Tragedy of the Global Commons: Causes, Impacts and Mitigation

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ABSTRACT

Global commons include such diverse things as space, climate, biodiversity, high sea marine fisheries, eco-systems and their services to human beings. They are all open access resources and are vulnerable to what Garret Hardin called "the tragedy of the commons". This is evident from increasing incidence and severity of such climatic aberrations as global warming, acid rain, depletion of ozone layer, droughts, floods, cyclones, and hurricanes. All these climatic aberrations are caused mainly by human activity and partly by natural processes. But they all adversely impact on human wellbeing and the quality of our environment.

But times of crises are also times of opportunity. There is now growing awareness of the need for adoption of active global policies to create more sustainable economic structures and processes to mitigate the adverse impacts of climatic aberrations on human wellbeing and avert the "tragedy of the global commons". Consequently, several catch phrases such as green accounting, green gross domestic product, a global Green New Deal, low carbon economy and a green energy revolution have come into vogue and now find their way into governance and management of global commons.

This paper attempts to characterise the nature of the problem of global commons, identify its root causes, assesses the impacts of the tragedy and propose a strategy for managing the global commons so as to minimise the adverse impacts of the tragedy.

The strategy proposed comprises a mixture of market-based instruments and command and control measures. The paper is largely based on a review of the relevant literature available on the subject and partly on the empirical work done by the author over the last three decades or so.

Key words: *Global commons, 'tragedy of the commons', climate change, global warming, causes, impacts, strategy*

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1. INTRODUCTION AND BACKGROUND

By global common pool resources (GCPRs), or simply global commons, we mean resources, or facilities, or services, which are or can be used in common by a number of countries in the world, or by several people in a country simultaneously. They include such diverse things as space, climate, biodiversity, eco-systems and their services, high seas and marine fisheries beyond the Exclusive Economic Zones (EEZ) of nations, unpatented scientific discoveries and innovations, and global institutions such as the United Nations Organisation (UNO) and its sister institutions. They are all open access resources, i.e., resources which are everybody's property and access to which is free and unrestricted. The problems of open access arise from the lack of ownership of the resource by any person or organisation. There is some truth in the conservative dictum that " everybody's property is nobody's property" and hence open access is likely to be abused, misused, and over-exploited (Gordon, 1954: 135). In other words, they are subject to what Hardin (1968) called "the tragedy of the commons"

Most of the GCPRs are under high biotic[1] and abiotic[2] pressures in most of the countries of the world, particularly the developing countries including India. They are misused, over-exploited, misappropriated and polluted. For example, in India, in 2000, about 20% of its total geographical area was degraded due to various reasons. Agricultural lands suffer from soil erosion, water-logging, salinity and general loss of fertility, making them less productive. Similarly, most of India's rivers, lakes, tanks and ponds are polluted and the groundwater aquifers are over-exploited in most of its arid and semi-arid regions. Fishery yields have been declining year after year due mainly to indiscriminate fishing using mechanised trawlers equipped with very wide maws and radars (Singh, 2009:41-44).

At the global level, there have been drastic changes in climate including such aberrations as increasing intensity of global warming, acid rain, depletion of ozone layer, and increasing frequency of occurrence of floods, droughts, hurricanes, cyclones, and eruption of volcanoes. Biodiversity is being lost at an almost unprecedented pace. Space is being crowded with satellites and polluted by sonic booms of supersonic aircraft. All those changes will bring about rapid and unpredictable changes in the earth's entire biophysical system and adversely impact on human wellbeing. As a matter of fact, some of the ancient civilisations have disappeared due to the neglect of natural resources, particularly land and water resources. Famous British historian Toynbee (1939: 42-45) observed that it was the loss of command of physical environment,

[1] The biotic factors affecting the GCPRs include high levels of human and domestic animal populations, their high density and rapid growth, high incidence of poverty, high level of illiteracy, high levels of emission of green house gases and high density of use of the space for various purposes.

[2] Abiotic factors include floods, cyclones, hurricanes, tsunamis, earthquakes, and eruption of volcanoes.

which led to the breakdown of the civilisation of the Tigris river basin[3]. There are thus massive indications of the tragedy of global commons caused partly by human activity and partly by natural factors. But times of crises are also times of opportunity. There have been many initiatives in the past at both national and international levels to mitigate the adverse impacts of climatic aberrations on human wellbeing and avert the tragedy of the global commons. But the measures adopted followed conventional lines of unsustainable technological and economic practices and weak institutional structures. So, wise use and management of land, water and other natural resources including environment at both the national and global levels is of critical importance for global sustainable development.

