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Abstract

When confronted with market weaknesses and failures determining sustainability problems for environmental common-pool resources, economic analysis has proposed government intervention as the only alternative available. Elinor Ostrom showed that this dichotomy between market and government is not always helpful, and proposed a more complex approach to institutions focusing on an active role of communities, social norms and a polycentric system of governance. This paper summarizes the main factors at work in determining the role of institutions to deal with sustainability issues and explores the implications of this wider approach in dealing with environmental commons, particularly with global environmental commons, discussing two issues: climate change and biodiversity. Involvement of governments and a reference framework provided by intergovernmental agreements are necessary, but the difficulties of building a successful intergovernmental institutional framework require responsible and convinced actions at the level of consumers and firms, public opinion involvement in individual countries, and coordination between local and national levels of government: provided that some conditions are fulfilled, common resource management can be very helpful in achieving them.

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Environmental Resources as Common-Pool Resources.

In economic analysis there are two types of goods to which one can refer when the term "commons" is used: public goods and common-pool resources.

Both types of goods share the feature of "non excludability": it is impossible or very costly to exclude somebody from the use of the good; this is the case when many persons can utilize the good in a simultaneous way, as it happens with the air we breathe.

An additional feature of public goods is "non rivalry": not only the use of a existing public good by someone does not exclude that the same good is used by others, but it doesn't reduce the availability of the good for future use. Accepted examples of public goods are public order and national defense: any citizen can enjoy them in a non excludable and non rival way.

Common-pool resources are non excludable, but rival: when many persons have access to the use of a common-pool resource, this implies that some amount of the resource is subtracted to the use of other persons and to future use.

Environmental resources are common-pool resources. Examples of environmental common-pool resources are grazing areas, fisheries, forests, water quantity and quality, the air quality. They are available in limited amounts: hence utilizing them in a non exclusive way can make their use excessive.

As noted by Ostrom (2002), increasing the number of participants in the use of a public good does not produce dramatic effects on the stock of the public good, due to the absence of rivalry; it may even have a positive effect on the production of additional quantities of the good as it makes more resources available to finance this additional production. In the case of a common-pool resource, on the contrary, increasing the number of users and an aggressive behavior in utilizing the resource are likely to generate increasing costs in terms of a higher probability of depleting the stock of the resource.

For exhaustible natural resources, such as mineral and fossil fuels, utilization by human activity only depletes their stock; hence the economic problem with exhaustible natural resources is that of an optimal depletion. However, property rights could be defined on this type of resources because of their physical features. Hence markets could in principle work in determining the optimal rate of exploitation and the optimal level of stock conservation. However, markets have worked rather imperfectly in dealing with this problem.

The role of markets is more difficult for common-pool resources because of the higher complexity of the property rights issue. Some economists have defined common-pool resources as "open access" resources; but this is not an intrinsic feature of a common-

pool resource: open access only happens in absence of any kind of management of the resource. Others have defined common-pool resources as “common property resources”; but even this is not appropriate as a general definition, as a common-pool resource can be managed with different forms of property: public property, private property, common property or as a “res nullius” which means considering it as an open access resource.

When dealing with the problem of property rights with common-pool resources, it is important to consider that, once used, they can be re-generated through natural biogeochemical cycles. If the flow of utilization remains within the re-generation capacity, the stock of the resource can be maintained over time. For environmental common-pool resources as re-generable resources a sustainability target can be defined, related to a stock that can be maintained over time at a desired level.

The distinction between the utilization flow and the stock is crucial for re-generable common-pool resources. Human action can be directed to utilizing the flows of goods and services of the resource for consumption or as productive inputs, but it can also be directed to provide and maintain the stock. Balancing the human action between these two directions is essential in determining the resource sustainability. The optimal combination is likely to emerge when those who appropriate the flows also feel a responsibility in provision and maintenance of the stock; which unfortunately is not often the case.

The problem arises because the appropriation of the flow is in itself exclusive (when a fisher appropriates some fishes caught in a fishery this cannot be done by another fisher), but the joint appropriation by many users is a non exclusive joint use of the stock (many fishers can appropriate the fishes in a fishery, although not the same fishes).

The consequence is rivalry and hence the existence of costs to maintain the stock. The possibility of appropriating the flows without contributing to the costs of maintaining the stock explains opportunistic behavior resulting in excessive flow appropriation (free riding) and insufficient action to increase or at least maintain the stock.

