DKN2A - ENVIRONMENTAL ECONOMICS

UNIT-I: Introduction and Basic Theories of Environmental Economics

Meaning definition of environmental economics - importance, scope, economics and environment - Theories of optimal use of exhaustible and renewable resources – concept of sustainable development- Economic accounting and the measurement of environmentally corrected GDP.

UNIT-II: Externalities

Externalities and market inefficiency - externalities as missing markets; property rights and externalities, non-convexities and externalities. Pareto optimal provision of public goods - Lindhal's equilibrium, preference revelation problem and impure and mixed goods, common property resources.

UNIT-III: Measurement of Environmental Values

Use values; option values- existence value and non-use values; valuation methods- Hedonic property values and household production models (travel cost method and health production function), methods based on response to hypothetical markets, contingent valuation methods- Natural resources accounting – concepts, methods and empirical evidences. Environment and trade- Cost of environment, pollution, life cycle assessment- Impact of development on biodiversity- Development indicators and human health.

UNIT-IV: Theory of Environmental Policy

Pigouvian taxes and subsides, marketable pollution permits and mixed instrument (the charges and standards approach) Coase's bargaining solution and collection action, informal regulation and the new model of pollution control. Global environmental externalities and climate change-tradable pollution permits and international carbon tax.

UNIT-V Economic Impact of Environmental Pollution and Environmental Regulations

Environmental laws and their implementation: policy instruments for controlling water and air pollution and forestry policy; Environment and its impact on biosphere-Environmental impact on health of living creatures- Environmental Institutions and Gross Root Movement.

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UNIT - I

INTRODUCTION AND BASIC THEORIES OF ENVIRONMENTAL ECONOMICS

1.1 Introduction

Environmental economics is a subfield of economics concerned with environmental issues. Quoting from the National Bureau of Economic Research Environmental Economics program: Environmental Economics undertakes theoretical or empirical studies of the economic effects of national or local environmental policies around the world.

Particular issues include the costs and benefits of alternative environmental policies to deal with air pollution, water quality, toxic substances, solid waste, and global warming. Central to environmental economics is the concept of market failure.

Market failure means that markets fail to allocate resources efficiently. "A market failure occurs when the market does not allocate scarce resources to generate the greatest social welfare. A wedge exists between what a private person does given market prices and what society might want him or her to do to protect the environment.

Such a wedge implies wastefulness or economic inefficiency; resources can be reallocated to make at least one person better off without making anyone else worse off." Common forms of market failure include externalities, non excludability and non rivalry.

Environmental economics is related to ecological economics but there are differences. Most environmental economists have been trained as economists. They apply the tools of economics to address environmental problems, many of which are related to so-called market failures- circumstances wherein the "invisible hand" of economics is unreliable.

Most ecological economists have been trained as ecologists, but have expanded the scope of their work to consider the impacts of humans and their economic activity on ecological systems and services, and vice-versa.

This field takes as its premise that economics is a strict subfield of ecology. Ecological economics is sometimes described as taking a more pluralistic approach to

environmental problems and focuses more explicitly on long- term environmental sustainability and issues of scale.

Environmental economics is viewed as more pragmatic in a price system; ecological economics as more idealistic in its attempts not use money as a primary arbiter of decisions. These two groups of specialists sometimes have conflicting views which may be traced to the different philosophical underpinnings.

Environmental economics was once distinct from resource economics. Natural resource economics as a subfield began when the main concern of researchers was the optimal commercial exploitation of natural resource stocks.

But resource managers and policy-makers eventually began to pay attention to the broader importance of natural resources It is now difficult to distinguish "environmental" and "natural resource" economics as separate fields as the two became associated with sustainability. Many of the more radical green economists split off to work on an alternate political economy.

Environmental economics was a major influence for the theories of natural capitalism and environmental finance, which could be said to be two sub-branches of environmental economics concerned with resource conservation in production, and the value of biodiversity to humans, respectively. The theory of natural capitalism (Hawken, Lovins, Lovins) goes further than traditional environmental economics by envisioning a world where natural services are considered on par with physical capital.

The more radical Green economists reject neoclassical economics in favour of a new political economy beyond capitalism or communism that gives a greater emphasis to the interaction of the human economy and the natural environment, acknowledging that "economy is three-fifths of ecology" – Mike Nickerson.

1.2 Environmental Economics

Meaning

In the words of D.W. Pearce, "Environmental Economics brings the discipline of economic analysis to environmental issues such as pollution, the rate of use of renewable and non-renewable natural resources, conservation of living species and resources, and the choice of policy to achieve environmental ends."

The mainstream economics is based on market mechanism. Its primary emphasis is on the market as a supplier of advice about human preferences. It focuses on the rational behaviour of consumers and producers. It studies the micro and macro aspects of the economy. But economics differs from environmental economics.

In economic sense, pollution is termed as any loss of human well being arising from physical environmental change. Pollution may also have short- run or long-run impacts upon the health of human beings. Resource issues, as pointed out by D.W. Pearce, may be interpreted as possible degradation of the human environment. Other forms of degradation may also be added, such as the exploitation of natural resources other than for crop land (for housing/transport etc.), the exhaustion of non-renewable resources (such as oil and mineral), and the mismanagement of renewable resources.

According to Charles Kolstad, the best division between environmental economics and resource economics is between static and dynamic issues related to the natural world. "Environmental economics involves questions of excessive production of pollution by the market (or insufficient protection of the natural world due to market failure).

Resource economics, on the other hand, is concerned with the production and use of natural resources, both renewable and exhaustible. Renewable resources would include fisheries and forests. Non-renewables would include minerals and energy as well as natural assets."

1.2.1 Subject matter of Environmental Economics

There are different approaches on the subject matter of environmental economics.

(A) 1. Natural resources scarcity approach

Classical economists have expressed their arguments on natural-resources scarcity. Malthus has analysed this problem in relation to the growth of population. "Population has this constant tendency to increase beyond the means of subsistence, and that it is kept to its necessary level by these causes and thus, humankind, is necessarily confined in room by nature."

It means that if the pressure of increasing population continues in relation to food supply, then human life is destined to be miserable. Hence the pace of economic development will be retarded due to growth in population with limited natural resources.

J.S. Mill has extended the natural-resources scarcity approach to nonrenewable mineral resources. “The only products of industry, which, if population did not increase, would be liable to a real increase of cost of production, are those which depending on a mineral which is not renewed, is either wholly or partially exhaustible such as coal, and most if not all metals for even iron, the most abundant as well as most useful of metallic products, which forms an ingredient of most minerals and of almost all rocks, is susceptible of exhaustion.”

In the words of Dr Herbert Ginits, “Balancing the goal of improving the natural environment against other desirata such as increased consumption and leisure is a problem of Marshallian scarce resources towards competing ends, to use the well-known phrase of Lionel Robbins. However, these views do not concern about environmental problems.”

The classical school considers environment as a free good. But, society has overused the natural resources, leading to environment degradation. Marshall does not assume any absolute resource limits but only admits that resources decline with limited productive powers of nature. Ricardo argued that relative scarcity is a problem of growing economy. Relative scarcity is set by rising costs as the highest grade resources which are exploited and substituted for all low grade resources.

2. Marxist Ecological Approach

Marx is against capitalism. Under capitalism, every capitalist is engaged in introducing labour saving methods and replacing the labour by machines. The natural environment is polluted by installing more machines by capitalists.

In the words of Marx, “The forces of nature are appropriated as agents of labour process only by means of machines and only by the owners of machines. The application of these forces of nature on a broad scale is only possible where machines are used on a broad scale.” In short, we may say that mechanical methods lead to man’s exploitation of nature in his own interests.

F. Engels has expressed his views on Economic growth and Environmental crisis. He is of the view that man is a product of nature and also a part of it. Therefore, economic growth need not damage man's harmony with nature. In an essay entitled, "The Part Played by Labour in the Transition from Ape to Man", he has expressed his views thus: "Let us not, however, flatter ourselves over much on account of our human victories over nature. For each such victory nature takes its revenge on us we are reminded that we by no means rule over nature, like someone standing outside nature, but that we……..belong to nature."

3. Chicago Approach

According to this approach, in the real world, there is always market failure due to externalities. Externalities are market imperfections where the market offers no price for service or disservice. For example, a factory situated in a residential area emits smoke which affects adversely health and household articles of the residents.

In this example, the factory benefits at the expense of residents who have to incur extra expense to keep themselves healthy and the households clean. These are social marginal costs because of harmful externalities which are higher than private marginal cost and also social marginal benefits. To protect the society's gain, Pigou suggests state interference by imposing pollution tax or subsidies to firms to reduce the pollution.

Pigou's approach to externalities has been challenged by Dr. Coase. According to him, the main source of externalities is an inappropriate assignment of property rights. If property rights are clearly defined then the affected parties will adopt policies to internalise the externalities.

Dr. Coase explains his arguments with the help of an example. He assumes only two parties, a cattle raiser and a wheat producing farmer. They are operating on neighbourhood properties without any fencing. The externality is the damage done by the cattle roaming on the unfenced land of the farmer.

As the cattle raiser increases the size of the herd, the damage to the farmer's crop increases. According to Dr. Coase, property rights should be properly defined and enforced. The farmer has the right that his wheat be not destroyed. Therefore, the cattle raiser will then be forced to pay damages to the farmer for the crop destroyed.

4. Conservation Approach

Ciriacy-Wantrup has advocated a safe minimum standard approach for natural resources use. In the face of uncertain demand and uncertain technological improvements that create substitutes, a certain minimum of preservation would give some options for future use.

This approach suggests to adopt a conservation process which involves the identification of a safe minimum standard of critical zone of renewable resources use because of the uncertainty and irreversible degradation of these resources. It is the prime duty of the institutions to safeguard against the inefficiency in the use of these resources.

K.W. Kapp argued that destruction of renewable resources is the result of uncontrolled competition in the utilization of these resources. Over hunting, over fishing, excessive timber felling and exhaustion of the soil have led and still lead to the extinction of species and erosion of fertile land.

He also deals with the problems of non-renewable resources like oil and coal. As a result of cut-throat competition, great waste occurs in production and here too no allowance is made for the consequences for future generations. For maintaining a stable ecosystem, he stresses on abiotic conditions such as the quantity of nutrient salts, soil structure, ground-water level, degree of acidity and humidity.

K.E. Boulding argued that earth's environmental resources should be viewed as essential irreplaceable social capital and the main purpose of economic activity should be to conserve this stock of natural capital intact for future generations. To put it more precisely, environment is the resources potential on which mankind depends and development consists of transforming elements of environment into resources.

Diachronic solidarity with future generations compel us to reject predatory from hand to mouth practices of cowboy economy and to seek instead a pattern of resources use based as much as possible on sustainability.

5. Technological Approach

The technological approach to the environment emphasizes the link between the nature of technological change that has taken place and its environment implications. Barry Commoner believes that the main purpose of business firms is to maximize their

profits in an economic system. Moreover, profits of business firms have increased with the advancement of technology. But what happened to environment? He explains two facts regarding environment.

First, pollution tends to become intensified by the displacement of older productive techniques by new, ecologically faulty but more profitable technology. Thus, in these cases, pollution is an unintended concomitant of the natural drive of the economic system to introduce new technologies that increase productivity.

Second, the cost of environmental degradation is chiefly borne not by the producer but by society as a whole in the form of externalities. In support of his views, he says that there are vital changes in the nature and composition of commodities produced in U.S.A. after World War II.

Since 1946 the provision of basic goods such as food, clothing and shelter grew in proportion to the growth of population but the environmental impact of these goods has also increased. B. Commoner uses the term 'technology' to indicate the qualitative changes in production with damaging environmental consequences.

B. Commoner is of the view that in most of these changes that have been part of our economic growth since 1946, the new technology has an appreciably greater damaging impact on the environment than the technology it displaced. On the basis of his studies, he concludes that the postwar technological transformation of productive activities is the chief reason for the present environmental crisis.

He argues that productive activities with a large damaging effect on the environment have displaced those with much less serious damaging effect. But it does not imply that technology is by its very nature detriment to the environment. It does not mean that the advantages that accompany technology must be scarified. We must try to develop new technologies that incorporate ecological wisdom.

E.F. Schumacher considers appropriate technology which is labour intensive, energy saving, producing little pollution and also employment generating. Huber considers ecological modernization in place of technological changes. Ecological modernization refers to a process of an ecological switch over to industrialization

process. It is a way out of the environmental crisis. Accordingly, crisis can be averted by adopting cleaner technologies.

6. Ethical Approach

Lester Brown regards pollution as an ecological stress on mankind. According to him, "Pollution is more than a mere nuisance. It can impair and even destroy the productivity of local biological systems. It can ruin forests, crops and fisheries, fresh water lakes and streams, destroy whole species of plants and animals, impair human health, break up the ozone layer, impede the exchange of oxygen and carbon dioxide between the oceans and the atmosphere; and even damage clothing; buildings and status."

Further, new challenges before mankind are population growth and climate changes. Climate changes are due to fossil fuel or carbon-based economy. Therefore, there is a need for stabilizing climate. Stabilizing climate means shifting away from carbon-based economy to solar-hydrogen economy.

Second, there must be a change in human reproductive behaviour.

Third, there must be some social changes in the global economy in terms of values and lifestyle of the people so that it does not degrade its natural system.

Fourth, another ecological stress is in the form of physical deteriorating grasslands and soil erosion.

Fifth, at the next level, the stresses manifest themselves in economic terms—scarcity, inflation, unemployment, and economic stagnation or decline.

Sixth, the stresses assume a social and political character—hunger, forced migration to the cities, deteriorating living standards, and political unrest.

The need to adapt human life simultaneously to the carrying capacity of the earth's biological systems and to the limits of renewable energy sources will require a new social ethic. The essence of this new ethic is accommodation—the accommodation of human numbers and aspirations to the earth's resources and capacities.

Above all, this new ethic must arrest the deterioration of man's relationship to nature. If civilization as we know it is to survive, this ethic of accommodation must replace the prevailing growth ethic of unlimited exponential growth and great faith in technological fixes.

7. Socio-Economic Approach:

Dr. Mostafa K. Tolba lays emphasis on socio-economic approach. According to him, we may now look upon environment as the stock of physical or social resources available at a given time for the satisfaction of human needs, and upon development as a process pursued by all societies with the aim of increasing human well-being. Thus the ultimate purpose of both environmental and developmental policies is the enhancement of the quality of life, beginning with the satisfaction of the basic human needs.

Further, environmental problems are caused by lack of adequate development. Today there are hundreds of millions of people without the basic human necessities like adequate food, shelter, clothing and health, and hundreds of millions more lack access to even a rudimentary education.

This is not only an intolerable situation in human terms, but it also has serious environmental consequences. The relentless pressures that arise where basic human needs are not met erase the resource base from which man must inevitably gain his sustenance.

The destruction of forests, the loss of arable soil, the loss of productivity through disease and malnutrition and the increasing pressure on fragile ecosystems which so often result from poverty. These things are as significant as the pollution created by industry, technology and over-consumption by the affluent. All of them lead to the rapid depletion of natural resources. Many human settlement problems also arise from lack of adequate development.

In support of his argument, Dr. Tolba suggests that in the industrialized countries, it will be necessary to reorient society's aims so that the entire population has more opportunity for self-expression in the fields of culture, education and humanities. These non-physical areas of development represent the highest levels of human achievement.

This new orientation must be less demanding on the environment, in particular on natural resources and energy. Present patterns of production and consumption, based on waste, extravagance and planned obsolescence, must be replaced by conservation and reuse of resources.

Developing countries, which still lack the infrastructure and readily useable resources are required to meet the growing needs and aspirations of its people. This approach must continue to have a strong physical orientation.

But in earlier stages, each country should be helped to follow a path to development best suited to its own human skills and natural resources. This responds to its own needs and accords with its own culture and value systems. It should adopt environmentally sound technologies in relation to its natural resources of soil, water, plant and animal life, and should avoid the destruction of the resource base.

(B) Economic Growth and Environment:

Since the times of Malthus, Ricardo and Mill, economists like Galbraith, Mishan, Boulding, Nordhaus, Commoner, etc. have voiced their concern about the harmful effects of economic growth on environment. They are of the view that economic growth has produced pollution and wasteful consumption of trivia that contribute nothing to human happiness.

According to them, the objectives of economic growth are to be reviewed because it has negatively affected the quality of life, pollution of the environment wastes of natural resources and its failure to solve socio-economic problems.

E.J. Mishan has expressed his anti-growth arguments in his book entitled The Costs of Economic Growth. According to him, "It is hardly possible to move along this golden path of self-perpetuating economic growth without subjecting people to manifold pressures. Moreover, pressures appear to increase both the stage of economic, growth and with the rate of economic growth."

Lester Brown has pointed out at the present state of economic growth. He argues that economic benefits are out-weighted by the costs. These costs are more rapid depletion of natural resources, urban problems like congestion, noise pollution and problems of the country side such as strip mining and the indiscriminate clear cutting of timber.

(C) Population Growth and Environmental Crisis

Of the classical economists, especially Malthus has expressed his views on population growth and environmental crisis. There is a social and environmental crisis in

Malthusian population trap model. In the words of Malthus, “Population has this constant tendency to increase beyond the means of subsistence, and that it is kept to its necessary level by these causes and thus, humankind, is necessarily confined in room by nature.” Thus Malthus foresaw humanity deprived, depraved and malnourished because its appetites would inevitably overtax the capacity of the available farmland to produce food.

The neo-classical economists have analysed the relation between population growth and environmental crisis in terms of the vicious circle. Rapid population growth (or high fertility rate) leads to poverty and low status of family members especially women and children in society.

Further, scarcity of land and housing facilities pushes large number of people to ecological sensitive areas. Moreover, exploitation of natural resources by overgrowing and cutting of forests for cultivation lead to severe environmental damages.

(D) Impact of Climate Change

Climate changes have always affected humans. The most difficult and challenging problems before mankind are global warming, acid rains, ozone depletion, changes in rainfall pattern etc. These may have far reacting effects on the global ecosystem. Economists have analysed the impact of climate changes on agriculture, wild life, human life and water resources etc

1.3 CONCEPT OF ENVIRONMENTAL ECONOMICS

Environment

The word environment has been derived from the French word ‘Environer’ which means to surround. Environment includes water, air and land, and their inter-relationships with human beings, other living creatures, plants and microorganisms. Environment provides basic services essential to humanity such as supporting life, supplying materials, energy and absorbing waste products.

The services of environment are used by production and household sector in an economy. These include minerals such as coal, petroleum and a wide assortment of ores that can be processed into metals/metal alloys. Other resources include plant, soil and water components used directly in production processes. Life supporting services are also provided by environment. These are clean air, water and food etc.

Environmental Pollution

A change in the physical, chemical or biological characteristics of the air, water or soil that can affect the health, survival or activities of human beings or other living organisms in a harmful manner. In economics, pollution is termed as any loss of human well-being arising from physical environmental changes.

Natural Resources

Anything obtained from the physical environment to meet human needs relates to natural resources. Basic human needs are fulfilled by materials provided by nature itself. They are air, water, soil, minerals, coal, petroleum, animals and plants.

These stocks of the nature, useful to mankind are called natural resources. In the primitive age, man had used only those resources that supported his life. But the process of economic growth and increase in population have led to mismanagement of natural resources.

There are two types of natural resources:

(i) Non-renewable resources

(ii) Renewable Resources.

(i) Non-renewable Resources

These resources were formed in millions of years and hence will get exhausted sooner or later. Some of the nonrenewable resources are coal, petroleum, natural gas, minerals etc. The stock of these resources is limited. They are susceptible to be degraded in quantity and quality by the human activities.

(ii) Renewable Resources

These resources are present in unlimited quantity in the nature. They are solar radiation, air and water. These are not likely to be exhausted by human activities.

Ecology

Ecology and economics share the same etymology—OIKOS (House). In Ecology, it represents the study of our house, whereas in economics, it ensures the management of that place. Ecology is concerned with the relationship between the physical environment (soil, water and air) and organism environment (plant and animal life etc.).

Ecological economists have analysed the interdependence between the physical environment and economic activities in their models. According to them, some economic activities may be the cause of environmental degradation.

Industrial Ecology

Industrial Ecology is the means by which humanity can deliberately and rationally maintain a desirable carrying capacity, given continued economic, cultural and technological evolution. It is a system in which one seeks to optimize the total material cycle from virgin material, to finished material, to components, to product, to obsolete product and to ultimate disposal. Factors to be optimized include resources, energy and capital.

Industrial ecology redefines waste as a starting material for another industrial process. It also seeks to structure the economy's industrial base along the lines of natural economic systems whose cyclical flows of material and energy are both efficient and sustainable.

Ecosystem

Ecosystem is a term applied to a particular relationship between living organism and their environment. An eco-system has two main components: (a) abiotic, and (b) biotic. All the non-living components of environment present in an ecosystem are known as abiotic components.

These include the inorganic and organic components and climatic factors. On the other hand, the living organisms of an ecosystem are known as its biotic components which include plants, animals and micro-organisms.

Ecosystems may be affected by anthropogenetic factors. They also face short and long run natural changes imposed from both within and outside the systems such as climatic changes.

Ecological Goods and Services rendered by Ecosystems	*Its Functions*
1. Gas regulation.	Regulation of atmospheric chemical composition.
2. Water supply	Storage and retention of water.
3. Raw materials and Food production	Portion of gross primary production extractable as raw materials and food.
4. Erosion control	Retention of soil within an ecosystem sediment retention.
5. Genetic resources	Sources of unique biological materials and products.
6. Disturbance regulation	Damping and integrity of ecosystem response to environmental fluctuations.
7. Nutrient cycling	Storage, internal cycling, processing and acquisition of nutrients.
8. Recreation	Providing recreation opportunities for tourism.
9. Climate regulation	Regulation of global temperature.

Let us explain the functions of ecosystems with examples.

The major components within the ecosystem are lithosphere (solid earth), the atmosphere, the hydrosphere (water) and the biosphere. There is also the cryosphere (of ice and snow).

1. Ecosystem Diversity:

The ecosystem diversity can be classified into two major types:

(a) The aquatic, and

(b) The terrestrial.

The aquatic eco-systems are further classified into marine, estuarine and freshwater while the terrestrial are divided into sixteen biomes representing major formations in terms of vegetation types.

2. Social Carrying Capacity

Biophysical carrying capacity expresses “the maximum population size that could be sustained under given technological capabilities”. Social carrying capacity can be defined as the “maximum numbers of human beings which the environment can support”. The population generally stabilizes around the carrying capacity.

Hardin, Ehrlich and Daly have applied the concept to environmental impacts of human activities. Social carrying capacity is determined by the influence of human consumption patterns, technological changes and its impact on the environment. It stresses on the fact that nature s bounds can be transgressed by rapidly growing population and accelerated use of natural resources.

We may conclude that sustainable carrying capacity as the maximum number of persons that can be supported in perpetuity on an area with a given technology and set of competitive habits without causing environmental degradation.

3. Eco-development

It has been defined as ecological sound development which is a process of positive management of the environment for human benefit. Eco-development and sustainable development are interchangeable.

4. Economic Sustainability

The most common interpretation of economic sustainability is maintaining a non-declining level of economic welfare now and into the future. This economic welfare is derived from the income generated by the capital stocks which include manufactured capital, human capital and natural capital.

5. Environmental Goods

Environmental goods are public goods. They include air quality, water quality and sun heat etc. Environmental goods are unique in nature. Excess use of these may lead to environmental degradation. For example, due to global climate change, the snow on the peaks of the Himalayas starts losing its density and thickness.

1.4. Nature of Environmental Economics:

Environmental economics is considered both as positive and normative science. It also covers both micro and macro aspects of different pollution problems.

Positive and Normative aspects:

Environmental economics is an application of scientific theories and general application of welfare economics. When we study the cause and effect relationship, it covers the positive aspect. For example, the laws of thermodynamics are equally applicable to economic process.

If the problem is related to policy measures, then it is considered as normative aspect. Therefore, environmental economics is a normative science because it prescribes the goals of environmental policy. As pointed out by B. C. Field, "Environmental degradation is the result of human behaviour that is unethical or immoral. Thus, for example, the reason people pollute is because they lack the moral and ethical strength to refrain from the type of behaviour that cause environmental degradation. If this is true, then the way to get people to stop polluting is somehow to increase the general level of environmental morality in the society." Field calls it as moral approach to environmental issues.

A Study of Micro and Macro Aspects:

Economists such as Pigou, Hoteling and Nordhaus have formulated their models in relation to individual firms and natural resources. Therefore, it covers the micro and macro aspects of the pollution problem. There are many examples of micro and macro aspects of environmental problems in the present times.

We generally observe crowded market places, industrial units, and even residential areas in a city like, Delhi. We do not get enough fresh air at these places. Its solution lies in micro level planning. On the other-hand, when the pollution problem is related to the economy as a whole such as rise in temperature, then it is related to macro aspect of environmental planning.

Environmental economics draws more from microeconomics than from macroeconomics. It focuses primarily on how and why people make decisions that have consequences for the natural environment. It is concerned also with how economic institutions and policies can be changed to bring these environmental impacts more into balance with human desires and the needs of the ecosystem.

Static and Dynamic

Classical and Neoclassical economists have applied both static and dynamic approaches in relation to environment. They have applied economic welfare approach to environment which is static in nature whereas under dynamic approach, they focus on forests, minerals, fossil fuels and water resources etc.

A social science

Environmental economics deals with economic and managerial aspects of pollution and natural resources. It interacts between human beings and their physical surroundings. It studies the impact of pollution on human beings and suggests national utilization of resources in a proper way so that there may be an increase in social welfare or minimization of social costs.

Environmental economics is also concerned, with the natural environment, but not exclusively so. For example, man-made and cultural or social environments may also be a part of the nature of environmental economics.

Environmental Pollution as an Economic Problem

Environmental pollution is an economic problem because it requires us to make choices and to resolve conflicts of interests. It is an economic problem because the means by which pollution can be reduced are themselves resources using. Further, it also reduces the value of some resources that society has at its disposal.

It means that pollution is a problem of scarcity in terms of waste disposal capacity. The main problem of choice is how to utilize the scarce resources in relation to society's needs. The market forces will be helpful in determining these scarce resources in most rational manner. The equilibrium will be attained at the equality of demand and supply of environmental quality.

Since resources are scarce they cannot be used to produce all types of goods simultaneously. Therefore, if they were used to produce one thing, they have to be withdrawn from other uses. The problem of choice facing a modem society is whether to maintain environmental quality or to increase industrial production (i.e. automobiles). It creates conflicts of interest between potential gainers and potential losers.

The problem of externalities is an important aspect of environmental quality. The external effects of industrial production may affect the environmental quality. Therefore, the economic problem is the optimal allocation of resources in the context of externalities.

One of the objectives of environmental quality is to restrict those production activities which enhance social costs to society. Environmental quality is largely

influenced by human activities in terms of excess exploitation of resources and the production of waste. How much environmental quality is affected by exploitation of resources and production of waste depends on ecological conditions of the economy. More exploitation of it means more pollution.

Environmental pollution as an economic problem is explained in terms of Figure 1.1

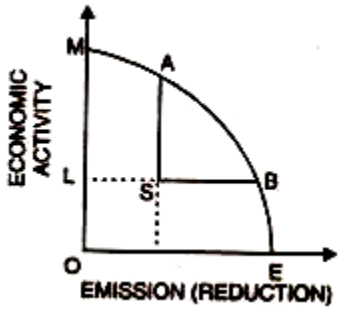


Fig 1.1

It is assumed that the economy is producing two sets of goods, a composite good (M) which is the aggregate of all existing goods and services, and second, an environmental quality good which also represents certain quantity of emission reductions.

The ME curve represents a production frontier which explains the trade-off between economic activity and emission reduction. If the economy moves from point S to point A on the ME curve, it means more production with increase in economic activity without increased emission.

On the other hand, if the economy moves from point S to points B on the ME curve, it means more emission reduction without reducing the economic activity level (L) because point S and point B lie in the same direction.

In this connection Ian Hodge points out, "What we will find is that choices made about the environment depend upon similar factors as do choices made in other areas of economics. Our views of changes in environmental quality depend (as do all prices) upon supply and demand factors: how much of the environment is supplied for particular purposes and how much is demanded." Thus, the forces of supply (production) and demand (preference for clean environment) and market instruments used by the state are important issues in environmental policy.

Economic growth can affect environmental quality under different situations. Environmental quality can increase with economic growth. Thus increased incomes, for example, provide the resources for public services.

With availability of these services individuals can devote more resources for conservation. Second, environmental quality can initially worsen but then improve as the growth rate rises. Third, environmental quality can decrease when the rate of growth increases.

1.5 SCOPE OF ENVIRONMENTAL ECONOMICS:

Environmental economics is considered both a positive and a normative science. Therefore, it has wide scope.

Economy-environment analysis

Environmental economics is primarily concerned with the impact of economic activities on environment and its implications for the individual firm, industry and the economy as a whole. Economists have formulated economy-environment models to explain the various economic activities and their external effects. For example, the Material Balance Model and the Leontief Abatement Model explain these externalities.

Eco-development

The main objective of environmental economics is to maintain a balance between economic development and environmental quality. In order to achieve it, environmental economists have to explore the various socio-economic possibilities to reduce pollution and uplift the standard of living of the people. This objective gained momentum after the publication of the Report on Limits to Growth.

Welfare approach

Environmental economics has emerged as a discipline to tackle environmental problems from an economic welfare framework. The welfare framework covers scarce resources and market failures due to property rights and ethical aspects of different problems of pollution. Thus it suggests the best possible means to tackle the environmental problems.

Dynamic and stock-flow analysis

The mainstream economics is largely confined to the static problems of market behaviour. But environmental management issues are about resources and are dynamic in nature. Moreover, resources have a stock and they have a rate of depletion and replenishment such as oil, minerals, and forests. Thus there is the inevitable stock-flow dimension to environmental issues.

Environmental values

Environmental issues are about resources. The neo-classical economists have analysed the use of various resources like fisheries, forests, fossil fuels and water in a rational manner and with environmental values. In fact, environmental values are economic values. It is important for the society to conserve its limited resources in the interest of economic efficiency and welfare.

Clean Technology

Presently environmental pollution is caused by misuse of existing technology and failure to develop better one. Environmental economists are in favour of appropriate and clean technologies which provide the most rational use of natural resources and energy and to protect the environment.

International Cooperation

There are many international issues like hazards of trans-boundary shipments, unwanted substances and common property resources which need international cooperation among nations. There are many negative effects of inadequate toxic wastes generated within countries and hazardous goods exported to other countries.

Most countries of the world are insisting on uniform standards and environmental regulations for all nations. Other issues are related to international common property resources, especially the share of river water and forest lands, etc.

Conservation Policy

The longstanding foundation of environmental economics lies in conservation economics which tends to emphasis the impact of economic activities on demand for productive resources and energy resources. It suggests the optimal strategy in the utilization of natural resources in a rational manner.

Multi-disciplinary base

Environmental economics is inherently a multi-disciplinary subject. It consists of an integration of many varied disciplines such as biology, ecology, physical sciences, ethics and main stream economics. Therefore, it has wide scope.

1.6 ENVIRONMENT - ECONOMY LINKAGES

All economic activities either affect or are affected by natural and environmental resources. Activities such as extraction, processing, manufacture, transport, consumption and disposal change the stock of natural resources, add stress to the environmental systems and introduce wastes to environmental media. Moreover, economic activities today affect the stock of natural resources available for the future and have inter-temporal welfare effects. From this perspective, the productivity of an economic system depends in part on the supply and quality of natural and environmental resources.

Natural and environmental resources have three economic roles : waste disposal services, related to the environment's assimilative capacity; natural resource inputs into production; and directly consumed life support services and aesthetic amenities. The natural and environmental resource input function is central to understanding the relationship between economic growth and environment. Water, soil, air, biological, forest and fisheries resources are productive assets, whose quality helps determine the productivity of the economy. Focusing on this role of environment as a producer good highlights the direct effect environmental problems have on economic growth. Thus, economic management impacts on the environment and the environmental quality impacts on the efficient working of the economy. Environmental degradation imposes costs on the economy which results in output and human capital losses.

