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# Governing atmospheric sinks: the architecture of entitlements in the global commons

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**Abstract:** This article revisits key works on the management of common-pool resources under common property arrangements, in order to elicit a broader notion of *collective ownership* for analysing institutional arrangements that govern the use of large-scale environmental resources such as biodiversity and atmospheric sinks. The article proposes a model for analysing the institutional design of governance solutions which draws attention to 1) tiers and levels, 2) organisation of generic governance functions, and 3) formulation of specific institutional rules. The article exemplifies these analytical solutions by examining the emerging governance framework for global atmospheric sinks. The article 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 their use. The article 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:** Atmospheric sinks, climate change, common-pool resources, environmental governance, institutional analysis

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> *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.*
>
> (Hardin 1998, p. 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 have approached institutions from slightly different angles. The scholars working on smaller-scale resources have shed light on the links between collective action among the users and institutional solutions, while the international relations and human dimensions of global environmental change scholars working on larger resources have examined how the institutional design of governance solutions, and linkages between solutions, influence their effectiveness in attaining intended outcomes.

This article 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 bridge the two areas of scholarship focusing on small and large scale environmental resources. I propose to do so by eliciting a broader notion of *collective ownership* as a concept for analysing institutional arrangements that govern the use of environmental resources such as water and air quality, biodiversity, and atmospheric sinks (Paavola 2007). Large-scale environmental resources such as these are typically governed by formal legal institutions such as national environmental policies or international environmental conventions. The article demonstrates that these arrangements can be characterised as 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 article examines the governance of atmospheric sinks for greenhouse gases (GHGs) to exemplify the conceptualisation of formal environmental governance institutions as collective ownership arrangements. It also examines the attributes of the atmospheric GHG sink and its users, indicating that the main challenges in governing this large common-pool resource are to constrain its use, to distribute the costs and benefits of its use, and to eliminate free riding. The article then examines the design of the multilevel governance framework for atmospheric sinks of GHGs, indicating 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 GHG sinks (Adger et al. 2006; Paavola 2005a; Paavola and Adger 2006). Entitlements to the use of atmospheric GHG sinks have not yet been adequately formalised and remain based on capture. Costs and benefits of using atmospheric GHG sinks also remain unequally distributed and the actors directly affected by the use of GHG sinks cannot participate in decisions about their use and governance (Paavola 2005a).

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

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

## 2. From common property to collective ownership

Environmental governance is best understood as the resolution of environmental conflicts through the establishment, change or reaffirmation of institutional arrangements (Paavola and Adger 2005; Paavola 2007). This definition extends the analytical focus of the new institutional research on environmental governance because it eliminates the distinction between "governance" and "government" prevalent in the contemporary literature. Instead of excluding state-based solutions from the realm of governance, the definition invites us to explain why solutions not involving the state are used to respond to some environmental conflicts, and why solutions based on a central role of the state prevail in others.

The key argument of this article is that all environmental governance solutions can be understood as forms of ownership, and that doing so helps to appreciate the full range of state-based and other governance solutions and to examine their outcomes. Debates on property regimes offer the best starting point for the argument. For two decades after Hardin's (1968) damning analysis of the commons, the nationalisation or privatisation of natural resources seemed the only alternatives for 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 open access or *res nullius*, common property, state property and private property are the four alternatives that exist for governing the use of natural resources (Bromley and Cernea 1989; Bromley 1992; Hanna et al. 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 conventional typology of property regimes. Moreover, "state property" does not have a clear meaning. On one hand, the state holds ordinary private property rights to some environmental resources and can alienate them at its will. This is the case with forest resources in many developed market economies. On the other hand, the state can manage certain resources such as air basins and watercourses on behalf of people as if holding them in public trust, without legitimate authority to alienate them (Sax 1970; Rose 2003). The latter case is an example of collective ownership not unlike common property. Thus, the category of state property can be abandoned if common property is 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, the typology of ownership regimes should distinguish between *res nullius*, collective ownership, and private ownership. Private ownership vests comprehensive decision-making authority in the owner, who can alienate assets on the market (Cole 2002). Forms of collective ownership do not usually constitute a right to alienate a resource, instead, they typically create inalienable or non-transferable access, use (or withdrawal), management, and exclusion rights held individually or collectively (Ostrom and Schlager 1992). But the distinction between private and collective ownership is often ambiguous. Private ownership can be vested in organisations such as firms, which face similar internal collective action problems as members of communities may face as commoners. In turn, collective ownership can involve individual transferable rights. For example, usufruct rights to land can be bequeathed across generations. Some rights, such as water rights in the Spanish *Huerta* arrangements described by Ostrom (1990, p. 69–82) or land rights among the Waluguru in Tanzania (Young and Fosbrooke 1960), can also be transferable within the community.