The main objectives of this paper are to : (i) characterise the nature of the problem involved in using and managing the GCPRs; (ii) identify the root cause of the problem; (iii) assess the impacts of some of the climatic aberrations; (iv) identify some of the challenges and opportunities; and (v) propose a strategy for wise management of the global commons. The paper is partly based on a critical review of the literature available on the subject and partly on the author's work spanning over the period of more than three decades.

We begin with a characterization of the nature of the problem of degradation of GCPRs including environment and identification of its root cause.

2. THE PROBLEM OF GLOBAL COMMONS AND ITS ROOT CAUSE

Although global commons include a wide variety of resources, they all face one common problem of how to coordinate the actions of individual user nations to attain an optimal rate of production or consumption for the world community as a whole. Need for coordination and management generally becomes apparent when the flow of benefits or services from a resource is insufficient to meet the demand of its users. The primary causes of the demand for products / services of a global common exceeding its supply are increase in human and animal populations, discovery of new uses for the resource and / or its products, development and availability of new technologies for exploiting the resource and for processing, transporting, and marketing its products, discovery of new markets, and launching of new international policies and programmes. Over a relatively short period of time when the demand is constant, a problem may occur due to the decline or deterioration in the supply of the resource caused by such factors as degeneration due to natural processes, destruction by natural and / or man-made calamities, lack of necessary maintenance, etc. (Singh 1994: 12).

[3] The Tigris River is the eastern member of the two great rivers that define Mesopotamia, along with the Euphrates. The river flows from the mountains of southeastern Turkey through Iraq.

If the world community of users is unable to control the use of its commons under changing circumstances, destructive competition or conflict among the users is bound to follow, which eventually results in the depletion or degradation of the resources. Hardin (1968) characterised this eventuality as 'the tragedy of the commons'. The logic underlying the tragedy is purely economic in nature and can be stated as: unregulated access to a global common pool resource creates a decision-making environment in which incremental private benefits to an individual nation from the increased use of the resource markedly exceed the incremental costs associated with the increased use. Under these circumstances, each rational consumer or user of a global common is motivated to consume or use more and more of the resource till the resource is completely destroyed or degraded as a result of collective and uncoordinated use by all the individual users. Thus, individual rationality leads to collective irrationality.

The calculus of incremental or marginal private benefits markedly exceeding the incremental costs follows from the fact that, in the case of a GCPR, whereas an individual user nation can appropriate all the benefits resulting from its increased use of the resource, it bears only a small fraction of the incremental costs associated with its increased use; the incremental costs are shared by all the nations of the world community, implying the existence of an externality[4] in the use of the GCPR in question. Thus, the common pool problem is basically one of the existences of externality - a divergence between private cost and social cost of exploitation which eventually leads to either depletion or over-crowding or congestion (Friedman, 1971: 855). The problem is a manifestation of either the absence of exclusive private property rights or the breakdown of the structure of property rights, or institutional arrangements (Randall, 1975: 734).

Hardin's thesis of the 'tragedy of the commons' has since become the dominant paradigm of the exploitation of global commons resulting from their open access nature. It has formed the basis of numerous policies seeking to privatise or nationalise natural CPRs in many developed and developing countries of the world. Like any other thesis, it also has had its share of criticism and approbation. McKean (1987: 1-23) enumerates the following three conditions under which co-owners of a GCPR usually fail to cooperate in using it optimally and consequently the problem of non-cooperation or cheating arises and spreads like a contagion through the group.

1. When the perceived private costs to nations of cooperating may exceed their perceived benefits of co-operating;

[4] An externality may be defined as an unintended or spill –over effect of actions of an individual or a firm on other individuals or firms. It is characterised by joint use or consumption of a resource or a commodity and lack of compensation, i.e., one who creates a positive externality (benefit) is not completely rewarded for it nor is the one who creates a negative externality (cost) made to pay for it (Singh, 1994: 71).

2. When nations feel that their own contribution to the collective goal is minuscule and would not be missed if withheld because others will continue contributing, enabling them easily to free ride on the contributions of others; and

3. When nations have no assurance or certainty that the other co-user nations will make their contributions (or cooperate) and that their lone contribution to the effort would be sufficient to produce the desired outcome.

Hardin's thesis explicitly mentions only the first condition. Thus, by listing two more conditions, McKean adds to the Hardin thesis and presents a more pragmatic explanation of GCPR problem.

