooke, 1960).

Many contemporary environmental governance solutions also create complex systems of rights. In market economies, the use of land is partly governed by private ownership and markets. In figure 1, this is represented by the regime C. However, forest policies define aspects of forested land as a distinct resource and establish a layer of institutional rules which qualify the authority of private owner over it. In figure 1, this is represented by regime B. Game and wildlife policies establish another layer of institutions (A) that define game and wildlife a distinct resource and establish rules for its governance. Still further layers of institutions exist for the governance of sub-soil minerals, ground water, historical heritage, landscape amenities and biodiversity. Water resources, the coastal zone, air basins and atmospheric sinks are similarly governed by a conglomerate of governance institutions. That is, many environmental resources are governed by institutional frameworks that consist of overlapping institutions established for the pursuit of different governance goals with regard to different dimensions of resource systems.

Figure 1. Governance regimes and environmental resources



This kaleidoscopic picture of resource rights and governance arrangements may not appeal to those who promote exclusive and non-attenuated private ownership of environmental resources. Their argument has been that private property rights maximise the value of resources and ensure that they are allocated to their most highly valued uses (Posner, 1992: 33-34). However, property rights and governance systems are costly to establish and maintain and thus the value of a resource sets limits to how costly its governance solutions can be (Bromley, 1989: 15-18; see also Dahlman, 1980). This line of reasoning suggests that some resources remain ungoverned because they generate too low benefits or entail too high governance costs. When resources offer greater benefits or entail lower governance costs, they may support a common property regime. When benefits increase or governance costs decrease still further, resources can support private property rights.

But private property rights are not necessarily the pinnacle in the evolution of governance institutions: the theory merely suggests that it becomes affordable to define rights in a greater detail when a resource becomes more valuable. Private property rights vest the private owner with the authority to refine and alienate rights to dimensions of the resource. But this is only one way to specify resource rights in greater detail, one not particularly attractive when transaction costs are high and prevent the emergence of markets for rights to dimensions of the resource. An alternative is to form new layers of collective ownership which specify new usufruct or regulatory rights to dimensions of the resource. Complex governance systems involving overlapping institutions can thus have a solid economic explanation: they can reflect the high value of environmental resources and help to realise a broad range of diffuse benefit streams (see Balmford et al, 2002; Turner et al., 2003).

Despite clarifying some conceptual issues, distinctions between *res nullius*, collective property and private property are not sufficiently detailed to help make concrete claims about the institutional design of governance solutions and their performance. In what follows, I will discuss how the institutional design of governance solutions can be analysed in greater detail.

3. INSTITUTIONAL DESIGN OF GOVERNANCE SOLUTIONS

I suggest that all environmental governance solutions constitute either private or collective property, and that the institutional design of governance solutions has three core aspects. These include 1) functional and structural tiers; 2) governance functions and their organisation, and 3) formulation of key institutional rules. These aspects of institutional design have significant implications for governance outcomes such as the range, magnitude and distribution of benefit streams that are obtained from environmental resources. In what follows, I will briefly discuss the three aspects of institutional design.

5.1 Functional and Structural Tiers of Institutions

Governance institutions have three functional tiers which are governed by corresponding rules. For example, Kiser and Ostrom (1980: 208-215) and Ciriacy-Wantrup (1971: 44-46) discuss the "three worlds of action" and the "three-level hierarchy of decision-systems". At the "operational level", individuals make choices within the constraints of "operational" rules which define their choice sets. A decision to catch fish within the constraints set by regulations regarding approved gear or catch is an example. At the "collective choice" level, authorised actors make collective choices such as whether to take an enforcement action against a fisherman who has been detected using disallowed gear. These decisions are based on "institutional" rules. Finally, decisions regarding the authority of collective actors and the procedures they are supposed to follow form the "constitutional" level of action. Accordingly, these decisions are governed by "constitutional rules".

However, operational, institutional and constitutional levels refer to institutional *functions* rather than to the vertical *structure* of governance solutions. Some governance solutions such as customary common property arrangements exhibit all three functional levels while being frequently based on single-level or *uniplanar* institutions. However, today many governance solutions have both the three functional levels and a multi-level structure. For example, the U.S. Clean Water Act directly establishes many rules of water use, but it also provides for the establishment of state-administered permit programs under which permit conditions are set for individual polluters. Constitutional, institutional and operational levels exist both at the federal and state level of governing water quality.