Many national 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, these policies define the right of other users to be free from greater pollutant concentrations. Attenuated and non-transferable entitlements created by these policies resemble the usufruct rights in common property arrangements. 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, also constitute a form of collective ownership (Rose 2002; Tietenberg 2002) which is not fundamentally different (apart from differences in scale and formality) from trading irrigation water within common property arrangements (Ostrom 1990). But there are also policy instruments, such as environmental label schemes and insurance requirements, which constitute good environmental performance and environmental risks as private property.

The revised typology of ownership regimes can be coupled to standard new institutional analysis of governance challenges as constituted by the physical attributes of environmental resources and the attributes of their users. Rivalry or non-rivalry of use and the difficulty of exclusion are the most important physical attributes that divide goods into private goods, common-pool resources, toll goods, and pure public goods (Paavola 2007). Rivalry prevails when two users cannot simultaneously use, for example, a fish or a litre of clean air – use by one agent precludes that by another. Non-rivalry enables simultaneous use of a resource, such as landscape amenity, by several agents and generates a decision dilemma about whose preferences count when the quantity and quality of jointly consumed goods cannot be individually provided. Difficulty of exclusion introduces the possibility of free riding or using a resource without contributing to the costs of its provision. This increases the costs of provisioning to others and decreases their willingness to participate in collective provisioning. Other resource attributes such as amenability for multiple uses, mobility, stability or fluctuation of yields, and amenability for storage also often shape the challenges in the provisioning of ecosystem services, which must be overcome by governance institutions (Schlager et al. 1994, p. 294–299; Schmid 1987). Informal and formal governance solutions have different strengths in addressing the challenges created by physical resource attributes, and in some cases a multilevel governance solution is called for.

Attributes of resource users such as their number, heterogeneity, and social capital are also constitutive of governance challenges (see Paavola and Adger 2005). They create and influence conflicts regarding whose interests and preferences are to be realised when they differ and everybody cannot be pleased. When only a small number of agents are involved, they can observe the behaviour of others and maintain accountability for it. Large numbers make individual behaviour difficult to observe and facilitate free riding, increasing the cost of collective action and potentially undermining collective action altogether (Olson 1971, p. 11–12). Heterogeneity of interests, income levels, goals, and values often translates into conflicting preferences with regard to environmental resources. For its part, social capital can help to overcome problems associated with large numbers and heterogeneity by fostering trust and facilitating transactions. Again informal, formal, and multilevel solutions have their specific capacity to deal with differences in, e.g. scale and heterogeneity.

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 themselves 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. 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 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. However, forest policies define aspects of forested land as a distinct resource and establish an additional layer of institutional rules which qualify the authority of the private forest owner over it. Game and wildlife policies establish another layer of institutions that define game and wildlife as a distinct resource with different ownership and governance implications. Still further layers of institutions modifying ownership and governance exist for 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 which give varying roles to governmental and nongovernmental organisations as well as users.

Many environmental resources are thus governed by complex multilevel or overlapping institutions. This 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 valuable uses (Posner 1992, p. 33–34). However, property rights 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, p. 15–18; Dahlman 1980). This 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 resource rights in greater detail when a resource becomes more valuable. Private property rights vest the 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 multiple levels or 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 (Balmford et al. 2002; Turner et al. 2003).

Despite clarifying conceptual issues, the 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, a way is proposed for analysing the institutional design of governance solutions in greater detail.

## 3. Institutional design of governance solutions

I suggest that the institutional design of governance solutions has three core aspects: 1) functional and structural tiers, 2) organisation of governance functions, and 3) formulation of key institutional rules. The way in which governance institutions are designed in these respects has significant implications for governance outcomes such as the range, magnitude and distribution of benefit streams that are obtained from environmental resources.

Governance institutions have three functional tiers. For example, Kiser and Ostrom (1980, p. 208–215) and Ciriacy-Wantrup (1971, p. 44–46) discuss the "three worlds of action" and the "three-level hierarchy of decision-systems." At the "operational tier," individuals make choices within the constraints of operational rules which define their choice sets. An example is a decision to catch fish within the constraints of regulations regarding approved gear or catch. At the "collective choice tier," authorised actors choose the rules regarding approved gear and catch. These decisions are based on institutional rules. Finally, decisions on the authority of collective actors and the procedures they are to follow form the "constitutional tier" of action which is governed by constitutional rules.