The problem of non-cooperation of co-users of a GCPR could also be illustrated through the Prisoners' Dilemma (PD) game. The classic PD game is analogous to many situations that prevail in the use of environmental resources, particularly the GCPRs (Singh 1994: 37-42). The two-person game can easily be extended to a multi –person (nation) game played repeatedly if, for Prisoner I, we substitute any GCPR user nation and similarly for, Prisoner II, all the other GCPR users. Such extensions are more plausible than the original two-person game because in real world situations many nations use or share a GCPR and face the PD situation repeatedly, i.e., day after day, or year after year.

The relevance of the classic PD model to the problems of GCPRs can be illustrated with reference the problem of over-fishing in high seas beyond EEZs of nations. Envision a high sea marine fishery in the Indian ocean with: (1) India and Pakistan having access to the fishery; (2) 100 square kilometers of fishery that can sustain at a reasonably good level of productivity only a catch of 1000 metric tonnes per season; and (3) no formal or informal institution or organisation acceptable to both the nations for arbitration on the matters of fishing In the absence of any institution or organisation, both the nations do not negotiate towards individual fishing quotas that would lead to socially optimum level of fishing and do not have any fishing norms, rules, or regulations — a no-holds-barred situation. Following the structure of the classic PD game, we assume that one of the nations is represented Nation I and the other by Nation II. There are two strategies open to each nation : (1) to cooperate with the other nation by permitting only 20 fishing boats per season for fishing ; and (2) do not cooperate and send any number of fishing boats for fishing We show the expected pay-offs of these two strategies in Table 1. The first figure in each of the four boxes represents the expected pay-off to Nation I and the second figure to Nation II.

Suppose if, prior to each fishing season, the group of fishing nations is indifferent to the distribution of potential benefits from fishing between Nations I and Nation II, then the pay offs are highest (250) when both the fishing nations cooperate, and lowest (150) when they do not cooperate. Now under the given

structure of the game, or situation, Nation I asks this question to itself: Given Nations II's decision to cooperate, what is my best strategy? The obvious answer is: I do better by not cooperating because the expected pay-off of Rs. 160 million from non-cooperation is higher than the expected pay-off of Rs. 125 million from cooperation. Alternatively, if Nation II decides to not cooperate; still Nation I does better by not-cooperating as the expected pay-off of Rs. 75 million from non-cooperation is higher than the expected pay-off of Rs. 40 million from cooperation. Using the same logic, a similar conclusion (non-cooperation) is arrived at by Nation II Thus, each of the fishing nations finds that it is better off by "not cooperating" whatever the decision of the other nation. So, both the nations home in on (75, 75) which is the second best alternative for them. This means that "non-cooperation" is the dominant strategy in this game.

Table 1: Expected pay-offs from cooperation and non-cooperation in fishing in high seas

(Rs. Million per nation)

Nation I	*Nation II*		
		Cooperate	*Not cooperate*
	Cooperate	*125, 125*	*40, 160*
	Not cooperate	*160, 40*	*75, 75*

The PD game has fascinated many scholars and its analogy used to understand and explain so many complex problems related to the use of GCPRs. The outcome of the game is a paradox in that it shows that individually rational strategies lead to collectively irrational strategies and thus poses a challenge to many fundamental concepts in ethics, political philosophy, and social sciences (Campbell and Sowden 1985: 3). However, the paradoxical outcome of the PD game is very much contingent, like in other games, on the structure and rules of the game. Structures of many real world situations where GCPR problems exist are not similar to the structure of the PD game in that the resource users may be free to communicate with one another and enter into mutually binding contracts, i.e., both the structure and the rules of the game can be changed. When this is so, the dilemma or the "tragedy of the commons" can be resolved by co-operative action of the user nations. Also, when a situation is repeated again and again, rational resource users could learn from the past sub-optimal

decisions and select strategies that yield collectively rational or optimum outcome (Braybrooke 1985; R. Hardin 1982).

Theoretical, experimental, and empirical studies of multi-person repeated games suggest that cooperation can emerge under a wide variety of circumstances and that issues of strategy, ethics, and expectations play bigger roles in multi-person games than in single person games (Magrath 1986: 33). Axelrod (1984) advances several propositions dealing with the emergence of co-operation in iterated prisoners' dilemmas. The most important among them is that the threat of and the willingness and ability to retaliate against defections is vital to the emergence of co-operation. In the Hawk-Dove game type situations, the "first come first served" or "weaker yields to stronger" convention could avoid conflict and produce cooperative behaviour (Hirshleifer 1987: 225-226).

To sum up, we can say that the classic PD game is a good theoretical construct that can be used to explain why nations do not cooperate and do not act collectively in using and managing environmental goods and amenities. It also points to the conditions under which nations might cooperate and act collectively.