The behavior concerning both the flow and the stock of an environmental common-pool resource are likely to be less opportunistic and more responsible if those who use the flow and do not contribute to the stock were more informed on the negative effect of such kind of behavior, not only on the others but also on themselves. This information could be provided from external sources, but when scientific and empirical evidence is lacking, it is the outcome of a learning process from the experience of the users, which may take some time.

On the other hand, opportunistic behavior leading to excessive use of the flow and insufficient protection of the stock is made easier by a perception of the current benefits

of exploiting flows higher than the perception of the future benefits of a higher or constant stock; this gap between perceptions is widened by the utilization of a higher discount rate to determine the present value of the future benefits of the stock preservation.

Appropriate norms of behavior shared and internalized in the behavior of the majority of the members of a community are a social capital that can improve the relation between exploitation and preservation of a resource, even if there will always be some individuals in the community who ignore the norms and act in an opportunistic way when they have the possibility of doing so.

Individual strategies are normally conditional to beliefs on the strategies adopted by the majority of the others: hence they can be oriented in the right direction when people believe that the other members of a community will behave in a cooperative responsible way; this would favor thrust leading to sustainability.

The approach of economic analysis: the market- state dichotomy.

Dealing with problems concerning the relation between flow exploitation and stock preservation for common-pool resources requires choosing the most appropriate model of property and management. Should property and management be assigned to the State, should they be assigned to private individuals or companies, or should they be assigned directly to the responsibility of a community which means considering them as "common goods"?

Ostrom (2002) helps to clarify what property and management of a resource should properly mean. According to Ostrom, property right should be considered as a bundle of five types of rights.

First there is the right of access to the use of the resource; examples of authorized entrants are those who have the right to use a forest or a river for recreation, but do not have the right to harvest forest products or to catch fishes from the river.

Second, there is the right of withdrawal; authorized users have the right to obtain resource units and trade them (cut trees of a forest or catch fish from a fishery, and sell them on the market).

Third, there is the right of management, which the right to participate in building rules for the use and the transformation of the resource; authorized "claimants" not only have the right of access and withdrawal, but they also have a collective-choice right of participating in taking decisions concerning limits on withdrawal rights and building and maintaining facilities to preserve the resource stock.

The fourth type of right is that of exclusion, which is the right to determine who has the access right and the right of harvest from a resource; “proprietors” have all the rights of “claimants” plus the right of exclusion,.

Finally there is the right of alienation, which is the right to sell or lease management and exclusion rights. Those who possess this right possess the full bundle of the right constituting property right: they are “owners”.

Ostrom (2002) notices “that the world of property rights is far more complex than simply government, private and common property. These terms better reflect the status and organization of the holder of a particular right than the bundle of property rights held”.

Economic analysis has oversimplified the possible modes of holding property rights by only considering them as assigned to the State or to some private person or company; according to economic analysis a situation where property rights are assigned neither to the State nor to private people means open access; in the case of environmental resources it does not guarantee sustainability.

This oversimplification is largely based on the “tragedy of commons” model introduced by Garrett Hardin (1968), a “prisoners’ dilemma” game in which the dominant strategy is non cooperation, implying an excessive unsustainable use of the resource. As in any one-shot “prisoners’ dilemma” game, this outcome is due to a lack of communication among players which make the lack of reciprocal thrust the most likely situation.

When property and management of the resource are assigned to the State, the game is modified by imposing a penalty to those not following the cooperative strategy. This makes cooperation the dominant strategy, but it requires that the government agency has the information necessary to establish the correct penalty (for instance a tax to discourage the excessive resource use), and the ability of monitoring and enforcement of the chosen policy, also to react to the inevitable attempts of capture from private interests.

The proposed alternative by economic analysis is the privatization of the resource where possible. In the case of a grazing area, for example, this may mean to divide it in parts and to assign the property of each part to one shepherd who could exploit it to maximize profit; or it may mean that the whole grazing area is assigned to one owner who could maximize profits by leasing the different parts to individual shepherds who should pay a rent as right of access and withdrawal. The reason for privatization is that the private owner should reduce the use of the resource in order to increase profits.