Operational, institutional and constitutional tiers are distinct from a multilevel vertical structure of governance solutions. Some governance solutions such as customary common property arrangements exhibit all three functional tiers while being based on uniplanar (single-level) institutions. Today increasing number of governance solutions have a multilevel vertical structure. For example, the U.S. Clean Water Act 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 tiers exist both at the federal and state level of governing water quality.

Multilevel governance solutions can emerge as a result of different processes. There are instances where federations and over-arching institutions have been created by bottom-up processes to coordinate the functioning of smaller-scale governance solutions (Ostrom 1990; Sengupta 2004). Top-down processes create many formal multilevel 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 require both national legislation and local solutions for the governance of biodiversity (Paavola 2004b). The United Nations Framework Convention for Climate Change (UNFCCC) requires national actions, programs or solutions for the planning, coordination and implementation of internationally agreed upon actions (Paavola 2005a). World systems scholars argue that for this reason international environmental agreements have been a driver of national environmental policy making (Frank 1997; Frank, Hironaka, and Schofer 2000).

The top down processes usually generate institutional structures where smaller jurisdictions are nested within larger jurisdiction(s). Hooghe and Marks (2003) call these kinds of multi-level governance solutions as "Type 1," ones based on permanent, general-purpose jurisdictions with relatively few levels and nonintersecting membership. An example of Type 1 solution is a federal state. Hooghe and Marks (2003) also identify "Type II" multilevel governance solutions which are often based on nonpermanent and special-purpose jurisdictions and which can have numerous levels and intersecting memberships. Special districts for the provision of public services are examples of these kinds of multilevel governance solutions (see e.g. Blomquist 1992). These kinds of governance solutions are more likely to emerge as the results of bottom up processes.

While the types of governance suggested by Hooghe and Marks (2003) capture important aspects of classes of governance solutions, the reality is more complex as hybrid forms of governance combining elements from Type 1 and Type 2 governance also exist. Many international environmental conventions are for all practical purposes special jurisdictions but they frequently rely on pertinent national and subnational general jurisdictions at lower levels of governance. Particularly in developing countries, but elsewhere as well, public service provision and some governmental functions are occasionally performed by non-governmental organisations at the national or subnational levels.

Whatever the type of multilevel governance solution, it is likely to have an economic or political rationale. As will be explained in greater detail shortly, all governance solutions have to perform generic governance functions such as exclusion and provisioning. Multilevel governance solutions of Type 1 or Type 2 can emerge to realise economies of scale or scope in the implementation of these governance functions (see Le Quesne 2005). That is, governance functions may be implemented at different levels of governance and different levels of governance may be functionally complementary, instead of just being nested. Many other aspects of the institutional design can also adjust to realise benefits or to reduce costs, including involving both governmental and nongovernmental organisations.

There has been a notion of governance functions in the commons literature from the outset. For example, when discussing common property arrangements, Schlager and Ostrom (1992) distinguish between "ownership functions" and "management functions" (see also McCay 1996). A more detailed and analytically highly useful typology of governance functions can be distilled from the lists of common features of successful governance solutions presented by Ostrom (1990, p. 88–102) and Agrawal (2002). On the basis of these lists, I suggest that 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 functions differently. In a customary common property regime, resource users are often members of a community which performs all governmental functions without separation of powers by making, enforcing and adjudicating the rules of resource use. Resource users can participate directly in the environmental decisions affecting them and they may also perform some governance functions such as the exclusion of unauthorised resource users and the monitoring of compliance with rules of authorised resource use. Formal national policies have a deeper division of labour between governmental organisations and multilevel 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 other decisions to specialised agencies which may involve stakeholders directly or through representation. Specialised agencies frequently monitor and enforce rules while conflict resolution can be shared between these agencies and general-purpose courts. Most contemporary environmental policies also require users to practice self-monitoring and reporting. International environmental conventions constitute special-purpose jurisdictions which have their own decision-making, monitoring and implementation bodies, and designated conflict resolution processes.