3. IMPACTS OF SOME OF THE CLIMATIC ABERRATIONS [5]

Many of the climatic aberrations such as increasing global warming, increasing incidence of acid rain, droughts, floods, cyclones, eruption of volcanoes and depletion of ozone layer are to a large extent the consequences of the tragedy of the global commons caused mainly by human activities. They all have adverse impact on human wellbeing and the quality of environment and eco-systems. So much so that, as we stated earlier in this paper, some of the highly developed ancient civilisations had broken down due to the neglect of their physical environment and eco-systems.

We now assess the impacts of some of the major climatic aberrations of global significance such as acid rain, global warming, and depletion of ozone layer.

3.1 *Global warming*

There have been perceptible changes in the climate all over the world, particularly in the last two decades or so. The greenhouse gas concentrations have been increasing, leading to global warming. Scientists generally believe that the combustion of fossil fuels and other human activities are the primary reason for the increased concentration of carbon dioxide. Global mean surface

[5] This section is largely based on (Singh and Shishodia, 2007 : 333-347).

temperatures have increased 0.5-1.0℉ since the late 19th century. The snow cover in the Northern Hemisphere and floating ice in the Arctic Ocean have decreased. Globally, sea level has risen 4-8 inches over the past century. Worldwide precipitation over land has increased by about one percent. According to the Fourth Assessment Report: Climate Change 2007 prepared by the U.N. Inter-Governmental Panel on Climate Change (IPCC), world temperatures could rise by between 1.1 and 6.4 ℃ (2.0 and 11.5 ℉) du ring the 21st century and that sea levels will probably rise by 18 to 59 cm.

Global warming has the following major effects:

- Adverse effect on human health, leading to increase in heat-related diseases and deaths, higher incidence of malaria, dengue, yellow fever and viral encephalitis caused by expansion of mosquitoes and other disease carriers to warm areas.
- Precipitation pattern may change, causing some regions to have more frequent droughts and some areas suffering from heavier snowfall and rainstorms.
- Shortage of fresh water in many arid and semi-arid areas.
- Adverse effect on agricultural production due to droughts and increased incidence of pests, causing shortage of food.

As we all know, droughts, floods, cyclones and tsunamis cause immense loss of life, property, and agricultural production, Besides, they degrade the eco-systems in the regions where they occur, causing irreversible damages in many cases. In Table 2, we present a few salient details of the major natural catastrophes that occurred in the world in the year 2005. As shown in the table the total number of lives lost (fatalities) were 91,364 and the total losses suffered US $ 1, 72,200.

3.2 Acid rain

The problem of acid rain started long ago when the Industrial Revolution commenced. Acid rain is one of the most dangerous and widespread forms of pollution. Sometimes called "the unseen plague," acid rain can go undetected in an area for years. Technically, acid rain is rain that has a larger amount of acid in it than what is normal. Acid deposition in the atmosphere occurs due to the release of sulphur oxides and nitrogen oxides in the atmosphere. Motor vehicles are a major source of nitrogen oxides and electrical power plants and industrial boilers are the main sources of sulphur dioxide emissions. The acid rain can be carried over long distance by atmospheric winds so much so that one country can export acid emissions to another. Due to its movement from the locations of its origin to other places within and across nations, the problem has become too complex and highly politicized to be resolved. There is no agreement on sharing of the cost of abatement of acid rain.

Table 2 : Major natural catastrophes in the world in 2005

Region	No. of catastrophes	Type of catastrophe	Fatalities (No)	Overall losses US $ (Million)	Insured losses US $ (Million)
India	30	Floods	1,150	5,000	770
USA	37	Hurricane Katrina	1,322	125,000	60,000
USA	41	Hurricane Rita	10	16,000	11,000
Middle America	44	Hurricane Stan	840	3,000	100
Pakistan & India	45	Earthquake	88,000	5,200	NA
Mexico, USA & Caribbean	46	Miscellaneous	42	18,000	10,5 00
All	243	All types	91,364	1, 72,200	82,370

Source: Annual Review: Natural Catastrophes 2005, Geo Knowledge Series, Munich Re Group, Germany (http://www.munichre.com), quoted in : Singh and Shishodia (2007: 345)

Acid rain affects lakes, streams, rivers, bays, ponds and other bodies of water by increasing their acidity until fish and other aquatic creatures can no longer live. Aquatic plants grow best between pH 7.0 and 9.2. As acidity increases (pH numbers become lower), submerged aquatic plants decrease and deprive waterfowl of their basic food source. At pH 6, freshwater shrimp cannot survive. At pH 5.5, bottom-dwelling bacterial decomposers begin to die and leave un-decomposed leaf litter and other organic debris to collect on the bottom. This deprives plankton--tiny creatures that form the base of the aquatic food chain--of food, so that they too disappear. Below a pH of about 4.5, all fish die.