The problems when transforming an environmental common-pool resource in a private good derive not only from difficulties due to the physical characteristics of the resource (as it is the case with atmosphere), but also from the likely market failures. Private

management leads to monopoly when the resource is not technically divisible; there is no incentive to take into account the positive externalities from preserving the resource stock or the negative externalities from destroying it; on the other hand there in an incentive to take advantage of asymmetric information.

Both the alternatives proposed by economic analysis to deal with problems of excessive use of a common-pool resource aim at reducing, or even eliminating, non exclusivity. However, taking into account the complexity of the bundle of rights behind the concept of property leads to dealing with the problem of sustainability for an environmental common-pool resource not simply by cutting non exclusivity, but organizing it in a different way. This is at the basis of the opportunities offered by a common responsibility in the resource management when environmental common-pool resources become “common goods”.

The contribution of Elinor Ostrom.

According to Elinor Ostrom (1990, 2002, 2005, 2009, among many others) there are many cases in which neither the State nor the market are successful in granting a productive use and the long term sustainability of systems of environmental common-pool resources.

At the basis of the dichotomy State-market lies the pessimistic idea that any institutional change able to lead actions of the resource users to sustainable results must be externally imposed. On the contrary, Ostrom presents a number of cases in which users have been able to arrive voluntarily to an enforceable and stable agreement for a sustainable management of the resource.

In the “Institutional Analysis and Development” (IAD) framework used by Ostrom, three types of factors affecting individual actions should be considered. First, the biophysical features of the resource; second, the characteristics of the community (its history, its degree of homogeneity, its level of social capital); third, the set of rules in use concerning actions that should, should not or could be undertaken.

A necessary condition for a group of persons forming a community to be successful for a sustainable management of a common-pool resource is their ability to build an organization exerting the bundle of access, withdrawal, exclusion and trading rights.

To achieve this result, a voluntary contract must be signed after an internal debate on the regeneration capacity of the stock, on the assessment of benefits and cost of implementing the agreement, and on a fair distribution of these benefits and costs, without depending on an external regulator that is likely to have an incomplete and distorted information. Monitoring and enforcement of the contract should be assured by the participants to the agreement through reciprocal control.

Moving to coordinated choices through a voluntary agreement does not imply the absence of rules and constraints to individual behavior, concerning the maximum resource flow that can be appropriated and the amount of investments to maintain or increase the resource stock. But these rules should emerge from a reciprocal credible commitment to monitoring and punishment. The participants can delegate to some external institution the task of facilitating, monitoring and enforcing the agreement, but not that of deciding and modifying its terms.

The challenge is building an institutional change that favors a situation in which the appropriators of the resource flows do not act in an independent way, but by adopting coordinated strategies in order to grant to each of them higher benefits, also in terms of lower environmental damages. Benefits should be larger than the costs required to arrive at the final outcome; these costs can be expected to be rather high in some circumstances.

The features of the context in which the process to build the voluntary contract takes place may be very different, depending on the historical and cultural situations. The success of the process is not automatically assured in any situation. Institutional changes do not grow in an abstract way as answers to theoretical indications; they arise from concrete necessities which must be internalized first by those promoting the change and afterwards by those who must implement it; the best is when the two coincide.

Ostrom (1990) presents a number of successful examples of common management of environmental resources; and other unsuccessful or problematic cases. She insists on successful cases because they confirm the critique to the dominant state-market dichotomy, and respond to the objection implied by this dichotomy that persons are by definition unable in any situation to solve collective choice dilemmas by means of voluntary agreements and common management.

Ostrom (1990, 2002) indicates a number of factors playing a role in explaining the successful cases. We can distinguish two groups of factors: the first concerns the characteristics of the institutions necessary to lead to a successful common management; the second concerns the characteristics of the individuals or groups participating in the community.

There are eight necessary institutional conditions (Ostrom, 1990). The first condition is the ability to correctly define the borders of the resource and to identify those who have the access and withdrawal rights. Any potential appropriator should know who the other appropriators are, otherwise it would be impossible to establish some kind of coordination, and excessive individual exploitation becomes more likely.

The second condition concerns the capacity to define rules dealing with time, localization and technology to appropriate the resource flows and to invest in maintaining and possibly increasing the resource stock. These rules are strongly

dependent on the physical and biological features of the resource and on available technologies.

The third condition is that all, or at least the great majority of, those who are involved in using the flows and providing the stock of the resource should have the possibility of participating not only in establishing, but also in modifying the rules.