Multi-level governance solutions may emerge because an upper level of governance solutions are established to coordinate lower-level solutions, or because a lower level of governance is established to implement higher-level strategies. There are instances where federations and over-arching institutions have been created through bottom-up processes to coordinate the functioning of local governance solutions (Ostrom, 1990; Sengupta, 2004). The opposite, top-down process creates many formal multi-level governance solutions. Many federal environmental and natural resource policies provide for or mandate the establishment of state programs in the United States. European Union's Birds and Habitats directives also require both national legislation and local solutions for the governance of biodiversity (Paavola, 2004b). The United Nations Framework Convention for Climate Change (UNFCCC) similarly requires national actions, programs or solutions for the purposes of planning, coordination and implementation (Paavola, 2005a).

The bottom up and top down processes both usually generate institutional structures where the governance solutions with a smaller jurisdiction are nested within the solutions with a larger jurisdiction. But this is not all that there is to multi-level governance solutions. As will

be explained in greater detail in the next sub-section, all governance solutions perform certain generic governance functions such as exclusion and provisioning. Multi-level governance solutions may emerge to realise economies of scale or scope in the implementation of these governance functions (see LeQuesne, 2005). That is, governance functions may be implemented at different levels of governance and that different levels of governance are functionally complementary, instead of just being nested. There are always "degrees of freedom" between the levels of governance in multi-level solutions. At lower levels, the surrounding institutional framework has an impact on what the effective institutional and operational rules are. Moreover, the way in which operational, institutional and constitutional choices can be made and the authority and responsibilities conferred to actors at different levels vary according to adopted institutional solutions.

5.2 Governance functions

When discussing common property arrangements, Schlager and Ostrom (1992) distinguish between "ownership functions" and "management functions" (see also McCay, 1996). I suggest (see Paavola, 2006) that a more detailed and analytically useful typology of governance functions can be distilled from the lists of common features of successful governance solutions presented for example by Ostrom (1990: 88-102) and Agrawal (2002). On the basis of these lists, generic environmental governance functions include:

1) exclusion of unauthorised users;
2) regulation of authorised resource uses and distribution of their benefits;
3) provisioning of rival and non-rival goods and recovery of their costs;
4) monitoring of resource users;
5) enforcement of the rules of resource use;
6) resolution of conflicts over resource use;
7) collective choice for the modification governance solutions.

Different governance solutions organise these governance functions differently. In a small, customary common property regime, resource users are often members of a community such as a village or a fishermen's association which makes, enforces and adjudicates the rules of resource use. The community performs all governmental functions without separation of powers and the resource users have a possibility for direct participation in environmental decision-making affecting them. Resource users may also themselves perform some governance functions such as the exclusion of unauthorised resource users and monitoring of the compliance with rules of authorised resource use.

Formal national policies entail deeper division of labour between governmental organisations and multi-level solutions may organise different functions at different levels. General-purpose legislatures make some of the collective choices at the local, state or federal levels while delegating others to be made in specialised agencies which may involve interested and affected parties directly and/or through representation. Specialised agencies also frequently monitor and enforce rules while conflict resolution can be split between these agencies and general-purpose courts. Most contemporary environmental policies also require the resource users to practice self-monitoring and reporting. International environmental conventions are "constitutions" for special-purpose jurisdictions which have their own decision-making, monitoring and implementation bodies and designated conflict resolution processes.

Governance solutions thus perform broadly similar functions but organise them in different ways. The organisation of governance functions always has transaction cost implications. The

nature and scale of the governance problem, the institutional design of governance solutions, and its transaction cost implications influence the choice and performance of governance solutions (Paavola and Adger, 2005). For example, community-based solutions can work when the scale of the governance problem is limited and homogeneity and social capital reduce transaction costs and foster collective action among the affected and involved actors. Co-management solutions may work better when extra-local funding or transfers are involved but when implementation depends crucially on local knowledge and collective action. State-based solutions in turn require state capacity, social capital and rule of law to be effective. When different governance functions such as collective choice and provisioning are best organised at different spatial levels, multi-level governance solutions emerge.