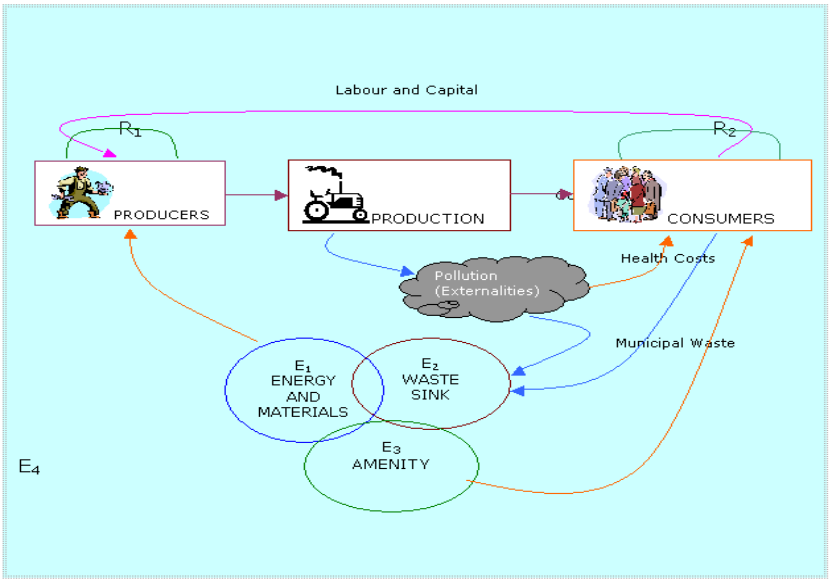
Lost labour productivity resulting from ill health, foregone crop output due to soil degradation and erosion, lost fisheries output and tourism receipts from coastal erosion or lost soil productivity from deforestation can be some of the manifestations of such reduced output. Moreover, a growing body of epidemiological studies suggest that air and water pollution are taking a heavy toll, particularly of people in the developing world, through ill health and premature mortality. The impact of water and air pollution is particularly adverse to the younger, the very aged and poor. Pollution control, is thus

linked to sustainable development and not a “luxury good” to be afforded after the development process has taken off.

Linkage between Economy and Environment

The environment, both biological and physical, is the source of all natural resources. Some natural resources are renewable (e.g., water, biological resources) while others are non renewable (e.g., geological deposits). The interlinkages between the economy and the environment are summarized in the figure. The economy consists of two sectors: Producers and Consumers, exchange of goods, services and factors of production (Labour and Capital) take place between the two sectors. The environment is shown in two ways: as the three interlinked circles E1, E2 and E3, and the all encompassing boundary labeled E4 .The production sector extracts energy resources (such as oil) and material resources (such as iron ore) from the environment, these are transformed into outputs through the production process, these transformation processes also generate wastes at different stages and often the environment is used as a repository (Sink) for waste products. There is some recycling of resources within the production sector, shown by the loop R1, and within the consumption sector, as shown by the loop R2.

As we can see the environment’s first role is as a supplier of resources. Secondly it acts as a sink or a receptor for waste products. These wastes may result directly from production, as already mentioned or from consumption. When an individual puts out their garbage, or when they drive to work, they are contributing to this form of waste. Finally the environment also serves as an amenity these include scenic beauty, recreation and other aesthetic values offered by the environment.



Linkage between Economy – Environment

Figure 1.2

Ayres-Kneese's Material Balance Model

In the words of Ayres and Kneese, "If waste assimilative capacity of the environment is scarce, the decentralized voluntary exchange process cannot be free of uncompensated technological external diseconomies unless all inputs are fully converted into outputs, with no unwanted material residuals along the way and all final outputs are utterly destroyed in the process of consumption."

The functions of an economy are related to production, consumption and distribution activities. These activities have a direct relation with nature. Nature provides raw materials to the economy for its production and consumption activities. Residuals from both the production and consumption processes usually remain and they usually render disservices like killing fish, reducing public health, soiling and deteriorating buildings due to industrial pollution.

Some wastes (residuals) from production and consumption activities are ultimately returned to nature. Remaining wastages are recycled. Further, all emission of residuals do not cause pollution damage because of assimilative capacity of the environment.

Further, energy that is taken out of the environment must reappear somewhere else in the economic system. Its form may, however, be changed so that it appears as waste products and gases. Moreover, waste energy cannot be recycled but waste materials can be used up to a point. It means that economic activity always affects environment in a direct or indirect manner.

Thus the law of conservation of matter and energy holds that matter can be transformed to other matter or into energy but can never vanish. All inputs (fuels, raw materials, water and so forth) used in the economy's production processes will ultimately result in an equivalent residual or waste. The model is explained in the Material Flow Diagram (Figure 1.3).

Flow Diagram.

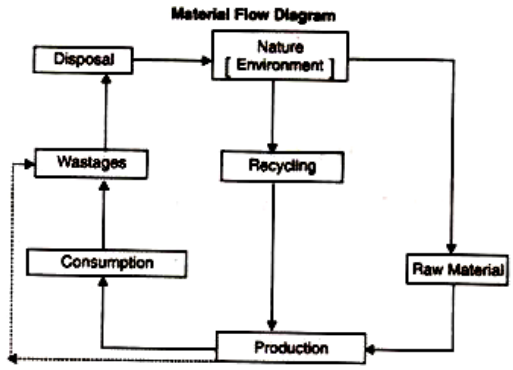


Figure 1.3

The material flow diagram implies that mass inputs must equal mass outputs for every process. Moreover, all resources extracted from the environment must eventually become unwanted wastes and pollutants. This means, among other things, externalities (market failures) associated with production and consumption of materials are actually pervasive and they tend to grow in importance as the economy itself grows. Materials recycled can help but recycling is energy intensive and imperfect, so it cannot fully compensate.

According to John H. Baldwin, the conventional model of production and consumption omits important considerations. This omission results in emphasizing and managing only those sectors of production and consumption that are monetized.

Most real production and consumption of goods and services in the world, especially in developing countries, occur even outside the formal monetized economy. Hence, the materials balance model provides a useful framework for analyzing alternative methods of resource and residuals management.

Thus, economics of the environment may be defined as a study which concerns allocation of resources among alternative uses in such a way that there is an efficient reduction of the waste or residuals in the environment, which lead to an increase in social welfare.

Its implications

The material balance model has important implications:

1. Disposal activities may affect both consumers and producers. The environment can act as a conduit for carrying the disposal activities. Business firms generally smoke into the air and this may affect the consumer's welfare. The consumers may also litter the landscape; produce vast quantities of trash and sewage.

Each of these activities may affect each other. Because there are no markets regulating the flow of goods through disposal, there is also a possibility that too much of these activities will be carried on. Each will regard his disposal costs as zero and will use the environment so long as this use permits him to improve his own welfare.

2. The environment has a large waste assimilation capacity, but this is not infinite. Too much waste entering the environment rather than being recycled or reused will put too much stress on the assimilative capacity of the environment to handle such waste safety. The result will be a range of pollution and resources degradation impacts, and consequent economic damage cost.

3. With the application of the laws of thermodynamics, economic production and consumption activities always generate some pollution and waste. It requires proper disposal. Moreover, it is not always possible to have 100 percent recycling. Nevertheless, society does not have a choice over the total quantity of waste that its economic system produces.

4. In a general sense, policy makers can weigh up the social benefits of various productive activities and compare them with the social costs (including disposal) imposed

by these activities. Policy makers may then decide to intervene in the economic process in order to change or modify production processes.

5. If a balance can be reached between acceptable levels of materials flows, there will be an increase in output and improvement in environmental quality.

6. From the policy point of view, this approach emphasizes recycle process and less residual-generating production process. It is only possible by modifying an environmental medium through investment in control facilities so as to improve its assimilative capacity. Investments involving public goods such as transportation systems, sewage disposal and river flow regulation are intimately related to the amounts and effects of residuals and must be planned in the light of them.

7. It is important to develop not only measures for the external costs resulting from different concentrations and duration of residuals in the environment but more systematic methods for forecasting emissions of external cost-producing residuals, technical and economic trade-offs between them, and the effects of recycle on environmental quality.

8. The application of the law of thermodynamics to the problem of waste is an important event in integrated residuals management. Residuals are generated by all production and consumption activities. This pervasive nature of the residuals problem, along with the inter-relationships of residuals, economic activities and recycling provides a physical system basis for environmental quality management.

In other words it demonstrates that waste generation is pervasive to the economy. In turn, if the capacity of the environment to assimilate and degrade the waste into harmless form is limited, the externalities arising from the waste will be pervasive. This is in marked contract to the view that externalities are occasional deviations from market perfection.

9. The importance of the materials balance principle lies in the fact that it provides a coherent framework in which an economic analysis of resources use and its implications for the environment can be placed. It draws one’s attention to the long-term implications of economic activity, by focusing on the stock-flow relationships implied by that behaviour and its importance in this relationships.

Conclusion

As suggested by S. Baker, to improve the analysis of environmental economy interactions, the empirically relevant and up-to-date knowledge of ecological and natural sciences needs to be used and integrated into environmental economics in a more systematic way.

1.7 NATURAL RESOURCES

The term "resource" means anything that we use from our environment to achieve our objective. For example, we require bricks, cement, iron, wood etc. to construct a building. All these items are called the resources for construction of building. A resource can be defined as 'any natural or artificial substance, energy or organism, which is used by human being for its welfare. These resources are of two types:

(a) Natural resources and

(b) Artificial resources.

All that the nature has provided such as soil, air, water, minerals, coal, **sunshine** (sunlight), animals and plants, etc., are known as **natural resources**. Human being uses these directly or indirectly for survival and welfare. The resources, which have been developed by human being during the growth of civilization, are called **artificial resources**. For example, biogas, thermal electricity, plastics, etc are manmade resources. These man-made resources are generally derived from some other natural resources. For example, plastics and many other chemical products are ultimately derived from the natural resource of petroleum.

Classification of Natural Resources

The air we breathe and the light we get from the sun are available in unlimited quantity. But what about coal, forest, and petroleum? The stock of these resources is limited. The quantity of these resources is depleting day by day.

Resources

1. Natural and Artificial (e.g. electricity)
2. Exhaustible and Inexhaustible(e.g. solar energy, wind, rainfall, tidal energy)
3. Renewable and Non-renewable (e.g. wind, water, forests) (e.g. coal, petroleum, iron, biological species)

Exhaustible Resources

On the other hand, there are some resources, which are available in limited quantities and are going to be exhausted as a result of continues use. These are called **exhaustible resources**. For example, the stock of coal in the earth is limited and one day there will be no more coal available for our use. Petroleum is another important exhaustible resource.

I**nexhaustible Resources**

The resources which cannot be exhausted by human consumption The resources which cannot be exhausted by human consumption and other uses, are called **inexhaustible resources.** These include energy sources like solar radiation, wind power, water power (flowing streams) and tidal power, and substances like sand, clay, air, water in oceans, etc.

Renewable Resources

Some of the exhaustible resources are naturally regenerated after consumption and are known as **renewable resources.** e.g. The living beings (both animals and plants) reproduce and can thus, replace the dying or killed individuals. However, if the consumption of these resources exceeds the rate of regeneration they may also get totally exhausted. Some examples are fresh water, fertile soil, forest (yielding wood and other products), vegetation, wildlife, etc.

Non-renewable Resources

The resources, which cannot be replaced after the use, are known as **non-renewable Resources.** These include minerals (copper, iron etc.) fossil fuels (coal, oil etc.).Even the wildlife species (rare plants and animals) belong to this category

1.8 CONSERVATION OF NATURAL RESOURCES

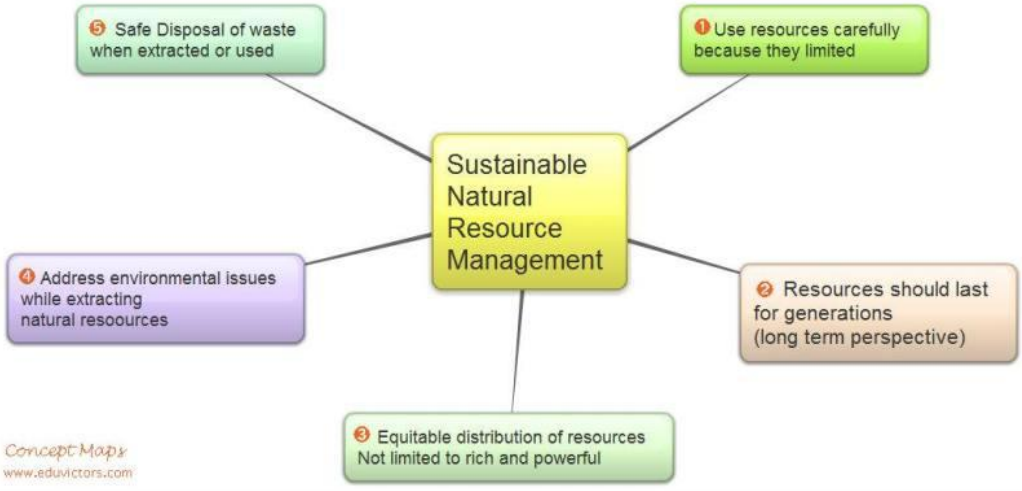
As the human population is continuously growing the consumption of natural resources is also increasing. With the increasing industrialization and urbanization of the modern human society, the use of all the resources is rising. If they are not properly used and well managed, a serious scarcity will result. Therefore we need to conserve the

natural resources. This will also upset the ecological balance. *Conservation is the proper management of a natural resource to prevent its exploitation, destruction or degradation.* Conservation is the sum totals of activities, which can derive benefits from natural resources but at the same time, prevent excessive use leading to destruction or degradation.

Need for Conservation of Natural Resources

We know that nature provides us all our basic needs but we tend to overexploit it. If we go on exploiting the nature, there will be no more resources available in future. There is an urgent need to conserve the nature. Some of the needs are:

1. To maintain ecological balance for supporting life.
2. To preserve different kinds of species (biodiversity).
3. To make the resources available for present and future generation.
4. To ensure the survival of human race.



1.9 MANAGING EXHAUSTIBLE RESOURCES

Exhaustible resources will be depleted so long as the extraction rate is positive. Are our exhaustible resources being depleted too rapidly? To answer questions like this we need to know the optimal rate at which to extract/deplete exhaustible resources. With that in view we will present here some simple and intuitive results involved in the theory of depletion.

What are the conditions that must hold while depleting an exhaustible resource over time, that is, along an optimal depletion path? The supply (and extraction) behavior of a price-taking owner1 of an exhaustible resource such as oil differs from that of an ordinary good or resource. An exhaustible resource is limited in quantity and is not producible like an ordinary good. Ordinary goods produced in the economy using available methods of production can be replicated. Since exhaustible resources are created by geological processes with geological time spans, they can be regarded as fixed in quantity, although the total quantity available may not be known.

A price-taking firm supplying ordinary goods will adjust production in all periods so that the incremental cost of production of an extra unit of output, i.e., its marginal cost (*mc*) of production in each period equals price (*p*) in that period. If the *mc* is less than *p*, the supplier can raise current profits by increasing production. However, when the firm is the extractor of an exhaustible resource, such behavior might require extraction of more stocks than is available to the firm.

Cases like this, then, require some modifications of the standard theory. Since an exhaustible resource is limited in quantity and is not producible, extraction and sales of a unit today, involves an *opportunity cost*; the value that might have been obtained for that time at some future date. This opportunity cost is usually given the name *user cost* (*uc*). The presence of user cost is central to the economics of exhaustible resources. User cost does not exist for conventional reproducible goods since the consumption of an amount now does not reduce the quantity that can be consumed in the future; additional quantities can always be produced. However, a barrel of oil extracted today is a barrel unavailable for extraction in the future. In deciding whether to extract and sell an additional barrel today, the extractor must consider not only the cost of pumping the barrel, but also the cost of foregoing the highest return that could have been earned if the oil had instead been pumped and sold in the future. Hence, it is necessary to have a more inclusive definition of marginal cost and we call it *augmented marginal cost* (Salant, 1995). The augmented marginal cost (*amc*) is, then, defined as the marginal cost of extraction (*mc*) plus the user cost (*uc*).

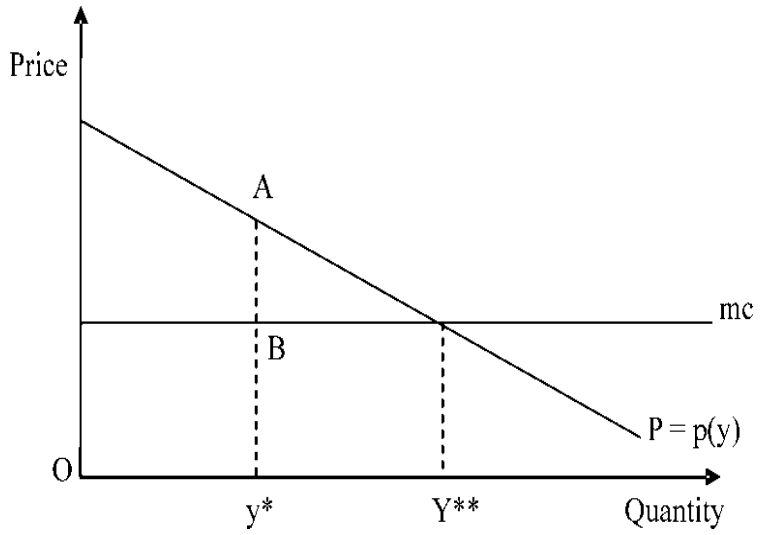
When *mc* is redefined in this way, it is optimal for a competitive resource owner (firm) to extract the resource in each period to the point where its *amc* equals the market price (*p*). Instead of the usual efficiency condition, price (*p*) = marginal extraction cost (*mc*), we have:

$$p = mc + uc.$$

This is the first condition of optimal depletion. As shown in Figure 1, it implies that less of the resource will be extracted today than if it were a producible ordinary good or a resource. Given the relation between demand and price $p = p(y)$, where *p* is the price and *y* is the quantity demanded and extracted, only y^* units (rather than y^{**} where $p = mc$) will be extracted by a resource planner or a price-taking firm seeking to allocate extraction efficiently over time. This

leaves a positive difference AB (the opportunity cost/user cost) between *p* and *mc*.

Figure 1: Optimum Extraction of an Exhaustible Resource



Beneath the apparent simplicity of this rule lies a wealth of subtlety (Salant, 1995). The rule implies, for example, that the current extraction rate by a private owner of a natural resource depends not only on the current price, as in the standard theory, but also on expectation about future prices. These price expectations determine the opportunity cost of additional current extraction. A competitive supplier that expects future prices to be sufficiently low compared with the current price may extract and sell

intensively in the current period, judging the opportunity cost of additional extraction to be small. But if future prices are expected to be sufficiently high, the same current price may induce no extraction whatsoever today.

For some further results let us, for simplicity, assume just two periods: the resource owner either extracts and sells the resource today, in period 0, or retains it in the ground until the next period 1. Let the price he can obtain for a unit of the resource today be *p0* and the price he expects to prevail for a unit in the next period be *p1*. The cost per unit of extracting the resource and delivering it to the buyer is *C*, which is not expected to vary between periods 0 and 1, that is $C = mc$ remains constant.

Because the owner has a fixed stock (to be supplied from) of the resource, any unit sold in period 0 will reduce the quantity that can be sold in period 1. If he sells the unit in period 0 he will receive net revenue of $p0 – C$ but forgo revenue of $p1-C$ in the following period. The value in period 0 of the net revenue foregone is its present value $(p1-C)/(1 + r)$ where *r* is his discount rate2. Hence his return from selling a unit today will be:

$$(p0 – C) – (p1 – C) / (1 + r)$$

$(p1-C)/(1+r)$ is the opportunity cost of his decision to sell a unit today. It is the user cost of his decision. It arises because he is faced with the alternative of selling it in the following period. If

$$(po – C) > (p1 – C) / (1 + r)$$

he will be better off selling his resources in the current period. If, on the other hand,

$$(po-C) < (p1-C) / (1 + r)$$

he will be better off by leaving it in the ground. His optimum amount of current extraction is given where

$$po-C = (p1-C) / (1 + r) \quad (1)$$

This implies that $po = C + (p1 – C) / (1 + r)$ (1a)

Equation (1a) states our earlier result that the current price of the resource when it is extracted optimally, should be equal to the *mc* plus the user cost (*uc*).

With reproducible resources there is no element of user cost since resources are produced in each period to satisfy the demand in that period and there is no carry over from period to period. Hence, as we have seen earlier, for a reproducible resource the optimum output is given where $po = C$.

Transposing equation (1a) we have

$$(p1 - C) = (po - C)(1 + r) \qquad (2)$$

Equation (2) is the second condition of optimal depletion and is usually described as the fundamental equation (due, originally, to Hotelling, 1931) of exhaustible resource extraction. It says that numerical example may help to illustrate this fundamental condition. Suppose the interest rate along the optimum extraction path, where the resource owner is indifferent as to the options of extracting or leaving the resource in ground, the price of the resource, net of marginal extraction costs, that is, the user cost has to rise at a rate equal to the discount rate. A is 10 per cent and the net price $(p - mc)$, that is, user cost per unit of the resource is Rs. 20. If the net price (user cost) is not expected to grow by 10 per cent to Rs. 22 next year, it pays to extract more of the resource in the current period, because the resulting income from sales will earn 10 per cent interest if invested in interest bearing assets. If the net price is expected to go above Rs. 22 that is, to grow faster than the rate of interest – the producer will have no incentive at all to extract in the current period. This is because any unit extracted today will (even after interest earning) be worth less in a year than a unit extracted and sold a year from now.

If *mc* of extraction is small relative to the price of the resource, equation (2) approximates to

$$p1/po = 1 + r \text{ or } p1 = po(1 + r).$$

Thus along the optimum path resource prices grow at the discount rate. The higher the discount rates the faster the rise of resource price along the optimum path. A higher discount rate reduces the user cost of the resource and causes mine owners to deplete their resource at a faster rate. In reality, of course, extraction costs are never zero. Whenever they are positive, a price increase equal to the interest rate would cause the net

price to rise by more than the interest rate. For example, suppose the price per unit of a resource is Rs. 30 and the net price is Rs. 25. A 10 per cent price rise (in the rate of interest) would boost the net price from Rs. 25 to Rs. 28, or by more than 10 per cent. This difference would give every extractor an incentive to postpone extraction rather than satisfy current demand. If such imbalances are to be avoided, the price in successive years must rise by less than the interest rate.

We will see that this analysis may illuminate many questions of practical policy. Let us consider for illustration, the following questions (Salant, 1995):

i. Suppose a state-owned or controlled enterprise say Coal India Limited (CIL) is entrusted with selling an exhaustible natural resource (in this example coal) on the world market. For a small country3 can it be right to extract it to the point where the *mc* of extraction equals the world market price? Is it ever prudent to refrain from extracting a resource, even though it is profitable to begin with that is, current price exceeds the mc of extracting the first unit?

ii. Credit may be more tightly rationed (and interest rates higher) in one country than in another. How does this affect the former country's relative rate of resource extraction?

iii. Suppose a government decides to restrict the extraction of a resource that is privately owned and extracted because the resource is considered highly valuable (such as gold in India) or because the extraction process generates pollution (such as gold mining which uses mercury or arsenic). Is it right in such cases to give the extractor a grace period before the restrictions are effectively imposed to overcome the dislocations that such policies will cause?

Each of the questions raised above ceases to be puzzling once attention is properly refocused on the opportunity cost of current extraction and how that cost changes when a new policy is anticipated.

Expanding short-run coal production based on the equality of mc of extraction and market price is excessive because it fails to account for the future net return (profit) foregone, when an additional ton of coal is extracted. Moreover, if this opportunity cost is

sufficiently high, no amount of the resource should be extracted today even though the current price exceeds the current mc of extracting the first unit.

As regards the second problem, when the real interest rate rises, the *uc* of extracting another ton declines because the future profit (from the ton that must be foregone) is worth less today (that is discounted profit is low today). Hence, even if *mc* does not shift, the augmented *mc* (*amc*) in early periods will fall. As a result, the same sequence of prices would generate an initial expansion in extraction. This outcome can be used to explain differences in the behavior of

two countries selling the same natural resource on the world market. Assume that both countries have approximately the same underground reserves and costs of extraction. If credit is rationed more tightly in one country, that country should extract more rapidly in the short-term in order to maximize national wealth.

In the third problem where (say) it is proposed to shut down a highly valued or/and polluting gold mine but the mine operator is permitted a grace period to mitigate the dislocations caused by the closure, during the grace period premature closing lowers the *uc* of an additional unit. Consequently, the *amc* in each period before the date of closing is lower than it was before the policy was announced. If the sequence of world price is unchanged, the mine operator will find it profitable to intensify mining throughout the grace period.

1.10 NATURAL RESOURCE POLICY

POLICY ON CONSERVATION OF RESOURCES

With growing consciousness of environment conservation, the efficient use of resources has become important for a developing country like India. We have to increase our R & D (Research and Development) efforts to explore for new resources, devise technologies to minimize waste and conserve non-renewable resources. Government of India has formulated several policies and programmes to implement for conservation of our biotic & abiotic resources.

1. A ministry of forests and environment was created at the Union level in 1980 to give high priority to issues relating forest and environment in the country. By now, all the state government have also created independent ministry of forest and environment.

2. National Forest policy of 1950 was revised in 1988 to make an effective tool as per current needs to protection, conservation and development of forest in the country. Under this policy social forestry scheme was launched to increase green coverage, produce and supply of fuel wood etc.

3. National land use and conservation Boards were established in 1983, and restructured in 1985 for land resource conservation and preparation of perspective plan for optimum utilization of land resources.

4. National water policy was adopted in 1987 which accord the highest priority to drinking water, followed by irrigational hydel power generation, nevigational, industrial and other uses of water.

5. A National Mineral Policy framed in 1990 has allowed both domestic and foreign enterprise to invest in mineral extraction and export. It also allowed the authority to permit investment in minerals

NATURAL RESOURCE POLICY IN INDIA

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5. A National Mineral Policy framed in 1990 has allowed both domestic and foreign enterprise to invest in mineral extraction and export. It also allowed the authority to permit investment in mineral extraction directly under the Union Ministry of Mines. 6. In new agriculture policy of encouragement is given to use eco-friendly and sustainable agricultural technology, i.e. bio-technology.

The National Water Policy of India

The National Water Policy of the Government of India was first enunciated in 1987. The policy laid down an allocation prioritization principle for water as follows:

1. Drinking Water
2. Irrigation
3. Hydro-power *f* Navigation
4. Industrial and
5. other uses

The National Water Policy (NWP 2002) was subsequently introduced in relation to the rapidly changing scenario in the domain of water to address the emerging issues and provide critical policy inputs. NWP 2002 gave emphasis for the first time to ecological and environmental aspects of water allocation.

The National Water Policy (NWP 2012) calls for a common integrated perspective to govern the planning and management of water resources. Such a perspective would consider local, regional, and national contexts and be environmentally sound. The Policy2 clearly states that water needs to be managed as a common pool community resource that is held by the State under the public trust doctrine to ensure equitable and sustainable development for all.

NWP 2012 has done away with water allocation prioritization mentioned in NWP 1987 and 2002, but has emphasized on treating water, over and above the pre-emptive need for safe drinking water and sanitation, as an economic good. NWP 2012 also emphasizes the fact that the service provider role of the State has to be gradually shifted to that of a regulator of services and facilitator for strengthening the relevant institutions

Land Use Policy

Land Use Policy is an international and interdisciplinary journal concerned with the social, economic, political, legal, physical and planning aspects of urban and rural **land use**.

Land Use Policy aims to provide policy guidance to governments and planners and it is also a valuable teaching resource.

There is a need for a policy framework to be formulated at the national level incorporating concerns of various sectors and stakeholders so as to ensure optimal utilization of land resource through appropriate land use planning and management.

A "National Land Use Policy Guideline and Action Points" (1988) was prepared by the Government of India, Ministry of Agriculture after intensive deliberations. In the said policy, framing of suitable legislation and its sincere enforcement were stressed by imposing penalties, of violation thereof. The said policy guidelines were placed before the 'National Land Use and Wasteland Development Council' under the chairmanship of Prime Minister and its first meeting was held on 6th February, 1986. The Council agreed to the adoption of policy and circulated the same throughout the country for adoption after suitable considerations at the State level. However, the policy did not make the desired impact.

Under the Environment (Protection) Act, 1986, the Ministry of Environment & Forests, GoI is notifying "Eco Sensitive Zones", which require preparation of Zonal Master Plans or Zonal Development Plans that guide further development in the area. "Eco Sensitive Zones" may be defined as areas which contain natural features with identified environmental resources having 'incomparable values' (water resource, flora & fauna etc.) requiring special attention for their conservation. The Eco Sensitive Areas will include protected areas such as National Parks, Wildlife Sanctuaries, Conservation

Reserves and Community Reserves (total number: 659), which cover about 4.79% of the total geographic area of the country. The areas other than protected areas such as landscape areas, areas with historical value also are covered under Eco Sensitive Zones.

1. The objectives of declaring Eco Sensitive Zones are: To maintain the response level of an ecosystem within the permissible limits with respect to environmental parameters.
2. To take care of special protection needs because of its landscape, wildlife, historical value etc. and to ensure that the new activities allowed are within the carrying capacity of that area.
3. To ensure protection and conservation of 'Entities of Incomparable Values' of these zones and regulate development activities based on a scientific basis and based on adequate participation in the decision making by the local communities.
4. To ensure compliance to the provisions contained in the approved Zonal Development Plan/Master Plan/Management Plan through the constitution of high level monitoring committees.

The State Governments identify these Eco Sensitive Zones and the Ministry of Environment & Forests, GoI finalises the same and notifies under the Environment (Protection) Act, 1986. Accordingly, the Zonal Development Plans are prepared and implemented for regulating further development or land uses in the areas. If all the Eco Sensitive Zones in the country are notified and planned, this would bring about 5% of the country's land under planned development.

Forest Policy

The term forest policy connotes actions of a Government for the preservation, maintenance, enhancement of forests and the optimum utilisation of forest resources to attain national welfare. It is defined as a set of principles or guidelines adopted by a Government to attain fixed objectives in forestry for the welfare of the nation.1 Forest policy has to undergo changes according to the changed circumstances. Initially, the orientation was mostly towards obtaining the required timber. Subsequently efforts were made to plant for replacing the felling. This was later followed by systematic conservation of forests through protective steps to guard against unregulated felling. Then

regeneration and afforestation2 had become an integral part of forest conservation policy to compensate for the felling and also to augment resources. In the present times, forest policy has attained a new dimension to solve problems arising out of rising trends of environmental hazards caused mainly by deforestation.

1. Forest Policy of 1894
2. The National Forest Policy of 1952
3. The National Forest Policy of 1988
4. The Wildlife (Protection) Act of 1972
5. The Forest (Conservation) Act, 1980

In new agriculture policy of encouragement is given to use eco-friendly and sustainable agricultural technology, i.e. bio-technology.

1.11 SUSTAINABLE DEVELOPMENT

Definition

More than one hundred definitions of sustainable development exist, but the most widely used one is from the World Commission on Environment and Development, presented in 1987. It states that sustainable development is "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainable development promotes the idea that social, environmental, and economic progress are all attainable within the limits of our earth's natural resources. Sustainable development approaches everything in the world as being connected through space, time and quality of life.

In terms of the world being connected by space, consider the following: Pesticides sprayed in Chile have the potential to harm fish stocks off the coast of Japan. The air pollution we emit in Los Angeles affect the quality of air in Asia. On the flip side, clean air practices on one continent will positively impact air quality across the ocean.

The earth's connection to time is demonstrated in how we, today, are either benefitting or suffering from the choices of our grandparents and other ancestors. Their decisions about how to farm their land, for example, continue to impact the agricultural practices of today. Looking to the future, the economic choices we make and policies we endorse today will be the ones affecting our children and grandchildren as adults.

Sustainable development constantly seeks to achieve social and economic progress in ways that will not exhaust the earth's finite natural resources. The needs of the world today are real and immediate, yet it's necessary to develop ways to meet these needs that do not disregard the future. The capacity of our ecosystem is not limitless, meaning that future generations may not be able to meet their needs the way we are able to now.