Building rules does not imply an automatic behavior according to them. Hence the fourth condition, which concerns the capacity of the users to organize and implement a monitoring system of their own behavior or at least to assign it to an agency in which they have thrust; and the fifth condition, which concerns the agreement on the rules of sanctioning violating behaviors; these sanctions should be applied, in an incentive compatible way, by the users themselves or to an agency in which they have thrust.

Users' involvement is a crucial factor: experience shows that the most successful examples of common management of environmental resources are those in which the users have been able to learn from past mistakes, and appropriately react, in organizing good monitoring and sanctioning systems.

The sixth condition is the capacity to build "places" where to discuss and hopefully solve conflicts; the seventh concerns the right of the users to define and build management institutions without recurring to an external authority, because this would mean passing from a common to a government management.

The final condition has to do with "governance": to an increasing complexity of the problems in obtaining a sustainable management of the environmental resource, there must correspond an increasing complexity in the levels of hierarchical organization (a polycentric system, according to Ostrom), giving the each level well defined and not overlapping tasks.

Governments, at different levels, and public policies are not excluded in a polycentric governance system. They can exert useful levels of governance, and more importantly they can intervene as facilitators to promote the agreement within communities or as coordinators of different communities; this last role is very delicate as it should imply avoiding excessively uniform rules that do not take adequate account of the differences in the biophysical features of the resources and in the social and cultural characteristics of the various communities.

What is important is to avoid considering the public sector as a top-down hierarchical level without intermediate levels able to give space to communities' action. It is wrong to presume that local communities can never take care of collective choice problem. Of course, it would also be wrong to pretend that local communities will always be able to solve collective action problems. There no a unique best solution that can be applied to

any collective action problem: the nature of the collective action problem is crucial (Ostrom, 2012).

There are a number of examples of negative effects of public policies that do not consider the historical and cultural heritage of past management systems of common-pool resources. For example, where local village communities have experimented for decades or even centuries a sustainable management of local forests, a nationalization of these forests is not only seen as expropriation, but has the consequence of increasing the difficulties of the management process for the lack of cooperation by the local communities to the policies decided by the national agency.

The second group of factors in successful cases of common resource management concerns the characteristics of the individuals or groups participating in the community in order for the institutions to achieve success and stability in the common resource management (Ostrom, 2002).

First, all the participants must be willing to share the benefits from the implementation of the rules for a sustainable management of the resource.

Second, their interaction should show up in a adequate stock of social capital in terms of reciprocal thrust.

Third, there should be not too relevant differences in the size and power of users: the bigger, wealthier and more powerful among them constrain the process of rule formation and implementation, against the smaller, poorer and less powerful; they are more likely to capture operators and institutions deputed to monitoring and sanctioning. This is particularly dangerous when the more powerful users prefer the short run objective of benefits from exploiting the resource flows to the long run benefits from preserving and improving the resource stock.

Forth, homogeneity of community members is also very important. It helps reciprocal understanding and thrust building, and hence it reduces the transaction costs of an agreement and favors its stability.

Finally a crucial role is played by size. The larger the size of the group of community members, the higher will be the transaction costs for an agreement. A larger size is normally associated to a smaller degree of homogeneity.

If the participants work and live with their families in the same area where the resource is located, so that even their descendants can enjoy of the resource sustainability, this will favor cooperation; but this is more likely the smaller is the size of the group.

Only in some cases the experience shows that the negative effects of a larger size are compensated by the positive effects of the larger potential amount of resources that can

be mobilized to improve the stock and of the higher incentive to contribute due to the smaller amount of the individual contribution.

The management of global environmental commons.

A larger size, both of the resource and of the number of its effective and potential users, is likely to bring to more complications in the process of institutional transformation, of rule creation and implementation, for a common-pool resource. This becomes a crucial issue with global environmental commons (Ostrom and others, 1999).

With global commons there is an additional element to be taken into account. Not only there are many individual users (billions for a true global common as the atmosphere in the climate change problem), but there is an intermediate role of sovereign States that can constrain individual users' behavior by means of their national laws and public policies.

To-day the problem of global commons is dealt with as a problem of finding an agreement among sovereign governments. If one considers the governments as the only agents involved in the choices concerning the management of global commons, the problem of the dichotomy between State and market does not exists: global regulating institutions very seldom exist; the only possibility is for the "political market" in which sovereign governments interact to achieve a cooperative outcome.