5.3 Institutional rules

Institutional analysis should also examine central institutional rules of the above discussed generic governance functions, because their formulation has implications for transaction costs and distributive, procedural and governance outcomes. I will discuss below those rules that provide for the exclusion of unauthorised users from the resource, create entitlements to and regulate authorised resource use, provide for monitoring of resource use and structure participation and decision-making in environmental governance.

Rules of exclusion influence (together with the attributes of the resource in question) how effectively unauthorised users can be excluded. For example, early state water pollution control programs in the United States often prohibited "the creation of public nuisances" or "harmful pollution of water" (see Paavola, 2004a). The purpose of these rules was to exclude certain uses and users from the watercourses. However, it was difficult to monitor compliance with and to enforce this kind of rules – it required expensive litigation to find out whether a public nuisance had been created. Frequently this kind of exclusion rules resulted in lax (if any) enforcement. In contrast, contemporary water and air pollution policies typically contain a blanket prohibition of *unlicensed* discharges which provides a better basis for the exclusion of unauthorised users and for the regulation authorised use.

Entitlement rules are key rules in all governance regimes, because their formulation has significant implications for environmental outcomes. But their formulation also governs the distribution of benefits of resource use. For example, riparian law – which establishes common rights of riparians to the use of water in a watercourse abutted by their land – underwent several changes in the 19th century United States (Paavola, 2002b; Rose, 1994). Early in the 19th century, the doctrine of natural flow entitled riparians to undiminished quantity and quality of water. Industrialisation put pressure on the use of water resources in the following decades. The adoption of the rule of reasonable use in the late 1820s made it possible for water users to change the quantity or quality of water somewhat without legal liability for damages. In the mid-19th century, the rule of reasonable use was transformed into a balancing test, which confirmed the more valuable water use as the reasonable one and extinguished less valuable rights without compensation. This was a part of what Morton Horwitz (1977) called the capital subsidy to the industry in the 19th century United States.

Monitoring rules determine what is being monitored and by whom. For example, the 19th century common law of water rights required water users to monitor each others' water use and to actively seek the protection of their own interests when they were harmed. This was relatively straightforward as most discharges contained solids that caused obvious damages such as the clogging of waterwheels of downstream mills (see Paavola, 2002b). Water

pollution that endangered public health was not as obvious to the naked eye, which brought about water quality monitoring by government agencies. Today monitoring of compliance with federal water pollution control legislation consists of a complex mix of state and federal inspections and water quality monitoring as well as self-monitoring and reporting by the polluters (e.g. Magat et al., 1986).

Decision-making rules determine whose interests are recognised and who can participate in environmental decisions, and what are the rules and procedures that have to be observed when making decisions. These rules largely determine the procedural justice implications of governance solutions. Decision rules influence distributive outcomes as well. For example, the governance of water quality under the common law in the 19th century United States was organised so that decisions were made in the courts as a result of private litigation (see Paavola, 2002b). This granted participation in decision-making according to the ability and willingness of plaintiffs and defendants to pay for litigation. This was the primary reason for the gradual relaxation of rules of water use discussed above. Decision rules have important implications for the contemporary environmental governance solutions as well. For example, implementation, effectiveness and legitimacy of the European Union's Habitats Directive suffered when stakeholder groups angered by the lack of opportunity to participate and to voice their concerns over the designation of habitat preservation sites staged protests across the member states (Paavola, 2004b).

To summarise, the formulation of key institutional rules has implications for transaction costs and distributive and procedural justice and it influences the performance and legitimacy of governance solutions. Judgments regarding the implications of institutional rules require the consideration of the governance problem and its context because they fundamentally shape the governance challenges (Adger et al, 2003): institutional designs are just one variable which can affect governance outcomes. In practice, institutional analysis has to compare and analyse the implications of alternative institutional designs if applied to the governance problem at hand. In what follows, I will apply the above presented concepts and reasoning to the atmospheric sinks of GHGs in order to draw some lessons regarding their governance.

