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Concepts and public policy issues in environmental and natural resource analysis

Chapter 1

Introduction

This chapter introduces the relevant concepts in environmental and natural resource analysis and brings out why there is a need for governmental regulation and policy for environmental management. Classification and definitions of environmental goods and services are presented in the second section. In the third and fourth sections, an attempt is made to discuss environmental goods as a necessity or an amenity and as public goods and to examine the major characteristics of these goods. In the fifth section, policy context is examined. Given the public goods nature of environmental resources, the importance of conscious policy on use and conservation is highlighted. Concluding remarks are contained in the last section.

Definition of environmental goods and services and natural resources

Webster New World Dictionary defines environment as the 'conditions, circumstances, and influences surrounding, and affecting the development of an organism or groups of organisms'. For our purpose, organisms are primarily human beings and ecosystems. Whether they are man-made such as agriculture or occur naturally as biodiversity, they impact human well-being. These resources are useful in the same way as manufactured capital stocks, such as roads, buildings, and machinery are utilised in production. However, environmental and natural resources, because of their open access nature, are more freely available to anyone. This open access property makes these resources more vulnerable to excessive use and degradation.

In economics literature, there are five factors of production: land, capital, labour, organisation and entrepreneur (Samuelson and Nordhaus, 2007). Land is important in the present context because it is a part of the environment and is defined to include the surface of the land, anything residing below land and anything coming to the land surface from above. Thus, soil, surface water and groundwater, sunrays, rainfall, atmosphere and climate are different forms of land and are examples of environmental goods. Natural capital is a wider term to capture all forms of environment, environmental goods and natural resources that are derived from nature. Natural resources are further divided into exhaustible and non-exhaustible. Minerals and oil are exhaustible natural resources, and forest, bio-diversity and river water, underground water and ocean water are examples of non-exhaustible natural resources. The latter can be replenished under given conditions.

Site-specific characteristics of a natural resource system (soil, ground water, and hydrology) determine its capacity to support the ecosystem. For example, an agricultural farm is one form of natural resource system, which produces output and also provides ecosystem services. The beneficial outcomes that result from ecosystem functions are better fishing and hunting, cleaner water, better scenic views, and reduced human health and ecosystem risks. The value of an ecosystem is measured in terms of its beauty, its uniqueness, support to human habitat and health, and contribution to commercial and recreational activities. Economic values of ecosystem services can be expressed in relative terms using indicators of willingness to pay (WTP) for their environmental services.

Since markets do not exist for many environmental goods and services, hypothetical markets are created to know what prices to put on these non-market resources. In the absence of real world markets, we can depend either on the invisible hand for the management of these hypothetical markets or government intervention is needed. Leaving everything to the invisible hand assumes that market forces work. The efficient functioning of market forces would, however, require that buyers and sellers' property rights are well defined, which is not the case with most environmental goods. Because of the public good nature of these goods, such property rights are not well defined. Open access renders these goods as common pool resources and their over use causes decline and decay. This is described as the tragedy of the commons as developed by Hardin (1968).

Rainfall and climate are some other interesting environmental goods. Rainfall contributes to output growth and scenic beauty. But it can be viewed as an environmental bad if it causes flooding and landslides and soil erosion. Similarly, climate is an environmental good. But if we consider the effects of climate on output, productivity and health (human and animal), it can have adverse effects, particularly in tropical countries. This effect seems to be strongly related to the presence of malaria, which may be a proxy for a range of tropical maladies that are geographically associated with that disease. Moreover, geographic location of countries will have differential effects on growth. Access to the coast seems to matter for growth because it lowers transport cost and creates agglomeration economies (Gallup et al., 1999, 151).

The significance of services has expanded in recent years but the environmental dimensions of various services have not attracted similar attention particularly because these are much more difficult to measure. Commonly defined as 'anything that you can't drop on your feet', services might initially appear as intangible and therefore environmental concerns emanating from them are likely to be underplayed. In reality, however, the production, consumption and distribution of many services have large ecological footprints in terms of pollution and degradation, and other services by their nature would involve environmental mediation or protection. Transportation services – everything from trucking food to shipping steel – are important sources of greenhouse gases and other air pollution. Uncontrolled tourist development threatens some of the world's most sensitive ecosystems. Waste management and disposal services, water distribution, sewage and sanitation if not adequately addressed can damage human health and the health of the environment.