On the other hand, it the global common is a diffused resource, as the atmosphere, the definition of property rights is not possible for individual sovereign states, which makes difficult the working of this "political market".

Experience confirms that achieving a global agreement eventually leading to a global authority is not an easy process and is seldom successful. The problem is how to make individual governments to interact in the flow utilization and the stock preservation of the global resource. The vested interests of the individual users become those of the individual sovereign states; the agreement cannot be reached without giving up some of this sovereignty.

Differences between local and global resources concern other elements beyond the scale and the number of users (Stern, 2011). First, in the case of local resources excessive flow utilization is mostly the result of conscious and targeted actions, while in the case of global resources it is often a not intentional result of intentional actions. For instance, CO2 emissions worsening the climate change problem derive from production and consumption actions not directly and consciously linked to that outcome.

Second, the weight of divergent interests and of different market power is much more relevant among states for global resources than among individuals for local resources.

Third, cultural, social and political heterogeneity is much more relevant for global resources; and finally, physical and technological complexity is also more relevant for global resources.

These differences imply that applying the criteria for a common sustainable management of environmental resources is much more difficult when these are global resources.

These difficulties show up particularly in involving all the users in designing rules and in the monitoring and sanctioning of behaviors not complying with those rules; in the institutional design to coordinate the different types and levels of institutions; in deciding how much to invest and in which direction to improve scientific knowledge of the problems and to find out technical solutions, even if scientific and technological progress offers increasing opportunities of cooperation.

Coordinated governmental action cannot be avoided in order to deal with the difficulties to achieve a sustainable management of global environmental resources; but it would be a mistake to rely only on this coordinated action among governments.

In global commons, increasingly important is the role of public opinion and non governmental organizations in the various countries; cultural differences need to be overcome to move towards a global common-oriented cultural dimension according to a principle of "common cultural heritage of the mankind".

Considering the sustainable management of global commons as a problem concerning only national governments is a distorted vision which is likely to lead to counterproductive results. Efforts to arrive at a coordination of national governments are necessary in order to define some fundamental rules at a global level and for national policies; but they are not enough; they will not succeed without parallel efforts to involve local communities, which represent a more realistic level to promote changes in individual behavior, reciprocal thrust and credibility, more effective monitoring and sanctioning.

The problem of climate change.

Atmosphere is a global common whose importance in increasing because of the climate change problem. This problem represents the most relevant challenge to the sustainability of the current economic model based upon fossil fuels.

We have the typical dilemma for global common-pool resources: each country benefits from actions to reduce greenhouse gas emissions adopted by other countries, and thus has an incentive to refrain from acting, thus avoiding emission abatement costs and

shifting them on the other countries. This is the main reason why it is difficult to arrive at a global agreement to deal with the climate change problem.

An example of the role played by asymmetry in the characteristics and weight of the participants (in this case nations and their governments), is the debate between developed and developing countries. Developed countries claim the future CO2 emissions will mainly come from emerging and developing countries; therefore these should feel responsible for undertaking emission reduction actions. Developing countries on the other hand point out that emissions per capita are much lower than in developed countries and that this gap will continue in the future; hence the responsibility for reducing emissions should continue to be of developed countries.

This "war of attrition" is the main reason for the inconclusive results of the recent Conferences of the Parties which should expected to implement the objectives indicated in the United Nations Convention for Climate Change.

But this is not the only open issue. There is now a global consensus on the fact that a carbon price is a necessary condition for reducing CO2 emissions; but there is a lack of agreement on the most appropriate tools to arrive at a carbon price. The European Union has decided to use tradable CO2 emission permits. The system was welcomed with great hopes, but it revealed at least two drawbacks. First, the system covers CO2 emissions from the larger sources in the power and heat sector, oil refineries, and other big material producers; but it does not cover small emitters such as those in transport, housing, agriculture and waste. Hence a lot of carbon emitting sources are not covered by the system. Second, the lack of coordination among EU governments led to a too high cap, and the market for allowances was subject to business cycles and speculation. As a result the price of permits collapsed after the global crisis. Moreover the initial allocation of permits was free and they did not provide revenues to governments.