Some of the more common examples of sustainable development practices are:

1. Solar and wind energy. Energy from these resources is limitless, meaning we have the ability to eliminate dependence on non-renewable power sources by harnessing power from renewable resources.
2. Sustainable construction. Homes, offices and other structures that incorporate recycled and renewable resources will be more energy efficient and stand the test of time.
3. Crop rotation. Many farmers and gardeners are using this method as a chemical free way to reduce diseases in the soil and increase growth potential of their crops.
4. Water fixtures. Water conservation is critical to sustainable development, and more and more products are available that use less water in the home, such as showers, toilets, dishwashers and laundry systems.

The world's resources are finite, and growth that is unmanaged and unsustained will lead to increased poverty and decline of the environment. We owe it to future generations to explore lifestyles and paths of development that effectively balance progress with awareness of its environmental impact. In order to preserve the future, we must appreciate the interconnectedness between humans and nature at all levels. Sustainable development practices can help us do this, and through education and building awareness, preserving the future is within everyone's reach.

THE ECONOMICS OF SUSTAINABLE DEVELOPMENT

Introduction

'Sustainable Development' has become a political buzzword since the 1992 Rio Conference on the Environment, organised by the United Nations. But what

exactly does it mean? That is a difficult question to answer since sustainable development (SD from now on) means different things to different people: people place varying emphases on multiple aspects of the rather vague notion which is SD. The best-known definition is that given by the Brundtl and Commission in 1987 (WCED, 1987): development that meets the needs of present generations without compromising the ability of future generations to meet their own needs.

Another definition was offered by Asheim (1994)

A requirement to our generation to manage the resource base such that the average quality of life we ensure ourselves can potentially be shared by all future generations.

Many people see sustainable development as in fact serving multiple goals - economic development, a better environment and a particular concern for the poor (Pearce and Atkinson, 1998). At the more general level, development is indeed viewed rather differently to growth, implying some progress in areas such as health and education, rather than just increasing incomes. Two common features of many definitions of *sustainable* development are equity across and within generations, but most of the economics literature on sustainability has emphasized the former. Economists would say that SD is indeed principally an equity rather than an efficiency issue. However, the bigger the economic pie (broadly defined as total 'quality of life'), the more of it there is to go around, since other things being equal, economic growth raises the average *level* of well being. There is thus a potential complementarily between promoting both efficiency and equity. This view is controversial some would argue (e.g. Daly,1990, Meadows et. al 1992) that economic growth is in itself the *cause* of declining sustainability, since an expanding economic scale pushes increasingly against environmental constraints, threatening the operation of .the joint economic-environment system, whilst there is a view that increasing income has a weak impact on increasing well-being above some threshold level.

It is also possible to distinguish between the idea of sustain ability, namely the property whose *performance* can be maintained over time, and sustainable devel-opment the extent to which *development* can be sustained. In general, however, the

terms ‘sustainable development’ and 'sustainability' are used interchangeably in economics, with each being about as contentious as the other. This chapter tries to pick out the main contributions that economists have made to the debate on sustainability, and on how we might measure it.

Why should we worry about the well-being of future generations? Two lines of reasoning have emerged. The first takes a utilitarian approach, and says that social welfare is concerned with the discounted sum of well-being of all people in a society over time. What the discount the rate should be in calculating these present values is not something we have room to discuss here - the interested reader is referred to Sheraga and Sussman (1998) and Wietzman (1998). An alternative argument is that future generations have moral rights to a level of well-being, perhaps no less than our own. This Kantian view is in philosophical opposition to the utilitarian view above.. Norton gives a good account of the issues involved in taking this position.

Economics’ views on what defines a sustainable development path for an economy over time may be divided into two broad groups. The first (the outcome approach) is concerned with how the economic process directly affects human well-being. 'Well being’ is synonymous with the standard economic concept of utility or welfare of an individual. Hence, sustainability can be defined as the utility of a representative agent in any period t, U(t) – taken to represent society's interests - to be non-declining for the rest of the from time t* onwards.

$$\partial U(t) / \partial t \geq 0, \text{ all } t > t^* \qquad (1.1)$$

or that in any period *t*, the utility of that representative agent does not exceed the maximum sustainable level of utility, depending on the economy's potential at time *t* (Pezzey and Toman, 2002):

$$U(t) \leq U_m(t) \qquad (1.2)$$

Where, for time periods following on from time periods *t:*

$$U_m(t) = \max U \quad \text{given } U(s) \geq U(t) \quad \text{for all } s \geq t \qquad (1.3)$$

Equation (2.1) says that SD occurs when utility per capita is not falling over time (this Means that constant utility equals sustainability, as well as rising utility). A variant on the outcome-based approach is to define SD in terms of the observable

determinants of utility. In other words, if we know what factors affect utility - for example, the level of consumption and the level of environmental quality - then by examining changes in these factors we can infer whether a sustainable path is being followed according to Pezzey's definition. This idea is taken up again in Section 2.4, where we set out a formal model of sustainability indicators. A time path of consumption over time which is rising and then falling might be consistent with maximising the present value of social well-being, according to the utilitarian view, but would not be a sustainable path. There is thus a trade-off here between sustain ability and present-value maximising optimality. Note also that the outcome definition of sustainable development implies that it is the absolute level of consumption and environmental quality per capita that matters for well-being, not one's consumption/environmental quality relative to one's neighbours, implying that rising real incomes result in higher utility. For a theoretical discussion of this assumption, see Pezzey (1997); for a 'recent review of empirical evidence, see Blanch flower and Oswald (2004).

The second economic approach to defining sustainability focuses on maintaining the means .which are available to society to generate well-being or consumption, namely its resources. Resources consist of physical stocks and the technology which we use to exploit them. Economists have thought about SD from this viewpoint in terms of the concept of capital. Four forms of capital may be distinguished. (Hanley and Atkinson, 2003)

1. *Man-made, or produced, capital, Km:* This is the 'capital' that most economics students are familiar with. It comprises the results of past production, as the excess of output over consumption. *Km* includes factories, machinery, roads, bridges, phone networks and satellites, and may be used up (depreciated) in the production of consumption goods and services. This depreciation needs to be offset with new investment or else the stock of *Km will* decline over time.
2. *Human capital, Kh:* Human capital is people, their skills and knowledge. The stock of *Kh can* also depreciate (e.g. if unemployed people lose their skills),

and can be added to through training and education.

3. *Natural capital, Kn:* Natural capital comprises all gifts of nature, and so includes renewable and non-renewable energy and material resources, clean air and water, nutrient and carbon cycles and biodiversity. Natural capital can clearly be depreciated when, for example, a non-renewable resource such as oil is used up or when a species dies out. Investments in *Kn* would include forest re-planting and re-stocking of fisheries.
4. *Social capital, Ks:* Recent attention has been directed towards the link between 'social capital' and sustainability, see World Bank (1997) for a discussion. Putnam (1993) speaks of social capital as comprising certain features of social organisation -norms of behaviour, networks of interactions between people and between institutions and trust between people. This could be important for sustainability in several ways. First, it is argued that there is an 'economic pay-off from social capital whereby conditions favorable to economic growth are fostered by a climate of trust between agents (Knack and Keefer; 1997). Second, there could also be an 'environmental pay – off' whereby for example, strong communities ties help enforce-owner ship regimes and management systems for common property (Grafton, 2000).

Sustainable development, in what we might refer to as an 'opportunities approach' to the issue, can then be defined as a non-declining stock of capital over .time. Or, we can link the two approaches, and we show later that a declining stock of capital means development is unsustainable by definition, so that these two approaches overlap, even if they are not identical.

Can development be sustained?

Economists have long been concerned with the question as to whether the natural environment imposes binding constraints on economic development and growth1. This concern starts with the writings of the classical economists Malthus, Mill, Ricardo and who all recognised the possible limits that finite land supply, variable land and finite natural resources could impose on economic growth. Just over 100 years , concerns re-emerged with the publication of *The Limits to Growth*

(Meadows *et al.*,1972), with worries over limits implied by environmental pollution being added to those of resource scarcity. The economists' response was to re-consider natural resource constraints, this time in the context of optimal growth models (Dasgupta and Heal, 1974, Solow, 1974). This work showed that, in the absence of technological progress, optimal growth patterns dictated an ultimately falling level of consumption and utility for future generations: in other words, optimal consumption would be single-peaked. A sufficient degree of (exogenously determined) technological progress coupled with substitution possibilities between the different inputs used by the economy to produce consumption goods could offset this decline, but the trade-off .between an optimal path and a sustainable one had been pointed out. Consumption can be sustained over time but this implies a different objective function for society. None of this work, however, was set in the explicit context of sustainable development, More recently, the of ideas of endogenous technological progress has led to a re-evaluation of the links between resource depletion, population growth and economic growth, and has on the whole led to more optimistic conclusions on the degree to which growth can be sustained (Bretschger, 2005), particularly where the sector of the economy that 'produces' new ideas is less resource-intensive than other sectors.

An important move towards an economics of SD was to show conditions under which nature resource scarcity was consistent with non-declining consumption for an economy overtime. In a seminal paper, Hartwick (1977) showed what was for consumption to be held constant in a resource-dependent economy, as we explain in Section 2.3. Again, this implied a trade-off between sustainability and optimality over time. Pezzey (1997) noted that sustainability was essentially achieved by imposing constraints on present-value optimising in an economy, but asked who would take this role. Market forces will not generate this pressure, even in an overlapping generations set-up, unless people living now care 'enough' about sustainability in and of itself (Beltratti *et al.*, 1995). Failing this, governments must take responsibility for the provision of 'sustainability', just as they take responsibility for providing public goods: indeed, one can think of sustainability as an inter-temporal

public good. We now turn to look at some ‘rules’ which a sustainability-promoting government could potentially utilize.

Possible sustainability rules: Weak versus strong sustainability

Weak and strong sustainability

Above, we noted that one way of conceptualizing SD is in terms of maintaining the economy's capital stock. Based on this idea, two different paradigms have developed. The first, which has become known as 'weak sustainability', requires that the real value of the *total* capital stock *K,* where *(K = Kn +Kh* +Km), be non-declining (note that we ignore social capital from now on). This permits natural capital to be run down (through using up oil stocks, *say)* so long as human and man-made capital are increased sufficiently. Maintaining the overall asset balance implies consuming merely the interest on this aggregate capital (Solow, 1986). This view clearly presumes that we can aggregate Kn, Kh and *Km* in the same units, and that they are *substitutes for each other* in terms .of their capacity both to produce welfare and to maintain system functioning. The genuine savings (GS) and green net national product (GNNP) indicators of sustainability (discussed in the next section) both derive from this weak sustainability view of the world, and are part of an overall 'smooth substitution' approach that also underlies the utility-based definitions of sustainability already encountered in Section 2.1.

An alternative view has been to maintain that SD requires that some part of the stock of *Kn* itself has to be prevented from declining. This view has been called 'strong sustainability', and derives primarily from the view that reductions in *Kn cannot. be substituted* for by increases in *Kh, Km* or any other forms of capital (Norton and Toman, 1997). Support for the concept of strong sustainability is also based on a view that ecological *systems* are characterised *by* non-linearities and discontinuities, which means that the welfare losses from declines in *Kn,* both present and future, are hard to predict. In other words, environmental limits matter, and breaking these limits is not compatible with long-term system stability. Strong sustain ability requires the physical protection of absolute levels of environmental goods. This position has also been characterised by a focus on 'critical' natural capital. Critical natural capital is

the subset of in which is either (1) essential for human survival and / or (ii) not substitutable for by increases either in other elements of Kn, or in Kh or Km. An example might be the ozone layer, or the natural climate and atmospheric composition regulation functions of the earth.

Sustainability, from this perspective, is defined as no decline in this stock of critical Natural capital. If humans need the services of ecosystems, it is important to maintain these ecosystems in a functioning state. This in turn means protecting their natural (ability to withstand shocks), which may be achieved by ensuring that keystone are species are preserved.

Table 1.1 (adapted from van Kooten and Bulte, 2000) gives some more detail on the differing worldviews of weak and strong sustainability, and the neo-classical/ecological economies viewpoints with which they are respectively associated

Weak sustainability rules

In an influential paper in 1977,John Hartwick proposed a rule for ensuring non-declining consumption through time, in the case where an economy made use of a non-renewable resource such as oil) in its economic process. Hartwick showed that, as long as the total stock of capital did not decline over time, non-declining consumption was possible. The stock of capital could be held constant by re-Investing all HoteIling rents (price minus marginal cost differentials) from non-renewable resource extraction in man-made capital we discuss these rents, and the optimal pattern ‘of non-renewable resource depletion. These rents are those resulting from the inter temporally efficient extraction /programme for the non-renewable resource. Thus, as the stock of oil (a type of natural capital) runs down, the stock of man-made capital is built up in replacement. This result has been very important for the development of the economics of SD. It arises in the Hartwick model owing to the assumptions employed therein: crucially, that the aggregate production function in an economy is a Cobb-Douglas one. This implies that man-made and natural capital are assumed to be unlimited substitutes for each other (the elasticity of substitution is equal to one) and that as the amount remaining of the non-renewable resource goes to zero, its average product goes to infinity (so that, even though the natural resource is

technically essential for the production of consumption goods, it does not act as a constraint to growth).

Table 1.1 Weak sustainability rules

Weak sustainability – the Neo –classical Economics view	***Strong sustainability – the view from ecological economics***
Focus marginal analysis as the nexus for decision making – absolute scale is of little relevance	Focus on scale of matter – energy throughput
Monetary valuation of changes in natural capital	Monetary valuation down played
Discounting and present values are central to analysis; focus on efficient resource allocation over time	Discounting generally opposed; focus on fair resource allocation over time and the rights of future generations
Prices provide crucial signals of relative security	Prices unreliable due to widespread externalities
Technological progress seen as major factor in growth over time	Technological progress not seen as a cure-all solution, but as something which poses environmental problems in and of itself
Utilitarian approach to values	Rights-based approach to values
Current generation ensures sustainability by passing on an undiminished stock of aggregate capital	Current generation needs to safeguard stock of natural capital for the future
Individual behaviour seen as being consistent social well-being, so long as enforce property rights	Need for government intervention in terms of managing the scale and manner of economic activity and environmental impacts
Economics focus on the steady state internal dynamic behaviour and management of natural resources	Focus on threshold effects, uncertainty, irreversibility's and resilience.

Hamilton and Hartwick (2005) and Hamilton and Withagen (2006) have recently shown that the standard Hartwick rule – maintain zero net or 'genuine' saving is actually a special case of a more general policy rule for sustainability. If genuine saving is positive and growing at less than the interest rate along a competitive path, then utility (or consumption) will rise everywhere along this path. Hamilton and Withagen show that a particular instance of this rule – maintain a fixed positive genuine saving rate – leads to unbounded consumption in the simple exhaustible resource economy of Hartwick (1977).

Criticisms of the Hartwick rule follow several lines. First, that individual derives utility directly from the environment, and do not view it merely as an input to production. If this is the case, non-declining consumption is not equivalent to non-declining welfare over time. This is not a fatal flaw, however, since it merely implies re-writing the utility function of the representative agent to depend on consumption and on environmental quality. Second, the simple Hartwick rule holds only in a closed economy: Asheim (1986) shows that once trade in natural resources is allowed for, resource-rich countries need to invest less than their Hotelling rents, whilst resource-poor countries need to invest more. Third, the performance of the rule depends on the Cobb-Douglas form chosen for the aggregate production function. Hartwick was able to restate his rule for a CES (constant elasticity of substitution) production function (Hartwick, 1978), but this function had the property that the elasticity of substitution between the natural resource and man-made capital was greater than one, so that the fixity in supply of the natural resource is actually irrelevant. Fourth, Common and Perrings (1992) argue that weak sustainability, as implied by the Hartwick rule, is not necessarily consistent with ecological sustain ability, defined by them to be the property of ecosystems to maintain their functioning in the presence of external shocks: However, this is more about the possible need to focus on more than one definition of sustainability, rather than a failure of the Hartwick rule to achieve what it claims to – constant consumption - unless one believes in (I particular link between ecological and economic stability (we return to ideas of ecological sustainability below). For an account of how one country (Botswana) has tried to implement the Hardwick rule, and the implications this had for measures to sustain its economy, see Lange (2004). Finally, we note that what one assumes about the nature of technical progress in the economy will have implications for how one interprets the Hartwick rule, and for its implications for sustainability.

Strong sustainability rules

Critics of the Hartwick rule argue that natural resources and man-made capital are not substitutable as the weak sustainability approach suggests. According

to what might be termed the 'thermodynamic' school (Christensen, 1989; Daly, 1990), natural capital and man-made capital are in most cases complements rather than substitutes. Christensen terms the various elements of the natural capital stock 'primary inputs', and man-made capital and labour the 'agents of transformation'. While substitution possibilities may be high within each of the two groups (e.g. wood for leather, plastics for copper, machines for labour), substitution possibilities between the two are very low, increasing output thus means increasing use of both types of input in most cases.

If it is necessary to maintain some amount of the natural capital stock constant in order to allow future generations to reach the same level of utility as the average held by this generation, this holding constant of the natural capital stock becomes a rule for SD. The important question here, however, is, how much of *Kn* should be held constant? Three possible views would be (1) the existing level, (2) the level consistent with maintaining critical element of *Kn* (environmentalists might argue we have beyond this) and (3) some amount in between these two. All three of these alternatives however, assume that we can measure the *value* of *Kn* at any point in time; in other words, that the different elements of *Kn* can be aggregated together in comparable units. Should natural capital be measured in physical or monetary units? Physical units confound addition since an oak forest cannot be added to a blue whale. Only if the two types of natural assets are expressed in common units can they be aggregated, the most obvious unit being money. However, this may be seen as objectionable, since one whale $10 million is then equivalent to $1000 whales worth $10,000 each. If natural assets constant in physical terms, the level at which the category is defined will become all-important. Consider the maintenance of woodlands in Britain by constant total area.. This woodland stock definition might raise the objection that a hectare of Sitka spruce is less valuable than a hectare of native Scots pine or of ancient oak. The category could be disaggregated to hold constant the stock of deciduous trees and the stock of conifers. However, some might wish to go further and distinguish between different types of deciduous woodland (oak forests, birch scrub etc.). Van Pelt (1993) identifies another problem

with the constant natural capital stock concept. This is the problem of spatial aggregation: within which geographic area should we hold stocks constant?

If the natural capital stock cannot be fully aggregated, it may be necessary to Compartmentalise it by sector, and keep each compartment constant. Van Pelt (1993) suggests renewable resources, biodiversity, pollution assimilation capacity (including, for example, the pollution assimilation capacity of wetlands) and non –renewable resources as possible categories. To these might be added the integrity of nutrient cycles. However, non-renewable resources, such as oil, are by definition fixed finite stocks which must decline with use. The only ways to maintain a constant economic reserve are for new discoveries to equal extraction and/or for costs per unit extracted to decrease with technological progress as quickly as they rise as the result of cumulative extraction. More strictly, given a finite total crustal abundance of each non-renewable resource, only a zero extraction rate is consistent with a constant natural capital stock unless trade-offs are permitted between renewable and non-renewable resources.

Supposing that the aggregation problem for natural capital can somehow be overcome (perhaps by extensive disaggregation into separate classes and physical quantification), an early rule for SD suggested by the strong sustainability school was to prevent reductions in the level of *Kn* below some constraint value (or series of values for the separate classes). This might appear a heavy restriction on development if the current level of *Kn* is chosen as the constraint, since it would involve all projects/policies having a dele terious effect on *Kn* to be banned. The alternative to this suggested by Pearce *et al.* (1990) involves the use of 'shadow projects'. These are projects/policies designed to produce environmental benefits, in terms of additions to *Kn*, to exactly offset reductions in *Kn* resulting from a specified collection (portfolio) of projects or policies, For example, in any year, for each hectare of wetland drained, the government would require a new hectare of wetland to be created to offset this loss in natural capital. Yet how could governments enforce such a rule, and what general equilibrium effects would it have?

Closely linked to the non-declining natural capital stock approach is that of safe minimum standards (SMS),identified primarily with Ciriacy- Wantrup (1952) and Bishop (1978, 1993). The SMS approach originates from decision making under uncertainty. Society is deemed to be unsure about the future costs of current environmental degradation. Broadly, two classes of action may be taken: conserve environmental resources (such as a wilderness area) or do not conserve. Deciding not to conserve a resource is usually referred to as a decision to 'develop' (although this form of words has some unfortunate internal inconsistencies'). Deciding to conserve today can be the risk-minimising way to proceed if we are unsure about the consequences of environmental degradation, in that conservation can internal the maximum possible loss to Society. As Randall and Farmer (1995) have pointed out, an SMS approach shifts the burden of proof from those who wish to conserve to those who wish to develop. The following is the SMS rule: prevent reductions in the natural capital stock below the safe minimum standard identified for each component of this stock unless the social opportunity costs of doing so are 'unacceptably' large. Toman (1994) argued that the SMS concept was a useful way of thinking about the choice between economic trade-off's and environmental and moral absolutes, which is one way of 55nternalizing55g the weak versus strong sustainability debate: as the sustainability stakes rise, absolute, strong sustain ability rules should take preference over weak sustainability rules that allow trade-off's between natural and man-made capital.

How are SMS levels identified? This has only really been worked out for flora and funa and corresponds to their minimum viable population levels in an area. How should 'unacceptably large' opportunity costs of preservation be identified? By social consensus and the democratic process (although note that it is still only the preferences of the current generation that count here). Perhaps for smaller-scale potential losses, government agencies could be relied on to take such decisions. For larger losses, public referenda would be necessary. Economists would be charged with identifying the opportunity costs of conservation and with designing cost-minimising policies to protect the SMS, but not with estimating the non-market values of

conserving wildlife, for example since the economic benefits of conservation do not enter the SMS rule directly.

Daly's operational principles'

In a 1990 paper in *Ecological Economics,* Daly identified what he termed 'operational principles' for strong sustainability. If these principles were followed, then nations could move towards an SD position. The principles are as follows:

1. Renewable resources (fish, forests, game). Set all harvest levels at less than or equal to the 'population growth rate for some population size (density-dependent growth is the rule for such resources, as Chapter 9 explains) .
2. Pollution. For degradable pollutants, establish assimilative capacities for receiving and ecosystems maintain waste discharges below these levels. Daly proposes no rule for cumulative pollutants, but the implication is that their discharge should be set close to zero.
3. Non – renewable resources. Receipts from non-renewable extraction should be divided into an Income stream and an investment stream. The investment stream should be invested in renewable substitutes (e.g. biomass energy for oil) such that by the time period when the non-renewable resource reaches the end of its economic extraction, an identical level' of consumption is available from the renewable substitute to what was available from the non-renewable resource at the start of the depletion programme. Only the income stream should be available for consumption. The proportion of funds which is necessary to divert to the renewable substitute will depend on its growth rate, the rate of technical progress, the discount rate and the size of the non-renewable resource (El-Serafy, 1989).
4. Controls on a macroeconomic scale. Daly believes that it is vital to minimize matter /energy throughput in the economy. This is a question of 'scale'. Such controls must be· quantitative, and aimed at population levels and resource use.

Maintaining system resilience

Resilience is a concept taken from systems ecology, which has recently been

promoted as a usual way of thinking about strong sustainability (Levin *et al.,* 1998; Ludwig, Walker and Holling, 1997) As explained by Holling (1973),resilience refers to the ability of the main processes within an ecosystem to remain functional in the presence of exogenous shocks. Ecosystem variables may well undergo large changes as a result of such shocks, but the overall functioning of the system is maintained within bounds. As economic growth increases our demands on ecosystems via resource depletion and rising emissions, so society becomes more sensitive to external shocks as the environmental system becomes more sensitive (Arrow *et al.,* 1995). Boosting resilience is equivalent to reducing this sensitivity. This is important since the nature of the dynamics of the economy-environment system (non-linear, adaptive and far-from-equilibrium) means that the system can suddenly lurch from one state to another, radically different state. Whilst such changes do not have to be undesirable, in an environmental context they have often been so in the recent past (e.g, the collapse of certain ocean fisheries).

Levin *et al.* (1998) argue that, in general, resilience is a desirable property. For the environment-economy system, maintaining resilience might be viewed as an SD strategy since it maintains system functioning over time. But how can this be done? Resilience is determined by flexibility and the ability to change adaptively (Brock *et al.,* 2000). Flexibility can come from many sources. One important source is argued to be biodiversity, so that maintaining biodiversity helps maintain resilience. However, this is not sufficient according to Levin *et al.* Resilience also depends on ' … the coupling of stimulus and response in terms of space, time and organizational scales', Combined with the idea of flexibility, this means that promoting free market competition *and* effective government intervention when markets fail is vital. However, as Common and Perrings (1992) note, most economic models of sustainable development omit to include any concept of resilience within their structure: the concept still seems to be mainly in the domain of system ecologists, rather than environmental economists.

Finally, one misconception which is important to correct here is concerned with the valuation of non-market environmental goods. It might be thought that if

all environmental externalities are correctly valued (using methods explained in Chapter 11) and if these values are properly incorporated in decision making by both private individuals/firms and governments, then the economy will necessarily move towards a sustainable development path. This is incorrect. While the correct valuation of non market environmental goods is essential for an economy to be (inter temporally) efficient in its use of resources, and therefore achieve an optimal development path where present value is internal, it does not guarantee that the economy will develop sustainable. Pezzey (2004) shows a clear distinction between sustain ability policy, aimed at achieving intergenerational equity, and environmental policy aimed at internalizing non-market values.

That valuation of the environment will not necessarily result in SD has also been demonstrated by Howarth and Norgaard (1992). In Figure 1.15, we show a utility possibility frontier, defined on given tastes, technology and resource endowments, across two generations. If environmental goods are incorrectly valued, then the economy must be at some point inside this frontier (e.g. at pointA). Correct valuation makes the economy efficient (we assume no .other distortions), which might move the economy to point: B. However, the move from A to B whilst efficient, is not consistent with SD since the

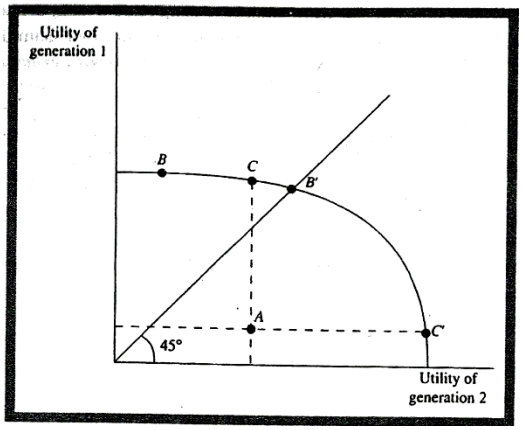


Figure 1.15

Utility (welfare) of generation 2 has been reduced below that of generation. 1. This will be so unless costless transfer mechanisms enable us to redistribute utility from B to 'B' Points along the line segment B'C can only be chosen if we know what the intertemporal social welfare function looks like.

1.13 Economic indicators of sustainability

If the following section, we set out the two main economic indicators of sustainability, namely green net national product and genuine savings. Both are firmly based on the weak sustainability assumption.

Green Net National Product

A large literature has recently emerged on whether the well-known macroeconomic measure gross national product (GNP) can be transformed to produce an indicator of SD (Asheim, 2003). GNP .has traditionally been thought of both as a welfare measure and as a measure of national Income. By relating this to a particular concept of income put forward by Hicks in 1946, some authors *have* sought to transform GNP into an indicator of SD, Hicks 'view on income was that it represented that portion of the value of output which could be consumed in any year without reducing one's wealth, defined as one's potential future consumption. This clearly has resonance with some definitions of SD. Green net national product (GNNP), it is argued, would also be a *better welfare measure for* society - irrespective of whether it is a good sustainability indicator (Aronsson et al., 1997).

Why is it necessary to adjust the conventional national accounts? Because these accounts omit many of the inputs which the environment provides to the economy, since they are un priced by the market. When a country depletes its natural capital, this depreciation of its stock of resources is ignored in the national accounts, even /though depreciation of man-made capital is allowed for. Calculating GNNP thus involves correcting for these omissions. Two approaches have been taken to work out what corrections should be made. One, associated with authors such as Repetto, involves a series of ad hoc deductions for depreciation in natural capital stocks, to allow for development impacts such as deforestation, ground water depletion and soil erosion. The second includes

many of the same effects, but tries to value them in a way consistent with economic theory. This is what we now develop here, drawing on work by Weitzman (1976), Maler (1991), Pezzey and Toman (2002) and Pezzey *et al. (2006).*

Natural resource accounting in Asia

A country can fell its forests, erode its soils, exhaust its minerals, pollute its aquifers and erase its wildlife, all without adversely affecting its measured income. By failing to recognise the asset value of natural resources, the UN System of National Accounts (SNA) misrepresents the policy options which nations face. In Costa Rica increases in the rates of deforestation, soil erosion and the consequent impacts on inshore fisheries and coral reefs, compounded by overexploitation, have had major socioeconomic impacts. Natural resource accounts compiled for the 1970s and 1980s using remotely sensed data on land use change, field data on forest productivity, GIS (geographic information system) studies of soil erosion and sample studies of fish populations reveal the problem. These studies suggested that Costa Rica had been depleting its forest, soil and fishery capital by at least 5 per cent on average of GDP per year since 1970. The asset value and sustainable profits of the principal fish species in the major fishing area in the Gulf of Nicoya dropped to zero as fishermen's earnings fell below the level of welfare payments to the destitute. Leaving aside the unquantified service value of Costa Rica's forests (as wildlife habitat, tourist attractions, ecosystem regulators and suppliers of non-timber products), the forestry' sector generated substantially negative net national income throughout the 1980s and overall deforestation estimates from 1966 to 1989 were 28.2 per cent. Ignoring declines in soil fertility due to losses of micronutrients, biological activity and desirable soil structure, and restricting off-site concerns to siltation effects on hydroelectric systems, economic losses, primarily through the cost of replacing lost macronutrients, accounted for 9 per cent of all agricultural production. Using these figures, it can be shown that natural resource depreciation rose from 26 per cent of) gross capital formation in 1970 to 39 per cent in 1989. Thus, the conventional accounting actual net capital formation by 70 per cent in 1989 (Repetto, 1992).

Using oil and forestry data for 1970-84 from Indonesia and a joyances soil erosion study in 1985, Repetto et al. (1989) presented national accounts which incorporate measures of natural resource depletion, yielding environmentally adjusted 'net' domestic product (NDP). Indonesia's national income and economic growth have been overstated by conventional CDP, which increased at an annual rate of 7.1 per cent from 1971 to 1984. Revenues from oil and gas production hard mineral extraction and the harvesting of timber and other forest used to finance government development and routine expenditures. However the losses of oil .reserves, topsoil and forest cover have resulted in a depleted natural resource base which will restrict future development opportunities. The annual rate of increase of NDP was in fact only 4.0 per cent. The raw data used for the soil erosion study are being debated and reason to doubt the assumed magnitude of soil erosion and the importance on the process. Nevertheless, a more complete accounting system which estimates the depreciation in future productive potential for other environmental resources such as fisheries, non-timber forest products, natural gas, coal, copper, tin and nickel might reveal more unsustainable trends.

Consider an economy with a representative agent who derives utility from consumption of both produced goods and environmental amenities, given by a vector Ct where t. t indexes time. Production is determined by the aggregate (man-made plus natural plus stock, a vector K, and technological progress which depends solely on the passage of time. An economy is deemed to be sustainable at time *t* if utility is less than or equal to maximum sustainable utility at this time, where 'sustainable' here means consistent with non-declining values of U(C), as in (1.4) and (1.5) . The economy maximizes the present value of utility over infinite time, at a constant discount rate *p*

$$Max_{ek} \int_{t}^{\alpha} u(ot)\, e^{-pt} dt \qquad (1.4)$$

Pezzey and Toman show that for this economy to be sustainable, green net national product Yt, defined by

$$yt = P(t) \,.\, C(t) + V(t)kt) \qquad (1.5a)$$

where K is the rate of change in *K* per unit of time, subject to production possibilities given by K(t) and *t:* and where' P is the relative price for the consumption goods and amenities and environmental amenities and *V* is the price for each element of the capital stock, *must be non- declining at time t,* that is

$$Y(t) \leq 0 \Rightarrow U(t) > Um(t) \qquad (1.5b)$$

That is, if green net national product is declining at time *t,* then utility must exceed the maximum sustainable level, In Equation (1.5), both the K and C terms are 'augmented', which means they include a 'value of time': this is the discounted value of future exogenous technological improvements and resource price appreciation in a resource-exporting country, together with capital gains on net foreign capital. The value of time term is shown in detail in .Equation (1.11), but one can think of it intuitively as the discounted value of 'time passing' to the economy, in terms of its capital gains both from capital held over seas and from its natural resource net exports - for instance, if we are thinking about an oil exporter such as Mexico - plus the change in the value of production possibilities over time brought about by exogenous technical progress. This 'non-declining trend' in GNNP as a signal of sustain ability is a result also reached by Asheim and Weitzman (2001).