Pollution is an important by-product of human intervention and technological growth. If pollution is an environmental bad, it will be useful to call all such goods and services,

which help in environmental conservation and protection, as environmental goods and services. With this extension of the list of environmental goods and services, environmental technologies for the abatement of pollution and other negative effects will also be included in the list of environmental goods and services. The interesting part is that such goods and services are tradeable in the market and therefore in such cases property rights are well defined.There are attempts to create tradeable permits in CO_2 emissions both within a country and between countries.

OECD classification of environmental goods and services

According to OECD and Eurostat experts, the environmental goods and services industry consists of activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco systems. This includes cleaner technologies, products and services that reduce environmental risk and minimise pollution and resource use. OECD classified environmental goods and services into four groups:

The pollution management group includes goods that help control air pollution, manage wastewater and solid waste, clean up soil, surface and groundwater, reduce noise and vibrations, and facilitate environmental monitoring, analysis and assessment.

Cleaner technologies and products are goods that are intrinsically cleaner or more resource-efficient than available alternatives. For example, a solar photovoltaic power plant is fundamentally cleaner than a coal-fired one.

Goods under the category of resource management are used to control indoor pollution, supply water, or to help farms, forests or fisheries to become **sustainable**. This group also includes goods used to conserve energy (such as double-paned windows), and goods that help prevent or reduce the environmental impacts of natural disasters, such as fire-fighting equipment.

The fourth category consists of **environmentally preferable products** that cause significantly less environmental harm at some stage of their life cycle than alternative products that serve the same purpose. Examples would include improved solid-fuel cooking stoves and reusable shopping bags made of canvas or jute rather than plastic or paper.

United Nations Environment Programme (2005) has developed the following classification of goods and services in order to facilitate preferential treatment of goods and services in international trade.

- Goods destined to be used in environmental remediation or clean up (e.g. oil spill remediation equipment), prevention of environmental damage in industrial processes (e.g. air pollution control, waste management, energy savings), or equipment for environmental monitoring and analysis.
- Technologies and products that, in their use, are more environmentally friendly than the norm. This includes consumer goods such as electric cars, and producer goods such as wind turbines and technology for cleaner burning of coal.
- Goods and services that have been produced in environmentally friendly ways (e.g. organic produce, recycled paper).

Box 1.1. Some interesting questions on UNEP's classification

a In the first category, a thermostat is an apparatus for heat/energy savings and management but it has other uses not related to environmental management. How will you justify that it is an environmental good?
b In the second category, an electric car is a good candidate for environmental good. But what about other fuel-efficient cars?
c Is eco-tourism an environmental good?
d In the third category, how will you treat transportation services, medical tourism and filmmaking and entertainment services?

Environmental goods as a necessity or an amenity

In the conventional environmental economics literature, environment is treated as an amenity for human enjoyment. According to Carson (1962), the disappearance of birds brought about by pollution was regarded as a loss of important amenities. It was considered as the degradation of the beauty of the nature, and if the degradation continued, people would no longer have the pleasure of watching and listening to birds each spring. When Holling (1994) analysed the disappearance of migratory birds in North America, he looked at the effects on insect populations and the possible destruction of boreal forests from the increasing number of these pests. The same cause would have two different impacts, one (the loss of timber) can be measured but the quantity and quality of the other (the loss of amenity) can only be guessed at. But both the loss in amenity and the loss in timber production will reduce well-being of the rich and the poor differently. Therefore, it is important to distinguish between value of an amenity and value of an environmental resource as an input in production.

Environment as an input in production

If an environmental resource is only being used in production, there may not be any amenity value for purposes of environmental accounting and the value of the environment as an input is equal to the value of (marginal) productivity of that environmental resource. It is important to note that physically invisible environmental resources such as climate and atmosphere cannot be ignored in the production process. Nordhaus (1993) studied the role of climate (latitude and average temperature) on income but its effect may be swapped by other variables. He reports that incomes per square kilometre vary from a low of $31 in China to a high of about $36,000 in Hong Kong and from $37 in Indonesia to $6,200 in Japan. In fact, latitude explains less than 1 per cent of the variance in income per capita and per area. According to computations by Gallup et al. (1999), average GDP per capita in tropical countries in 1995 was $3,326 as against $9,027 for non-tropical countries.