The effects of aid rain have been recorded in parts of the United States, the late Federal Republic of Germany, Czechoslovakia, the Netherlands, Switzerland, Australia, Yugoslavia and elsewhere. It is also becoming a significant problem in Japan and China and in Southeast Asia. Rain with a pH of 4.5 and below has been reported in many Chinese cities. Sulphur dioxide emissions were reported in 1979 to have nearly tripled in India since the early 1960s, making them only slightly less than the then-current emissions from the Federal Republic of Germany.

3.3 Ozone depletion

Within the stratosphere, a concentration of ozone molecules make up the ozone layer. Around 90% of the ozone is within the ozone layer. There are several layers surrounding the earth's atmosphere. The layer that is around us is called the troposphere. A level higher is known as the stratosphere. Stratospheric ozone is a gas which occurs naturally. The ozone layer could be thought of as Earth's sunglasses, protecting life on the surface from the harmful glare of the sun's strongest ultraviolet rays, which can cause skin cancer and other maladies. The stratospheric ozone layer filters ultraviolet (UV) radiation from the sun. As the ozone layer is depleted, more ultraviolet radiation reaches the earth's surface.

The ozone layer can be depleted by free radical catalysts, including nitric oxide (NO), hydroxyl (OH), and atomic chlorine (Cl) and bromine (Br). While there are natural sources for all of these catalysts, the concentrations of chlorine and bromine have increased markedly in recent years due to the release of large quantities of manmade organohalogen compounds, especially chlorofluorocarbons (CFCs) and bromofluorocarbons. Ozone levels, over the northern hemisphere, have been dropping by 4% per decade. Over approximately 5% of the Earth's surface, around the north and south poles, much larger (but seasonal) declines have been observed; these are the *ozone holes* (Raven et al., 1998, 471-75).

There are reports of large ozone holes opening over Antarctica, allowing dangerous UV rays through to Earth's surface. Indeed, the 2005 ozone hole was one of the biggest ever, spanning 24 million sq km in area, nearly the size of North America. While the ozone hole over Antarctica continues to open wide, the ozone layer around the rest of the planet seems to be on the mend. For the last 9 years, worldwide ozone has remained roughly constant, halting the decline first noticed in the 1980s.

Overexposure to UV rays may cause several health issues for humans. Skin cancer is the most widely known. In addition, overexposure to UV rays can also cause cataracts.
(http://www.sciencedaily.com/releases/2006/05/060527093645.htm)
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4. SOME CHALLENGES AND OPPORTUNITIES

As we stated earlier in this paper, there are massive indications of a crisis of GCPRs, caused mainly by human activity. The main challenge facing the world community today is how to (i) reverse the process of degradation and depletion of its natural resources including physical environment; (ii) avoid the tragedy / crisis of GCPRs; (iii) coordinate the actions of various national and international agencies

engaged in addressing the problems of GCPRs; and (iv) attain the goal of global sustainable development.

Without an intentional cultural shift that values sustainability over consumerism, no government pledges or technological advances will be enough to rescue humanity from unacceptably hazardous environmental and climate risks, concludes the Worldwatch Institute in the latest edition of its flagship annual report, *State of the World 2010: Transforming Cultures—From Consumerism to Sustainability.* According to report, in 2006, people consumed $30.5 trillion worth of goods and services, up 28 percent from just 10 years earlier. This rise in consumption has resulted in a dramatic increase in resource extraction; the world digs up the equivalent of 112 Empire State Buildings worth of materials each day. How to inculcate among people a cultural change that attaches higher importance to sustainability than consumerism is perhaps the biggest challenge facing the global policy makers.

But times of crisis are also times of opportunity. In response to the crisis of CPRs, several initiatives have been taken at both national and international levels and there has been growing awareness of the need for government action to address the problems. While many of the measures taken follow conventional lines of unsustainable economic practices, there is now growing awareness of the need for active public policies to create more sustainable economic structures and processes to combat both economic and environmental crises. Green recovery, a global Green New Deal, and a green energy revolution are catch phrases that now find their way into governance and policy making processes. In 2010 the United Nation's Millennium Development goals will be a decade old and there will only be five years left to achieve them. Meeting this challenge requires bold and concerted action on global, national and local levels and across societal groups and organisations in the global North and the South. With the entirety of closely connected social, health, economic and ecological goals, the Millennium Development Goals guide an integrated approach to development and human well-being that goes beyond the usual polarisation between development and environmental goals. In this situation, ecological economics and environmental economics are poised to play a leading role in addressing these global challenges. The rapidly changing patterns of economic, political, and economic systems necessitate integrated and innovative analyses, ideas, concepts and solutions. They have both pioneered in integrating ecological and social concerns into economic analyses and practical solutions and have united scientists, practitioners and decision makers from various disciplinary backgrounds in innovative and participatory research and decision-making processes.