4. ATMOSPHERIC SINKS AS RESOURCES

I suggest that the atmospheric sink for greenhouse gases such as CO_2 can be fruitfully conceptualised as a common-pool environmental resource not unlike a pasture or an aquifer, and that doing so sheds light on both the key problems in governing atmospheric sinks as well on the design of governance solutions that could be used for the purpose. The atmospheric sink for CO_2 is a common pool resource because units of the sink are rival in consumption and because exclusion from the units is costly (e.g. Ostrom, 1990). Units of the sink are rival in use because a unit used by one actor cannot be used by another actor simultaneously. Rivalry in the use of units of sinks has often been overlooked because it appears possible to use the units without limitation – an observation which has sometimes lead to the use of public goods language with regard to sinks. However, the reason for the use of units of sinks without limitation is the difficulty of exclusion.

Sinks are best understood as stock resources which have a limited capacity to provide a flow of sink services, the units of which are rival. Some stock resources such as aquifers and fisheries have an obvious physical regeneration rate and thus a relatively well-defined capacity to generate a flow of resource units. Other sinks, such as the capacity of watercourses to deal with pollutants, air basins and global atmospheric sinks do not have as

obvious regeneration rates but they have sources of rivalry and capacity limitations all the same. These sinks are replenished by natural processes at a certain pace. They also form parts of larger resource systems catering for multiple uses (Paavola, 2006) and their use is frequently interdependent with other uses of the resource system. Therefore, the use of units of a sink is rival both within the sink use and with other uses of the resource system. Some resources may also have use thresholds which, if surpassed, may lead to the collapse of the resource system. This is in all likelihood true of the climate system (Schellnhuber and Held, 2003; Steffen et al, 2004). As Garrett Hardin (1998) reflected in the citation in the beginning of this paper, the key challenge in governing the global atmospheric sink for GHGs is the same as with all other common-pool resources: to establish a constraint for the use of the resource to prevent its destruction. A derivative task is to distribute the available resource units among the competing users.

However, the challenges of governing the atmospheric sink for GHGs and other common pool resources are also shaped by other resource attributes, particularly by the difficulty of exclusion (see Ostrom, 1990). Greenhouse gas emitting activities range from the operation of large coal and natural gas powered electricity generation plants to driving a family car and keeping cattle. The size of the sink, the range of activities that make use of it, and the large number of users make it difficult to monitor the use of sinks and to exclude unauthorised users. There are also other reasons for the difficulty of exclusion, such as absence of clear borderlines, and the fact that the emissions of GHGs mix perfectly in the atmosphere. Difficulty of exclusion means that it is difficult to enforce any entitlements to them. Users also have incentives to try to use units of the resource before others do so and make the units unavailable for them, even when agreements or rules constraining resource use do exist.

Private ownership may not be a feasible governance alternative when exclusion is difficult or costly, because only effective exclusion can maintain private property rights. Collective ownership and enforceable collective agreements to constrain resource use, or widely shared values which overcome incentives for self-interested behaviour, can overcome the challenge of difficult exclusion. However, rivalry in use and difficulty of exclusion are not the only resource attributes that influence what particular designs of collective ownership arrangements would desirable in the governance of atmospheric sinks. A consensus view has emerged that the climate system is non-linear. This means that if the use of sinks surpasses critical thresholds, the climate system may irreversibly change towards a new equilibrium which may fundamentally alter the conditions of life on Earth. At the same time, there is fundamental uncertainty about what those thresholds are. There are also other important areas of uncertainty, such as uncertainty regarding the incidence of the impacts of GHGs. Therefore, governance solutions have to facilitate management of risks and uncertainty.

While resource attributes to an important degree shape the challenge of governing atmospheric sinks for GHGs, the attributes of their users are also important: they determine the starting point for collective action aimed at establishing or modifying governance institutions, shape the costs and prospects of acting collectively for each involved group of users, and influence what governance solutions can ultimately be agreed upon. The starting point of collective action is shaped by global political-economic factors as well as current patterns in the use of atmospheric sinks for GHGs. The most important aspect of global political-economic order is the role of nation states as collective actors representing, for better or worse, populations within their territory. The law on international relations treats nation states as formally equal, sovereign actors in international affairs. The formal equality contrasts starkly with unequal developmental and other attainments among the states.