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). Community-based solutions work when the governance problem has limited scale and homogeneity and social capital reduce transaction costs and foster collective action among the involved actors. Co-management solutions help when extra-local funding or transfers are involved but implementation depends crucially on local knowledge and collective action. State-based solutions require state capacity, social capital and the rule of law to be effective. When different governance functions such as collective choice and provisioning are best organised at different spatial levels, multilevel governance solutions can emerge.

Institutional analysis should also examine the key rules related to the above discussed generic governance functions as a distinct aspect of institutional design of governance solutions. The formulation of key institutional rules has significant implications for transaction costs and distributive, procedural and governance outcomes. I will exemplify below the significance of the formulation of 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.

The formulation of *exclusion rules* (together with the attributes of the resource in question) influences 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" (Paavola 2004a). The purpose of these rules was to exclude certain uses and users from watercourses. However, it was difficult to monitor compliance with and to enforce these kinds of rules – it required expensive litigation to find out whether a public nuisance had been created. Frequently these kinds 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 solutions because their formulation governs the level of appropriation of resource units and their distribution. For example, in the early 19th century United States, the doctrine of natural flow in riparian law entitled riparian land owners to an undiminished quantity and quality of water (Paavola 2002; Rose 1994). The adoption of the rule of reasonable use in riparian law 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-nineteenth 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 gradual weakening of rights to water quality was a part of what Morton Horwitz (1977) calls the capital subsidy to the nascent industry in the nineteenth-century United States. The formulation of entitlement rules is still contested today, as debates on tradable rights and regulatory rights demonstrate.

*Monitoring rules* determine what is monitored and by whom. The nineteenth century common law of water rights required water users to monitor each other and to actively seek the protection of their interests when their rights were infringed. This was relatively straightforward as most discharges contained solids that caused obvious damages such as the clogging of waterwheels of downstream mills (see Paavola 2002). 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 (Magat et al. 1986).

*Decision-making rules* determine who can participate in environmental decisions and how, and what procedures have to be observed in decision making. For example, the governance of water quality in the nineteenth-century United States was organised so that decisions were made in the courts (Paavola 2002). Litigation granted participation in decision-making according to the ability and willingness of plaintiffs and defendants to pay for it. This was the primary reason for the gradual erosion of rights to water quality in a situation where industrial polluters had the greatest ability to pay. Decision rules have important implications in the contemporary environmental governance as well. The implementation, effectiveness and legitimacy of the European Union's Habitats Directive suffered when stakeholder groups angered by the lack of opportunity 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. But judgments regarding the implications of institutional rules also 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 affects governance outcomes.

In what follows, I will exemplify the arguments presented above by applying them to the governance of global atmospheric GHG sinks.

## 4. Atmospheric sinks as resources

The atmospheric sinks for greenhouse gases (GHGs) can be conceptualised as a common-pool environmental resource not unlike a pasture or an aquifer. Sinks are stock resources which have a limited capacity to provide a flow of sink services. Resources such as aquifers and fisheries have a physical regeneration rate and thus a relatively well-defined capacity to generate a flow of resource units. Similarly, watercourses, air basins and global atmospheric sinks have a capacity to absorb pollutants which is replenished by natural processes at a certain pace. These sinks also form a part of a larger resource system catering for multiple uses. Therefore, the use of units of the atmospheric GHG sink is always rival within the sink use (a unit used by one user is not available to others), and the sink use can also be rival with other uses of the resource system if a threshold for multiple use is surpassed. Some resources have thresholds which, if surpassed, may lead to the collapse of the resource system. The climate system may change its nature if atmospheric $CO_2$ concentrations surpass 400–500 ppm (Mastrandrea and Schneider 2004; Schellnhuber and Held 2002; Steffen et al. 2004).

The key challenge in governing the GHG sink is the same as with all other common-pool resources: to constrain its use so as to prevent its destruction. A derivative task is to distribute the sustainable capacity of the atmospheric GHG sink among the competing users. However, the challenges of governing the atmospheric GHG sink are also shaped by the difficulty of exclusion (Ostrom 1990). Users of GHG sinks range from large coal and natural gas powered electricity generation plants to families driving a car or 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. The absence of clear borderlines, and perfect mixing of emissions of GHGs in the atmosphere contribute to the difficulty of exclusion. Because of the difficulty of exclusion, enforcement of entitlements to sinks is complicated. Users also have incentives to use units of the GHG sink before other users make the units unavailable for them. Private ownership is not a feasible governance alternative when exclusion is difficult but collective ownership and agreements to constrain resource use and widely shared values can overcome the challenge of difficult exclusion.