The other instrument, a carbon tax, also has implementation difficulties concerning not only coordination between sovereign countries to fix the carbon tax level, but also its organization in order to provide the right incentives. One problem is that the carbon tax should be on carbon consumption, not only on carbon production; but this means taxing not only the carbon content of domestic production, but also the carbon content of imports (Helm, 2012). There is an open debate on whether this would be compatible with an internationally efficient trade system.

Other instruments indicated by the Kyoto Protocol and by more recent Conferences of the Parties act in an imperfect way and risk to have unintended harmful effects. An example concerning the Clean Development Mechanism (CDM), which allow developed countries to get emission reduction credits by investing in emission abatement in developing countries, is provided by Ostrom (2010): the revenues from the sale of carbon credits generated for HFC-23, a greenhouse gas used as a refrigerant,

were so high compared to abatement costs that manufacturers increased their production just to benefit from the credits' sale.

Another example provided by Ostrom (2010) concerns the efforts to reduce emissions from deforestation and degradation (REDD). Recognizing the carbon stored in forest ecosystems is very important, but the role of management forest methods provided by the traditional knowledge of indigenous people should not be ignored: sometimes small fires to clear forests may prevent larger and more destructive ones.

Positive opportunities for action by government and large corporations are offered by scientific and technological cooperation. The role of technological breakthrough is crucial in solving the climate change problem. The experience with the Montreal Protocol for dealing with stratospheric ozone depletion shows that an international agreement can be easier and quicker if the technological alternative is available, in that case for substituting CFCs.

One of the reasons which delay a successful dealing with the climate change problem lies in the fact that an alternative energy system to fossil fuels is not yet available. Joint scientific and technological cooperation is necessary and urgent. Efforts in implementing this cooperation are likely to be more productive than those to arrive at an agreement on quantitative global CO2 emission targets or to uniformly accepted instrument to control these emissions.

But investments to decarbonizing the world economy, with improved efficiency in using fossil fuels and with an increasing resort to new energy sources not based upon fossil fuels, are very costly: according to the most recent energy technology perspectives of the International Energy Agency (IEA, 2012) additional total investment needs to move from a business-as-usual scenario to a 450 Scenario (linked to an increase in temperature not large than 2°) amount to 36 trillions USD from 2010 to 2050. Transport will be the leading sector (more than 40%); the residential sector (buildings) follows with 30% and power with 20%.

A similar effort cannot proceed without cooperation among governments. In scientific and technological cooperation the role of government and public policies is crucial because the technological revolution required to decarbonize the economy will be fundamentally different from the past technological revolutions.

What all the past technological revolutions had in common was a virtuous circle between innovations and market demand: innovations aimed at widening market demand, particularly for consumption goods, and larger market demand allowed increasing profits to support further investments in R&D and new products.

The technological progress to permanently decarbonize the economy will only partly be supported by private demand, even if the required cultural change takes place. The

prevailing demand for a low carbon economy will be for a public good. Hence governments cannot be absent in this strategy.

But Ostrom (2010, 2012) rightly claim that relying only on governments and on large corporations in their transnational activities is not enough.

Decisions with impacts on climate change which are by definition global are made by households, with their choices about heating systems, electrical appliances and transportation means, by firms with their choices of technologies, and by communities with their choices concerning power generation utilities, transportation systems and urban planning. Public policies adopted by governments, individually or on the basis of the strategic lines decided in international agreements, must be able to affect those local actions. And this will not happen unless the social norms and the lifestyles values do not embody the acceptance of a change in behavior.

This is why pointing only to recommend the building of global intergovernmental agreements and a global public authority is a too weak and reductive strategy. Efforts in that direction are necessary, but not sufficient at all. A polycentric approach should be adopted, encouraging experimental projects concerning specific communities and ecosystems. This strategy increases the likelihood of developing reciprocal thrust in individual and community behaviors affecting the global problem. Successful projects can form a network helping coordination in information sharing and monitoring at an international level.

A number of examples exist of communities that have decided to invest in energy efficiency projects, relying on the future benefits whose present value is higher than the initial investment costs; that have promoted networks of renewable energies; whose interventions in urban traffic, primarily aimed at reducing air pollution, have shown joint benefits also in terms of greenhouse gases emissions.

To build a polycentric system will not be simple; what is important however is that this process accompanies that of achieving a global solution. The two types of efforts should proceed in an integrated way, on the basis of the belief that reducing individual emissions is important for dealing with a global problem such as climate change.

The biodiversity problem.