More detail on how exactly GNNP is calculated is best provided through an example. We take the work of Pezzey *et al.* (2006), who construct a set of sustainability accounts for Scotland. They assume that utility depends positively on consumption, and .environmental amenities provided by landscape and biodiversity goods, *B(Jt),* which depends in turn on government spending on programmes to encourage farmers to provide these goods, *1.* Utility is negatively impacted by pollution emissions E, a vector made up of emissions of six air pollutants. The extended consumption vector is thus

$$C = (C, E, B\,[J]) \qquad (1.6)$$

Scotland is an open economy, with exports X and imports M; a stock of foreign debt/assets *K f* also exists. This stock changes according to

$$K^f = rk^f + X - M \qquad (1.7)$$

(r.Kf is the return on foreign capital) whilst domestic man-made capital changes according to investment (I) and depreciation *(αK),* such that k*: = I - UK.* Output depends on *K,* natural resources used up domestically, and technology.

Scotland exploits two renewable resource stocks (fish and forests) and three non renewable, oil, coal and aggregates, denoted R_1, ... ,R_5. These stocks evolve over time according to

$$S=-R+G(S)+D \qquad (1.8)$$

where S is the stock change, *R* is resource extraction, G(S) is density dependent growth for renewable and D is discoveries for non-renewable. Natural resources sell at prices given by *pR* and are extracted at marginal costs given by *fRo* GNNP is then given by:

$$Y= c-ef+bB+K+k^f+(P^R-fR)S \qquad (1.9)$$

Where is the marginal damage cost of pollution emissions E, and b is marginal willingness to pay for landscape and biodiversity goods B. Allowing for the impacts of time on production possibilities (due to exogenous technical progress) and exogenous resource price changes gives augmented GNNP equal to

$$Yang = c-eE+bB+K+k^f+(P^R-f_R)S+Qt \qquad (1.10)$$

Where

$$Qt = \int_t^{\alpha} [Fs+P^R(R^r-R^m)] (s)\, e^{-r(s-t)} ds \qquad (1.11)$$

This shows the value of time, Qt to depend on future technical change *(F_s)* (measured at the predicted change in productivity in the economy) plus the value of resource price changes in productivity in the future *(P^R)* multiplied by net resource exports *(R^x -* R^M). All of this will be hard to ascribe values to in practice, especially since the theoretical model from which Equations (1.9) and (1.10) are derived assumes all of these variables and parameters are equal to their optimal values along a present-value maximizing path. These difficulties are notwithstanding. Fig 1.17

gives an empirical example of the calculation of GNNP along these lines.

Green net national product and genuine savings for Scotland

Pezzey et al. (2006) report results for time-augmented green NNP for Scotland over the period 1990-1998 using the theoretical model set out in Section 2.4. They include terms for the following:

1. The Impacts of pollution on utility, using estimated emissions of air pollutants and a range of marginal damage impacts cost estimates.
2. The impacts on utility of agri-environmental schemes, which generate improved wildlife and landscapes.
3. The value of resource depletion/investment for forestry, fisheries, oil, coal and aggregates.
4. Estimates of the 'value of time', based on technological progress (actual and forecast) and changes in oil prices over a 30-yellr time horizon.

Results showed a rising value of GNNP, and positive genuine savings, indicating the lack of a weak sustainability problem in Scotland over the period in question (Figure 1.16). However, the team has to cope with big gaps in the data, and used actual rather than optimal or sustainable prices in calculations. How much reliance can be placed on the results is therefore doubtful.

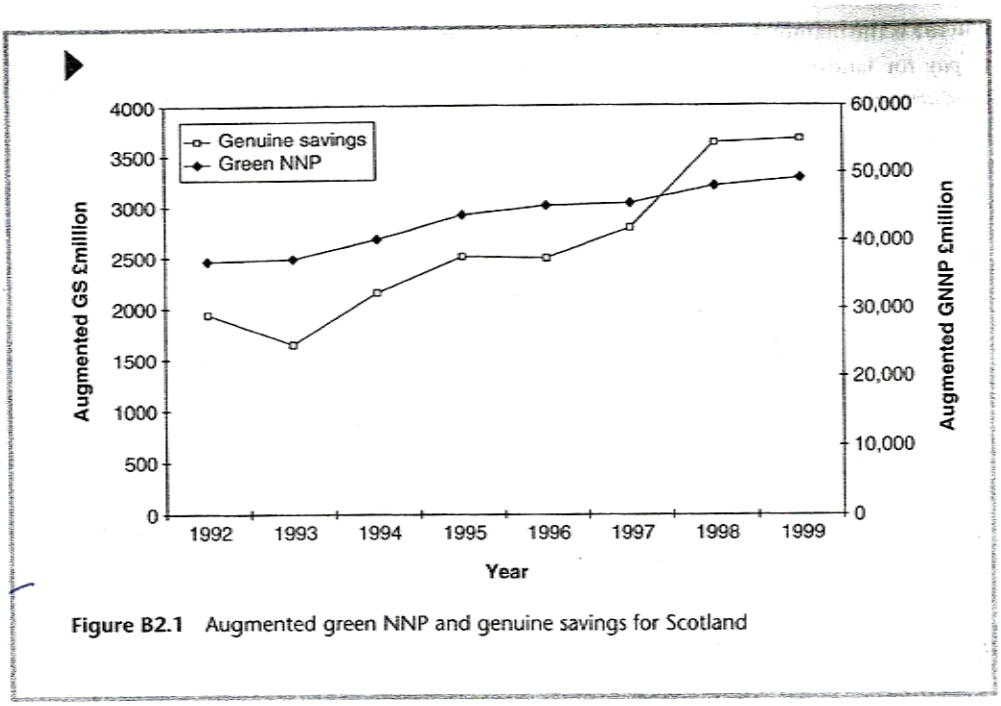


Figure B2.1 Augmented green NNP and genuine savings for Scotland

Figure: 1.16 Augmented green NNP and genuine savings for Scotland

How good a measure of sustain ability is the change in GNNP? Several weaknesses may be noted. First, there is disagreement among economists of how exactly adjustments to the conventional accounts should be made (e.g. over how to treat new discoveries; and how to value environmental liabilities, see Hanley (2000). It is also true that, for the adjustments to be correct, the price and marginal cost values used should be those which result from a competitive, dynamically optimal use of resources. However, the well known problem of the absence of clearly defined property rights means this is unlikely to be true, especially for fisheries. There is also a dispute amongst economists about whether GNNP can be used even in principle as a sustainability indicator. Dasgupta *et al.* (1996) suggest in a less restrictive model that if a correctly evaluated GNNP is rising, then the country's long-term welfare is increasing. However, Asheim (1994) shows that unless the adjustments to conventional GNP are made using the prices that would hold along a *sustainable* (as distinct from an inter-temporally efficient) path, GNNP tells us nothing about sustainability. Consistent with this, Pezzey and Toman (2002) showed that GNNP is only a one-sided indicator of SD: it only tells us when an

economy is behaving unsustainably, but cannot guarantee that an economy is in fact sustainable.

Genuine savings

An alternative economic indicator of SD, closely related to GNNP, is the *genuine savings* concept, put forward originally by Pearce and Atkinson (1993) and Hamilton (1996). GS compares investment in an economy with depreciation of all forms of capital. As such, it is an empirical application of the 'opportunities' approach to sustainability, and has been thought of as a test of whether an economy is the Hartwick rule since it involves a comparison of investments and depreciation in total capital, it is also referred to as net *investment.* How is GS calculated? Again, contrasts can be drawn between sometimes ad hoc empirical approaches and approaches based on underlying theory. In fact, GS can be derived from exactly the same theoretical model as that outlined above for GNNP. The equivalent GS to GNNP shown in (1.9) is

$$GS = V'K = K + K^f + (pR - f_R)S \qquad (1.12)$$

That is, GS is given by the net change in produced capital *K,* plus the change in foreign capital, plus the value of depreciation of natural resource stocks, given by the physical change times the Hotelling rent. A time-augmented version of GS can also be given, which would be just (1.12) modified for a value of time term Qt similar to that outlined for GNNP.

The test of unsustainable development is then whether GS is negative or not. That is,

$$GS(t) < 0 \Longrightarrow U(t) > Um(t) \qquad (1.13)$$

We can include changes in the stock of human capital in Equation (1.12) - spending on education and training would be a positive term here - whilst augmentation of the indicator with the value of time *Qt* allows for technical change to be included ..If' GS is negative, then this is a clear indication of unsustainable behaviour. Investments in the aggregate capital stock must be increased. This increased investment could include investments in pollution treatment, fisheries and forest stocks, and searching

for new, economically viable, non-renewable resource deposits. It could equally comprise increased investments in hospitals, schools and railways. The GS indicator has recently been extended to allow for international trade. effects. GS and GNNP are closely linked to each other since they are both derived from the same underlying theory. It is possible to show formally that (1.5b) and (1.13) are equivalent tests of sustainability *in theory if GS is* negative, then GNNP must be falling. Furthermore, Asheim and Weitzman (2001) show that the rate of change of GNNP at time *t* must be equal to the real interest rate multiplied by GS. Pezzey and Toman (2002) show that this relationship holds for the time augmented versions of the two measures. If this is so, then which measure we prefer may come down to which data it is easier to acquire: the data needed to measure GS of the data needed to measure GNNP. Since the former is less than the latter, this suggests a preference for GS.

Figure 1.18 shows some results from Hamilton and Atkinson's (1996) estimates of GS for the united Kingdom for the period 1980-1990. Results from the Hanley *et al. (1999) study for GS* for Scotland are also given in Figure 1.18. The Scottish economy can be seen to have behaving unsustainably for much of this period, since GS were negative. This mirrors the finding by Hamilton and Atkinson (1996) for the UK as a whole over this period. However, the discrepancy between depreciation of capital stocks and savings towards the end of the period.

Genuine savings estimates for the UK

Hamilton and Atkinson (1996) estimate genuine savings for the United Kingdom for the period 1980-1990. The UK genuine savings rate over this period is illustrated in Figure 1.17 and is plotted alongside estimates using other definitions of the UK savings ratios beginning with gross savings. Shown as a proportion of GDP, these display. the successive deductions from gross saving proposed above, with 'Res. Net Saving' indicating traditional net saving less the value of resource depletion. On this measure the UK appears to have persistently under-saved during much of the 1980s. In the period 1980-1986 genuine savings rates were between -1.6% and -3.1 % of GDP. This is a striking result and shows that, by simply beginning the process of redefining a nation's savings rates to be .net of the depletion of non-renewable resources and the value of air

pollution, inadequate provision to offset asset loss was made during the 1980s in the UK. The measure of genuine saving indicates that the UK stopped dis-saving towards the end of the decade. Some of this increase is attributable to a reduction in the value of resource depletion, which in turn is in large part due to the reduction in world oil prices after 1986. Paradoxically, this conveys the impression that, other things being equal, a decrease in the price of oil raises genuine saving. Offsetting this is the fact that the remaining oil reserves are now a less valuable form of wealth, which could conceivably result in a lower level of future welfare. Hanley *et al* (1999) Genuine Savings Results for Scotland over a similar time period tell a similar story to the UK figures (Figure 1.18). Neither of these sets of calculations include a 'value of time' term.

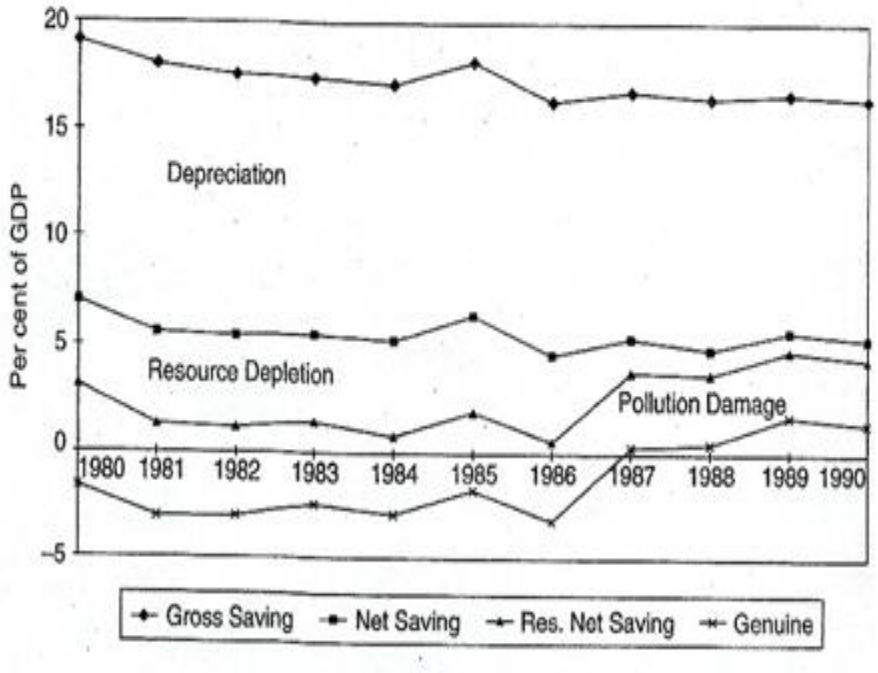


Figure 1.17 Genuine savings in United Kingdom : 1980-1990

Source: Hamilton and Atkinson. (1996).

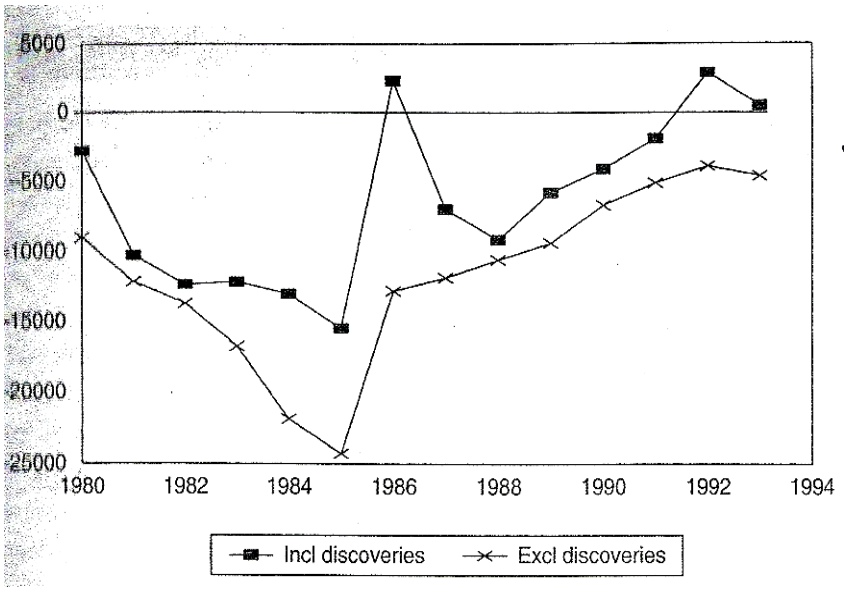


Figure 1.18 Genuine savings in Scotland, 1980-1994

Source: Aniey et al. (1999).

Examples of the application of the concept of genuine savings to sustainability in the developing world can be found in World Bank (2006) for a great many countries; in large (2004) .for countries in Southern Africa; and in Hamilton and Clemens (1999). Some results from the Hamilton and Clemens study are illustrated in Table 2.2. In these estimates, genuine savings are defined as gross savings (assumed to equal gross investment) net of the depreciation of produced capital and natural resource depletion it is no allowance has been made for environmental damage). Nevertheless, the results indicate that on average over the period 1980-1994, genuine savings were negative for all countries featured in Table 2.2, except Argentina, Brazil and Colombia. It is reasonable in speculate that this arose as a result of a failure to adequately re-invest the proceeds of resource depletion in alternative assets over this period. Put another way, several Latin American and Caribbean countries appear, on balance, to have been liquidating their assets. Understanding the reasons for this persistent dis-saving and the design of policy responses to .manage more carefully an economy's portfolio of assets in the future are integral to making good commitments to the goal of sustainable development. This process

of addressing what has gone wrong with past development decisions might not have come about .but for attempts to calculate such SD measures.

How good GS, as a sustainability measure? Three criticisms may be noted. First, GS is a measure of sustainability only. If sufficient substitution possibilities do not exist between the different types of capital, then a positive GS will not guarantee non-declining welfare over time. This is a criticism that could be leveled at GNNP too, of course. Second, Asheim (1994), Common and Perrings (1992) and Pezzey and Toman (2002) all argue that market prices should not, strictly speaking, be used to calculate the depreciation term for *Kn* although for different reasons.

Table 1.2 Genuine savings in selected Latin American and Caribbean economies, 1980-1994

Country	Average Genuine Savings Rate (%of GDP)
Argentina	2
Bolivia	-30
Brazil	6
Chile	-3
Colombia	2
Ecuador	-14
Guatemala	-2
Haiti	-7
Jamaica	-12
Mexico	-3
Peru	-1
Trinidad and Tobago	-23
Venezuela	-24

Source: Hamilton and Clemens, 1999.

For Common and Perrings, the reason is that an additional condition must be imposed on the economy-environment system, one which safeguards total system resilience. For Asheim, and for Pezzey and Toman, prices would need to be those found on an SD path, which is why GS calculated with optimal market prices is only a one-sided test of sustain ability, in that it is possible to have a positive GS with utility bigger than maximum sustainable utility.

Strong sustainability indicators

We will say less about this side of the indicator literature since it has not been the main focus for economists. However, economic contributions to the strong sustainability indicator debate can be found. They include 'distance to goal' approaches such as work by Hueting *et al.* (1992), who adjust NNP to account for the costs of reaching environmental goals. Ekins and Simon (1999) have recently built upon this approach in proposing an analogous indicator: the sustainability gap. The focus here is on the distance between the current level of impact on a natural asset and a sustainability standard, set in physical or monetary terms. However, strong sustainability has mainly been the province of non-economic approaches (Imhoff *et al.*, 2004). Insights from ecology have led to measures such as the net primary productivity-consumption ratio (sometimes referred to as appropriated carrying capacity) and ecological fool prints (EF; Rees and Wackernagel, 1994). Socio-political indicators also exist, notably the Index of Sustainable Economic Welfare, the Genuine Progress Indicator and Ecological Debt. For details. and examples of all of these, see Moffat *et al*, (2001).

The ecological footprint

The Ecological Footprint (EF) was put forward as a concept for measuring sustainability by Rees And Wackemagal in 1994 (Wackernagel and Rees,1996; Rees and Wackernagel, 1994). They defined it as ... 'an accounting tool that enables us to estimate the resource consumption and waste assimilation requirements of a given population or economy in terms of its corresponding land area'. It has since been taken on board by many environmental groups as a useful lobbying concept and as a communication tool (e.g. see WWF's website). But what is its academic appeal as a robust indicator of sustainability?

The main ideas behind EF are ecological rather than economic. Society is seen as imposing demands on the earth in the form of energy use, consumption, transport and waste. Land is the ultimate resource which is capable of meeting these demands sustainably. If all demands can be converted into 'land requirements', these can then be related to the available land area of a country, region or (even) city. At the global level,

goes the argument, global demands cannot exceed global supply. Yet Wackernagel and Reesfound that the world footprint was 1.8 times the available surface area - in their view, an unsustainable outcome. For any individual/country/region/city, the size of EF can be seen as a measure of unsustainability, with larger footprints being less sustainable (Canada was found to have a footprint equal to 4.3 times its available area). Countries can have footprints bigger than one by importing consumption –intermediate goods or by running down their natural capital. However, this might mean exporting un-sustainability' to other countries - see Box 2.5. The policy advice that follows is to reduce demands (e.g. by encouraging energy efficiency, or less consumption, or less pollution), or to increase supply by improving the technology which transforms land into consumption (e.g more efficient agricultural systems).

However, *there* are big problems with the EFasa scientific concept. Aggregating all demands and all supplies into land imposes some very awkward assumptions - for example, that all inbuilt on land is equally valuable and that substitution in resource use is a bad thing. Accounting boundaries are unclear, and the EF is not robust to changes or variations in underlying efficiency parameters (e.g. yield factors used to convert timber demands into areas of forest land required to sustain them). Differences in opportunity costs and economic values are not recognised (Ares, 2000), and there is no recognition of differences between sustainable and sustainable uses of land. Usually a high proportion of the EF for a country is made up of the need to sequester CO2 emissions - but is this weighting consistent with peoples' preference? Whilst having global demands greater than the earth's capacity to sustain them bad outcome, does this mean we require demands to be less than local supplies for every country, region and city in the whole world?

For those interested in pursuing this topic more closely, the journal *Ecological Economics a published* a special issue on the EF in 2000.

Sustainability and trade

A common critique of neo-classical indicators of sustainability is that they ignore the impact of a country's economic activity on other countries. Countries such as Japan

and the Netherlands can 'export unsustainability', it is argued, if they import primary commodities from other countries which thus deplete their stocks of natural capital. It is a moot point which country's accounts these impacts should be included in. The Ecological Footprint is a response from ecologists to including such effects (Wackernagel and Rees,1996). Economists have also sought to include trade effects on natural capital in weak sustainability measures. One such attempt is presented by Proops *et al.* (1999). They use input--output methods to identify the flows of non-renewable resources that accompany trade, in order to modify calculations of GS. This basically allows them to quantify the impact of final demand in country A on natural capital in country B. The authors use data from 12 regions of the world economy over the period 1980-1990. The main conclusions drawn by the authors are as follows:

1. Allowing for trade effects on *Kn* in other countries decreases the size of positive GS in Western European countries, but it remains positive.
2. For the rest of the world, the sustainability performance of the US is worsened, and the performance of the Middle East improved.
3. The difference between 'open economy' and 'closed economy' measures of genuine savings is in general small, around 1%.
4. Biggest impacts are on the Middle East. Africa and Latin America.
5. Using the open-economy calculations, global sustainability seems to have improved overall over the period in question.

This approach has been extended by Atkinson and Hamilton (2002), who again attempt ' ... to attribute resource depletion to the country where it eventually goes to satisfy domestic final demand'. Again, input-output methods are used to identify both direct and indirect resource consumption. They calculate an 'ecological balance of payments' for 95 countries, defined as a country's total use of (global) resources minus its production of resources from domestic sources. For 1985, the OECD countries turn out to be net consumers of global resources, and the Middle East and North Africa net suppliers. The authors then relate resource dependencies to genuine savings figures for resource exporters. However, they make the point that although Japan draws its resource needs from several countries with negative genuine savings, Japan is not to blame for

this: it may rather show the difficulties many resource-exporting countries have in implementing the Hartwick rule.

Can try to achieve it and how they can try and measure it.: One conclusion that emerges from the literature is that a sustainability policy is not the same as an environmental policy, since sustainable development depends either on non-declining utility over time, and many other factors than just environmental ones impact on utility; or because sustainable development is about maintaining all forms of capital intact, not just natural capital. In other words, governments need a policy on sustainable development to achieve SD: environmental policy on its own will not do. Why have an SD policy anyway? Perhaps because SD can be thought of as a merit or public good which the competitive market does not supply. Whether from a utilitarian or a rights-based perspective, future generations have rights which we need to take into consideration.

How we measure SD turns out to depend on whether we believe in weak or strong sustainability. Arguments continue here over the extent of substitution both in production (between different forms of capital) and in direct utility terms (substitution possibilities between - consumption goods and environmental quality). The theory of developing weak sustainability indicators is now quite advanced, but empirical applications are inherently difficult and thus lag behind. The economics of sustainable development is very much an area of ongoing enquiry.

Economic Accounting and the measurement of environmentally corrected GDP

Economic Accounting

System of Environmental-**Economic Accounting** (SEEA) is a framework to compile statistics linking environmental statistics to **economic** statistics. SEEA is described as a satellite system to the United Nations System of National **Accounts** (SNA).

The System of Environmental-Economic Accounting (SEEA) contains the internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics on the environment and its relationship with the economy. The SEEA framework follows a similar accounting

structure as the System of National Accounts (SNA) and uses concepts, definitions and classifications consistent with the SNA in order to facilitate the integration of environmental and economic statistics.

The SEEA is a system for organizing statistical data for the derivation of coherent indicators and descriptive statistics to monitor the interactions between the economy and the environment and the state of the environment to better inform decision-making. The SEEA does not propose any single headline indicator. Rather it is a multi-purpose system that generates a wide range of statistics and indicators with many different potential analytical applications. It is a flexible system in that its implementation can be adapted to countries' priorities and policy needs while at the same time providing a common framework and common concepts, terms and definitions. The SEEA brochure provides additional information on what environmental accounting has to offer.

` A multi-year process of revision to the System of Environmental-Economic Accounting was initiated by the United Nations Statistical Commission. The revised SEEA consists of three parts: the *Central Framework*, which was adopted by the UN Statistical Commission as the first international standard for environmental-economic accounting; Experimental Ecosystem Accounting and Applications and Extensions of the SEEA.

Subsystems of the SEEA framework elaborate on specific resources or sectors, including: Energy, Water, Fisheries, Land and Ecosystems, and Agriculture. These 'sub-systems' are fully consistent with the over-arching SEEA, but provide further details on specific topics and try to build bridges between the accounting community and the community of experts in each specific subject area.

Apart from these specific applications, the SEEA can also be used for:

1. Deriving a range of indicators concerning environmental-economic issues such as energy use, water consumption, depletion of natural resources, etc;
2. Ttrend analysis through the use of common definitions and standards;
3. Providing a framework for organising existing data and for assessing its quality and completeness;
4. Mmonitoring the state of the environment and its relationship to the economy;

5. Changes in trade patterns and emissions embedded in categories of final demand through physical input-output analysis;

6. Understanding where and when the benefits and costs of natural resource use accrue; and

7. Enabling international reporting and comparisons.

The SEEA as a system

The SEEA consists of a coherent, consistent and integrated set of tables and accounts each of which focus on different aspects of the interaction between the economy and the environment or on the changing state of the environment. The tables and accounts are based on internationally agreed concepts, definitions, classifications and accounting rules.

There are four main types of accounts in the SEEA framework. These accounts can be integrated with the existing monetary stock and flow accounts of the SNA:

1. Physical flow accounts;
2. Functional accounts for environmental transactions;
3. Asset accounts in physical and monetary terms; and
4. Ecosystem accounts.

The first three types of accounts form the core of the SEEA and are known as the accounts of the SEEA Central Framework. Ecosystem accounts will be described in a second part of SEEA known as SEEA Experimental Ecosystem Accounts. The four main types of accounts are briefly described below:

Physical flow accounts record flows of natural inputs from the environment to the economy, flows of products within the economy and flows of residuals generated by the economy. These flows include water and energy used in production (e.g. of agricultural commodities) and waste flows to the environment (e.g. solid waste to landfill).

Functional accounts for environmental transactions record the many transactions between different economic units (i.e. industries, households and governments) that concern the environment. The relevant transactions are identified by

first defining the set of environmental activities, i.e. those activities that reduce or eliminate pressures on the environment and that aim to make more efficient use of natural resources. Examples include investing in technologies designed to prevent or reduce pollution, restoring the environment after it has been polluted, recycling, conservation and resource management. Environmental activities are classified as being either environmental protection activities or resource management activities.

Asset accounts in physical and monetary terms measure the natural resources available and changes in the amount available. Asset accounts focus on the key individual components of the environment: mineral and energy resources; timber resources; fish/aquatic resources; other biological resources; soil resources; water resources; and land. They include measures of the stock of each environmental asset at the beginning and end of an accounting period and record the various changes in the stock due to extraction, natural growth, discovery, catastrophic loss and other reasons.

The compilation of asset accounts in physical terms can provide valuable information on resource availability and may help in the assessment of sustainability. A particular feature of the SEEA asset accounts is the estimation of depletion of natural resources in physical and monetary terms. For non-renewable resources the quantity of depletion is equal to the quantity of resource extracted but for renewable resources the quantity of depletion must take into account the underlying population, its size, rate of growth and associated sustainable yield.

Ecosystem accounts are a developing area and not part of the SEEA international statistical standard. Ecosystems are areas containing a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. Ecosystem accounts are structured to summarise information about these areas, their changing capacity to operate as a functional unit and their delivery of benefits to humanity. The benefits received by humanity are known as ecosystem services. They are delivered in different forms and are grouped into three broad categories. The first category of ecosystem services is provisioning services. These are the benefits received from the natural inputs provided by the environment such as water, timber, fish and

energy resources. The second category is regulatory services. These include the benefits provided when an ecosystem operates as a sink for emissions and other residuals, when an ecosystem provides flood mitigation services or when an ecosystem provides pollination services to agriculture. The third category is cultural services. These are the benefits provided when an ecosystem such as a forest, provides recreational, spiritual or other benefits to people.

Each of the different types of accounts is connected within the SEEA framework but each focuses on a different part of the interaction between the economy and the environment. Examples of the relationships between the different accounts include:

1. Asset accounts and ecosystem accounts focus on the stock and changes in the stock of environmental assets, with asset accounts focusing on the individual components and ecosystem accounts focusing on the interactions between these components.
2. Changes in the stock are most often the result of economic activity which in turn is the focus of physical flow accounts. Measurement of flows of natural inputs in the physical supply and use tables is consistent with the measurement of extraction in the asset accounts and the measurement of provisioning services in ecosystem accounts.
3. Measurement of flows of residuals to the environment as recorded in physical supply and use tables is an important consideration in the measurement of ecosystem services, particularly regulatory services.
4. Measures of the flows of natural inputs and residuals can also be related to transactions recorded in functional accounts for environmental protection and resource management, including investment in cleaner technologies and flows of environmental taxes and subsidies. For example, payments for emission permits recorded in functional accounts can be related to the flows of emissions recorded in the physical supply and use tables.

5. The effectiveness of the expenditure for environmental purposes may, ultimately, be assessed by changes in the capacity of ecosystems to continue their delivery of ecosystem services as recorded in ecosystem accounts.
6. These examples serve to highlight the many and varied relationships between the accounts, each taking a different perspective. Throughout the SEEA these relationships are supported by the use of common concepts, definitions and classifications.

VALUATION

One of the most difficult aspects of environmental decision-making is how to make trade-offs between the environmental assets that deliver a range of non-market goods and services, including ecosystem services, against development alternatives for which there are clear economic values. The SNA and the SEEA Central Framework include the value of environmental assets that have direct economic values. For example land, timber, fish, minerals and fossil fuels are included in the national balance sheet. Valuation in the SNA and the SEEA Central Framework is based on market transactions or, where these are unavailable, the net present value of future expected income resulting from the use of these assets is recommended.

However, some environmental assets and many ecosystem services are not transacted in markets, although the value of some services may be included in the value of goods and services traded in markets. For example, the value of pollination is captured in the value of agricultural crop production, while tourism operators derive income from the people visiting natural attractions such as Uluru and the Great Barrier Reef.

The development of standardised methods for identifying and separately distinguishing the value of environmental assets and ecosystem services is an on-going area of work in the SEEA Experimental Ecosystem Accounts. The recognition of the value of these assets and services will provide important information to decision-makers and enable comparisons between different development alternatives.

THE SEEA AS A CO-ORDINATING FRAMEWORK FOR ENVIRONMENTAL-ECONOMIC STATISTICS

The SEEA stands apart from individual sets of environmental statistics in a number of ways. While sets of environmental statistics are usually internally consistent, there is, usually for good reason, often little consistency between one set of statistics and another. Environmental statistics are often collected with a particular regulatory or administrative purpose in mind and the way in which they are structured is specific to this need.

In contrast, the SEEA is an integrated system of accounts in which, to the fullest extent possible, there is consistency between one account and another in terms of concepts, methods, definitions and classifications. In addition, implementation of such an integrated system aims for consistency across time. This is of the utmost importance in developing the comparable time series estimates that are necessary in informing the policy process. The final important difference between environmental statistics and the SEEA is the latter's explicit goal of achieving compatibility with the economic information of the SNA, including that contained within satellite accounts of the SNA. This adds considerable value to both environmental and the economic information, as it facilitates their analysis within a common framework.