But when we discuss the use of environmental resource by households, there is a need to distinguish between production value and amenity value. Let us compare two households, rich and poor with different willingness to pay (WTP) for an environmental resource. Now we should expect that as income rises, the value of the resource as input

also rises. Mailer (1997) concludes that input environmental resources are more important for the poor than for the rich. The relationship between mangroves and fisheries is quite instructive. Fishers are quite aware that the destruction of mangrove forests means the destruction of their fisheries, which will force them to pursue other economic activities or to become almost permanently unemployed. In this example, the income elasticity of an environmental resource will be negative, that is, as income increases, the demand for an environmental resource as input decreases. This is for the fact that environment as an open access resource will be more important for the less rich households. Here, such an environmental resource is a necessity for the poor and again these resources will suffer from excess use and degradation. Besides this, once these resources are useful in production directly or invisibly, both quantity and quality will be under the pressure from human needs.

Environment as an amenity

In developed countries, particularly in Europe and North America, environmental resources are generally considered as amenities, which are luxury goods. In other words, their income elasticity should be greater than one. But empirical estimates have revealed some interesting facts. Kristrom and Riera (1996), using contingent valuation surveys in Europe, in almost all cases, found income elasticity to be less than one. Kannanien and Kristrom (1993) analysed data sets from Africa and the United States to find essentially the same results.

In the light of these results, that is, income elasticity of environmental resource less than one, it can be argued that even environmental quality is not a luxury good. It is a necessity for all. This makes the case for environmental conservation and protection. Nevertheless, protection of environmental quality will benefit poor families more than high-income families. Since low-income families use environmental resources more for their short term survival, they degrade more and adversely affect the photosynthetic product of the planet; hence protection of environmental resources will be justified on both efficiency and equity grounds. If the decline of the photosynthetic product of the planet is reduced, the growth of GDP will be higher. Thus, growth-promoting environmental care is efficient. It is equitable as well because poor families benefit more from environmental protection because they need the environment more than rich families for their livelihood and survival.

Environment as a public good

Most environmental goods are different from private goods. Private goods (e.g., apples) are characterised as rival goods where one person's consumption reduces the amount available to others. But environmental goods are non-rival or public goods where it can be assumed that their use is equally available to everyone. Given this feature, many environmental goods, such as clean air and water, and scenic beauty are not traded in the market. In such cases, they are non-market goods and their economic values can be expressed in terms of the affected party's willingness to pay (WTP). Nevertheless, there are other environmental goods, for example, various elements of biodiversity such as fish, natural plants and

wildlife populations that are traded in national and international markets. While they have public good properties they become semi-private goods through some institutional arrangements. This is possible only by redefining property rights so that they become market goods.

Another feature of environmental resources is that people cannot be excluded from enjoying them and any attempt to exclude people would be prohibitive. So non-exclusion and free-riding would not allow any form of transactions through markets. The free-rider problem makes the task impractical for farmers to recoup the cost of on-farm conservation investments from those who benefit from such environmental improvements. Nevertheless, through government intervention, and by the use of subsidies, taxes or other incentives and controls, non-farm direct beneficiaries can be called upon to share the burden of private farm investments.

When the use of environmental goods is uncontrolled due to open access and free riding, and negative externalities are generated by production and consumption activities, these would tend to create risks for human beings and ecosystems. It is such negative externalities that constitute the foundation of environmental economics and applied welfare economics, and which form the basis of government intervention and environmental governance.

The United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 advocates the following objectives of environmental policy (UNCED, Agenda 21, Chapter 8, p. 85):

1 To incorporate environmental costs in the decisions of producers and consumers, to reverse the tendency to treat environment as a 'free good' and pass these costs on to the other parts of the society, other countries or to future generations.
2 To move more fully towards the integration of social and environmental costs into economic activities, so that prices will appropriately reflect the relative scarcity and total value of resources and contribute towards the prevention of environmental degradation.
3 To include, wherever appropriate, the use of market principles in the framing of economic instruments and policies to pursue sustainable development.