Industrialised developed countries have achieved high levels of per capita income and have strong, capable states. In the developing world, states are weak and at times dysfunctional, and they have been unable to promote income growth and wellbeing among their citizen. This means that developing country states lack capacity to forward their (and their citizens') interests in international negotiations on the governance of atmospheric sinks for GHGs.

The economies of nation states also exhibit different degrees of complexity, which affects their vulnerability to climate change impacts. Complex economies offer numerous sources of income, the risk attributes of which are different. Therefore, complex economies such as those of the developed countries are more resilient during periods of stress. Economies of most developing countries rely heavily on agriculture and other sectors of primary production such as mining. These economies are exposed to substantial climatic risks as well as to economic risks because of variations in global commodity prices. Because of underdeveloped financial sectors and insurance industry, many actors cannot insure their assets in less complex economies and stand to loose them when weather-related adverse events such as tropical storms, floods or droughts occur (see Paavola and Adger, 2006). Differences in the vulnerability of national economies to weather-related disasters are significant. Per capita income and growth experiences of developed countries are not affected noticeably by extreme weather events such as the drought and heat wave of 2003 in Europe, although the lost assets can still measure up to several percentages of the GDP. In contrast, disastrous extreme weather events such as the Hurricane Mitch can tax over 10 percent of the GDP of a low-income country (see Linnerooth-Bayer et al., 2005).

The differences in vulnerability between developed and developing countries are even more significant in terms of loss of life. Disasters of comparable magnitude claim many orders of magnitude more casualties in developing countries. For example, the magnitude 6.6-6.7 earthquakes in Northridge, California in 1994 and in Bam, Iran in 2003 killed 60 and 30 000 people, respectively. Hurricane Andrew in turn killed 23 people in Florida in 1992 while a comparable typhoon killed 100 000 people in Bangladesh in 1991 (see Adger et al, 2005). Brooks et al. (2005) have found that the level of educational attainment, level of health status and the quality of governance are important factors explaining the differences between countries in mortality due to natural disasters.

There are also other sources of heterogeneity that have implications for the ability of nation-states to act collectively. These include political ideologies, such as beliefs in the ability of markets or states to generate desirable outcomes, which affect the range and assessment of governance alternatives that are considered feasible. There are also other beliefs, including religious beliefs as well as political liberalism, that situate nation states differently in international political arenas. Contrary to commonly held beliefs, globalisation is unlikely to reduce these heterogeneities: it is more likely to increase them (see Paavola, 2005b).

Thus, the global community is divided by heterogeneities that make agreeing on a solution for governing the use of atmospheric sinks difficult. Developed countries have invested heavily in energy-intensive lifestyles, technologies and infrastructure, which make CHG reductions both expensive and time-consuming. At the same time, developed countries have capacity to avoid adverse consequences of climate change, as well as to recover from them. Developed countries form a homogeneous and powerful negotiation block, which has significant experience from having acted collectively in other contexts. Developing countries – particularly the Least Developed Countries – are in a different situation. They have contributed little to climate change because of their limited energy use and reliance of

renewable sources of energy. But their economic development requires increasing use of energy and emissions of GHGs. At the same time, developing countries are vulnerable to adverse climate change impacts. Finally, developing countries make up a large and heterogeneous negotiation block, with members from oil producing countries to small island states that are threatened by inundation by the rising sea levels.

There are, of course, more coalitions in climate change negotiations than just developed and developing countries, and the contours between the groupings are more complex than the discussion above suggests. But the point is that there are significant obstacles for acting collectively to govern atmospheric sinks. Actors start from uneven positions and their interests are different. Their views regarding feasible and acceptable solutions may also differ. I will now move on to examine to what extent the existing solutions for governing atmospheric sinks for GHGs meet the challenges they face.

5. THE GOVERNANCE FRAMEWORK

The governance framework for atmospheric sinks of GHGs is still largely in the making. However, it is obvious that it will be partly constituted by international environmental law, including the pertinent provisions of the UN Framework Convention for Climate Change (UNFCCC), the Kyoto Protocol (KP), the decisions of the Conferences of the Parties (COPs) (Melkas, 2002; Verheyen, 2002) as well as by the Vienna Convention on the Law of Treaties and international custom. Krasner (1982: 186) has argued that this kind of "collection of principles, norms, rules, and decision-making procedures around which actor expectations converge" on climate change can be called the "climate change regime". However, national legislation, policies and regulations as well as various sub-national and local level rules will also play an important role in the governance of atmospheric sinks, because they implement and complement international rules on the use of atmospheric sinks. That is, the governance of atmospheric sinks will be based on a multi-level solution.