We now proceed to propose a strategy that is designed to address the problems of CPRs.

5. A PRAGMATIC STRATEGY OF MANAGING GLOBAL COMMONS

There is growing awareness now of the need for adoption of active global policies and strategies to create more sustainable economic structures and processes to mitigate the tragedy of the global commons and avert the impending ecological crises. Green accounting, green gross domestic product, a global Green New Deal, low carbon economy and a green energy revolution are some of the catch phrases that now find their way into governance and management of global commons on a sustainable basis. A pragmatic management strategy should specify a particular set of instruments that could be used for addressing the problems of degradation and depletion of global commons and facilitate their sustainable use.

A priori, any one or a combination of market-based and institution-based instruments could be used to achieve the goals of a management policy and, theoretically speaking, any one of those instruments could be as good or as bad as any other. The choice of a set of instruments will depend on the particular resource and setting in question and often requires a multilateral approach, use of traditional knowledge and modern scientific knowledge and consultation among the co-users. It is not always easy to determine whether a GCPR would be better managed as a national property, or global common property; there are many `grey' areas when it comes to choosing a particular management system. Based on a survey of literature, we propose the following sets of instruments for managing natural resources and environment in the global context:

5.1 Global policies [6]

Global monetary, fiscal and foreign exchange policies have more powerful effects on how natural resources are allocated and used than national or sectoral policies. For example, other things remaining constant, the higher the costs of inputs of capital and labour used in resource extraction or in polluting industries, relative to the price of outputs, the lower the rate of resource depletion and the amount of pollution. If capital-intensive technologies are more polluting than labor-intensive technologies, then lower price of capital relative to labor will result in more pollution.

The rate of interest is an important macroeconomic parameter with macroeconomic implications for resource allocation because it links the present with the future. The higher the interest rate (or discount rate), the higher the cost of waiting and, therefore, the faster the rate of resource depletion and the lower the investment in resource conservation. However, this effect may be mitigated somewhat by the fact that a higher interest rate means a higher cost of capital, which tends to reduce capital-intensive resource depletion and environmental

[6] This section is largely based on Singh and Shishodia (2007: 181-193).

degradation. Interest rate ceilings and implicit interest rate subsidies for promoted industries have been the main interest rate distortions affecting the agricultural sector and the rural economy in general in many developing countries of the world including India. In this context, the World Bank, the International Monetary Fund (IMF), Asian Development Bank (ADB), and other international development banks could play an important role through facilitating the member nations is developing appropriate macroeconomic policies.

As most of the resource-based commodities produced in developing countries are internationally traded, or tradable (e.g., copper, oil, jute, cotton, tin, fish, rice, beef, rubber, and timber), or are substitutes for tradable commodities (e.g., natural gas, lignite, and hydropower), an overvalued exchange rate would reduce their depletion by reducing their price relative to non-tradable goods (e.g., transport, services, and construction). An overvalued exchange rate and export taxes have similar effects in that they discourage exports (and encourage imports) of resource-based commodities, thereby reducing the pressure on the domestic resource base.

Trade and industrial policy reforms amount to promotion of exports, liberalization of imports and encouragement of foreign investment. This is done by reducing absolute and differential protection, lowering production and transactions costs of exports and imports and promoting competition through institutional reforms. To ensure that industrial and trade policy reforms result in relative if not absolute environmental improvement, the import tariff structure should be used to internalize environmental costs into the pricing of technologies and products. Similarly increased industrialization and foreign investments are not detrimental to the environment as long as all environmental costs have been accounted for (internalized) and no major irreversible changes to the environment take place. Countries could use tariff reform as an opportunity to favour import or manufacture of environmentally benign technologies and machinery and discriminate against highly polluting technologies. Similarly, environmental conditions should be specified as part of any foreign investment project at the time of application and monitored as part of regular performance evaluation.