The SEEA is different from traditional sets of environmental statistics in important ways, but it also relies upon them for the basic statistics required in its implementation. Ideally, these statistics would be readily available in a format that allowed their direct incorporation into the system. For example, data on air emissions from industrial sources would ideally be classified according to the industrial classification used in the SEEA. This would allow their simple incorporation into physical flow accounts and combined accounts.

It is likely that over time, as the SEEA becomes better known and adopted, there will be changes to the way in which environmental statistics are collected and structured, and in particular the adoption of common classifications and definitions of concepts. For this to occur there must be a spirit of collaboration and respect between those producing environmental accounts and those collecting data. The former group must understand that

collecting data for environmental accounts may be a secondary concern for those responsible for providing information to, for example, a regulatory programme. The latter group must be convinced of the importance of having highly structured and consistent data within an accounting framework. The SEEA can serve as a guiding framework for the development of environmental information systems that are more compatible with economic statistics.

SEEA DEVELOPMENT AND IMPLEMENTATION

The ABS has been working closely with a range of institutions nationally and internationally on the development and implementation of environmental accounting. In Australia, the ABS, the Department of Sustainability, Environment Water, Population and Communities and the Bureau of Meteorology are collaborating on the National Plan for Environmental Information (NPEI), the State of the Environment Report as well as the planning for national environmental accounts. The NPEI is a particularly important initiative as environmental accounts must be underpinned by regular and reliable environmental information. Also at the national level the ABS is working with the Department of Resources Energy and Tourism and the Department of Climate Change and Energy Efficiency on issues relating to the data needed for regular SEEA-based energy and greenhouse gas emissions accounts. At the state level the ABS has worked closely with the Queensland and Victorian governments in developing pilot land accounts, with a view to developing land accounts in other states as resources and data permit. The ABS is also contributing to the development of environmental accounting in the catchment management authorities as well as to research by academics into biodiversity, carbon and ecosystem accounting.

Internationally the ABS has been working with the international statistical community to develop the SEEA, chiefly through the process established by the United Nations Statistical Commission and the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA). The UNCEEA is currently chaired by the ABS and has representatives from the national statistical offices of other countries as well as international agencies - Food and Agricultural Organisation, International

Monetary Fund, Organisation for Economic Cooperation and Development, United Nations Statistics Division, and World Bank.

The development of ecosystem accounts for the SEEA has been a focus of research in recent times. This work is building on the SEEA Central Framework as well as Australian and international experience. For example, the United Kingdom's National Ecosystem Assessment a range of work by the European Environment Agency, the development of the Common International Classification of Ecosystem Services, the Australia Ecosystem Services: Key Concepts and Applications) and others in Australia and elsewhere. Much of this experience has been brought together through a series of international meetings of the Expert Group on Ecosystem Accounts, held most recently in Melbourne 16-18 May 2012. The United Nations Statistical Commission at its 44th session held early in 2013 welcomed the work on SEEA experimental ecosystem accounting as an important first step in developing a statistical framework for ecosystem accounting and requested that the UNCEEA develop a program of further work to progress this topic.

Measurement of environmentally corrected GDP

Definition and methods

Macroeconomic accounting establishes the size of the economy by measuring the Gross Domestic Product. It is called 'gross', because the depreciation and amortisation of capital (deduction of capital expenses over a period of time) has not yet been deducted from it, to yield the National Income. There are three ways of calculating GDP, and all yield the same final number. The first way is to calculate the sum of all revenues or incomes in the economy, wages plus firms' profits plus land rents. The second is to calculate the total expenditures, in consumption and investment. The third method is to count the sum of all 'values added' in the economy, that is the market sales of goods and services minus the costs. When we allow, as we must, for the existence of government, we include its expenditures that are financed by taxes on incomes or on sales. However, notice that one could calculate the GDP of a state-less economy (or with a state

consisting only of one GDP accountant). The GDP must not be confused with the government budget.

There are very small differences between the GDP and the GNP (Gross National Product) that do not concern us here. What is important is that there have been many critiques against GDP accounting from the environmental point of view. As recently as September 2009, President Nicolas Sarkozy addressed the French national statistics agency and requested that the agency give greater consideration to factors such as quality of life and the environment (versus solely relying on GDP's reporting of goods and services marketed) in determining the nation's overall 'health'. In fact, Sarkozy should have referred to previous critiques of national income accounting by the early ecological economists Nicholas Georgescu-Roegen, Roefie Hueting, Herman Daly and René Passet. Even more disgraceful was not to quote Sicco Mansholt, a president of the European Commission who in 1972 wanted to debate GDP growth. Acknowledging the critiques against GDP from the 1960s and 1970s is a matter of intellectual honesty. It also reinforces today's arguments, because one cannot attribute the critique of GDP in Western countries only to sour grapes in the economic crisis of 2008–2009.

Eco-feminist economists (like Marilyn Waring, 1999) have long insisted on the fact that unpaid work (domestic and voluntary work) comprising a large number of hours is not included in the GDP. As Julie Nelson writes in **Ecological Economics** (2009): 'One would search in vain in the most paradigmatic models of economics for any inkling of where the materials used in production came from, or where the detritus from the production process goes. Similarly, one would search in vain … for a discussion of where economic agents come from, or where they go (and who takes care of them) when they are broken or used up.' In other words, economic accounting focuses on production for the market. It forgets the costs of social and environmental reproduction. Along these lines, Jeroen van den Bergh, a leading ecological economist, in 2009 authored an article (its initial title was 'Abolishing GDP') trying to explain why despite 'all theoretically and empirically motivated criticism of GDP as a social welfare and progress indicator, its role in economics, public policy, politics and society continues to be influential'.

In many countries, some economic indicators are deteriorating (or improving), some environmental indicators improving (or deteriorating) and some social indicators improving while others are deteriorating. These should not be added up into a single index. The Human Development Index takes into account social factors apart from GDP but it does not take into account environmental damages. It also correlates closely with GDP per capita. A single convincing economic–social– environmental index does not exist. Therefore, what is needed is a 'political downgrading' of GDP, and the introduction of participatory **multi-criteria assessments** to judge where the macro-economy is going where it should be going (Shmelev and Rodríguez-Labajos, 2009).

UNIT II

EXTERNALITIES

2.1 Introduction

Externalities are unintentional side effects of an activity affecting people other than those directly involved in the activity. A negative externality is one that creates side effects that could be harmful to either the general public directly or through the environment. An example would be a factory that pollutes as a result of its production process. This pollution may pose health risks for nearby residents or degrade the quality of the air or water. Either way, the owner of the factory does not directly pay the additional cost to address any health issues or to help maintain the cleanliness of the air or water. In some cases, however, the harmed parties can use legal measures to receive compensation for damages.

Positive Externality

A positive externality, on the other hand, is an unpaid benefit that extends beyond those directly initiating the activity. One example would be a neighborhood resident who creates a private garden, the aesthetic beauty of which benefits other people in the community. Also, when a group voluntarily chooses to create a benefit, such as a community park, others may benefit without contributing to the project. Any individuals or groups that gain additional benefits without contributing are known as "**free riders**".

Negative Externality

Traditionally, both negative and positive externalities are considered to be forms of market failure - when a free market does not allocate resources efficiently. **Arthur Pigou**, a British economist best known for his work in welfare economics, argued that the existence of externalities justified government intervention through legislation or regulation. Pigou supported taxes to discourage activities that created harmful effects and subsidies for those creating benefits to further encourage those activities. These are now known as **Pigovian taxes and subsidies**.

Many economists believe that placing Pigovian taxes on pollution is a much more efficient way of dealing with pollution as an externality than government imposed regulatory standards. Taxes leave the decision of how to deal with pollution to individual

sources by assessing a fee or "tax" on the amount of pollution that is generated. Therefore, in theory, a source that is looking to maximize its profit will reduce, or control, their pollution emissions whenever it is cheaper to do so.

Other economists believe that the most efficient solution to externalities is to include them in the cost for those engaged in the activity. Thus, the externality is "internalized." Under this framework externalities are not necessarily market failures, which weaken the case for government intervention. Many externalities (pollution, free rider benefits) can be internalized through the creation of well-defined **property rights**. Through much of his work, economist **Ronald Coase** showed that taxes and subsidies were typically not necessary as long as the parties involved could strike a voluntary bargain. According to **Coase's theorem,** it does not matter who has ownership, so long as property rights exist and free trade is possible.

Two methods of controlling negative externalities loosely related to property rights include **cap and trade** and **individual transferable quotas** (ITQs). The cap and trade approach sets a maximum amount of emissions for a group of sources over a specific time period. The various sources are then given emissions allowances which can be traded, bought or sold, or banked for future use, but - over the course of the specified period of time - overall emissions will not exceed the amount of the cap and may even decline. Therefore, individual sources, or facilities, can determine their level of production and/or the application of pollution reduction technologies or the purchase of additional allowances.

Individual transferable quotas are a market-based solution that is often used to manage fisheries. Regulators first determine a total annual catch that will preserve the health of the ecosystem, and then it is divided into individual quotas to prevent over-fishing. Each ITQ allows for a certain amount of fish to be caught in any given year. ITQs are transferable, which allows fishing vessel owners to buy and sell their quotas depending on how much they want to catch. The ITQ program also tries to create a commercial fishing industry that is more stable and profitable.

The options for dealing with externalities - positive or negative - are numerous, and often depend on the type of externality. The key is to identify the particular tool or

policy alternative that will best move the market toward the most efficient allocation of resources.

2.2 Market Efficiency

Situation where resources cannot be efficiently allocated due to the breakdown of price mechanism caused by factors such as establishment of monopolies. See also market inefficiency.

A **market failure** occurs when the supply of a good or service is insufficient to meet demand. This results in an inefficient distribution of resources among market participants.

How it works/Example:

Under free market conditions, prices are determined almost exclusively by the forces of supply and demand. Any shift in one of these results in a price change that signals a corresponding shift in the other. Then, the prices return to an equilibrium level. A market failure results when prices cannot achieve equilibrium because of market distortions (for example, minimum wage requirements or price limits on specific goods and services) that restrict economic output. In other words, government regulations implemented to promote social wellbeing inevitably result in a degree of market failure.

Why it Matters:

Economic and social policymakers try to consider the market failures that will result from specific legislation, and, in most cases, they ultimately attempt to minimize market failure by finding a balance between protecting social (or political) interests and maintaining efficient markets.

Market failure happens when the price mechanism **fails to allocate scarce resources efficiently** or when the operation of market forces lead to a **net social welfare loss**

Market failure exists when the competitive outcome of markets is not satisfactory from the point of view of society. What is satisfactory nearly always involves **value judgments**.

Complete and partial market failure

- **Complete market failure** occurs when the market simply does not supply products at all - we see "missing markets"
- **Partial market failure** occurs when the market does actually function but it produces either the wrong quantity of a product or at the wrong price.

Markets can fail for lots of reasons

1. **Negative externalities** (e.g. the effects of environmental pollution) causing the social cost of production to exceed the private cost
2. **Positive externalities** (e.g. the provision of education and health care) causing the social benefit of consumption to exceed the private benefit
3. **Imperfect information** or **information failure** means that merit goods are under-produced while demerit goods are over-produced or over-consumed
4. The private sector in a free-markets cannot profitably supply to consumers **pure public goods** and **quasi-public goods** that are needed to meet people's needs and wants
5. **Market dominance by monopolies** can lead to under-production and higher prices than would exist under conditions of competition, causing consumer welfare to be damaged
6. **Factor immobility** causes unemployment and a loss of productive efficiency
7. **Equity (fairness) issues**. Markets can generate an 'unacceptable' distribution of income and consequent social exclusion which the government may choose to change

Types of market failure

1. **Positive externalities** – Goods / services which give benefit to a third party, e.g. less congestion from cycling
2. **Negative externalities** – Goods / services which impose cost on a third party, e.g. cancer from passive smoking
3. **Merit goods** – People underestimate the benefit of good, e.g. education
4. **Demerit goods** – People underestimate the costs of good, e.g. smoking

5. **Public Goods -** Goods which are non-rival and non-excludable – e.g. police, national defence.
6. **Monopoly Power** – when a firm controls the market and can set higher prices.
7. **Inequality** – unfair distribution of resources in free market
8. **Factor Immobility** – E.g. geographical / occupational immobility
9. **Agriculture** – Agriculture is often subject to market failure – due to volatile prices and externalities.

Key Terms in Market Failure

1. **Externalities**: These occur when a third party is affected by the decisions and actions of others.
2. **Social benefit**: is the total benefit to society =
3. Private Marginal Benefit (PMB) + External Marginal Benefit (XMB)
4. **Social Cost**: is the total cost to society =
   Private Marginal Cost (PMC) + External Marginal Cost (XMC
5. **Social Efficiency**: This occurs when resources are utilised in the most efficient way. This will occur at an output where social marginal cost (SMC) = Social Marginal Benefit. (SMB)

Overcoming Market Failure

1. Tax on Negative Externalities – e.g. Petrol tax
2. Carbon Tax e.g. tax on CO2 emissions
3. Subsidy on positive externalities – why government may subsidies public transport
4. Laws and Regulations – Simple and effective ways to regulate demerit goods, like ban on smoking advertising.
5. Buffer stocks – aim to stabilise prices
6. Government failure – why government intervention may not always improve the situation.

Causes of market failure

Some of the major causes of market failure are: 1. Incomplete markets, 2. Indivisibilities, 3. Common Property Resources, 4. Imperfect Markets, 5. Asymmetric Information, 6. Externalities, 7. Public Goods 8. Public Bads.

In the real world, there is non-attainment of Pareto optimality due to a number of constraints in the working of perfect competition. An important cause of environmental degradation is market failure. It means poor functioning of markets for environmental goods and services. It reflects failure of government policy in removing market distortions created by price controls and subsidies.

1. Incomplete markets

Markets for certain things are incomplete or missing under perfect competition. The absence of markets for such things as public goods and common property resources is a cause of market failure. There is no way to equate their social and private benefits and costs either in the present or in the future because their markets are incomplete or missing.

2. Indivisibilities

The Paretian optimality is based on the assumption of complete divisibility of products and factors used in consumption and production. In reality, goods and factors are not infinitely divisible. Rather, they are indivisible. The problem of divisibility arises in the production of those goods and services that are used jointly by more than one person.

An important example is of road in a locality. It is used by a number of persons in the locality. But the problem is how to share the costs of repairs and maintenance of the road. In fact, very few persons will be interested in its maintenance. Thus marginal social costs and marginal social benefits will diverge from each other and Pareto optimality will not be achieved.

3. Common Property Resources

Another cause of market failure is a common property resource. Common ownership when coupled with open access, would also lead to wasteful exploitation in

which a user ignores the effects of his action on others. Open access to the commonly owned resources is a crucial ingredient of waste and inefficiency.

Its most common example is fish in a lake. Anyone can catch and eat it but no one has an exclusive property right over it. It means that a common property resource is non-excludable (anyone can use it) and non-rivalrous (no one has an exclusive right over it). The lake is a common property for all fishermen.

When a fisherman catches more fish, he reduces the catch of other fishermen. But he does count this as a cost, yet it is a cost to society. Because the lake is a common property resource where there is no mechanism to restrict entry and to catch fish. The fisherman who catches more fish imposes a negative externality on other fishermen so that the lake is overexploited.

This is called the tragedy of the commons which leads to the elimination of social gains due to the overuse of common property. Thus when property rights are common, indefinite or non-existent, social costs will be more than private costs and there will not be Pareto Optimality.

4. Imperfect Markets

Pareto efficiency increases under perfect competition. But it declines under market distortions or imperfections. Let us consider a case of monopoly. Initially, monopoly equilibrium is at point E where the private marginal cost curve, PMC, cuts the marginal revenue curve, MR, from below.

The monopolist produces OQ_1 output at OP_1 price. But the production process generates smoke in the air. Therefore, the pollution board levies a tax equal to TE on the monopoly firm. The imposition of a pollution tax is, in fact, a fixed cost to the monopoly firm. Now the social marginal cost curve cuts the marginal revenue curve at point e.

The monopolist increases the price of his product from OP_1 to OP_2 and restricts output to OQ_2 and thereby reduces consumers' surplus to $Q_2\,MLQ_1$ (= $OQ_1\,LP_1 - OQ_2\,MP_2$). In fact, $Q_2\,MLQ_1$ is the social cost of OQ_2 output. But the net loss to society is $Q_2\,MLQ_1 - TE$= eMLT, the shaded area in the figure. 1.4

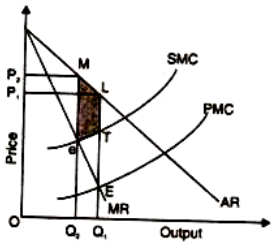


FIGURE 18.1 : (IMPERFECT MARKETS)

Figure 1.4

5. Asymmetric Information

Pareto optimality assumes that producers and consumers have perfect information regarding market behaviour. But according to Joseph Stiglitz, "In the real world, there is asymmetric (incomplete) information due to ignorance and uncertainty on the part of buyers and sellers. Thus they are unable to equate social and private benefits and costs."

Suppose a producer introduces a new antipollution device in the market. But it is very difficult for him to predict the current demand of his product. On the other hand, consumers may be ignorant about quality and utility of this anti-pollution device. In some cases, information about market behaviour in the future may be available but that may be insufficient or incomplete. Thus market asymmetries, fail to allocate efficiently.

6. Externalities

The presence of externalities in consumption and production also lead to market failure. Externalities are market imperfections where the market offers no price for service or disservice. These externalities lead to malallocation of resources and cause consumption or production to fall short of Pareto optimality.

Externalities, lead to the divergence of social costs from private costs, and of social benefits from private benefits. When social and private costs and social and private benefits diverge, perfect competition will not achieve Pareto optimality.

Because under perfect competition private marginal cost (PMC) is equated to private marginal benefit (i.e. the price of the product). We discuss below how external economies and diseconomies of consumption and production affect adversely the allocation of resources and prevent the attainment of Pareto optimality.

Positive Externalities of Production

According to Pigou, when some firm renders a benefit or cost of a service to other firms without appropriating to itself all the benefits or costs of his service, it is an external economy of production. External economies of production accrue to one or more firms in the form of reduced average costs as a result of the activities of another firm.

In other words, these economies accrue to other firms in the industry with the expansion of a firm. They may be the result of reduced input costs which lead to pecuniary external economies. Whenever external economies exist, social marginal benefit will exceed private marginal benefit and private marginal cost will exceed social marginal cost.

This is illustrated in Figure 1.5 where PMC is the private marginal cost curve or supply curve of firms. The demand curve D intersects the PMC curve at point E and determines the competitive market price OP and output OQ.

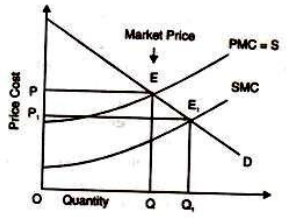


FIGURE. 18.2 : (POSITIVE EXTERNALITIES OF PRODUCTION)

Figure 1.5

SMC is the social marginal cost curve which intersects the demand curve D at point E_1 and determines the social optimum output level OQ_1 at price OP_1. Since for every unit of output between OQ and OQ_1 social marginal cost (OP_1) is less than the competitive market price OP, its production involves a net social gain equal to QQ_1.

Negative Externalities of Production:

When the production of a commodity or service by a firm affects adversely other firms in the industry, social marginal cost is higher than social marginal benefit. Suppose, a factory situated in a residential area emits smoke which affects adversely health and household articles of the residents.

In this case, the factory benefits at the expense of residents who have to incur extra expenses to keep themselves healthy and their households clean. These are social marginal costs because of harmful externalities which are higher than private marginal cost and also social marginal benefit.

This is illustrated in Fig. 1.6 where the PMC curve which intersects the D curve at point E and determines the competitive price OP and output OQ. But the socially optimum output is OQ_1 and price is OP_1, as determined by the intersection of SMC and D curve at point E_1.

Thus the firms are producing Q_1 Q more than the social optimal output OQ_1. In this case, for every unit between Q_1 and Q, social marginal cost (SMC) is more than the competitive market price OP. Thus its production involves a social loss i.e.. $OQ - OQ_1 - QQ_1$.

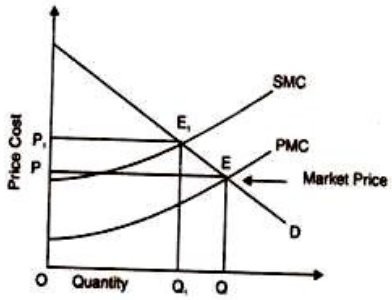


FIGURE 18.3 : (NEGATIVE EXTERNALITIES OF PRODUCTION)

Figure 1.6

Positive Externalities in Consumption

Externalities in Consumption lead to non-attainment of Pareto optimality. External economies of consumption arise from non-market interdependences of the satisfactions enjoyed by different consumers. An increase in the consumption of a good or service which affects favourably the consumption patterns and desires of other consumers is an external economy of consumption.

When an individual installs a TV set, the satisfaction of his neighbours increases because they can watch TV programmes free at his place. Here social benefit is larger and social cost is lower than the private benefit and cost. But the TV owner is likely to

use his TV set to a smaller extent than the interests of society require because of the inconvenience and nuisance caused by his neighbours to him.

Negative Externalities in Consumption

Negative externalities in consumption arise when the consumption of a good or service by one consumer leads to reduced utility (dissatisfaction or loss of welfare) of other consumers. Negative externalities in consumption arise in the case of fashions and articles of conspicuous consumption which reduce their utility to some consumers. For example, smokers cause disutility to non-smokers, and noise nuisance from stereo systems to neighbours etc. Such diseconomies of consumption prevent the attainment of Pareto optimality.

Suppose there are two room-mates A and B. Individual A likes to smoke while individual B likes clean air. Further, B's utility of consuming clean air is affected by individual A's smoking. This is explained in terms of Figure 1.7 (A) & (B). Initially, individual A's utility from smoking gives him 50 utilis at point A while individual B's consumption of clean air gives him 80 utilis at point B. When there are no externalities in consumption, the tangent at point A and point B are parallel to each other.

If individual A smokes at his leisure then his utility increases to 60 utilis and he moves to point E. The effect of individual A's smoking reduces the utility of clean air to individual B who moves from point B to point F on the same utility curve.

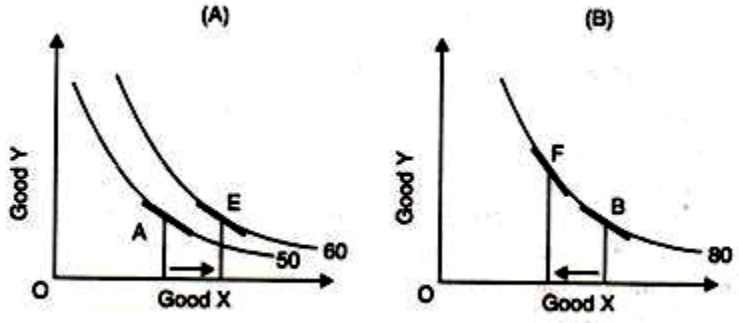


Figure 1.7

Individual A has moved on a higher utility curve from 50 to utility curve 60, but the non-smoker is on the same utility curve 80. Thus Pareto optimality is not attained because the utility of one consumer (smoker) A has increased whereas the utility level of the other consumer (non-smoker) B has been reduced.

7. Public Goods

Another cause of market failure is the existence of public goods. A public good is one whose consumption or use by one individual does not reduce the amount available for others. An example of a public good is water which is available to one person and is also available to others without any additional cost. Its consumption is always joint and equal.

It is non-excludable if it can be consumed by anyone. It is non-rivalrous if no one has an exclusive rights over its consumption. Its benefits can be provided to an additional consumer at zero marginal cost. Thus public goods are both non-excludable and non-rivalrous. Moreover, environmental quality is generally considered as a public good and when it is valued at market price, it leads to market failure.

The Paretian condition for a public good is that its marginal social benefit (MSB) should equal its marginal social cost (MSC). But the characteristics of a public good are such that the economy will not reach a point of Pareto optimality in a perfectly competitive market. Public goods create externalities.

The externality starts when the marginal cost of consuming or producing an additional unit of a public good is zero but a price above zero is being charged. This violates the Paretian welfare maximization criterion of equating marginal social cost and marginal social benefit. This is because the benefits of a public good must be provided at a zero marginal social cost.

Suppose potable water is supplied by the municipal corporation. There are two individuals A and B who use it. Both consume the same quantity of water. But they differ in how much they are willing to pay for any given quantity.

This is illustrated in Figure 1.8. where D_a and D_b are the demand curves of two individuals A and B respectively. Therefore, demand prices are OP_a and OP_b

corresponding to a given quantity OW of water. The curve ΣD is the vertical summation of D_a and D_b curves.

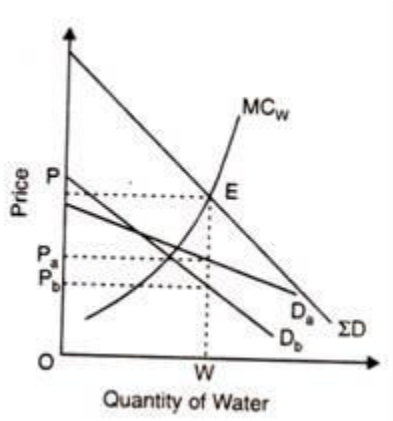


Figure 1.8

The Lindhal equilibrium for a public good exists where the sum of the individual prices equal marginal cost. Therefore,

$$OP = OP_a + OP_b = MC_W$$

But each consumer is being charged a different price. This is a case of price discrimination because price OP_a is greater than price OP_b for the same quantity of water OW. Hence there is market failure.

8. Public Bads

There are also public bads in which one person experiencing some disutility does not diminish the disutility of another, such as air and water pollution. Public goods and public bads cannot be handled by the institution of private property. K.E. Boulding has explained public bads with the following example: "If someone drives his car into my living room and pollutes it, I can sue him for damages. This is a private bad. But if someone congests the roads or pollutes the air, however, there is not much I can do about it as an individual. This is public bad."

Market failure is a necessary but not a sufficient condition for intervention. To be truly worthwhile, a government intervention must outperform the market or improve its functions. Second, the benefits from such intervention must exceed the costs of planning,

implementation, and enforcement, as well as any indirect and unintended costs of distortions introduced to other sectors of the economy by such intervention.

2.1.1 CONCEPT OF MARKET FAILURE

In economics, **market failure** is a situation in which the allocation of goods and services is not efficient. That is, there exists another conceivable outcome where an individual may be made better-off without making someone else worse-off. (The outcome is not Pareto optimal.) Market failures can be viewed as scenarios where individuals' pursuit of pure self-interest leads to results that are not efficient – that can be improved upon from the societal point of view. The first known use of the term by economists was in 1958, but the concept has been traced back to the Victorian philosopher Henry Sidgwick.

Market failures are often associated with time-inconsistent preferences, information asymmetries, non-competitive markets, principal–agent problems, externalities, or public goods. The existence of a market failure is often the reason that self-regulatory organizations, governments or supra-national institutions intervene in a particular market. Economists, especially micro economists, are often concerned with the causes of market failure and possible means of correction. Such analysis plays an important role in many types of public policy decisions and studies. However, government policy interventions, such as taxes, subsidies, bailouts, wage and price controls, and regulations (including poorly implemented attempts to correct market failure), may also lead to an inefficient allocation of resources, sometimes called government failure.

Given the tension between, on the one hand, the undeniable costs to society caused by market failure, and on the other hand, the potential that attempts to mitigate these costs could lead to even greater costs from "government failure," there is sometimes a choice between imperfect outcomes, i.e. imperfect market outcomes with or without government interventions. But either way, if a market failure exists the outcome is not Pareto efficient. Most mainstream economists believe that there are circumstances (like building codes or endangered species) in which it is possible for government or other

organizations to improve the inefficient market outcome. Several heterodox schools of thought disagree with this as a matter of principle.

Categories

Different economists have different views about what events are the sources of market failure. Mainstream economic analysis widely accepts a market failure (relative to Pareto efficiency) can occur for three main reasons: if the market is "monopolised" or a small group of businesses hold significant market power, if production of the good or service results in an externality, or if the good or service is a "public good".

Private Cost and Social Cost

Private Cost

Private cost refers to the cost of production incurred and provided for by an individual firm engaged in the production of a commodity. It is found out to get private profits.

This cost has nothing to do with the society. It includes both explicit as well as implicit cost. A firm is interested in minimising private cost.

Social Cost

Social cost refers to the cost of producing a commodity to the society as a whole. It takes into consideration all those costs, which are borne by the society directly or indirectly. Social cost is not borne by the firm. It is rather passed on to persons not involved in the activity in the direct way. Social cost is a much broader concept.

It is found out to get social profits rather than private profits. The production of a commodity by a firm generates advantages (benefits) as well as disadvantages (cost) to other members of society, called external benefits and external costs respectively.

These benefits are available free of cost. For instance, to facilitate easier movement of raw materials and finished products, a producer constructs a road, linking it with a highway. This road may be used by others, who will not pay for the benefits derived. On the similar lines, no producer compensates others for the costs incurred to them as a result of his production.

Water pollution caused by the disposal of wastes into a river (or sea) or air pollution and consequent health hazards by the smoke generation by factories or buses plying in big cities are some other examples.

Noise pollution and accident proneness are some other social costs due to rising traffic in big cities. While computing social costs, market prices of goods and factor of production are adjusted as social and shadow prices.

Social cost is the sum of private cost and external cost. Alternatively, external cost is the difference between social cost and private cost, which may be positive or negative. If social cost is more than private cost, there is an external cost (or. negative externality). On the other hand, if social cost is less than private cost, there is an external benefit (or positive externality).

Social cost is an important concept. Knowledge of social cost and social benefit is extremely important in the efficient utilisation of limited resources. The concept of social cost can be linked with opportunity cost to which we now turn.

Social cost

Social cost in economics may be distinguished from "private cost". Economic theorists model individual decision-making as measurement of costs and benefits. Social cost is also considered to be the private cost plus externalities. Rational choice theory often assumes that individuals consider only the costs they themselves bear when making decisions, not the costs that may be borne by others.

With pure private costs, the costs carried by the individuals involved are the only economically meaningful costs. The choice to purchase a glass of lemonade at a lemonade stand has little consequence for anyone other than the seller or the buyer. The costs involved in this economic activity are the costs of the lemons and the sugar and the water that are ingredients to the lemonade, the opportunity cost of the labour to combine them into lemonade, as well as any transaction costs, such as walking to the stand.

Theory

The ideas of social cost, externalities, and market failure are often used as an argument for government intervention in the form of regulations. Libertarians who believe in a free market respond that the existence of market failure should not lead to

government intervention, as they suspect that the proposed solution will itself be vulnerable to government failure. They prefer to rely on tradition, community pressure, and dollar voting.

Negative externalities (external costs) lead to an over-production of those goods that have a high social cost. For example, the logging of trees for timber may result in society losing a recreation area, shade, beauty, good quality soil to grow crops on, and air quality but this loss is usually not quantified and included in the price of the timber that is made from the trees. As a result, individual entities in the marketplace have no incentive to factor in these externalities. More of this activity is performed than would be if its cost had a true accounting.

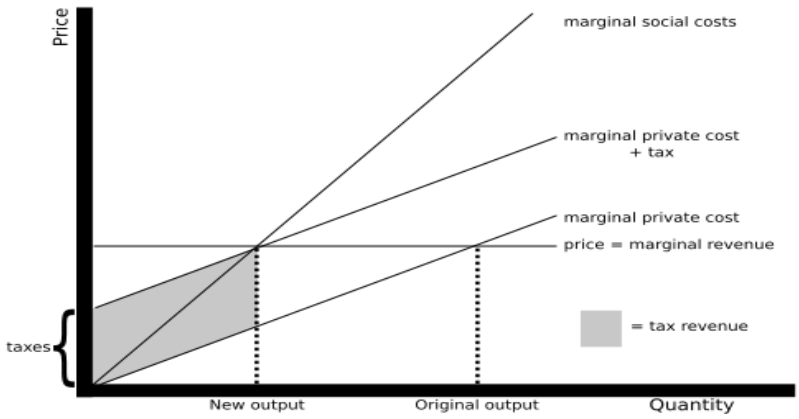


Figure 1.9

This can be illustrated with a diagram. Profit-maximizing organizations will set output at $\mathbf{Q_p}$ where marginal private costs (**MPC**) is equal to marginal revenue (**MR**). (This diagram assumes perfect competition, under which price (**P**) equals **MR**.) This will yield a profit shown by the triangular area **0**,**C**,**F**.