The best way to approach achievements in building up the climate change regime is to look at them from the viewpoint of governance functions. From this viewpoint, it is evident that international and national efforts have not been able to constitute the atmospheric sinks for GHGs as an exclusive resource. The goal of the UNFCCC is to "stabilise GHG concentrations in *the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner." (UNFCCC, Article II, emphasis added). The convention goal suggests that the atmospheric sinks for GHGs have a limited capacity, and that GHG emissions ought to be limited to a level which does not surpass that capacity.

Current scientific understanding is that atmospheric CHG concentrations of below 400 – 500 ppm might help us avoid dangerous climate change (Mastrandrea and Schneider, 2004; O'Neill and Oppenheimer, 2002). The atmospheric concentration of CO_2 was 377 ppm in 2004 and it has increased by about 2 ppm. Therefore, the lower limit of "safe" capacity – if such an expression is warranted - of the atmospheric sink for GHGs will be surpassed in two decades. Yet the Conferences of the Parties to UNFCCC have not specified any target for atmospheric concentrations of GHGs – largely because the United States has been unwilling to negotiate on anything but relative cuts from present emission levels. In 1997, some Parties to the UNFCCC agreed in Kyoto Protocol (KP) on cuts up to 8 % from the 1990 emission

levels by 2012, but only a few countries are on track to meet these targets. Yet even the maintenance of the current CO_2 concentrations in the atmosphere would result in significant climate change (Wigley, 2005) and the stabilisation of GHG levels in the atmosphere at relatively low levels would require far greater GHG reductions than those agreed in KP.

As a consequence of failing to establish a clear basis for excluding unauthorised users from the atmospheric sink for GHGs, the climate change regime also provides a weak basis for regulating its authorised use as well. The climate change regime provides for the regulation of the use of the atmospheric sinks for GHGs only in the sense of specifying the requirements for conduct in meeting the GHG reduction targets agreed in the KP. Countries that are Parties to KP are establishing national programs for meeting their GHG reduction commitments. National programs can contain several instruments for meeting GHG reduction targets, including domestic trading systems and other measures, joint implementation among the parties to KP, and Clean Development Mechanism (CDM) projects implemented in collaboration with non-Annex I countries. The UNFCCC and the KP have also provided for detailing of these instruments through standardisation of the methods for preparing national inventories of greenhouse gas emissions and for preparing CDM projects.

As already suggested above, in light of the latest scientific results, emission reductions agreed in KP are insufficient to prevent dangerous interference with the climate system. Moreover, they are problematic from the viewpoint of distributive justice. Relative cuts to current or past GHG emissions affirm the status quo emissions or part thereof as the basis for distributing the benefits from GHG sinks. This is problematic because different countries emit widely differing amounts of carbon dioxide. The world total per capita CO_2 emissions have been in the region of 4 tons per capita for the past two decades (see Figure 1). However, North America, including Mexico, has had CO_2 emissions of about 18 tons per capita and Western and Eastern Europe 8 tons per capita, while developing regions of Central and South America, Africa and Asia have had CO_2 emissions of 1-2 tons per capita. The gap between developed and developing regions has not changed much in the past quarter of a century. In this period, the only noticeable changes in CO_2 emissions per capita are the reduction of emissions from Eastern Europe as a result of the collapse of the Soviet Union, and the increase of CO_2 emissions from the middle East.

Distribution of benefits can be based on a number of criteria, including actual use. While this criterion – a variant of the desert or contributory principle of equity – may well be fair in mutual undertakings for mutual benefit, it is a problematic principle in the allocation of CO_2 sinks. The use of atmospheric sinks for CO_2 is not comparable to Lockean mixing of labour to natural resources, which in the eyes of Locke gave rise to a legitimate claim of private ownership. Rather, it is similar to a classic tort or nuisance: the act of emitting greenhouse gases harms others in various ways by changing their climate. Basing benefit sharing on status quo use would visit a double injury to developing countries. First, if there is any serious intention to set a limit to the use of atmospheric sinks, the legitimisation of current use of atmospheric sinks by developed countries would severely constrain the ability of developing countries to extend their use of atmospheric sinks to foster their economic development. Secondly, it would authorise developed countries to continue causing adverse climate change impacts which developing countries which have little capacity to deal with.