Biodiversity is a common-pool resource with global and local aspects. Biodiversity is ultimately determined by the variety of genetic material and it is essential for the functioning of ecosystems. Human societies have developed through a conversion process of natural capital into man-made capital and through an increasing specialization in the way natural capital.

This provided great benefits to human societies, but also increasingly relevant social costs that have been ignored for too long a time.

While benefits have been valued by the market, this has not been the case for the social costs, due to the characteristics of biodiversity as a public good. Social costs of reducing biodiversity are opportunity costs measured by the lost benefits when not preserving it. Benefits of biodiversity preservation are basically of three kinds: an information value, an insurance value and an existence value (Swanson, 1997).

The body of information contained in any ecosystem has a global value that makes biodiversity a global public good: the loss of the information value of biodiversity in an area of the planet (represented, for instance, by the loss of the possibility of getting new drugs when genetic resources are irreversibly destroyed in a tropical forest) is a global loss.

Biodiversity also has an insurance value: the wider is the portfolio of biological assets in a given ecosystem, the higher is the ecosystem resilience to shocks. The insurance value is more directly related to biodiversity as a local public good; but this does not mean that spillover effects are absent, affecting other ecosystems, even at the global level.

Finally biodiversity has an existence value: for ethical reasons people are willing to pay, simply to preserve the existence of some species; these people are often located in very distant areas from those in which the species reside; hence the existence value contribute to making biodiversity a global public good.

The features of global and local public good in the case of biodiversity are interrelated: in whichever area biodiversity is preserved, this provides benefits to other areas of the planet; on the other hand, in whichever area a loss of biodiversity is experienced, the costs spill over other areas of the planet.

The process of economic growth mainly determined the conversion process of natural capital and loss of biodiversity, first with land conversion for agricultural production, and afterwards through industrialization and urbanization; developed countries have benefitted from this process, increasing their endowment of physical and human capital, but loosing their natural genetic capital. The process of economic growth didn’t take place in many developing countries that are still rich in natural capital and genetic resources, but not in terms of physical and human capital (Swanson and Groom, 2012).

The historical and geographical evolution of the process of economic growth has determined an interdependence between developed and developing countries which has contributed to global biodiversity loss. Advanced countries, which are on the world technological frontier, need increasing amounts of genetic resources from developing countries; these are anxious to import the economic growth model experienced by the

developed countries, and thus are willing to exchange genetic resources located in their territories with capital and technologies (Swanson and Groom, 2012).

This model of interdependence has contributed to a global loss of biodiversity. The challenge now is to transform this perversely working model of interdependence into an opportunity for cooperation aiming at a sustainable growth model to preserve biodiversity. This is also the strategic line recommended by the Convention on Biodiversity. But, as in the case of climate change, it is not an easy task to be achieved.

Cooperation between developed and developing countries should lead to maximizing a global surplus including private profits from genetic resource use but also the social value of biodiversity; this would entail a transfer of resources to developing countries to preserve their biodiversity; moreover, there is a problem of fair distribution of the global social surplus. Arriving at a cooperative sustainable outcome is made difficult by the large amount of compensatory transfers required by developing countries, that could use a strategic threat of destroying their genetic resources in order to convince developed countries to provide larger compensations (Groom and others, 2012).

The effort to build coordination and agreements among governments should be attempted, but the implied difficulties and complexities are even greater than in the climate change case. These difficulties are certified by the inadequate functioning of the Global Environmental Facility, a mechanism proposed by the Biodiversity Convention, and of the more recently proposed Global Multilateral Benefit Sharing Benefit whoise implementation has not yet started.

In the case of biodiversity, there are not only the difficulties of identifying globally shared quantitative targets, but also those concerning which types of policy instruments to use and how to use them. An example is provided by economic instruments: deciding a price for biodiversity losses to be the object of an international agreement is even more problematic than fixing a carbon price in the case of climate change.

Graciela Chichilnisky (2012) has proposed to define property rights on the ecological services provided by natural resources (such as water basins or forests): not property rights on the resources themselves or on the land where the resource is located, but only on the ecological services provided. These property rights on ecological services should be given to institutions representing communities with the task of preserving biodiversity; ecological services could be sold under the constraint of using them respecting biodiversity preservation. For example, in the case of water the constraint could concern the operation of biological cleaning up system provided by micro-organisms resulting from biodiversity preservation; in the case of timber from a forest the constraint could be granting that the bio-prospection avoids bio-piracy of the genetic material. Revenues could be used to subsidize R&D and investments to improve the biodiversity. If assets representing ecological services can be traded on the market, they will be bought by those with lower costs to protect biodiversity.