But if externalities are present, the attainment of social optimality requires that the full social costs must be considered. The socially optimum level of output is $\mathbf{Q_s}$ where marginal social costs (**MSC**) or referred to as the Marginal Social Damage(**MSD**) is equal to marginal revenue (**MR**). The amount of output, $\mathbf{Q_p}$ minus $\mathbf{Q_s}$, indicates the

excess output due to the externality. Profits will decrease also, from **0**,**C**,**F** to **0**,**A**,**F**. It is clearly profitable for the firm to pollute, since "internalizing the externality" hurts profits. The amount of the externality will decrease from **C**,**D** to **B**,**A**.

Because the marginal social cost curve (**MSC**) is above the marginal private cost curve (**MPC**), this diagram illustrates the case of a negative externality. If the marginal social cost curve was below the marginal private cost curve, it would be a positive externality and social optimality would require a greater output than $\mathbf{Q_p}$ rather than a reduction of output.

Institutional ecological economists in the tradition of Karl William Kapp provide a different definition of social costs, i.e. that share of the total costs of production that is not born by producers but is shifted to 3rd parties, future generations or society at large. Kapp, hence, rejected Pigou's confusing terminology of externalities and provides several hundred pages of empirical data to support his argument that social costs are systemic, i.e. rooted in profit maximizing behavior of businesses, and an enormous problem of modern civilization. In the real world, they are usually not or cannot be internalized and must not be considered as accidental minor aberration from the "optimal norm" that can be fixed with ad hoc measures proposed by Pigou or Coase. Kapp proposes to prevent damages ex ante via precautionary regulations that reflect socially determined safety standards, instead of ex post via monetary schemes like taxation (e.g. Pigou) or bargaining (e.g. Coase).

The difference between private and social costs

This is an important distinction to understand. Private costs to firms or individuals do not always equate with the total cost to society for a product, service, or activity. The difference between private costs and total costs to society of a product, service, or activity is called an external cost; pollution is an external cost of many products. External costs are directly associated with producing or delivering a good or service, but they are costs that are not paid directly by the producer. When external costs arise because environmental costs are not paid, market failures and economic inefficiencies at the local, state, national, and even international level may result.

Let's start by defining private costs, external costs, and social costs. Next, we will briefly examine the impact external costs can have on prices, production, resource allocation, and competition.

Key Concepts

Private Costs + External Costs = Social Costs

If external costs > 0, then private costs < social costs

Then society tends to:

– Price the good or service too low, and

– Produces or consumes too much of the good or service.

Different Costs Matter

Private costs for a producer of a good, service, or activity include the costs the firm pays to purchase capital equipment, hire labor, and buy materials or other inputs. While this is straightforward from the business side, it also is important to look at this issue from the consumers' perspective. Field, in his 1997 text, Environmental Economics provides an example of the private costs a consumer faces when driving a car:

The private costs of this (driving a car) include the fuel and oil, maintenance, depreciation, and even the drive time experienced by the operator of the car.

Private costs are paid by the firm or consumer and must be included in production and consumption decisions. In a competitive market, considering only the private costs will lead to a socially efficient rate of output only if there are no external costs.

External costs, on the other hand, are not reflected on firms' income statements or in consumers' decisions. However, external costs remain costs to society, regardless of who pays for them. Consider a firm that attempts to save money by not installing water pollution control equipment. Because of the firm's actions, cities located down river will have to pay to clean the water before it is fit for drinking, the public may find that recreational use of the river is restricted, and the fishing industry may be harmed. When external costs like these exist, they must be added to private costs to determine social costs and to ensure that a socially efficient rate of output is generated.

Social costs include both the private costs and any other external costs to society arising from the production or consumption of a good or service. Social costs will differ

from private costs, for example, if a producer can avoid the cost of air pollution control equipment allowing the firm's production to imposes costs (health or environmental degradation) on other parties that are adversely affected by the air pollution. Remember too, it is not just producers that may impose external costs on society. Let's also view how consumers' actions also may have external costs using Field's previous example on driving.

The social costs include all these private costs (fuel, oil, maintenance, insurance, depreciation, and operator's driving time) and also the cost experienced by people other than the operator who are exposed to the congestion and air pollution resulting from the use of the car.

The key point is that even if a firm or individual avoids paying for the external costs arising from their actions, the costs to society as a whole (congestion, pollution, environmental clean up, visual degradation, wildlife impacts, etc.) remain. Those external costs must be included in the social costs to ensure that society operates at a socially efficient rate of output.

Market Failure and Property Rights

At the microeconomic level, a market allocation of resources solves the problem of scarcity in market economies. However the price mechanism rarely allocates environmental goods in an optimal manner because prices do not always reflect the true costs of using environmental resources.

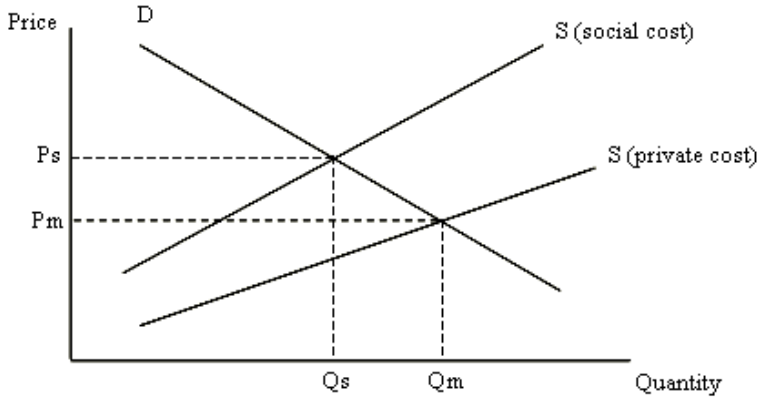


Figure 1.11

Market Failure Diagram

The societal supply curve takes into account all costs of production including environmental costs such as air pollution. It is above the private (producer's) supply curve, meaning that the 'socially optimum' price level (Ps) is above the market price (Pm), and the 'socially optimum' quantity (Qs) is below the market quantity (Qm). This clearly shows that the free market undervalues the environment and overexploits natural resources.

There is a distinction to be drawn here between private costs and benefits, and social costs and benefits of production and consumption.

- Private costs refer to the expenditure incurred by producers in using resources to produce output or the costs incurred by consumers in giving up a part of their money income in buying goods and services.
- Private benefits include the profits made by producers in selling goods and services or the utility gained by consumers from consuming goods and services to satisfy needs and wants.
- Social costs refer to the costs imposed or borne y society as a result of private actions. For example, the pollution caused by private production such as industrial output may be borne by the surrounding community. Markets do not exist for some environmental resources such as clean air or water and property rights for the use of environmental goods are not well defined or may be absent. The price mechanism cannot function without the use of a system of property rights. Property rights give individuals the right of usage and/or ownership over certain resources. They allow market exchange to occur because of three important features:
- Excludability – The owner of a property right has the right to exclude others from enjoying the benefits of using the property.
- Transferability – Property rights are marketable and can be traded in a market.
- Enforceability – Property rights are legally binding and courts can settle disputes and impose penalties on those who violate others property rights.

  The problem that arises with many environmental goods, especially common property, is a lack of well defined property rights.

Externalities, Social Cost and Private Costs

Externalities

Private costs are what they say – the costs incurred when producing something. Social costs are greater than private costs. Social costs include things like pollution and congestion that are suffered by society in general, not by any one producer.

These problems are called "externalities" i.e., they are external to the firm producing them. They can be negative externalities (which harm society) or positive externalities (which help).

Social cost = private cost + externality (if any)

Cost-benefit analysis tries to measure all the costs to society of a project.

A new tube line in London may never run at a private profit but still generate large savings elsewhere. For example, the new line might reduce motorcar use, reduce congestion, speed up traffic flow, and save people's time. The Victoria line, built 1968-71, was established knowing it would lose money - but the social benefits were so great.

We have a diagram for social costs:

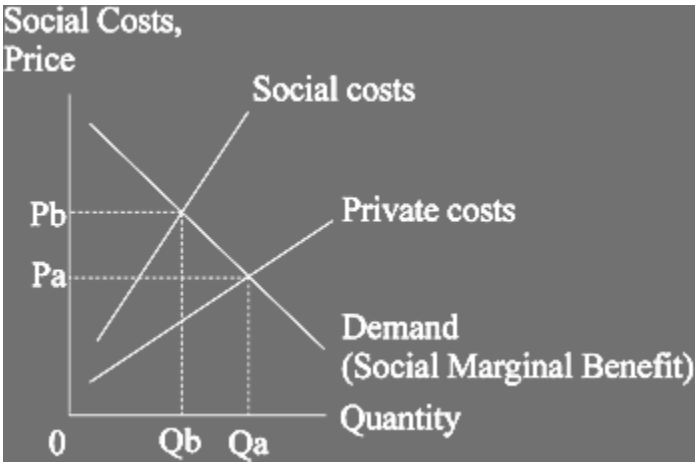


Figure 1.12

Equilibrium will be where private costs cut the demand curve at Qa, as firms try to maximise profits and charge price OP_a for quantity OQ_a.

But because of negative externalities (pollution maybe), the socially optimum position should be where social costs cut the demand curve. These would mean

producing at Qb, reading from the social costs curve, and selling at the higher price OPb to cover these costs.

To draw the diagram for positive externalities: just reverse the labelling of the curves of social cost and private costs above. This is done in the diagram below where you can see that we produce too little for society if firms profit maximise for themselves (as they do). They choose to produce at OQa and sell for a price of OPa, but for the greatest good of society they should be at OQb and selling at the lower price of OPb.

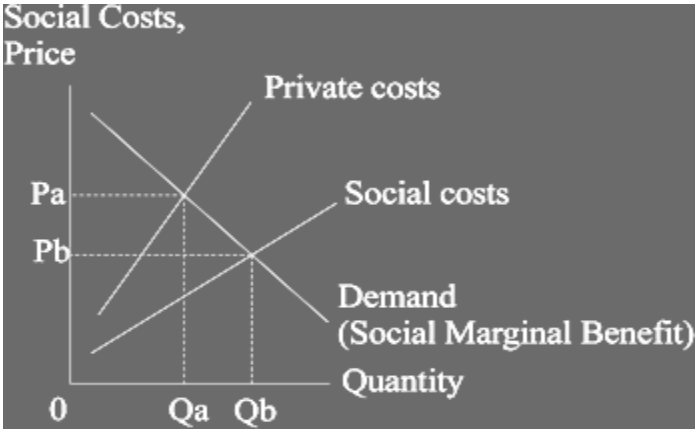


Figure 1.13

Government intervention may be necessary to correct or offset market failure caused by negative externalities – usually the government chooses to tax those producing too much, or they may use the law to prosecute for water pollution or whatever externality the government is tackling.

There are probably fewer cases of external benefits, but if we find any (such as private firms training labour well) we can encourage this by tax breaks or subsidies.

Government action with external diseconomies

Government might try (and does):

1. Taxation.
2. Regulation.
3. Perhaps extending property rights.

Let's think about polluters – what can the government do using the three points above?

a) Taxing polluters

The need is to try to stop the problem being "external" and try to "internalise" it, i.e., to make the polluter pay for it via a tax. As economists, what we are really doing is trying to get the firm to stop looking only at the private costs and benefits. In the diagram below, we do this by putting a tax on, which shifts the supply curve up from "S Private costs" to "Private costs + tax". If we get it right, this moves the equilibrium quantity produced from Qa to the smaller output Qb.

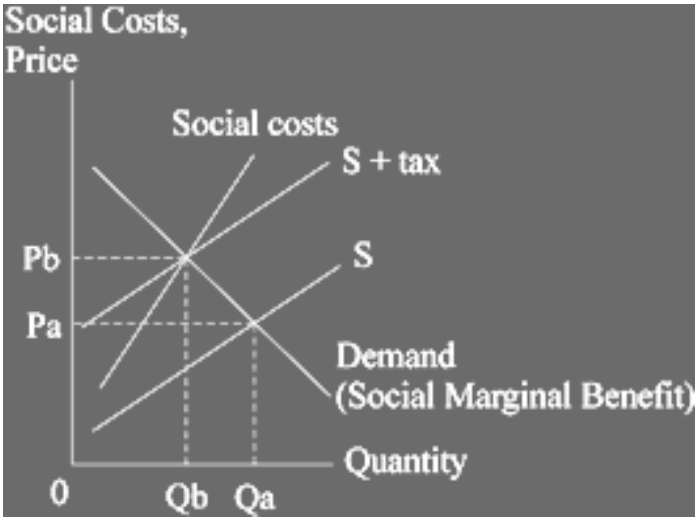


Figure 1.14

In the UK, we now have a Landfill Tax (since October 1996) to encourage recycling. Landfill operators have to pay a tax to the government. It was introduced at the rate for inactive waste, which is easy to deal with, of £2 a ton and other waste at £10 per ton. These amounts might increase shortly.

But there are problems with taxing polluters:

1. When it works, output is reduced and prices are higher – but this can reduce the consumer surplus, which some feel is not a good thing (Unit 4 looks at this concept).
2. It is often hard to identify the particular firms that are causing the pollution, and then determine how much each is responsible for the total pollution.

3. Poor legislation can hurt the innocent, e.g. households who wish to get rid of large items of waste may not be allowed to take them to the dump.
4. It is not easy to put a monetary figure on the damage pollution is causing.
5. Producers can pass on much of the tax to consumers if demand is inelastic and not pay it themselves.
6. Taxes on demerit goods (to limit their consumption) can be regressive, i.e., hit poor households the hardest. The tax on cigarettes does this because the poor are statistically more likely to smoke than the wealthier.
    a. In the UK, the government quite regularly increases duty on petrol, & tax on cigarettes.
    b. b) Regulating polluters approach (a second way that can be used in addition to tax)
7. Banning cigarette advertising at sporting events, or in places like cinemas.
8. Making workplaces no-smoking areas.
9. Increasing the penalties for firms that break the regulations.
    a. c) Extending property rights (a third way that can be used)

If a lorry crashes into your garden and destroys the wall and all your trees you can get compensation – but if a polluting factory puts out acid smoke and destroys the same trees you cannot.

If we extend property rights so you could sue for compensation, it would make the polluter think again and perhaps install anti-smoke devices on factory chimneys!

Benefits

1. The property owner knows the value of the property better than the government does, so the figures will probably be more accurate (but owners can, and perhaps would, lie!).
2. The polluter is forced to pay those suffering from his or her activities.

Disadvantages

3. The damage may occur abroad, e.g., German acid rain destroys East European forests – but it is next to impossible to enforce law across borders!

4. Global interests and national interests may conflict. The UK cannot make Brazil extend property rights over Brazilian trees which are being killed off at a rapid rate, yet the world might feel the destruction of the Amazon rain forest is wrong.

Trading permits to pollute

Many believe that it is so difficult and expensive to stop companies polluting (identifying who did it can be impossible e.g., with one stream and dozens of factories discharging into it) that instead we should auction off the right to pollute. Only those firms that pay a high price for the limited number of licences would be allowed to pollute. The government could then use the large sum of money raised to tackle the pollution itself. The end result could be much better than we currently have!

If we allow a firm to sell its right to pollute (it may have used only 80 per cent of what it is permitted, for example) then those with the greatest demand for their product, and hence the most profitable, can buy the remaining 20 per cent. It means the things we most desire still get produced but the government has the resources to tackle the resulting pollution.

Yet many think it is morally wrong to allow permits to pollute at all! Singapore uses such permits for ozone-depleting substances. The Kyoto Summit on Climate Change (Dec. 1997) saw a move towards such permits as being an improvement at least! But the United States and Russia refuse to ratify this. In September 2004, President Putin of Russia agreed to it, but it still has to go before the Russian Parliament.

2.3 Property Rights

Unsustainable agricultural practices commonly take place where those involved have limited or no property or user rights to the resources they are overexploiting. The awarding of secure rights, whether individual or communal, would greatly increase their vested interest in improving resource management and investing in soil conservation and other land improvements. Property rights have a wider institutional dimension relating to the efficiency of markets and the management of public goods. Environmental trade-offs are also not minimized in situations when the institutions controlling public goods have collapsed, or because markets are not able to value public goods such as fresh air, or to cost public "bads" such as pollution. Markets must be made to work better by defining

property rights more precisely and establishing or strengthening the institutions to manage them; introducing realistic prices for environmental goods such as water; and attempting to cost public "bads" and adopting "the polluter pays principle" where this is appropriate.

The international dimension

This dimension is particularly important given that much of the mismanagement of natural resources in developing countries relates to poverty and to the lack of economic growth to provide better and sustainable livelihoods outside subsistence agriculture. Minimizing the tradeoffs needs a global economic environment that is more conducive to growth so that the developing countries can significantly increase gainful employment outside agriculture. This is critically important for those arid, highland and land-locked countries with predominantly marginal land which tend to suffer from high transport costs for off-farm inputs like mineral fertilizers and/or poor inherent biological productivity. Therefore, any policies which affect the development prospects of the developing countries via the link of the international economic environment are of direct importance to the objective of minimizing the environment-development trade-offs. Here belong the issues of trade, debt and resource flows. Some of these issues are discussed in other chapters and the discussion is not repeated here.

Of particular interest is the extent to which environmental pressures are transmitted among countries by means of the agricultural trade flows. The terms "environmental subsidies" or "ecological footprints" are sometimes used to denote the transmission of such pressures. For example, there might be environmental subsidies from the USA to those countries which import large quantities of maize from the USA, whose production contributes to soil erosion, involves heavy applications of mineral fertilizers and pesticides which are a source of ground and surface pollution and a negative pressure on natural ecosystems. Similarly, the Netherlands exports dairy products which indirectly are a major cause of pollution in the Netherlands. On the other hand, the Netherlands, together with other European countries, imports large quantities of cassava chips from South-East Asia, which are commonly grown in high rainfall areas on steep slopes with fragile soils, and result in very large soil losses through erosion. Thus,

these are issues for developed and developing countries alike, but with the former better able to adopt the "polluter pays principle" or to introduce environmental regulations to make market prices reflect the environmental costs (for more discussions see Chapter 8).

The endpoint and the beginning

The possible environmental dimensions of the agricultural projections have been edged with uncertainty but they are objective as far as the data and understanding of them allow. They will be wrong to some degree or other. The feedback loops between the economy, agricultural development and the environment are too complex and too dynamic to mimic with any certainty. And consequently, the strengths of the trade-offs and their associated risks are equally uncertain, hence the present stress on minimizing them, and adopting the precautionary principle. Nonetheless, two aspects seem clear.

First, it is important not to take an excessively static view of what is possible. The people of the Machakos district of Kenya have shown that it is possible to turn back from the edge of environmental disaster, rehabilitate seriously degraded land and introduce more sustainable production systems (Box 12.1) as have others in China, Indonesia and many agroecologically different parts of the world.

Second, the required actions go well beyond the so-called technological fix, although new technologies based on the latest scientific understanding will be vitally important, as will the revival or up-grading of indigenous technologies. They include international action to create a more open and equitable trading system with wider and stronger environmental safeguards, and to channel development assistance towards sustainable agriculture in a more consistent way. But the key actions are at the national and local levels. They include those which promote development, create a regulatory and incentive environment that encourage the uptake of sustainable technologies, promote decentralized, participatory, bottom-up approaches to natural resource planning and management, and contribute to slowing down the population growth rate.

Perhaps most important of all, what is required is more recognition of the anthropocentric approach to development and to the very idea of environmental conservation, and greater humility among those who argue for an ecocentric approach that does not match the expectations and resources of the farmers in the poor countries.

Environmental Quality as a Public Good and a Public Bad

Public Goods

A public good is one whose consumption or use by one individual does not reduce the amount available for others. An example of a public good is water which is available to one person and is also available to others without any additional cost. Its consumption is always joint and equal. It is non-excludable if it can be consumed by anyone.

It is non-rivalrous if no one has an exclusive rights over its consumption. Its benefits can be provided to an additional consumer at zero marginal cost. Thus public goods are both non-excluded and non-rivalrous. Moreover, environmental quality is generally considerable as a public good and when it is valued at market price, it leads to market failure.

The Paretian condition for a public good is that its marginal social benefit (MSB) should equal its marginal social cost (MSC). But the characteristics of a public good are such that the economy will not reach a point of Pareto optimality in a perfectly competitive market. Public goods create externalities.

The externality starts when the marginal cost of consuming or producing an additional unit of a public good is zero but a price above zero is being charged. This violates the Paretian welfare maximization criterion of equating marginal social cost and marginal social benefit. This is because the benefits of a public good must be provided at a zero marginal social cost.

Suppose potable water is supplied by the municipal corporation. There are two individuals A and B who use it. Both consume the same quantity of water. But they differ in how much they are willing to pay for any given quantity.

This is illustrated in Figure 17.1. Where D_a and D_b are the demand curves of two individuals A and B respectively. Therefore, demand prices are OP_a and OP_b corresponding to a given quantity OW of water. The curve ΣD is the vertical summation of D_a and D_b curves.

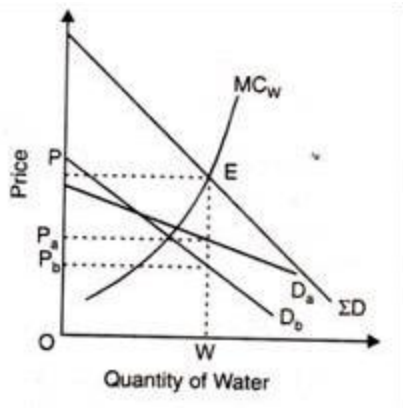


Figure 1.19

The Lindhal equilibrium for a public good exists where the sum of the individual prices equal marginal cost. Therefore,

$OP = OP_a + OP_b - MC_W$

But each consumer is being charged a different price. This is a case of price discrimination because price OP_a is greater than prices OP_b for the same quantity of water OW. Hence, there is market failure.

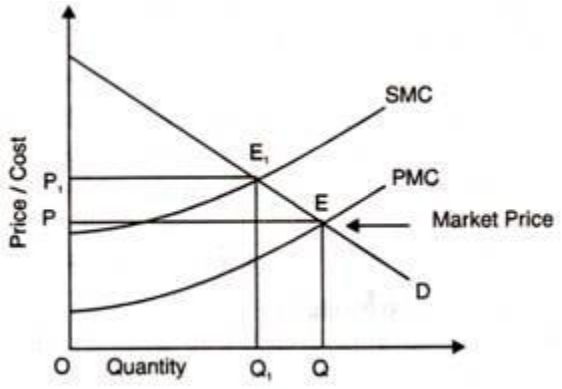
Public Bads

There are also public bads in which one person experiencing some disutility does not diminish the disutility of another, such as air and water pollution. Public goods and public bads cannot be handled by the institution of private property. K. E. Boulding has explained public bads with the following example: "If someone drives his car into my living room and pollutes it, I can sue him for damages. This is a private bad. If someone congests the road or pollutes the air, however, there is not much I can do about it as an individual. This is public bad."

A public bad is any product on condition that it decreases the welfare of others in a non-exhaustive manner. For example, a factory situated in a residential area emits smoke which affects adversely health and household articles of the residents.

In this case, factory benefits by producing more quantities of commodities but at the expense of residents who have to incur extra expenses to keep themselves healthy and their households clean. These are social marginal costs which are higher due to negative externalities (public bads).

This is illustrated in Fig. 1.20 where the SMC curve is above the PMC curve which intersects the D curve at point E and determines the competitive price OP and output OQ. But the socially optimum output is OQ_1 and price is OP_1, as determined by the intersection of SMC and D curves at point E_1.



Thus the firms are producing Q_1Q more than the social optimal output OQ_1. In this case, for every unit between Q_1 and Q, social marginal cost (SMC) is more than the competitive market price OP. Thus its production involves a social loss, i.e. $OQ - OQ_1 = QQ_1$.

Market failure is a necessary but not a sufficient condition for intervention. To be truly worthwhile, a government intervention must outperform the market or improve its functions. Second, the benefits from such intervention must exceed the costs of planning, implementation, and enforcement, as well as any indirect and unintended costs of distortions introduced to other sectors of the economy by such intervention.

2.3. 1 PARETO EFFICIENCY

Introduction

When someone says 'efficiency,' what do you think of? How well you manage your time? How many miles per gallon your car gets? How many hours a certain light bulb lasts? These are all everyday applications of the general idea behind efficiency—trying to maximize the output or benefit received from a limited resource. But efficiency as an economic concept is a bit more intricate. We'll start with the big picture, and then we'll address the details.

Pareto Efficiency

Pareto efficiency is a concept that originated with Vilfredo Pareto—a 19th century Italian economist (with backgrounds in engineering, sociology). His idea of Pareto efficiency is the following:

Definition: Pareto efficiency has been achieved if there is *no* way to make one person better off without making another person worse-off.

Taking goods from individual A and giving them to individual B would *not* be increasing Pareto efficiency—individual B gains, but individual A loses. Voluntary trade, on the other hand, is typically an example of Pareto efficiency: individuals are only willing to go through with the trade because both will receive benefit from it. Important exceptions to this are voluntary trade transactions that yield (negative) externalities—unintended effects on a third party—such as pollution. Because the third party is made worse off, this transaction does *not* move the system closer to Pareto efficiency.

Looking further into Pareto Efficiency

Now that we know what Pareto efficiency is, we can examine its components. Productive, consumptive, and trade efficiency are different types of Pareto efficiency—but you need *all* three in order to have *overall* Pareto efficiency. You can loosely think of efficiency in terms of a baseball diamond: bases 1-3 represent productive, consumptive, and trade efficiencies. Once you've run each of these bases (achieved each of the efficiencies), you can proceed to home base—Pareto efficiency. Home run!

Productive + Consumptive + Trade = Pareto

(Each efficiency (P, C, T) is necessary but insufficient, on its own, for overall Pareto efficiency)

1.) Productive Efficiency:

a.) If you can't produce more of one good (X, for example) without producing less of another good (Y). (Many textbooks also define productive efficiency as when the firm is employing all of its available resources in a way that maximizes output and minimizes costs.)

Condition: production bundle must be *on* the PPC

Figure 3.4 This diagram shows the production possibility curve/frontier for goods X and Y. All points on the PPC itself (such as B and C) are efficient in production because they satisfy the above condition. Starting from point C (11Y and 9X), you cannot produce more X without producing less Y—moving to point B (9 to 12 units of X) entails a gain of 3 X, but it comes with the loss of 4 Y (11 to 7). This reasoning works regardless of whether you move up or down the PPC.

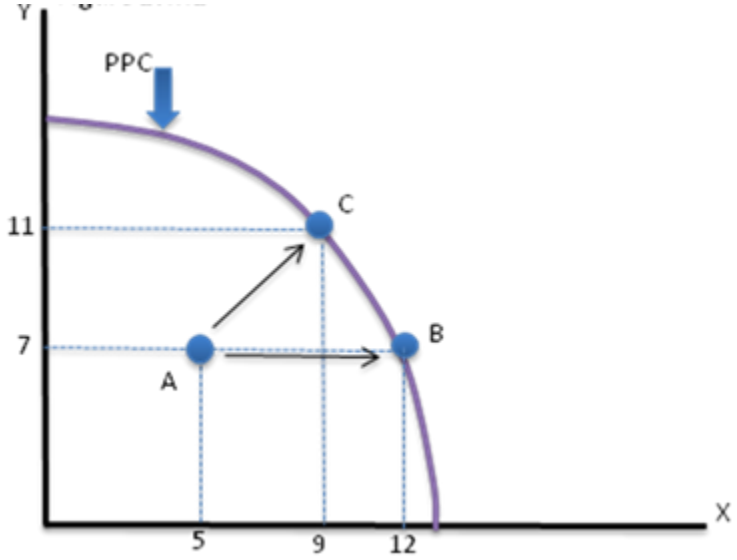


Figure 3.4

Looking at **Figure 3.4** also shows how productive efficiency is a precondition for Pareto efficiency. Point A is not efficient in production because you can produce more of either one or both goods (X and Y) without producing less of the other. (A→B = +7 X, no decrease in Y output; A→C = +4 X, +4 Y). Thus, moving from A to B or C enables you to make one person better off without making anyone else worse off (rise in Pareto efficiency). You can hand out 4 X and 4 Y to someone (and increase that person's benefit) by moving from A to C, without taking any X or Y from others (reducing their benefit).

b.) All producers face the same marginal cost of production (Note: because a firm's supply is determined based upon it's MC, the above condition is the same as saying that all firms face the same supply curves).

Condition: $MC_a = MC_b$ $[S_a = S_b]$

—The marginal cost of X (cost of producing an additional unit of X) faced by firm A is equal to that faced by firm B.

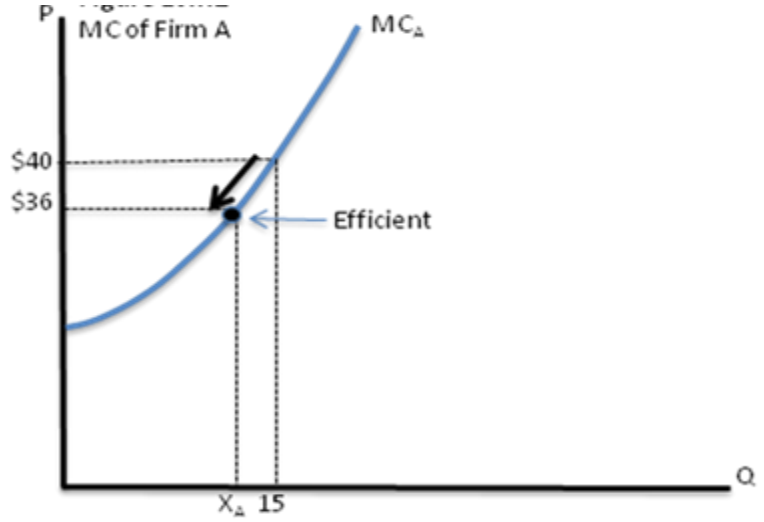


Figure 3.5

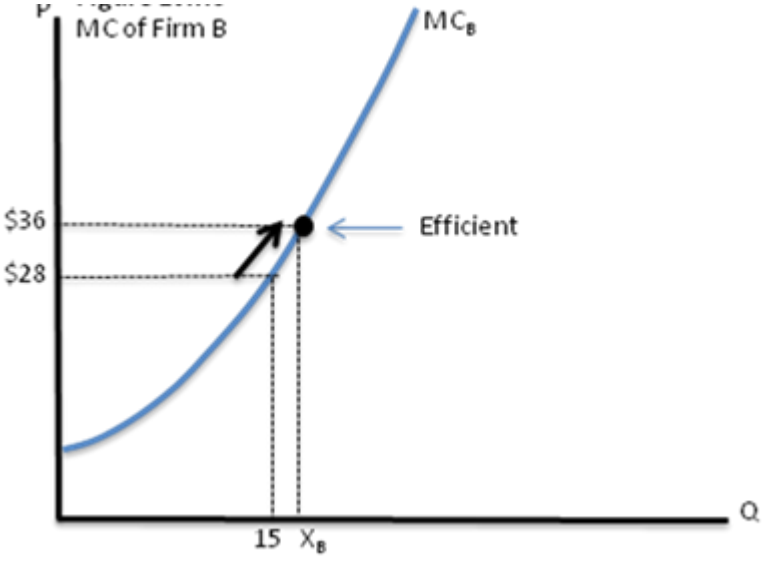


Figure 3.6

Figures 3.5 and 3.6 Firm A will decrease its production (from 15 to XA) and Firm B will increase its production (from 15 to XB) until $MC_A = MC_B$ ($36, in this example). At these altered outputs, productive efficiency is attained.

2.) Consumptive Efficiency:

Condition: $MB_a = MB_b$ $[D_a = D_b]$

—The marginal benefit of X (the benefit of consuming an additional unit of X) for consumer A is equal to that of consumer B.