There are also still further resource attributes influencing the governance challenges of atmospheric sinks. A consensus has emerged that the climate system is non-linear (Steffen et al. 2004). If the use of sinks surpasses critical thresholds, the climate system may change towards a new equilibrium which may alter the conditions of life on Earth. There is uncertainty about what those thresholds are; the current estimates of safe $CO_2$ concentration levels vary between 400–500 ppm. There is also uncertainty regarding climate change impacts and their incidence. Therefore, the governance solutions have to facilitate the management of risks and uncertainty.

The challenges of governing atmospheric GHG sinks are also shaped by the attributes of their users. User attributes determine the starting point for collective action aimed at establishing or modifying governance institutions, shape the costs and prospects of acting collectively, and influence what governance solutions can be agreed upon. Collective action is shaped by 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 populations within their territories. The law on international relations treats nation states as formally equal, sovereign actors in international affairs. The formal equality contrasts with unequal developmental attainments. 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 citizens. This also means that developing country states lack capacity to forward their (and their citizens') interests in international negotiations on the governance of atmospheric GHG sinks.

The economies of nation states also exhibit different degrees of complexity, which affects their vulnerability to climate change impacts. Complex economies of the developed countries offer numerous sources of income with different risk attributes and are more resilient during periods of stress. Economies of developing countries depend on primary production, agriculture in particular, and are exposed to substantial climatic and economic risks. Because of underdeveloped financial and insurance sectors, people in developing countries cannot insure their assets and stand to lose them when tropical storms, floods, or droughts occur (Paavola and Adger 2006). There are significant differences in the vulnerability of economies to weather-related disasters. In developed countries, per capita income and growth are not affected noticeably by extreme weather events such as the European drought and heat wave of 2003, even though the lost assets still measured up to a significant percentage of the GDP. In contrast, extreme weather events such as Hurricane Mitch can tax over 10 percent of the GDP of a low-income country (see Linnerooth-Bayer, Mechler, and Pflug 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 a much higher magnitude of casualty 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 killed 23 people in Florida in 1992 while a comparable typhoon killed over 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 influence the ability of the nation-states to act collectively. These include political ideologies, such as beliefs in the ability of markets or states to generate desirable outcomes. They affect the range and assessment of governance alternatives which are perceived feasible. Religious beliefs as well as secular beliefs in, for example, liberalism also situate nation states in international political arenas. Globalisation is unlikely to reduce these heterogeneities. It is more likely to increase them because it will introduce heterogeneity to previously homogeneous societies and increase heterogeneity where it has already been present (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 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 the use of energy and emissions of GHGs. At the same time, developing countries are highly 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 with 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 even this narrow account demonstrates 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 GHG sinks 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 will be partly constituted by international environmental law, including the UN Framework Convention for Climate Change (UNFCCC), the Kyoto Protocol (KP), the decisions of the Conferences of the Parties (COPs) as well as by the Vienna Convention on the Law of Treaties and international custom (see Melkas 2002; Verheyen 2002). Krasner (1982, p. 186) argues 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, the governance of atmospheric sinks will be based on a multilevel solution. National legislation, policies and regulations as well as various subnational and local level rules will also play an important role in the governance of atmospheric GHG sinks, because these lower-level institutions complement and implement international agreements on the use of atmospheric sinks.

The best way to examine the climate change regime is to analyse how it provides for and organises the generic governance functions discussed earlier in the article, starting from exclusion. 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 GHG sinks has a limited capacity, and that GHG emissions ought to be limited to a level which does not surpass that capacity.

However, international and national efforts have not yet constituted atmospheric GHG sinks as an exclusive resource. Atmospheric $CO_2$ concentration has increased about 2 ppm annually and reached 377 ppm in 2004, which contrasts starkly with the pre-industrial level of 280 ppm. Latest scientific results suggest that atmospheric $CO_2$ concentrations above 400–500 ppm may cause dangerous climate change (Mastrandrea and Schneider 2004; O'Neill and Oppenheimer 2002). Therefore, the lower limit of "safe" capacity of atmospheric GHG sinks will be surpassed in two decades. Yet conferences of the parties to the UNFCCC have not agreed on any target for atmospheric GHG concentrations because the United States has been willing to negotiate only on relative cuts from past emission levels. In 1997, a sub-group of parties to the UNFCCC agreed in the Kyoto Protocol (KP) on cuts up to 8 percent from the 1990 emission levels by 2012, but only a few countries are on track to meet the targets. Yet the stabilisation of GHG concentrations at the level of 400–500 ppm would require far greater GHG emission reductions of about 60–70 percent from 1990 figures (Houghton 2004, p. 257).