Figure 2. Regional carbon dioxide emissions per capita, 1980-2003. Source: Energy Information Administration (2005)

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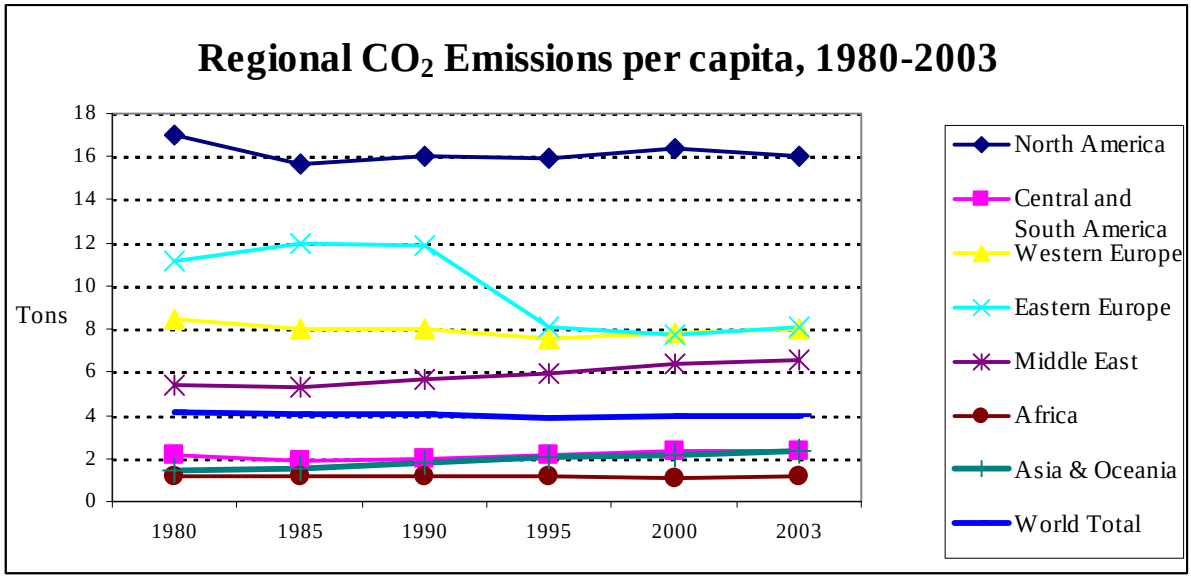

Looked from the viewpoint of provisioning atmospheric sinks for GHGs, at the moment developing countries have to suffer climate change impacts for developed countries to be able to continue to emit their GHGs. At the same time, the claims of developing countries to greater use of atmospheric sinks have an ambiguous position in the climate change negotiations. Present provisions of the climate change regime are based on the current use of atmospheric sinks and alternative provisions based for example on equal per capita allocations are not being considered seriously. Developed countries have made a commitment in the UNFCCC to share the costs of adapting to climate change in vulnerable developing countries. Some progress has also been made in establishing the institutional framework for channelling this assistance to recipients. However, to date little funds have been committed for assistance (see Paavola, 2005b). In contrast, developed countries have more readily assisted the participation of developing country Parties in the convention activities, such as the preparation of national communications (ibid.).

Monitoring of sink users is organised relatively well under the climate change regime. Parties to the UNFCCC have an obligation to report in national communications on their emissions and measures undertaken to reduce emission (Article 12). Developed Annex I countries have different reporting requirements than developing Non-Annex 1 countries. Least Developed Countries also have an obligation to prepare National Adaptation Plans of Action, which establish national priorities for adaptation measures. The Subsidiary Body for Implementation (SBI) examines reports and reporting. Many aspects of reporting have been or are in the process of being standardised. The convention has also established a Subsidiary Body for Scientific and Technological Advice (SBSTA), which provides science support across a range of subjects for the Conferences of the Parties.