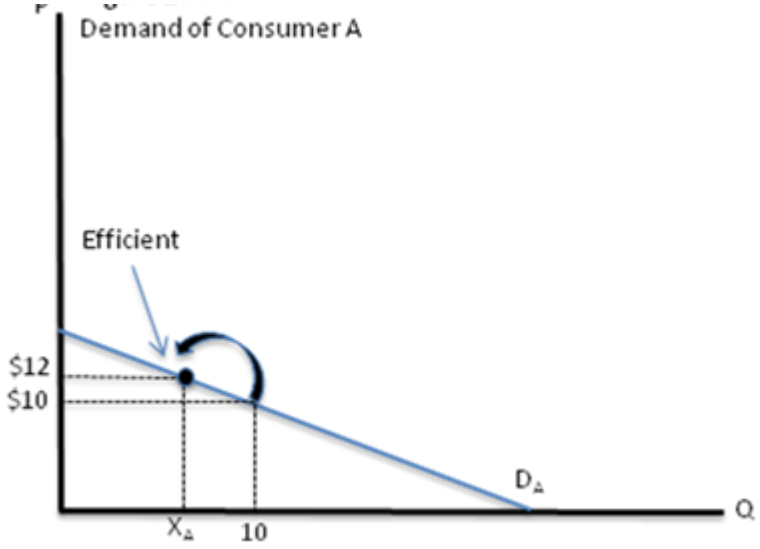


Figure 3.7

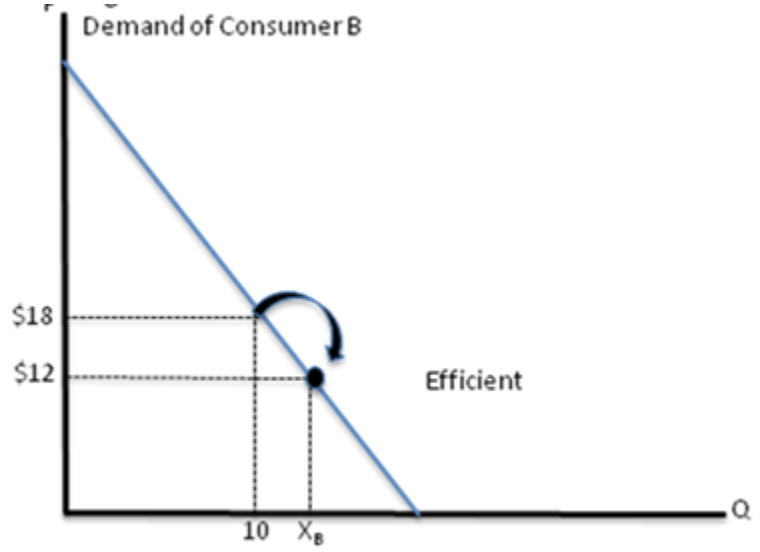


Figure 3.8

Figure 3.7: Consumer A decreases his/her consumption and consumer B increases his/her consumption until D_A (MB_A) = D_B (MB_B).Why would the marginal benefits of individuals approach each other and equal out? Think of it this way: When consumers A and B consume 10 units of X, they value each unit at $10 and $18, respectively. Therefore, a middleman could buy several units of X from consumer B at $11 (or any price greater than $10 and less than $18), and sell them to consumer A for $17 (or any price less than $18 and greater than $11). The middleman would earn a profit from the transaction. And the terms of trade are favorable to both consumers—everyone benefits. The system achieves consumptive efficiency and moves closer to Pareto efficiency.

3.) Trade Efficiency

Condition: For a given good, X, the marginal costs [supply] faced by producers (which must be equal, based upon the conditions for productive efficiency) and the marginal benefits [demand] of consumers are equal to each other.

$MC_x = MB_x = S_x = D_x$

This is where the 'invisible hand' (a term coined by Adam Smith), comes in. The firm's objective is to maximize its profits (in a competitive industry, a firm does this by producing the output at which MC = P). The consumers' objective is to maximize their utility. In other words, producers and consumers are pursuing their *self-interests.* But the net effect of each party's 'selfish' objectives is not only its own betterment, but also the betterment of society—and thus of the other party as well.

This 'invisible hand' reasoning is often used to support laissez-faire policies—if the invisible hand guides markets to Pareto efficiency, then government intervention will only impede this process and reduce efficiency, right? Not completely. Nicholson and Snyder, however, warn that:

"Such sweeping a conclusion...vastly overstates the general applicability of the simple models we have been using. No one should attempt to draw policy recommendations from a theoretical structure that draws so pays so little attention to the institutional details of the real world. Still, the efficiency properties of the competitive system do provide a benchmark a place to start when examining why competitive markets may fail" (Nicholson and

Another Way of Looking at Trade Efficiency: Combining Productive and Consumptive Efficiencies

You can't have overall Pareto efficiency unless you “tie together individual's preferences and the production possibilities.” In other words, both consumptive and productive efficiencies are needed for Pareto efficiency. The following condition 'joins' the two productivities:

MRS (Marginal Rate of Substitution—the slope of an indifference curve) =

RPT (Rate of Product Transformation—the slope of the production possibilities curve)

This ensures that consumers and producers value the two goods equally. The rate at which producers can substitute/exchange production of one good for production of another is equal to the rate at which consumers are willing to substitute consumption of one good for the other.

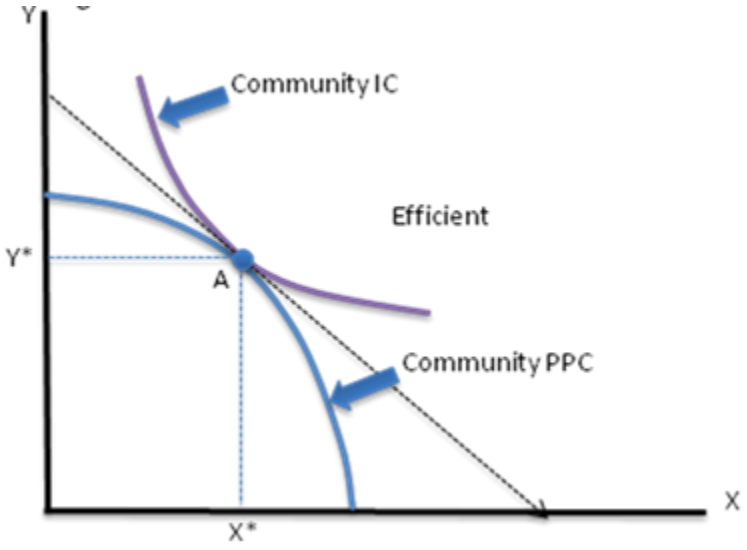


Figure 3.9

Figure 3.9: In this figure are shown the indifference curve for a community (which shows different consumption bundle combinations of goods X and Y that would yield the same level of utility), and the production possibilities curve of that community for those goods. At point A, the indifference curve is tangent to the PPC (the slope of these two curves [MRS (marginal rate of substitution) and RPT (rate of product transformation—

also called MRT, marginal rate of transformation), respectively] are equal). Point A represents a Pareto efficient combination of X and Y.

Understanding what Pareto efficiency means is one thing. But knowing how to apply it to real-life economic decisions is another. And the job of an economist includes both: not only making sense of graphs, but also *using* them for the betterment of society. It is also important to remember that the above laws and graphs are used to illustrate economic concepts—they are not 'how-to' manuals that transfer directly to real life (Rarely are real markets as simple as are the assumption-filled markets in textbooks).

Criticisms

Pareto efficiency does not require an equitable distribution of wealth. An economy in which the wealthy hold the vast majority of resources can be Pareto efficient. This possibility is inherent in the definition of Pareto efficiency; by requiring that an allocation leave no participant worse off, Pareto efficiency tends to favor outcomes that do not depart radically from the status quo.

Sen

Amartya Sen has elaborated a mathematical basis for this criticism, pointing out that under relatively plausible starting conditions, systems of social choice will converge to Pareto efficient, but inequitable, distributions. A simple example is the distribution of a pie among three people. The most equitable distribution would assign one third to each person. However the assignment of, say, a half section to each of two individuals and none to the third is also Pareto optimal despite not being equitable, because none of the recipients is left worse off than before, and there are many other such distributions. An example of a Pareto inefficient distribution of the pie would be allocation of a quarter of the pie to each of the three, with the remainder discarded. The origin of the pie is conceived as immaterial in these examples. In such cases, in which a "windfall" that none of the potential distributes actually produced is to be allocated (e.g., land, inherited wealth, a portion of the broadcast spectrum, or some other resource), the criterion of Pareto efficiency does not determine a unique optimal allocation.

Public Goods

Economists use the term Public Goods to refer to products (goods or services) that are difficult to keep non payers from consuming (no excludability), and of which anyone can consume as much as desired without reducing the amount available for others (no rival consumption). Examples include national defence, a clean environment, and air for breathing. Public goods are usually provided by government because a private business lacks the incentive linked to the profitability to produce them. Private businesses can't sell public goods in markets, because they can't charge a price and keep nonpaying people away. Moreover, businesses shouldn't charge a price, because there's no opportunity cost for extra consumers. For efficiency, government needs to pay for public goods through taxes.

The modern concept of public goods has its roots in 18th century scholarship and it can be traced back to classical economics. David Hume discussed the difficulties inherent in providing for "the common goods" in his Treatise of Human Nature, first published in 1739. Some 30 years later Adam Smith analysed similar questions in his Inquiry into the Nature and Causes of the Wealth of Nations. David Hume and Adam Smith agreed that government intervention is needed to supply goods and services characterized by collective benefits. If left to the spontaneous action of individuals or organizations, these goods would not be adequately provided.

After a pioneering contribution by Richard Musgrave in 1939, a modern and comprehensive theory of public goods was developed with the publication in 1954 of Paul Samuelson's seminal paper "The pure theory of Public Expenditure". Since then, research interest in the topic has grown rapidly. In his classic paper Samuelson defined a public good, as a good which all enjoy in common in the sense that each individual's consumption of such a good leads to no subtractions from any other individual's consumption of that good. This is the property that has become known as non-rivalry. A public good is "a commodity that can be provided to everyone as easily as it can be provided to one person", note economists Paul A. Samuelson and William D. Nordhaus (Samuelson and Nordhaus, 1992, p. 53). According to them the case par excellence of a public good, is national defence.

National defence, differs completely from a private good like bread. Ten loaves of bread, for example, can be divided up in many ways among individuals, and what you eat cannot be eaten by others. But national defence, once provided, benefits everyone equally. It matters not at all your way of life, your age or your religion you will receive the same amount of national security from the Army as does every other resident of the country. To the extent one person in a geographic area is defended from foreign attack or invasions, other people in that same area are defended also.

So public goods are ones whose benefits are indivisibly spread among the entire community, whether or not individuals desire to purchase the public good. Private goods, by contrast, are ones that can be divided up and provided separately to different individuals, with no external benefits or costs to others. Efficient provision of public goods often requires government action, while private goods can be efficiently allocated by markets.

The main Characteristics of Public Goods

Public goods have two distinct aspects: non-excludability and non-rivalrous consumption. Strictly speaking "non-excludability" means that the cost of keeping non-payers from enjoying the benefits of the good or service is too high so no one can be effectively excluded from using the good.

On the other hand "Non-rivalry" means that consumption of the good by one individual does not reduce availability of the good for consumption by others. For example, if one individual visits a doctor there is one less doctor's visit for everyone else, and it is possible to exclude others from visiting the doctor. This makes doctor visits a rival and excludable private good. Conversely, breathing air does not significantly reduce the amount of air available to others, and people cannot be effectively excluded from using the air. This makes air a public good, albeit one that is economically trivial, since air is a free good. Another example is the exchange of MP3 music files on the internet: the use of these files by any one person does not restrict the use by anyone else and there is little effective control over the exchange of these music files and photo files.

Impure Public Goods

In the real world, there is hardly any "pure" public good, that is absolutely non-rival and non-excludable. Most public goods possess mixed characteristics. Goods that only partly meet either or both of the defining criteria are called impure public goods. Because impure public goods are more common than the pure type, economists usually use the term "public good" to encompass both pure and impure public goods. That is considered a useful simplification because many of the implications of public remain very noticeable even when a good is only partly non-rival or partly non-excludable. According to this definition we may look at "pure private" and "pure public" as the extremes of a public-private continuum. Even an activity such as consuming a nutritious meal, which at first glance seems to be highly private, upon closer examination has public benefits. Indeed, a good meal adds to people's good health, and good health improves their ability to acquire skills and work fruitfully. This, in turn, benefits not only them but also their families and society as a whole. The immediate benefits, however, are mostly private.

Impure public goods fall into two categories (Figure 1). Goods that are non non-rival in consumption but excludable are called "Club Goods". Goods that are mostly non excludable but rival in consumption are "Common Goods". Such goods raise similar issues to public goods: the mirror to the public goods problem for this case is sometimes called the tragedy of the commons. For example, it is so difficult to enforce restrictions on deep sea fishing that the world's fish stocks can be seen as a non-excludable resource, but one which is finite and diminishing.

Supply problems

Because they are non-rival in consumption and non-excludable, public goods typically face supply problems, and so are often referred to as a case of market failure. Public goods problems are also closely related to externalities. Externalities arise when an individual or a firm takes an action but does not bear all the costs (negative externality) or all the benefits (positive externality) of the action. For example, educating women has positive effects on child survival and on slowing population growth. Releasing pollution into a river, by contrast, can harm nature and human beings. Put

differently, externalities are by-products of certain activities, spillovers into the public sphere.

Corner and Sandler argue that public goods, notably pure public goods, "can be thought of as special cases of externalities". For most of economists, positive and negative externalities are distinguished by their positive or negative utilities to third parties. So the term "public good" is usually used for goods and activities with positive utilities, including positive externalities. If a public disutility is involved the term we will use is "public bad".

Public bads are considered public goods that impose costs uniformly across a group. "These are unintended by-products of consumption or production activities" (Samuelson and Nordhaus, 1992, p. 30). Examples are air and water pollution that results from chemical production, energy production, and use of automobiles, and radioactive exposure to atmospheric tests of nuclear weapons or to accidents like the ones occurred at the Soviet nuclear plant in Chernobyl in 1986 or in Fukushima in 2011. Perpetrators of the "bads" do not intentionally try to hurt anyone so the externalities may be considered the unintentional but harmful side effects of economic activity.

Actually many problems that are often perceived as public-goods problems are of a different nature, and markets handle them reasonably well. For instance, although many people think a television signal is a public good, cable television services scramble their transmissions so that nonsubscribers cannot receive broadcasts easily. In other words, the producers have figured out how to exclude nonpayers. Both throughout history and today, private roads have been financed by tolls charged to road users. Other goods often seen as public goods, such as private protection and fire services, are frequently sold through the private sector on a fee basis. In some cases excluding non payers is possible. In other cases, potentially public goods are funded by advertisements, as happens with television and radio.

Partially public goods also can be tied to purchases of private goods, thereby making the entire package more similar to a private good. Shopping malls, for instance, provide shoppers with a variety of services that are traditionally considered public goods: lighting, protection services, benches, and restrooms are a case in point.

Charging directly for each of these services would be impractical. Therefore, the shopping mall finances the services through receipts from the sale of private goods in the mall. So the public and private goods are tied together. The main problem affecting the provision of public goods is known in economic literature as “free riding” or “easy rider” problem.

The free rider problem depends on a conception of the human being as a purely rational homo economics selfish, extremely individualistic and considering only those benefits and costs that directly affect him or her. Public goods give such a person an incentive to be a free rider. For example, consider national defense, a standard example of a pure public good. Suppose the homo economics thinks about exerting some extra effort to defend the nation. The benefits to the individual would be very low, since the benefits would be distributed among all of the millions of other people in the country. There is also a very high possibility that he or she could get injured or killed during the course of his or her military service.

On the other hand, the free rider knows that he or she cannot be excluded from the benefits of national defence, regardless of whether he or she contributes to it. There is also no way that these benefits can be split up and distributed as individual parcels to people. The free rider would not voluntarily exert any extra effort, unless there is some inherent pleasure or material reward for doing so (for example, money paid by the government, as with an all-volunteer army or mercenaries). The free riding problem is even more complicated than it was thought to be until recently. Any time non-excludability results in failure to pay the true marginal value, it will also result in failure to generate proper income levels, since households will not give up valuable leisure if they cannot individually increment a good.

Fig-1

	Excludable	**Non-excludable**
Rivalrous	Private goods, food, clothing, cars	Common goods fish stocks, timber, coal
Non-rivalrous	Club goods, cinemas, private parks, satellite television	Public goods, free-to-air television, air, national defence.

Mixed goods

Private goods are goods that are rivalrous and excludable. An interesting half-way house between a private and a public good is a "mixed good". A mixed good is like a private good in that it is rivalrous and excludable, but it provides significant non-rivalrous, non-excludable external benefits for which preferences are not revealed by the market mechanism. Examples are (a) health-care; (b) education; (c) public transport; (d) refuse collection and (e) fire-service. Let us illustrate this in the case of education. When a person is educated he/she receives a benefit from this, which is expressed in terms of higher earnings and improved job prospects. However, the community as a whole also benefits from the individual's education, in that his/her productivity is enhanced, which is good for everyone. The balance between private and public benefit varies, and there is debate in each case - that is, it is not easy to determine the public benefits for a good for which private preferences can be revealed by the market mechanism.

2.4 Common Property Resources

Definition

The "tragedy of the commons" has become a household phrase among economists and others concerned with environmental and natural resource problems. The concept has been used to explain overexploitation in fisheries, overgrazing, air and water pollution, abuse of public lands, population problems, extinction of species, fuelwood depletion, misallocation in oil and natural gas extraction, groundwater depletion, wildlife decline, and other problems of resource misallocation. Yet the rush to explain with a single

concept a whole range of natural resource problems—which happen to be similar only in having multiple users—has obscured some important distinctions in the physical characteristics and the manner of use of these resources. We ought not to fall prey to a "tyranny of words," as Learner (1983) in another context aptly warns, for the "tragedy of the commons" is such a catchy phrase that we are wont to apply it indiscriminately.

We look about us and everywhere find resources being used by groups of people in common and are tempted to say, "Aha! Here is another 'tragedy of the commons.' "What is this "tragedy of the commons"? The next chapter reviews the theory behind it in detail, but I will state it briefly and intuitively here. Where resource use is unlimited, many users are present, and there is excess demand for the resource, overexploitation results. It is said that "everybody's property is nobody's property," as each user rushes to harvest the resource before the next person does. Abuse of the resource occurs because each user, while striving for private gains, can spread some of the costs of his or her use to the other users. Hardin's (1968: 1244) classic description of a grazing commons illustrates this process in simple terms:

Common Property Economics

As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, "What is the utility *to me* of adding one more animal to my herd?" This utility has one negative and one positive component.

1) The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly + 1.

2) The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decision making herdsman is only a fraction of — 1.

Adding together the component partial utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. But this is the conclusion reached by each and every rational herdsman sharing a commons.

Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited.

Although faults exist with some particulars of the reasoning—there is for instance a theoretical limit on the herd's increase—the argument is compelling. How is it then that some commons seem to survive despite the dire predictions of tragedy? For example, the Swiss alpine grazing commons, which serve as the major case study for the current work, have been in use in some cases for a thousand years. If the tragedy of the commons always occurs, then surely it would have transpired in Switzerland by now. Dahlman (1980) points out that common property was the preferred form of land management for grazing across northern Europe for centuries during the Middle Ages. He argues that this was not due to the ignorance of the peasants who used the land, but that it was economically rational. How are these counterexamples reconcilable with Hardin's "tragedy of the commons"

The answer is quite simple. I have pulled a sleight of hand, but it is casuistry that the literature on "common property" has performed over and over again. Hardin's commons and the grazing commons of Switzerland are two different systems. Indeed, Hardin's commons and many examples of common property ought not to be spoken of in the same breath. What distinguishes them? There are two things, the main one being limitation of entry. The inputs to Hardin's commons may increase until economic exhaustion of the resource occurs. In the common property systems that have survived, people have learned to limit use. The second distinction is that with limited entry often comes coordinated management. There is no coordinated man-

What is Common Property?

Argument in Hardin's "commons" because no identifiable group has been distinguished as the managers. Where limited entry has been accomplished, the group of included users has the ability to collude and systematize use. These distinctions seem basic, yet all too many students of resource use institutions have missed them. The class of resources that has been labeled "common property" should more accurately be divided into two subsets. The subset that experiences overuse should be labeled "open access resources," for it is unlimited access that causes the tragedy. The subset that has

succeeded by limiting access and employing joint management is *true* common property. For reasons that Chapter 3 makes clear, this subset retains the label "common property" in the present book; in short, only when access has been limited can one talk about "property." Thus, the condemnation of a potentially viable resource use system, true common property, has been due partially to a problem of semantics. "Common property" has been applied to any natural resource used in common, whether it is an open access resource or a limited access, managed resource.

Because the theory in which a tragedy results really applies only to open access resources, rightfully speaking one would talk about the "tragedy of open access." Partly as a result of the semantic problem, however, the belief has grown that any multiple-user system will lead to overexploitation. This confusion between open access and common property resources has not had benign consequences. Certain authors, launching their reasoning from the assumption that all commonly used resources are overexploited, conclude that there is only one solution: private property.2 Private property, of course, is one solution to the open access problem. A secure, exclusive right to resource extraction imparts the incentive to the user to utilize the resource at an optimal rate: The private rights holder not only reaps the benefits but also incurs all the costs of additional resource extraction, and a balancing of these benefits and costs leads the user to an optimal extraction rate.

Common Property Resources

Common property resources (**environmental**) are natural **resources** owned and managed collectively by a community or society rather than by individuals.

Throughout the world there are assets that are neither private nor state property, but common property. The term denotes a class of institutions that govern the ownership and rights-of-access to assets. Common property assets are to be distinguished from "public goods," in that, unlike the latter, use by someone of a unit of a common property asset typically reduces the amount available to others by one unit (in economic terminology, such an asset is rivalrous in use). The institution of common property creates and harbors reciprocal externalities. As some of the most interesting examples of common property assets are natural resources, this entry is restricted to them.

Global and Local Commons

Broadly speaking, there are two types of common property resources. Assets that are mobile and have a global reach are subject to "open access," in that everyone in principle has access to them. Earth's atmosphere, as both a source of human well-being and a sink for depositing effluents, is the classic example: For physical reasons, the atmosphere cannot be privatized, nor can it be expropriated by any state. In a pioneering article published in 1954, H. Scott Gordon argued that an asset that is everyone's property is in fact no one's property. He showed that resources under open access are overused, in that it is in the public interest to restrict their use. His reasoning was simple–given that resource bases are finite in size, they have positive social worth. But an open access resource is free to all who use it. So, the cost that each user incurs is less than what it ought ideally to be. Under open access the rents attributable to the resource base are dissipated; there is excessive use. A user tax (or, alternatively, a quota) suggests itself as public policy.

It will be noticed that the production of public goods and the use of open access resources reflect features that are mirror opposites of one another: In the absence of collective action, there is an undersupply of public goods and an overuse of open access resources. Garrett Hardin's admirable metaphor, "the tragedy of the commons" (Hardin, 1968, pp. 1,243–1,248), is applicable to open access resources. Climate change owing to anthropogenic causes is an example of such a "tragedy." In earlier millennia demand would have been small, and such resource bases as the atmosphere and the open seas would legitimately have been free goods. But in the twenty-first century the matter is different.

However, there are geographically localized resources that are common property to well-defined groups of people, but to which people not belonging to the groups do not have a right of access. It has now become customary to refer to such assets as "common-property resources," or CPRs, which is an unfortunate usage, since open access resources are common property too. In what follows, CPRs are referred to as "local commons."

Examples of Local Commons

The local commons include grazing lands, threshing grounds, lands temporarily taken out of cultivation, inland and coastal fisheries, irrigation systems, woodlands, forests, tanks, ponds, and recreation grounds. In poor countries property rights to the local commons have been found most often to be based on custom and tradition; they are usually not backed by the kind of deeds that would pass scrutiny in courts of law. Therefore, tenure is not always secure–a vital problem.

Are the local commons extensive? As a proportion of total assets, their presence ranges widely across ecological zones. There is a rationale for this, based on the human desire to reduce risk. Communal property rights enable members of a group to reduce individual risks by pooling their risks. An almost immediate empirical corollary is that the local commons are most prominent in arid regions, mountain regions, and unirrigated areas, and least prominent in humid regions and river valleys. Another corollary is that income inequalities are less in those locations where the local commons are more prominent. Aggregate income is a different matter, though; it is the arid and mountain regions and un irrigated areas that are the poorest.

UNIT III

MEASUREMENT OF ENVIRONMENTAL VALUES

3.1 Introduction

Understanding value of Environmental Goods requires understanding of the notion of "values" of environmental goods There are two types of values: Use Value and Non-use Value Use Value: Satisfaction/utility that consumers obtain by directly consuming the goods. (e.g., hiking through the woods).

In case of environmental goods, Use Value could include current use ("I am currently visiting the park), expected use ("I plan to visit the park later this year) and possible use (I might visit the park within next 10 years) Option Value: The value placed on a future ability to use the environment people are willing to pay for an option to use the environment in the future even they are not currently using it.

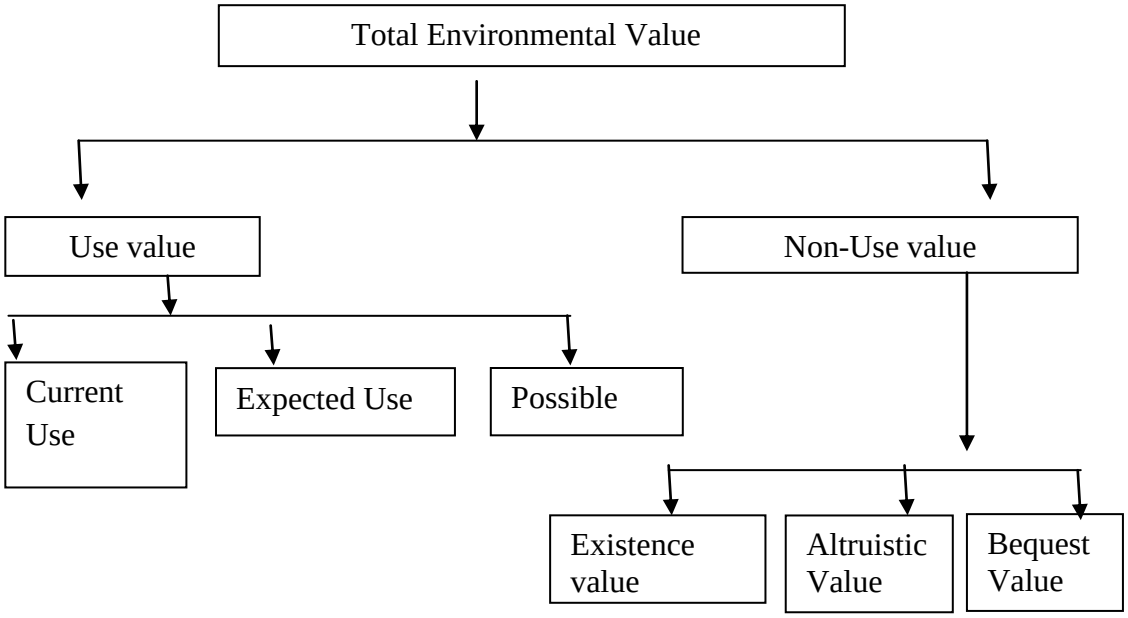
Non-use Value: It's a gain in person's utility without the person actually using the good directly. For example, one may value the wilderness areas in the Seirra Nevada, Nevada, not because because he/she plans to make use of the wilderness but because others may, and that may make him/her feel good .

There are three basic types of non-use value: Existence value, Altruistic vale and Bequest value:

Types of non-use value: Existence value: The value a consumer attaches to knowing something exists (e.g. One-horned rhinoceros in Kaziranaga National Park) Altruistic value: It's a value that the consumers derive from not consuming the goods themselves but from the fact they derive the benefit when someone else gains utility. (e.g. If person A's neighbor derives benefit from his cleaning his front yard, person A obtains utility from the fact that his neighbors are better off.

Types of non-use value:

Bequest value: It is associated with the well-being of the descendants. For example, if one values passing a wilderness area on to the next generation that wilderness area has a bequest value to the person even if he or she never uses it or intends to use it



Why do we have to value the environment?

1. No price data exists for non-marketed environmental resources (demand or prices for private goods can be obtained from the market)
2. Need for information on benefits and costs of protecting and restoring the environment to guide policy makings
3. Need information on benefits and costs of protecting and restoring the environment to guide budget allocations
4. Need information to guide compensation setting for victims
5. Need information on external costs of development projects to guide development policies
6. Need information to guide setting of user charges/fees/taxes for pollution control Need information to guide efficient and fair resource allocation

3.1.1 Methods of Measuring Environmental Values

Revealed Preference

In revealed preference approach real choices of people are observed in some market and information are inferred on the trade-offs between money and the environmental good.

Stated Preference: It basically involves asking people how much an environmental good is worth.

Table 1: Methods of valuation of environmental goods

Methods	**Revealed Preference**	**Stated Preference**
Direct		Contingent Valuation Contingent Ranking
Indirect	Hedonic Pricing Travel Cost Method Household Production Function Does Response Approached Averting Expenditure/Avoided Cost Approaches	

3.2 HEDONIC PRICING METHOD

Hedonic Pricing (HP) Approach is derived from the characteristic theory of value first proposed by Lancaster (1966) and Rosen (1974). This seeks to explain the value of a commodity as a bundle of valuable characteristics (e.g. the price/rent of house depends on number of rooms, availability of garden in the campus, proximity to shops, noise level in the neighborhood, air quality levels etc.)

HP was first applied to environmental valuation by Ridker and Henning (1967) HP proceeds on three stages: First, hedonic hedonic price function function is estimated estimated Second, implicit prices are calculated Third, a demand curve for this variable may be estimated Following example brings out these three stages.

Let’s now consider a simple structure that of a good (house) with a single characteristics (pollution/air quality level) Now we are interested in knowing p(z), the

house price as a function of air quality levels (i.e. how p (z) changes as a function of air quality levels (i.e. how p (z) changes when air quality changes)

Since price function is an equilibrium concept, resulting from the interaction of demand and supply function, we need to look at both consumer and producer side of the market. Assume that the market is competitive that is both the consumers and producers take p (z) as given.

A.The Consumer:

Suppose a typical consumer has utility function U and income y. The consumer's problem is to decide how to allocate income between the house (given the air to allocate income between the house (given the air quality z) and ordinary goods denoted by x (nominally priced at 1). The consumer's problem is, maxxz U (x, z) (1.a) subject to, x + p(z) = y (1.b)

We can look at the problem in another way, i.e. for particular level of z, to determine the amount of x that needs to be consumed to achieve a particular level of utility. This in turn determines how much money is spent on the house.

This in turn determines how much money is spent on x and how much income is available to spend on the house.