The climate change regime is also weak on regulating the authorised use of the atmospheric GHG sink because it fails to establish a clear basis for excluding unauthorised users. The climate change regime provides for the regulation of authorised use only in the sense of specifying requirements for meeting the GHG reduction targets agreed in the KP. Countries that are parties to the KP are to establish national programs for meeting their GHG reduction commitments. National programs can include various instruments, including domestic trading systems, joint implementation among parties to the KP, and Clean Development Mechanism (CDM) projects implemented in collaboration with non-Annex I (developing) countries. The UNFCCC and the KP have also standardised methods for preparing national inventories of greenhouse gas emissions and for preparing CDM projects, which facilitates the implementation of national programmes and their monitoring.

In the multilevel governance solution for atmospheric sinks, the national level will be crucial for the regulation of authorised use, in part because nation states have the mandatory powers needed to establish and enforce use regulations. For example, the European Union and its member states agreed to reduce their GHG emissions by 8 percent from 1990 levels by 2012. Initially the EU planned the adoption of a carbon tax but the plan could not be implemented at the EU level. Despite this, the United Kingdom first adopted a Climate Change Levy which imposed a charge on energy use in energy intensive industries (OECD 2005). In 2005, Europe-wide EU Emissions Trading Scheme (EU-

ETS) was launched to achieve agreed-upon GHG emission reductions (Stern 2007, p. 371–375). In Phase I (2005–2007), the trading scheme is limited to $CO_2$ and involves only energy intensive industries that account for about 40 percent of the EU $CO_2$ emissions. Involved industries have been allocated GHG permits in the National Allocation Plan and the scheme enables trading of the permits. The scheme also makes it possible to use CDM projects with developing countries to obtain credits. EU sources, together with Japanese sources, have created the bulk of demand for CDM projects globally (Stern 2007, p. 374). National regulations also specify further permit conditions, charges, and monitoring requirements (DEFRA 2006). Initially carbon was traded at 30 Euros per tonne but due to liberal allocation of permits carbon prices have later decreased to about 10 Euros per tonne (Stern 2007). In 2008, the scheme will be extended to other GHGs in addition to $CO_2$ and to a broader range of GHG sources.

The arrangements for the regulation of authorised use also have implications for the provision of GHG sinks and the distribution of costs and benefits of their use. As suggested earlier, emission reductions agreed in KP are insufficient to prevent dangerous climate change. Moreover, they have problematic distributive implications. Relative cuts to past GHG emissions affirm the status quo as the basis for distributing benefits from the use of GHG sinks. Yet different countries emit widely differing amounts of GHGs. The world $CO_2$ emissions have been about 4 tons per capita for the past two decades (Figure 1). However, North America 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 a quarter of a century. The only noticeable changes are the reduction of emissions from Eastern Europe after the collapse of the Soviet Union and the increase of $CO_2$ emissions from the Middle East.

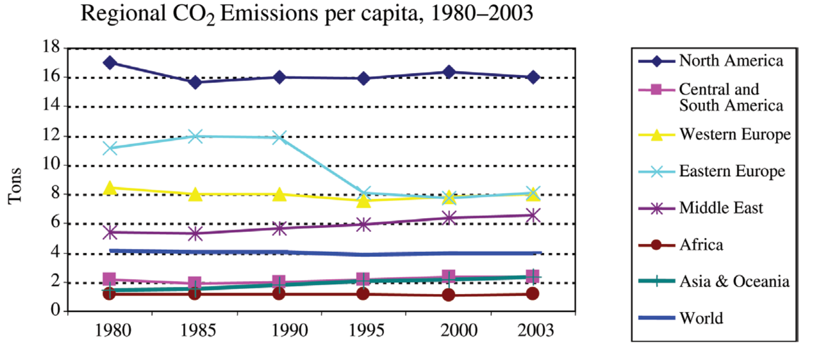


*Figure 1: Regional carbon dioxide emissions per capita, 1980–2003. Source: Energy Information Administration (2005).*