To provide such policies, it is important to determine the appropriate unit for environmental governance. According to the principle of subsidiarity, environmental decisions and implementation should be assigned to the lowest level of government capable of handling it without significant residual externalities. In other words, these allocations should be based on which layer of government would have the most information on those issues. For local reservoir pollution, the appropriate authority is the local government. For air pollution and natural degradation problems having regional effects, regional and provincial governments are appropriate. If these degradations cross provincial boundaries, central government or inter-provincial boards appointed by the central government become an appropriate authority. Environmental problems of a trans-boundary nature, such as acid rain, coastal zone degradation with effects on neighbouring countries, river pollution involving more countries, climate change, ozone layer depletion and biodiversity loss can

be handled by bilateral and multilateral co-operation and intergovernmental entities such as the United Nations.

Determining the level of government that is more suited for pollution abatement policy making and implementation within a country is a complex issue. While the stock of information available within the government is important, technology and administrative capability can be more pertinent. Governments at different levels will possess varying amounts of information, technology and administrative capability. Given that environmental externalities may not be aligned with the administrative boundaries of a government, institutional co-operation between governments at different layers is warranted. As regards the significance of information about environmental dynamics and degradation, a sharing mechanism can be designed.

Andersen and Jensen (2003) have shown that the central government can introduce a flexible grants-in-aid system that induces the local authority to mix local and central information. According to this study, if the central authority is highly uncertain about the environmental effects of a specific pollutant, the tax-subsidy scheme can be designed to allow local information to play an essential role in the environmental policy. If the central authority is certain that a pollutant must not exceed a specific limit, the tax-subsidy scheme should minimise the local influence on the environmental policy.

Sigman (2007) has explored the empirical relationship between decentralisation and environmental public goods, such as water quality in rivers at monitoring stations around the world. In this research, pollution levels and spatial variability of pollution within a country are examined both as a local and a regional pollutant. The results suggest higher pollution levels with greater decentralisation because of inter-jurisdictional spillover and free-riding across jurisdictions. It is concluded that since decentralisation allows policies more tailored to local conditions, it will be desirable that management functions of regional pollutants are assigned to higher level authorities.

Global environmental externalities and global public goods

International trade in hazardous chemicals, engendered species and contaminated goods, greenhouse gas emissions, ozone depletion and biodiversity loss are global environmental 'bads'. Since the effects of these bads are not felt on a uniform basis across nations, each country's interest may differ in controlling such international trends. It is also possible that controls in trade of such goods may hamper growth in low income countries, and therefore there may be a conflict of interests between developed and developing countries just on the basis of economic growth. This is besides the fact that such activities may not be environmentally friendly.

The Rio Declaration of 1992 advocates the following principles for international co-operation on environmental issues:

Principle 2: States have the sovereign right to exploit their own resources pursuant to their own environmental and development policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states.

Principle 6: The special situation and needs of developing countries, particularly least developed and those most environmentally vulnerable, shall be given special priority.

Principle 7: States shall co-operate in a spirit of global partnership to conserve, protect and resolve the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, states have common but differentiated responsibilities.

The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

Principle 9: States should co-operate to strengthen endogenous capacity building for sustainable development by improving scientific understanding through exchange of scientific and technological knowledge and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.

Principle 13: States should co-operate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problem of environmental degradation. Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination or a misguided restriction on international trade.

There has been steady progress on international co-operation in terms of multilateral agreements, namely the Uruguay Round on international trade in goods and services, the Montreal Protocol on ozone depletion, the Convention on Biological Diversity, the UN Framework Convention on Climate Change and the Kyoto Protocol. Capacity building and financial support initiatives to environmental management programmes in developing countries have made good ground. Nevertheless, only limited success has been achieved in the field of transfer of environmentally friendly technologies to developing countries. Climate change and global warming are causing sea levels to rise, thereby threatening the very existence of small islands. In this story, the role of small islands is minimal. When the carbon emissions of developed countries are higher than that of LDCs and small and island states, the price that small and island countries are paying in terms of bigger environmental challenges is disproportionate. They are suffering not because they are polluting but because other countries are producing higher growth rates and polluting. The international dimensions of global public bad are therefore more challenging than local dimensions, which may be trivial. It is vital to argue that when we are talking of a global carbon tax, there will be a case for compensating small and island economies for such vulnerabilities for which they are not responsible.