The proposal in interesting, but extremely difficult to implement; monitoring and enforcing sanctions are likely to imply very relevant transaction costs. The difficulty is much greater at an international level as the institutions owing the property rights on ecological services should be international. Attempts should be done and continued to realize this or similar proposals for economic instruments used in a coordinated international way, but this is another example that for global biodiversity preservation things cannot be left entirely to governmental and intergovernmental action.

Biodiversity is ultimately a characteristic of local ecosystems, although they may have different scales and complexity. The interaction between local and global aspects of the biodiversity as a common-pool resource is even more evident than in the case of climate change. This means that a polycentric approach is even more appropriate in the case of biodiversity preservation, where a greater emphasis should be put not only on national but also on local community action, possibly with the support from the international level.

The delays towards some kind of international agreement in the case of biodiversity are even more serious than for the case of climate change; hence the role of a polycentric approach is even more urgent. The diffusion of authority characterizing the polycentric governance model can compensate for the negative effects of an evident institutional fragmentation, helping to build a network among successful programs that can promote an effective process to extend them and to gather the required financial means to support them.

The biodiversity issue has special characteristics that make the polycentric approach convenient. The global biodiversity common results from many local commons; to manage them the support and the active role of local communities is required in most cases. For example, local communities with their traditional knowledge are in a better position to screen the information provided by the ecosystems in which they live.

But also local communities have to face the challenge of combining the target of biodiversity preservation with a sustainable model of economic growth. The experience shows that this challenge is not successfully dealt with when local communities, or groups within them, fighting for biodiversity preservation do not take into account the sustainability of economic growth; very often they simply reject this perspective holding de-growth positions.

However this is not a good reason to centralize policies and skip the role of local communities; this would be eventually counterproductive; the wise approach seems to be that of making local communities more responsible towards the need of avoiding the conflict between biodiversity preservation and sustainable economic activity. There are successful examples: in agricultural activities (in cooperation with FAO) and in improving water availability through eradication of widespread invasive plant species (Long, 2011).

There is an increasing perception of the importance of linking the biodiversity issue to the climate change which means linking the atmosphere global common to the global common represented by habitat protection (Long, 2011). Some species will be lost and other species may become invasive due to climate change. This issue linkage can be better implemented within a polycentric approach. Some instruments proposed by intergovernmental talk, such as the Reducing Emission from Deforestation and Degradation Program (REDD+) aimed at financially rewarding developing nations for actions to avoid greenhouse gas emissions caused by deforestation, are not yet satisfactorily applied at a global level. But there are examples of development of REDD projects through cooperation between local NOGs and supranational institutions in forests (with World Bank) and local marine protected areas (Long, 2011).

Conclusions.

The topic of environmental commons is an area where the economic analysis is confronted with the limitations of the traditional dichotomy between market and government. Both market and government are important to manage environmental commons according to a sustainable strategy. But they must be integrated in a wider approach involving communities' responsibility.

This conclusion is the main contribution of Elinor Ostrom approach known as Institutional and Development Analysis. In this approach institutions are prescriptions and constraints, including rules, norms and shared strategies, provided and used by persons to organize their structured interactions. Market and government do not exhaust the whole set of possible institutions to manage environmental commons in a sustainable way. Active governance by communities is possible; but its success strongly depends on the characteristics of the community and on the attributes of the biophysical environment within which the community acts. Key characteristics of the community are homogeneity of its members or shared values, resulting in thrust and reciprocity.

Institutional problems for governance of common-pool resources become more complex in the case of global environmental commons. Involvement of governments and a reference framework provided by an intergovernmental agreement are necessary and should therefore be pursued.

But the difficulties of building a successful intergovernmental institutional framework constitute a powerful incentive for a promoting role of responsible and convinced actions at the level of consumers', firms' and local community behavior, and of public opinion involvement of individual countries.

Nothing is granted in these attempts. But when successful, they will help in framing polycentric approach that is likely to make individual government policies, the way they

use market opportunities and eventually the achievement of an intergovernmental agreement, more likely and successful.

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