Distribution of benefits of the GHG sinks can be based on a number of criteria, including past use. This criterion is similar to the desert or contributory principle of equity because it would distribute the sinks in proportion of earlier efforts to make use of them. This kind of principle may well be fair in mutual undertakings for mutual benefit, but it is problematic in the allocation of GHG sinks. The use of GHG sinks is not comparable to mixing of labour with natural resources, which for Locke (1960) created a legitimate claim to private ownership. It is rather a public nuisance because the act of emitting greenhouse gases harms numerous others by changing their climate. Even long continued and established use cannot create a right to maintain a public nuisance. Status quo use as a basis of sharing GHG sinks is also inequitable towards developing countries. First, in the face of the pressure to reduce the use of atmospheric sinks, the endorsement of current use by developed countries would severely constrain the ability of developing countries to increase their GHG emissions to foster their economic development. Secondly, it would authorise developed countries to continue causing adverse climate change impacts which developing countries have little capacity to deal with.

The claims of developing countries to a greater share of atmospheric sinks currently have an ambiguous position in 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 or historical responsibility are not being considered seriously. Yet claims to status quo rights or a proportion thereof effectively ask developing countries to suffer climate change impacts so that developed countries can continue to emit their GHGs. 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, little funds have been committed for assistance to date (see Paavola 2005b). In contrast, developed countries have assisted the participation of developing country parties in convention activities such as the preparation of national communications (ibid.).

Monitoring of sink users is provided for in some detail in the climate change regime. Parties to the UNFCCC have an obligation to report in national communications on their emissions and measures undertaken to reduce them (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 Programmes of Action (NAPAs), which establish national adaptation priorities for the distribution of assistance for adaptation on the basis of other convention provisions. The Subsidiary Body for Implementation (SBI) plays a central role in monitoring and, for example, reviews 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. Yet many aspects of monitoring will necessarily be provided for, and undertaken at, lower (national) levels of governance.

Enforcement of the rules of sink use is less satisfactorily organised in the climate change regime because it has weak enforcement provisions just like other multilateral environmental agreements. International law is still based on the idea of sovereign states and thus all international agreements are voluntary (Paavola 2005a). In practice, nation states face some pressure to cooperate and comply, because in the thickening networks of international relations defection in one front may invite retaliation in another front. Many Parties also receive benefit streams from collaboration and the threat of losing them provides additional incentives for voluntary cooperation and compliance. Yet the enforcement of the provisions of the climate change regime must be undertaken primarily at the national level of governance, because the national governments are currently the primary source of mandatory powers. This is one important reason why the governance of atmospheric GHG sinks must necessarily be based on a multilevel solution.

The climate change regime also 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). These conflict resolution mechanisms are indicated for conflicts between the states. Other conflicts will remain to be addressed at national level conflict resolution bodies such as the courts.

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 Vienna Convention which 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 (Gupta 2002). Developing countries have small delegations which are not backed by legal and scientific experts. It is simply impossible for small country teams to be present in simultaneous meetings of numerous working groups. Language can also form barriers for participation in the less formal meetings where much of the preparation takes place. The Convention itself acknowledges that background inequalities influence participation in convention activities because it offers financial assistance and capacity building to developing country Parties. It also provides organisational templates such as the Least Developed Countries Expert Group to give more voice to developing countries.

The Convention has paid less attention to the ability of parties other than states to have a say on decisions and plans. The Convention has granted limited participation to non-state actors as observers in the Conferences of the Parties. 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 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 article has revisited key works on the management of common-pool resources under common property arrangements to elicit a broader notion of *collective ownership* for analysing institutional arrangements that govern the use of large-scale environmental resources such as biodiversity and atmospheric sinks. The article also proposed a model of institutional design of governance solutions to facilitate institutional analysis. The article examined the emerging governance framework for global atmospheric sinks for GHGs to exemplify the usefulness of conceptualising governance solutions as collective ownership arrangements and analysing the organisation of governance functions as one key aspect of the institutional design of governance solutions.

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, and as a Safe Maximun Standard. There is also a need to introduce a more equitable cost and benefit sharing.

This has to be done in part through the allocation of national GHG emission quotas. But it also calls for 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.

The architecture of entitlements to the global atmospheric GHG sinks has to an extent been agreed upon at the global level. However, the governance solution cannot rest exclusively on international environmental agreements. National climate change policies have a substantial role in detailing entitlements to GHG emissions and monitoring and enforcing compliance with them. As the climate change progresses and makes compensation and adaptation higher priorities, subnational levels of governance are likely to be needed to complement international and national levels.

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