The environment as an important public policy issue

According to the dominant social paradigm (DSP), which reflects the view of the industrial era, economic and population growth and continued exploitation of natural resources can continue without damage to the environment (Pirages and Ehrlich, 1974). The new environmental paradigm (NEP) (Dunlap and Van Liere, 1978) that emerged in

the mid-to-late twentieth century challenged this perspective and offers instead the view that more emphasis must be placed on environmental protection and the development of a systematic way to address the depletion of natural resources. In short, where the DSP emphasised development and production, the NEP has promoted conservation and sustainable development.

We know that natural resources and the state of the environment are under tremendous stress. Wherever there are externalities, particularly negative externalities, the market fails and government intervention is needed until government itself fails to control them. It is important to note that when government fails, it is not inevitable that markets will start working again. So when both markets and the government fail, there will be a need to devise a strategy of government regulation, which can provide good governance and also introduce incentives so that markets for environmental management are revived.

In the presence of positive externalities arising from an economic activity, social benefit is higher than private benefit, and the private optimum level of output will be lower than the social optimum level of output. The role of public policy then will be to provide incentives to expand private output. This is the basis of **subsidy policy**. It is important to note that a public policy in the form of granting subsidies to activities, which produce negative externality, will be misplaced. For example, many governments granted subsidies to fertilisers and pesticides to boost agricultural output, which damage land quality and lower water quality. This policy was based on the DSP whereas following the NEP, in the recent past, there is paradigm shift and such subsidies are being withdrawn in a phased manner. The approach now is to encourage proper or environmentally safe use of fertiliser inputs.

Similarly, when there are negative externalities, social cost is higher than private cost and hence the private optimum level of output will be higher than the social optimum level of output. This will require policies designed to discourage or regulate production so that the extent of negative externalities (pollution) can be reduced. The basis of tax policy in this case, is to provide disincentives to production of goods and services that harm human health and the health of the environment. Such taxes on polluting activities are called green taxes. These taxes entail 'double dividends' in the sense that they control polluting activities as well as raise revenue to finance government expenditure on pollution abatement. Ideally, the proceeds of green taxes should be spent on environmental management by earmarking, but, in practice, they are spent on other expenditure heads. Nevertheless, green tax revenues act as a dividend to provide relief on account of some other taxes. In other words, the potential growth of some other taxes will reduce due to revenue from green taxes. If the government does not trade green taxes with other taxes, they do provide additional revenue to the exchequer, in addition to some expected reduction of pollution and damage to the environment. There are other ways for a government to control negative externalities such as through the use of command and control tools by fixing physical standards and ceilings, or through revival of markets.

Well-designed regulation policy to control environmental damage is a public good because benefits will flow to all parties. However, conflicting objectives may frustrate the environmental goals. While discussing the complexity of environmental policy-making in the United States (it may also be relevant to any other country), Sussman (2005) writes

that 'the environmental movement is represented by a variety of groups that differ in size, tactics and strategies. Business and industry have substantial resources to support their attempt to shape environmental policy in their favour. Property rights groups that maintain a strong anti-federal government orientation prefer that state and local governments make environmental policy'.

'The science and politics problem is an integral part of the environmental policy-making process. On the one hand scientists collect data, employ the scientific method and replicate their studies. Politicians, on the other hand, are guided by factors including electoral considerations, pressure from interest groups and uncertainty. While scientists are guided by objectivity, politicians may view environmental issues through the prism of ideology or partisanship. Where scientists may need more time to experiment, politicians might need an answer before the next election. In short, science may be integrated effectively into public policy or it might be ignored or politicised to meet the needs of those in public office.'

In most developing countries, weak property rights and rapid population growth are major sources of environmental degradation. As the environment is degraded, there is a need to exploit these resources more to meet the requirement for food, energy production and shelter. Here there is apparently a vicious circle that affects mainly the poor: environmental degradation increases poverty, which increases degradation. In such economies, population control and poverty alleviation constitute major policy inputs to environmental improvements. It is contended that with economic growth, the magnitude of these problems would reduce and the pressures on the environment would be eased.