Minimum wage laws (which also encourage capital intensity) reduce labor employment and depress real non-manufacturing wage rates. This, under conditions of labor abundance, leads to (a) increased use of low-cost labor in depleting natural resources and (b) encroachment of resource sectors by unemployed or underemployed labor. Therefore, even if the issues of open access and externalities are satisfactorily resolved, resource depletion and environmental deterioration may continue unless the macroeconomic policies responsible for price distortions in the economy are reformed. The unintended but pronounced effects of fiscal, monetary and trade policies on natural resources and the environment must enter the assessment and formulation of these policies. The effects of minimum wage rates, subsidized credit, interest rate ceilings, and exchange rate adjustments (along with those of export taxes,

investment incentives, and import tariffs) on the rate of resource depletion in a resource-based economy cannot be ignored without endangering the long-term viability of the economy.

It would be unrealistic, however, to expect macroeconomic policies to be tailored to meet environmental objectives because of many other overriding considerations, such as growth stabilization and macroeconomic management, which determine these policies. What can be expected, at best, is that environmental implications are somehow taken into account when these policies are formulated and implemented. Consideration of the resource and environmental implications of macroeconomic policies could result in one of the following consequences: (a) environmental costs may tip the scale against marginal policies by raising their social costs above their social benefits; (b) macroeconomic policy interventions might be scaled up or down on account of their environmental implications; and (c) provisions might be made for cushioning the negative environmental effect of policies when such policies cannot be scaled down sufficiently to reduce their environmental cost to acceptable levels.

On the other hand, macroeconomic mismanagement is as detrimental to natural resource management and environmental quality as it is to the other sectors of the economy. Mounting foreign debt, widening balance of trade deficits, hyperinflation, rising interest rates, low savings, negative growth of investments and growing budget deficits work their way through economic stagnation, increased poverty, structural reversal and shortening of the planning horizon (increase in the discount rate) to encourage environmental degradation.

To help governments restructure their economies to better deal with the emerging problems, the World Bank, the International Monetary Fund (IMF) and other international development agencies have been financing Structural Adjustment Loans (SALs) and Sectoral Adjustment Loans (SECALs) for many years now. For the following reasons, it is important to consider the impact of these structural and sectoral adjustment programmes and loans on resource management and sustainable development:

(a) The adjustment programmes more or less defined the macroeconomic and sectoral polices to be followed for a good part of the 1990s and, as we have stated earlier in this section, macroeconomic and sectoral policies affect resource allocation and use;

(b) Since these programmes aim at restructuring the economy of the country, their impact will extend far beyond the expiration of the programmes and loans; and

(c) For the first time, environmental concerns have been raised by several countries and development assistance agencies in the context of macroeconomic and development policies and some provisions relating to natural resources and

the environment have been included in the loan agreements. Regardless of the adequacy or effectiveness of these provisions, the mere recognition of the implications of macroeconomic, trade, and development policies on the resource base and the environment is a significant step in the right direction. Yet, questions have been raised as to the overall impact of structural adjustment policies on the environment.

5.2 International treaties, conventions and institutions

As the GCPRs are *outside* the national jurisdictions, they could be managed only through international cooperation and agreements. Although an international environmental management policy still seems a rather distant possibility, there are many historical cases of international cooperation and conventions in this field. We could learn from their experience and try to develop some semblance of an international policy for management of global commons.

The following four major tools have been used in the past to secure international cooperation in environment management: (i) officially sponsored international conferences; (ii) treaties (conventions); (iii) establishment of permanent international agencies; and (iv) international commodity agreements (Ciriacy-Wantrup 1968: 305). Most of the early successful attempts at international regulation of fugitive resources were concerned with individual resources in limited areas. For example, marine fish was the first fugitive resource that was brought under international regulation through a series of regional conferences and conventions. Recently, more ambitious but as yet less successful attempts have been made to cover more resources and wider geographic extent. Examples of some recent international attempts include the United Nations Conference on the Human Environment, 1972, publication of *World Conservation Strategy: Living Resource Conservation for Sustainable Development* (1980) by the International Union for Conservation of Nature and Natural Resources, the United Nations Law of the Sea, 1982, (International) Conference on Common Property Resource Management, 1985, sponsored by the Board on Science and Technology for International Development, National Research Council, USA, the Montreal Convention on Ozone Layer, 1990, the United Nations Conference on Environment and Development, 1992 and. the Kyoto Protocol on Carbon Sinks and Emissions Trading, 1997[7].