Like other regimes based on multilateral environmental conventions (MEAs), the climate change regime has weak provisions regarding enforcement. International law is still based on the idea of the sovereignty of states and thus all international agreements are voluntary. In practice, nation states face some pressure to cooperate and comply, because in the thickening networks of international collaboration defection in one front may result in retaliation and

setbacks in other fronts. Many Parties (particularly developing country Parties) also receive benefit streams from collaboration. The threat of loosing them provides some additional incentives for voluntary cooperation and compliance.

The climate change regime provides for several conflict resolution alternatives. First, the Parties are expected to negotiate their dispute or to resolve it in other peaceful means. The Convention also makes available formal conflict resolution processes, including submission of the dispute to the International Court of Justice and the use of arbitration based on procedures accepted by the Conference of the Parties (Article 14).

Finally, the UNFCCC makes relatively detailed provisions regarding the making of collective choices because it is the constitution for the climate change regime. The UNFCCC establishes the Conferences of the Parties as the regularly meeting body for making collective decisions that refine and implement the provisions of the Convention. The Convention also provides for the process through which Amendments, Annexes and Protocols can be established. These decision-making arrangements are underpinned by the international law of treaties as agreed in the Vienna Convention: it treats parties to conventions such as the UNFCCC as formally equal sovereign states. In practice, negotiators representing developing countries cannot participate equally in decision-making under the Convention (see Gupta, 2002). Developing countries have only small delegations which are not backed by cadres of legal and scientific experts. It is simply impossible for the one or two person country teams to be present in the numerous simultaneous meetings of various working groups. Language can also form barriers for participation in the less formal meetings where much of the preparation work takes place. The Convention itself acknowledges that background inequalities influence participation in the convention activities because it offers financial assistance and capacity building to developing country Parties. It also provides for solutions such as the Least Developed Countries Expert Group to give more weight to the voice of developing countries.

The Convention has paid less attention to the ability of affected and interested parties other than the states to have a say on plans and decisions. The Convention has granted limited participation of non-state actors in the Conferences of the Parties as observers. The Convention process has also generated guidelines for the preparation of National Adaptation Programmes of Action (NAPAs), which are currently being prepared in Least Developed Countries. The guidelines require multidisciplinarity and public consultation in the preparation of the NAPAs (Decision 29/CP.7.). The guidelines are informed by concerns that non-transparent and unaccountable governments should not be able to dictate the content of NAPAs: vulnerable groups exposed to climate change impacts should be heard and their interests made to count. But these provisions are not sufficient to ensure that the interests of non-state actors have a fair hearing and a chance to exert influence over all climate change matters that can impact on them at different levels of governance.

6. CONCLUSIONS

This paper has revisited key works on the management of common-pool resources under common property arrangements to elicit a broader notion of *collective ownership,* and to suggest a model for analysing institutional arrangements that govern the use of large-scale environmental resources such as biodiversity and atmospheric sinks. The paper has also examined the emerging governance framework for global atmospheric sinks for GHGs to exemplify the usefulness of the model.

The analysis indicates that crucial parts of the institutional framework for governing the use of atmospheric sinks are still missing. Entitlements to the use of atmospheric sinks have not yet been adequately formalised and remain based on "capture". As a result, the current institutional framework has not yet overcome the "tragedy of the commons" in the use of atmospheric sinks. Other key problems in the institutional framework include highly unequal distribution of benefits from the use of atmospheric sinks and the inability of the affected non-state parties to participate in decisions that affect them at different levels of governance. Together these problems hinder the attainment of mutually agreed-upon solutions for the governance of atmospheric sinks through international negotiations.

To function, the governance solution for global atmospheric sinks has to cap the use of atmospheric sinks, instead of only prescribing relative cuts in its use as in the Kyoto Protocol. The cap is needed as the basis of exclusion and assignment of national emission entitlements. There is also a need to introduce a more equitable cost and benefit sharing. This could be done by introducing responsibility for the adverse impacts of greenhouse gas emissions through carbon taxation or other means, and by providing for compensation of climate change impacts and assistance for adaptation to climate change impacts. Finally, it will be necessary to create institutional solutions for enhancing participation in environmental decisions, particularly across the levels of governance, in order to guarantee progress in and legitimacy of the governance framework.

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