There is another strand in the literature called the 'Environmental Kuznets curve'. This curve explains a relationship between increases in per capita income and environmental quality. It is posited that as per capita incomes rise, the environment gets worse but with further increases in per capita incomes, environmental quality tends to improve. In other words, we produce and pollute more initially but as growth proceeds, the demand for a cleaner environment increases and also the capacity to take up environmental challenges increases. In this scenario, economic growth is a major vehicle to address the environmental problems in developing countries. In this framework, however, environmental policies can take the back seat.

The environmental Kuznets curve has not proved suitable for all environmental concerns. Moreover, this approach does not take into account the fact that environmental problems present themselves differently in different situations. Even though some of the environment may be a renewable natural resource, the rate of resource depletion may exceed the rate of regeneration and this may reduce net improvement. Technologies for the regeneration of natural capital are not well researched, though greater attempts are being made in this direction. For example, the global problems of deforestation, water and air pollution, greenhouse gas emissions, ozone depletion and biodiversity loss are the result of economic growth. Further economic growth may aggravate these problems and the cost of damage management may become prohibitive and complex. This is despite the fact that more resources and new technologies consequent upon further growth will be available. The upshot is that the policies to protect and regenerate environmental and natural resources without reducing economic growth may seem infeasible.

Arrow and others (1995) have described the role of Environmental Kuznets curves very aptly by noting that economic growth is good but not a panacea for environmental quality. According to them, what matters is how environmental resources are being used and depleted, and the quantum of the waste products that have to be disposed of in the environment. A 'Wait and see' policy and 'staying put and doing nothing' may not be helpful in crucial matters like the environment and natural resources. Thus Benjamin Franklin aptly wrote, 'It is not until the well runs dry that we know the worth of water'.

Concluding remarks

In this chapter an attempt has been made to define environmental goods and services. A distinction is drawn between environmental goods with positive externalities and environmental bads with negative externalities. In the absence of markets for most environmental resources, attention is drawn to such goods in international trade and the importance of policy making is discussed in the contexts of both environmental goods and services and environmental problems in developed and developing countries. It is noted that economic growth is not a panacea for all environmental problems, which reinforces the relevance of environmental governance.

It has been argued that environmental goods and natural capital, whether they are necessity or amenity, are subject to excessive use and degradation. Given that the income elasticity of environmental resource is less than one, it can be argued that even environmental quality is not a luxury good. It is a necessity for all. Hence the case for environmental conservation and protection in both developed and developing countries

While environmental goods are nature's product, it is brought out in the analysis that technologies and services that are designed to protect the quality of environment and natural capital are also environmental goods. With the expansion of the list of environmental goods and services, the role of markets as an instrument of policy increases. There is a need to design policies separately for non-market and market environmental goods and services.

It is argued that while economic incentives and command and control tools are important policy instruments, tax policy in particular has played a major role in environmental governance. The basis of tax policy in environmental governance is to provide disincentives to the production of goods and services that harm human health and the health of the environment. Such taxes on polluting activities are called green taxes. The interesting part of these taxes is that they entail 'double dividends' in the sense that they control polluting activities, as well as raise revenue to finance government expenditure on pollution abatement.

The chapter also distinguishes between different types of environmental public goods having local, regional, national and global jurisdictions. This distinction makes a case for different levels of government and inter-governmental coordination in environmental governance. The significance of international agreements and collaboration is highlighted. Further research initiatives are needed because when it comes to environmental concerns, 'we know what we know but we do not know what we do not know'. Therefore, information sharing is the kingpin of environmental and natural resource management.

Climate change and global warming are threatening the very existence of small islands. Given that the quantum of carbon emissions of developed countries is higher as compared with emissions of LDCs and small and island states, the price that the latter are paying in terms of bigger environmental challenges is disproportionately high. It is vital to argue that when we are talking of global carbon tax, there will be a case for compensating small and island economies for such vulnerabilities for which they are not responsible. Given that these countries are small in terms of geographical area and population, the degree of vulnerability they invite can be relatively larger. This will require the design of well informed environmental policy to meet the global challenges locally.

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