Besides, many international research institutes, centres, and professional associations such as the World Resources Institute, the International Institute for Environment and Development, the International Association for the Study of Commons, the International Society for Ecological Economics, the International Centre for Living Aquatic Resources Management, the International Irrigation Management Institute, the International Board for Soil Research and Management and the Inter-Government Panel on Climate Change conduct

[7] For details of selected environmental treaties and conventions, see Grafton et al. 2001, Appendix 7, pp.339-362.

research and training on different resource systems and develop innovative resource management practices (Singh and Shishodia, 2007, 196-197). In spite of all these attempts, enforcement of existing international regulations and conventions leave much to be desired. This is due mainly to the lack of a functional and effective global institutional mechanism for coordinating the actions of various global agencies involved in addressing the problems of GCPRs.

5.3 Safe minimum standards (SMS)

SMSs are used to maintain a safe minimum standard of conservation of renewable critical-zone natural resources like forests, fisheries, and groundwater. A SMS of conservation is achieved by avoiding the critical zone, i.e., level of exploitation at which it becomes uneconomical to halt and reverse the depletion Ciriacy-Wantrup (1968:253). Since it is impracticable to determine the socially optimum level of use of an environmental resource / amenity in most situations due to non-availability of required information, SMSs could be easily set up which would avoid serious depletion or degradation of the resource in question. In many practical situations, maintenance of SMSs does not require sacrifice of any use; rather, it involves a change in the technology of resource utilization. These changes may or may not involve any costs. Sometimes the costs are only public in the form of education and / or subsidies. An important prerequisite to the use of this tool is detailed specification of SMSs for various resources. This job is better done by a team of technical and social scientists and environment managers. For operational purposes, SMSs may be defined in terms of maximum use rates. SMSs when defined in terms of conservation practices could be adapted to suit local conditions, are easy to understand by users, and relatively less costly to administer. A drawback of SMSs is that they could be a technical constraint in securing economic efficiency in resource use. Another drawback is that their enforcement in most situations would be problematic and monitoring difficult and expensive. In India, use of SMSs has so far been limited to the monitoring and control of air and water pollution. Standards have been notified for 26 industries and are enforced by the Central and State Pollution Control Boards (Singh and Shishodia, 2007: 176-177).

5.4 Education and persuasion

This instrument seeks to change perceptions and priorities of users of natural resources and services by internalising environmental awareness and responsibility into individual decision making. Besides education and persuasion, this instrument could also take the form of provision of information and training as well as forms of ‘moral suasion’ such as social pressure and negotiation. They can complement economic and regulatory instruments and assist in their successful implementation.

Most scholars and practitioners in environment management recognize the need for education as an instrument of averting 'the tragedy of the commons'. Most users of environmental resources and services in both developed and developing countries of the world do not use them as they 'should', partly because they are ignorant about the nature and causes of environmental problems and partly because of many economic and institutional factors such as poverty, property rights, and tenure. This stands in the way of their adopting socially desirable behaviour. In the short run, education seems to be a logical and simple solution to the extent that environmental problems arise out of ignorance. Education should therefore be mainly used as a means of alleviating ignorance.

In the long run, education also affects environment management in two other ways. First, it influences population growth. With all else equal, people with more education tend to have somewhat smaller families and to that extent population pressure on the environment and consequently its exploitation and misuse are reduced. Second, education increases incomes. Many developing countries are trapped in the extreme poverty associated with rapid population growth, illiteracy, unemployment, poor nutrition and hygiene. All these factors tend to have an adverse effect on the environment. Increased incomes therefore help improve the status and management of the environment. In designing education programmes, it is important to keep these questions in mind: who is to be educated, in what subjects, and with what kind of information, by whom, and how? (Singh and Shishodia, 2007: 177-178).

6. CONCLUDING REMARKS

Most of the global commons are misused, over-exploited, misappropriated and polluted and are subject to what Hardin called "the tragedy of the commons". The root cause of the problem is the existence of externalities in the use of global commons and the lack of a global institutional structure for coordinating the actions of individual user nations so as to ensure their sustainable use .

There have been drastic changes in climate including such aberrations as a marked rise in global warming and acid rain, depletion of ozone layer and increased frequency of occurrence of floods, droughts, hurricanes, cyclones, and eruption of volcanoes. All these changes have an adverse impact on human wellbeing and the quality of our environment and ecosystems.

There is now growing awareness of the need for adoption of active global policies and strategies to create more sustainable economic structures and processes to mitigate the tragedy of the global commons and avert the impending ecological crises. A pragmatic global strategy of managing the global commons should comprise a set of global monetary, fiscal and foreign exchange policies, international treaties, conventions and institutions, safe minimum

standards and education and persuasion. An appropriate global institutional structure is also necessary for effective implementation of the global policies.

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