Fixing z, we U can solve the value of x that satisfies U(x, z) =U

This then defines a particular amount of income available for the house:

$y - x = \theta$

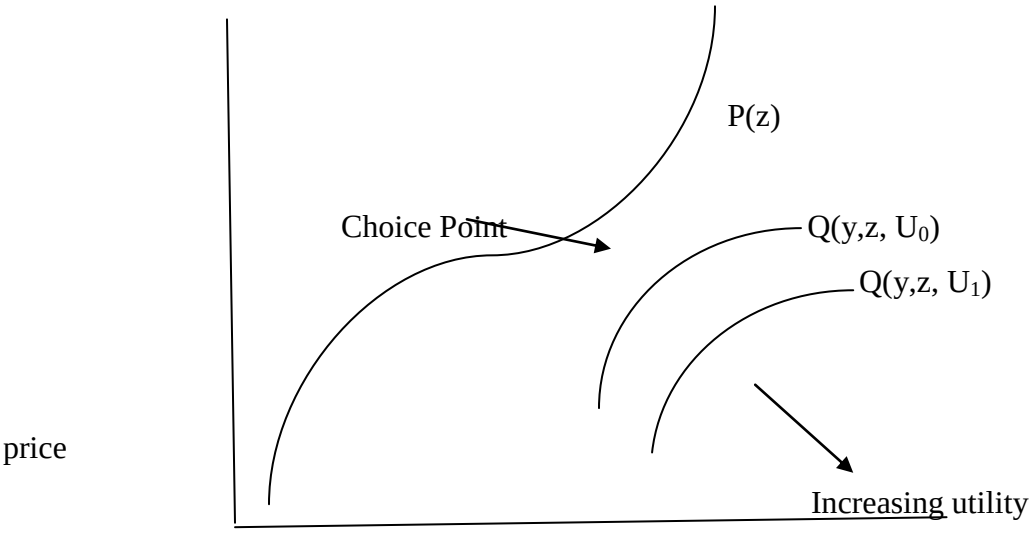
We can also find out θ solving,

U (y – θ,z) = (1.c) U (y – θ,z) = (1.c)

So given the values of z, y and we determine how much money is available for the house,

θ (y, z,U)

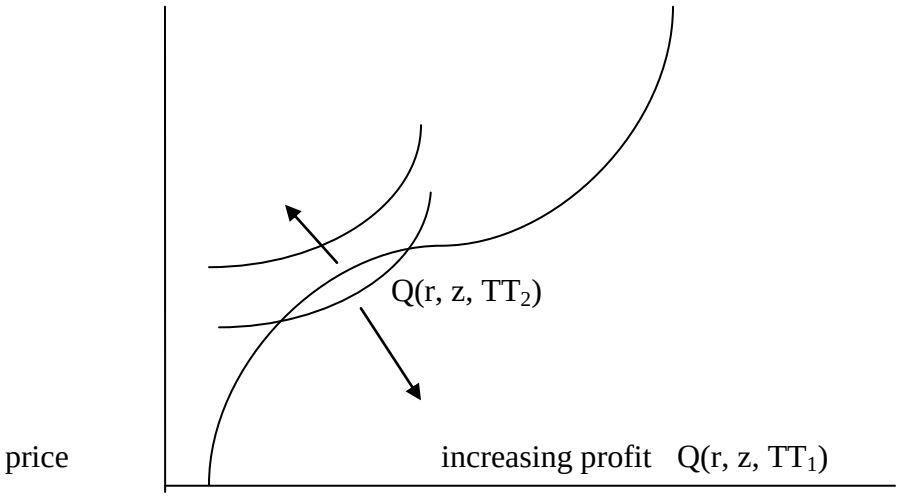
Let us call this a bid function because it represents the amount of money the consumer may bid for the house with characteristics z, to keep the utility at the level U assuming income y. (consider this situation in diagram 1)



Air quality Z

In figure 1, θ (y, z, U0) and θ (y, z, U1) are two bid functions. Lower bid function is associated with the higher utility. p (z) is the hedonic price function determined by the market.

For this consumer the point of choice is the point at which bid function is just tangent to the price function p(z) which gives maximum utility with the requirement that the amount the consumer is willing to pay (θ) must be equal to the price p(z).



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B. The Producer

Let's consider a producer with a given cost structure and facing constant returns to scale. Suppose the producer faces input prices r, so that the unit cost is given by c(r, z).

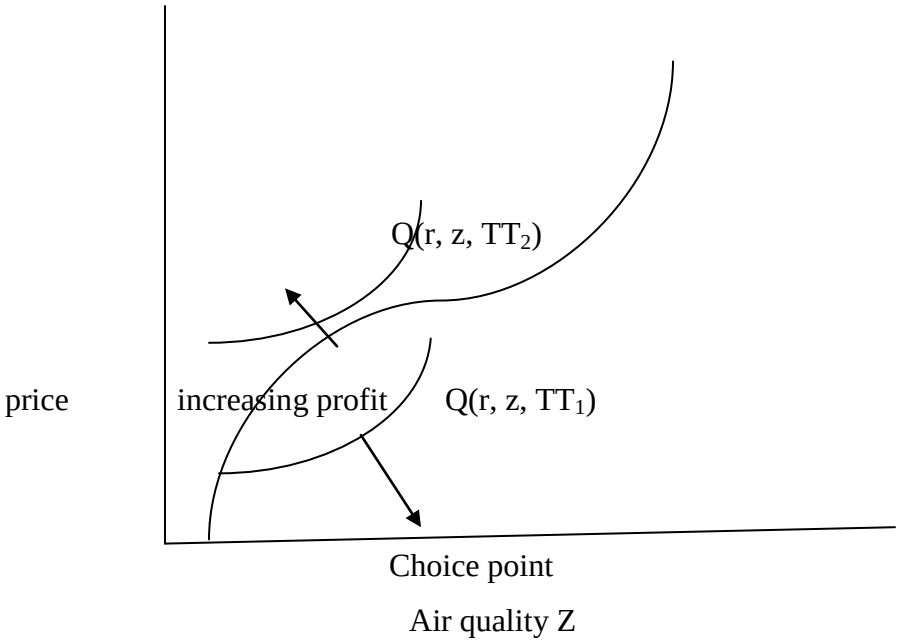
If the producer offers a price of Φ, then profits per house are given by,

$\pi = \Phi - c(r, z)$ (1. d)

B. The Producer

We can rewrite this as the price necessary to obtain a certain level of profit, given the level of the characteristics z: $\Phi(r, z, \pi)$. Let's call this as offer function. The offer function indicates the price at which the producer will offer the house to obtain a particular profit level π, given a particular value of input prices, r, and a particular value of z. If the

producer wants to sell a house, this offer curve has to intersect the price line. This is illustrated in figure 2)



In figure 2, the hedonic price function is shown p(z) as well as two offer functions for some particular firm, one function for each of two profits levels π1 and π2. The correct choice of z is one at which an offer curve The correct choice of z is one at which an offer curve is just tangent to the hedonic price line.

Market Equilibrium

Finally, we are now in a position to construct the hedonic demand functions. Hedonic price function corresponds to tangency Hedonic price function corresponds to tangency between the bid functions of some consumer and the offer function of some producers (Shown in Figure 3). The tangency determines a choice of z along with a price p(z) and the price line is constructed. .

Market Equilibrium

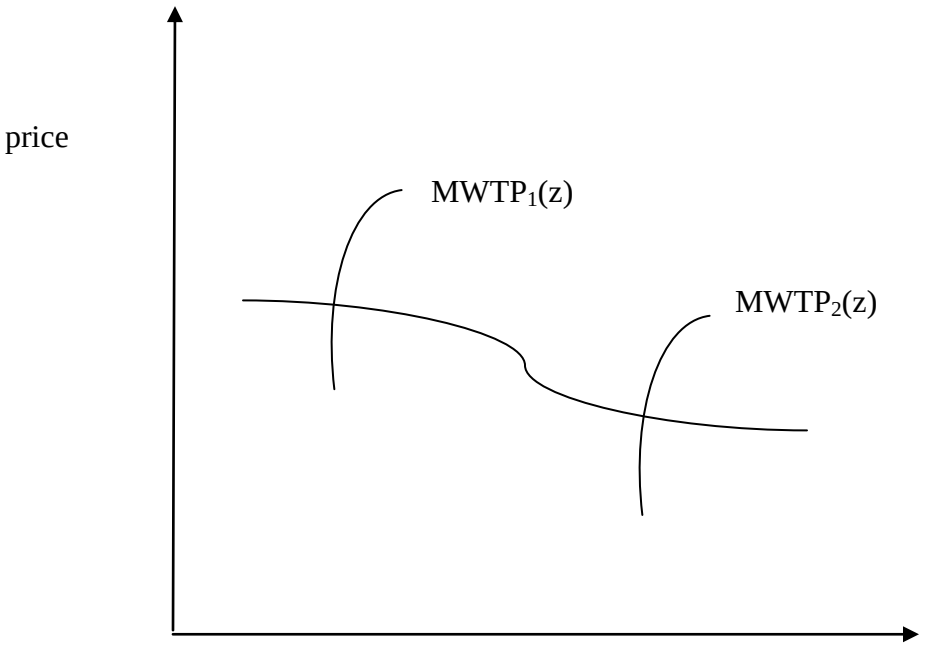
At the tangency points slopes of the bid function, offer function and the price line are equal. This equality implies that the producers, the equality implies that the

producers, the consumers and the market all have the same marginal valuation on a unit of the characteristics.

Willingness to Pay

So far we have measured the hedonic price function and thus, we know the marginal price/market of air quality at different levels air quality (z). Quality at different levels air quality (z). This is not a demand function because one individual chooses only one consumption point along the hedonic price function, not several consumption points. One point does not make a demand function.

The distinction between the marginal price of z as a function of z and the marginal willingness to pay for z is shown in figure 4 In fig. 4, p`(z) is the slope of a hedonic price line. MWTP1(z) and MWTP2(z) are the marginal willingness to pay functions for the two persons. The point of intersection of the MWTP functions with the marginal price line gives us the choice of z for the individual. But how much?



Assume that different individuals making choices along the hedonic price function are variants of the same person, simply with different incomes and characteristics (call these differences £). Thus we can translate the many observations on

choice of z into a set of data on how marginal willingness to pay varies with z, and thus statistically infer a marginal willingness-to-pay function.

Similarly, MWTP function can be derived for the producers denoting the differences as β. We thus have the following equations for demand and We thus have the following equations for demand and supply:

$$p`(z) = f(z, £) \quad (1.e)$$

$$p`(z) = g(z, \beta) \quad (1.f)$$

Since, the slope of the hedonic price function is analogous to the price of the characteristics or marginal willingness to pay for the characteristics, Equation 1.e states that MWTP depends on the level of the characteristics and other variables such as of the characteristics and other variables such as income. Similarly, equation 1.f is analogous to an inverse supply function, with the price related to the quantity supplied (in this case quantity of the characteristics) and factors that reflect the cost of the industry β.

Limitations of Hedonic Pricing Method:

1. **Omitted variable bias:** if some variable that significantly affects house price is omitted from the HP equation and is in addition correlated with one of the included variables, then the coefficient on this included variable will be biased. this included variable will be biased.
2. **Multi-collinearity:** some environmental variables (such as alternative air pollution indicators) may be highly collinear. This means that separate equations for each may need to be estimated, otherwise the implicit prices will be difficult to entangle
3. **Choice of functional form for the HP function**. Economic theory does not specify which non-linear function should be used for the HP equation function should be used for the HP equation.
4. **Expected versus actual characteristics levels:** house sale may be a function of expected future environmental conditions in addition to current observed conditions.

3.2.1 Dose Response Method

Dose response method involves finding a link between environmental change and production conditions for some marketed goods. Depending on the behavioral assumptions made and the statistical techniques employed, welfare estimates are then calculated using changes in, e.g., profits from the production of marketed goods.

For example, Ellis and Fischer (1987) estimated the contribution that wetland protection makes to the production of shellfish. They estimated a production function for Florida blue club off the Florida Gulf Coast which includes wetland club off the Florida Gulf Coast which includes wetland acreage as an input along with labour and capital.

3.2.2 Averting Expenditure Avoided Cost Method

This method tries to measure welfare loss to a household due to increase in averting or preventing expenditure arising out of decrease in environmental quality . The main notion is that a household produces flow of certain services or goods combining various inputs, one of which is environmental quality. For example, a rural household might combine water taken from its well with purification equipment to produce water potable.

Now, if water quality in the well declines, the household must increase its expenditure on other inputs to maintain quality of drinking water constant. This averting expenditure, as Cournot and Potter (1981) showed, can be used to measure welfare loss to the household household of the decline decline in environmental environmental quality. Other examples may include: the value of reduced risks of car accidents (Blomquist 1979), value of reduced risk of death as the result of fitting smoke alarms and noise nuisance from airports (layard 1972)

1. The conditions under which changes in averting expenditure (AE) produces exact welfare measures are
2. The AE must not be a joint product (i.e. it must not generate other benefits apart from offsetting the change in environmental quality)
3. The AE must be perfect substitute for the change in environmental quality

The change in AE must be entirely due to the change in environmental quality 4. None of the inputs must enter directly in to the persons' utility function

Expenditure must not yield benefits outliving the pollution incident

These conditions could be summarized as follows:

$$V(W\ Q1, Y) = V(WQ2, Y - AE)$$

Where, V is indirect utility, WQ is well water quality, Where, V is indirect utility, WQ is well water quality, Y is income, AE measures Averting Expenditure and W Q1 > W Q2 .

In other words, utility with the higher level of well water quality and no averting expenditure is equal to utility with a lower level of well water quality and AE.

3.2.3 Travel Cost Method

One of the oldest approaches to environmental valuation Proposed in a letter from Harold Hotelling to the US Forest Service in the 1930's, first used by Wood and Trice in 1958, popularized by Clawsen and Knetsch (1966) Premises • People bear cost to visit regions or sites (national park or estate) • Hypothesis : These costs are at least equal to the minimum value of the benefit people get when visiting the sites and their environmental goods or services. Thus these travel costs can be used as a proxy for the price of visiting outdoor recreational sites . (In other words, the recreational benefits at a specific site can be derived from the demand functions that relate observed user's behaviour to the cost of visit.)

Steps of Analysis

1. Estimate the cost of travel and visit for each regions of origin
2. Questionnaire : visitors trip, expenses and characteristics
3. Estimate of the demand for the site (and environmental goods and services) depending on the cost of travel and visit and other characteristics

Options for Applying the Travel Cost Method

A simple zonal travel cost approach, using mostly secondary data, with some simple data collected from visitors. The zonal travel cost method is applied by collecting information on the number of visits to the site from different distances.

An individual travel cost approach, using a more detailed survey of visitors. The individual travel cost approach is similar to the zonal approach, but uses survey data from individual visitors in the statistical analysis, rather than data from each zone. This method

thus requires more data collection and slightly more complicated analysis, but will give more precise results.

Hedonic Travel Cost Model which attempts to place values on the characteristics of recreational resources.

A random utility approach has been used to survey other data with more complicated statistical techniques. The random utility approach assumes that individuals will pick the site that they prefer, out of all possible fishing sites. Individuals make tradeoffs between site quality and the price of travel to the site. Hence, this model requires information on all possible sites that a visitor might select, their quality characteristics, and the travel costs to each site.

The travel cost method is applied by collecting information on the number of visits to the site from different distances. Because the travel and time costs will increase with distance, this information allows the researcher to calculate the number of visits purchased at different prices: the demand function and the consumer surplus, or economic benefits, for the recreational services of the site.

Step 1: The first step is to define a set of zones surrounding the site. These may be defined by concentric circles around the site, or by geographic divisions that make sense, such as metropolitan areas or counties surrounding the site at different distances.

Step 2: The second step is to collect information on the number of visitors from each zone, and the number of visits made in the last year.

Step 3: The third step is to calculate the visitation rates per 1000 population in each zone. This is simply the total visits per year from the zone, divided by the zone's population in thousands.

Step 4: The fourth step is to calculate the average round-trip travel distance and travel time to the site for each zone, using average cost per mile and per hour of travel time. What is the opportunity cost of time?

Step 5: The fifth step is to estimate, using regression analysis, the equation that relates visits per capita to travel costs and other important variables. From this, the researcher can estimate the demand function for the average visitor. In this simple model,

the analysis might include demographic variables, such as age, income, gender, and education levels, using the average values for each zone.

Step 6: The sixth step is to construct the demand function for visits to the site, using the results of the regression analysis. The first point on the demand curve is the total visitors to the site at current access costs (assuming (assuming there is no entry fee for the site), which in this example is 1600 visits per year.

Step 7: The final step is to estimate the total economic benefit of the site to visitors by calculating the consumer surplus, or the area under the demand curve.

Simple Travel Cost Model:

If the price (p) is the only sacrifice made by a consumer, the demand function for a good with no substitutes is x=f(p), given income and preferences. However, the consumer often incurs other costs (c), such as travel expenses and loss of time. In this case, the demand function is expressed as x = f(p, c). Under these conditions, the utility maximising consumer's behaviour should be reformulated in order to take such costs into account.

Simple Travel Cost Model: Given two goods or services (x1, x2), their prices (p1, p2), the access costs (c1, c2) and income (R), the utility maximizing choice of the consumer is:

$$\text{Max} = u(x, x)\ U = u(x1,x2)$$

$$\text{Subject to: } (p1 + c1)\, x1 + (p2 + c2)x2 = R \quad (1)$$

Now, let 'x1' denote the aggregate of priced goods and services, x2 the number of annual visits to a recreational site, and assume for the sake of simplicity that the cost of access to the market goods is negligible '(c1=0)' and that the recreational site is free (p2=0).

Under these assumptions, equation [1] can be written as:

$$\text{MaxU} = u(x1,x2)) \text{ Subject to: } p1x1 + c2x2 = R \quad (2)$$

Under these conditions, the utility maximizing behavior of the consumer depends on:

His preferences [u(x1, x2)],

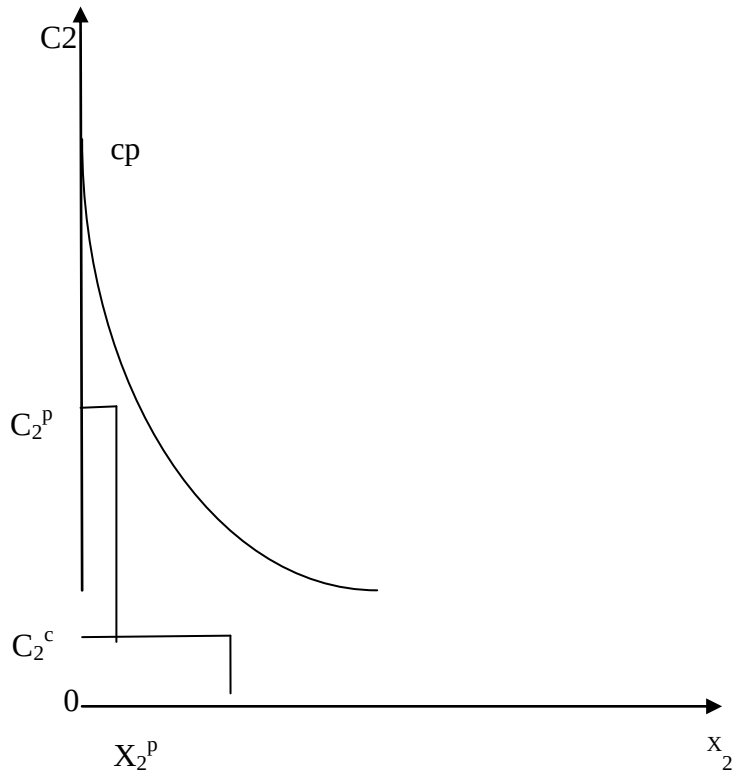
His budget (R),

The prices of the private goods and services (p1) and

The access cost to the recreational site (c2)

The TCM is based on the assumption that changes in the costs of access to the recreational site (c2) have the same effect as a change in price: the number of visits to a site decreases as the cost per visit increases. Under this assumption, the demand function for visits to the recreational site is x2=f(c2) and can be estimated using the number of annual visits as long as it is possible possible to observe observe different costs per visit and up to the cost at which visits become equal to zero. This simple model can be extended to include the effect of other substitute sites. Alternatively, same model can be used to estimate visits per time be an individual to site with c and p becoming specific to the individual only.

The basic TCM model is completed by the weak complementarily assumption, which states that trips are a non-decreasing function of the quality of the site, and that the individual forgoes trips to the recreational site when the quality quality is the lowest possible



The Figure depicts the expected relationship between the number of visits and cost per visit, given other variables, showing that the number of visits decreases as the cost per visit increases.

Hedonic Travel Cost Model

On many occasion, we interested in the value of changing characteristics of a site rather than in the value of the site in toto. In this respect, hedonic travel cost model attempts to place values on the characteristics of recreational resources. Hedonic travel cost model was first proposed by Brown and Mendelsohn (1984) and has been applied recently to forest characteristics by Englin and Mendelsohn (1991) and coastal water quality by Bockstael et. al. (1987)

Hedonic Travel Cost Model: Steps: 1.Respondents to a number of sites (e.g. forest) are sampled to determine their zone of origine. The levels of physical characteristics are recorded for each site A travel cost function is estimated for each zone, as

$$C(Z) = c0 + c1z1 + c2z2 + \ldots cmzm \quad (1)$$

Where, C (Z) are travel costs, z1 is distance to site, z1 . . . zm are characteristics and c0 . .. cm are coefficients to be estimated.

Hedonic Travel Cost Model: Steps: A separate regression is performed for each zone of origin such that each will have a vector of coefficients {c0… cm}. For a given characteristics m, the utility maximising individual will choose visits such that the marginal costs of characteristics (the coefficient cm) is just equal to the marginal benefit to him.

Hedonic Travel Cost Model: Steps: 2. Estimate a demand curve for each characteristics regressing a site characteristic levels (dependent variable) against the predicted marginal cost of that characteristic and socioeconomic variables for each zone of origin. A separate regression is run for each characteristic. The expectation is that the coefficient on the marginal cost variable will be negative implying that as the level of characteristics rises people are unwilling to pay as much for each further increment.

Issues and Limitations of the Travel Cost Method

The travel cost method assumes that people perceive and respond to changes in travel costs the same way that they would respond to changes in admission price.

The most simple models assume that individuals take a trip for a single purpose to visit a specific recreational site.

Defining and measuring the opportunity cost of time, or the value of time spent traveling, can be problematic. Because the time spent traveling could have been used in other ways, it has an "opportunity cost." This should be added to the travel cost, or the value of the site will be underestimated. However, there is no strong consensus on the appropriate measure: the person's wage rate or some fraction of the wage rate and the value chosen can have a large effect on benefit estimates.

If people enjoy the travel itself, then travel time becomes a benefit, not a cost, and the value of the site will be overestimated. The availability of substitute sites will affect values.

Interviewing visitors on site can introduce sampling biases to the analysis.
Measuring recreational quality and relating recreational quality to environmental quality can be difficult.

Standard travel cost approaches provides information about current conditions, but not about gains or losses from anticipated changes in resource conditions from anticipated changes in resource conditions.

In order to estimate the demand function, there needs to be enough difference between distances traveled to affect travel costs and for differences in travel costs to affect the number of trips made. Thus, it is not well suited for sites near major population centers where many visitations may be from "origin zones" that are quite close to one another.

The travel cost method is limited in its scope of application because it requires user participation. It cannot be used to assign values to on-site environmental features and functions that users of the site do not find valuable.

Most importantly, it cannot be used to measure Most importantly, it cannot be used to measure nonuse values. Thus, sites that have unique qualities that are valued by non-users will be undervalued.

As in all statistical methods, certain statistical problems can affect the results. These include choice of the functional form used to estimate the demand curve, choice of the estimating method, and choice of variables included in the model.

3.2.4 Contingent Valuation Method

Contingent Valuation Method (CVM) was first used by Davis (1963) in a study of hunters in Maine and it was widely developed with Bohm (1972), Randal et.al. (1974), Brookshire et. al., (1976) etc. The essence of CVM method involves asking

The essence of CVM method involves asking individual to imagine some situation that is typically outside the individual's experience and speculate on how he or she would act in such a situation.

It is called 'contingent valuation' because the valuation is contingent on the hypothetical scenario put to respondents.

1. CVM exercise can be split in to five stages:
2. Setting up the hypothetical market
3. Obtaining bids
4. Estimating mean WTP and or WTAC
5. Estimating bid curves
6. Aggregating the data

As Carson (1991) noted, there are six main component of a successful CV study:

1 .Define Market Scenario

2 .Choose elicitation method

3 .Design market administration

4 .Design sampling

5 .Design of experiment

6 .Estimate willingness-to-pay function

Define Market Scenario:

Is the information to be conveyed to a respondent? (i.e. one who will be asked about willingness to pay) To place the respondent in the right time frame of To place the respondent in the right time frame of mind to give meaning response to questions Description of the market should be realistic to the respondent and Defining appropriate payment mechanism

Choosing Elicitation Method:

Having properly defined the market scenario, the next step is to decide how best to obtain the valuation process. There are four ways of eliciting value: direct question, bidding game, payment card and referendum choice.

Under direct questioning the main task is to ask the respondents about their willingness to pay for the good. However, this suffers from a great demerit in the sense that there are few real markets in which we ask the respondent to generate data and in most occasion people may not spend much effort in determining their willingness to pay which may result in extreme response (either zeroes and very large numbers)

2.2 Bidding Game

Bidding game approach was first used by Randal et.al (1974). This approach involves a WTP number and seeks a yes-no response yes-no response. If the respondent replies yes, the amount is gradually increased until a no response is received. Similarly, if the respondent replies no, the amount is gradually decreased until a yes is received. The main problem with this approach is the starting-point bias.

2.3 Payment Card

A card with a number of figures, spanning the range of responses that might be expected. Each card has payment amounts along with several reference expenditure amount. The basic problem with the payment card is that they cannot be used for telephone surveys.

2.4 Referendum or discrete choice

Under this approach a willingness to pay figure is offered to the respondent who is asked if he or she would be willing to pay that amount, ‘yes’ or ‘no’. This approach

although has the merit of minimizing possible bias and is also familiar to the people in that people often vote yes/no on public referenda. One problem with referenda is that more data are needed to obtain statistically significant results which raised cost of the survey.

3. Design Market Administration:

Three approaches to survey administration: mail, telephone and in-person Mail Survey: cheaper to administer but suffers from the problem of acute non-response the problem of acute non-response Telephone Survey: relatively inexpensive to administer but limited by the availability of telephone within the population being surveyed. In-person Survey: Most expensive to administer but can be more reliable. However it suffers from the problem of interviewer bias.

Sample Design

It involves two steps: First, select the group (relevant for the study) from which to draw the sample. Second, draw the random sample.

Experimental Design

Experimental design requires careful design of survey instrument, its administration and its ultimate statistical analysis.

Estimation of Willingness to Pay Function

The last step of the Contingent Valuation Method is to take the survey results and correctly estimate the WTP functions

Problems with the Contingent Valuation Methods

Despite significant application of CV technique in eliciting values of environmental goods, the method has been scrutinized and found to suffer from a large number of limitations. Following are the important limitations of this method:

The value elicited in CV surveys are not based on real resource decisions - they are hypothetical. Presence of ambiguity in what people are valuing Problem of embedding. This problem generally pertains to the inconsistencies that people face when they are to value an environmental good (e.g. park) versus a group of environmental goods (several parks in our case) when they are substitutes. Another related problem is the valuation of existence value.

Valuing the Environment: Meaning and Need for Environment Valuation

Meaning

A measure used in survey-based valuation techniques, known as contingent valuation method, indicates an individual's willingness to pay money to obtain some derived level of a good or service for an improved environment. Value can be broadly categorized as either instrumental or intrinsic. Instrumental value refers to the capacity of something when used, to satisfy a want or preference. Intrinsic value is regarded by ecological economists as being inherent in something.

Instrumental or use value, can be defined as "accruing from those benefits which are attributed to present consumption of the resources". A distinction is made between direct and indirect use values. Direct use value may emerge from exchange or outside of exchange through self-consumption of resources to which individuals have access. On the other hand, indirect use value is the main consequence of the ecological functions that the natural resources perform. There is also option value and existence value. Option value refers to willingness of the people to keep the option of postponing the decision on the use of the resources. Existence value represents the value which an individual is willing to pay for the environmental amenity, even though that person receives no direct value. The existence value is often termed as non-use value.

Conceptually, the total economic value (TEV) of a resource consists of its use value (UV) and non-use value (NUV)

$$TEV = UV + NUV$$

Further, use value may be divided into direct use value (DUV), the indirect use value (IUV) and the option value (OV). Therefore, equation (1) can be rewritten as

$$TEV = [DUV + TUV + OV] + [NUV]$$

In the context of uncertainty, quasi option value is said to define the value of preserving options for future use in the expectation that knowledge about the potential benefits or costs is associated with the option. The basic concept of economic valuation underlying all these techniques is the Willingness to Pay (WTP) of individuals for an environmental service or resource.

A measure used in survey-based valuation techniques, known as contingent valuation method, indicates an individual's willingness to pay money to obtain some derived level of a good or service for an improved environment. The WTP measure is used when market prices do not exist.

Another concept of economic valuation is Willingness to Accept (WTA). It is a measure of what an individual would have to be given to cause him/her to accept a loss in welfare caused by, for example, a decline in the level of resources or environmental quality. The WTA measure indicates the monetary equivalent that would be necessary to compensate for the welfare loss from the change.

Non-use value is the **value** that people assign to economic goods (including public goods) even if they never have and never will **use** it. It is distinguished from **use value**, which people derive from direct **use** of the good. The concept is most commonly applied to the **value** of natural and built resources.

In cost–benefit analysis and social welfare economics, the term **option value** refers to the **value** that is placed on private willingness to pay for maintaining or preserving a public asset or service even if there is little or no likelihood of the individual actually ever using it.

1. **Existence values** are an unusual and somewhat controversial class of economic**value**, reflecting the benefit people receive from knowing that a particular environmental resource, such as Antarctica, the Grand Canyon, endangered species, or any other organism or thing **exists**.
2. **Bequest value**, in economics, is the **value** of satisfaction from preserving a natural environment or a historic environment, in other words natural heritage or cultural heritage for future generations. It is often used when estimating the **value** of an environmental service or good.

Need for Environmental Valuation:

The need for environmental valuation arises for the following:

Environmental Litigation

Non-market demand valuation have traditionally been used by government to assess the damage compensation and need for further changes in environmental policy.

Environmental Dispute Resolution

Environmental disputes frequently arise with respect to logging, new water storage, new mines, power stations and resort development etc. Estimates of environmental values potentially has a role to play in supporting more informed decision making in these cases, and in making decisions more transparent to stakeholders.

Guiding Environmental Regulations

Policy makers have to take decisions regarding environmental regulations. They will be better informed if environmental damage cost considerations are taken into account.

Evaluating Proposed Environment Programmes

A public cost- benefit framework is appropriate to assess the desirability of government initiative, such as green house gas reduction programmes and health programmes. These usually involve various social and environmental impacts of these programmes which the policy makers want to assess.

Contingent Valuation Method

Introduction

The contingent valuation method (CVM) is used to estimate economic values for all kinds of ecosystem and environmental services. It can be used to estimate both use and non use values, and it is the most widely used method for estimating non-use values. It is also the most controversial of the non-market valuation methods.

The contingent valuation method involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services. In some cases, people are asked for the amount of compensation they would be willing to accept to give up specific environmental services. It is called "contingent" valuation, because people are asked to state their willingness to pay, *contingent* on a specific hypothetical scenario and description of the environmental service.

The contingent valuation method is referred to as a "stated preference" method, because it asks people to directly state their values, rather than inferring values from actual choices, as the "revealed preference" methods do. The fact that CV is based on what people say they would do, as opposed to what people are observed to do, is the source of its greatest strengths and its greatest weaknesses.

Contingent valuation is one of the only ways to assign dollar values to non-use values of the environment—values that do not involve market purchases and may not involve direct participation. These values are sometimes referred to as "passive use" values. They include everything from the basic life support functions associated with ecosystem health or biodiversity, to the enjoyment of a scenic vista or a wilderness experience, to appreciating the option to fish or bird watch in the future, or the right to bequest those options to your grandchildren. It also includes the value people place on simply knowing that giant pandas or whales exist.

It is clear that people are willing to pay for non-use, or passive use, environmental benefits. However, these benefits are likely to be implicitly treated as zero unless their dollar value is somehow estimated. So, how much are they worth? Since people do not reveal their willingness to pay for them through their purchases or by their behavior, the only option for estimating a value is by asking them questions.

However, the fact that the contingent valuation method is based on asking people questions, as opposed to observing their actual behavior, is the source of enormous controversy. The conceptual, empirical, and practical problems associated with developing dollar estimates of economic value on the basis of how people respond to hypothetical questions about hypothetical market situations are debated constantly in the economics literature. CV researchers are attempting to address these problems, but they are far from finished. Meanwhile, many economists, as well as many psychologists and sociologists, for many different reasons, do not believe the dollar estimates that result from CV are valid. More importantly, many jurists and policy-makers will not accept the results of CV. Because of its controversial nature, users must be extremely cautious about spending money on CV studies and about using the results of CV studies.

This section continues with some example applications of the contingent valuation method, followed by a more complete technical description of the method and its advantages and limitations.

Hypothetical Scenario

A remote site on public land provides important habitat for several species of wildlife. The management agency in charge of the area must decide whether to issue a lease for mining at the site. Thus, they must weigh the value of the mining lease against the wildlife habitat benefits that may be lost if the site is developed. Because the area is remote, few people actually visit it, or view the animals that rely on it for habitat. Therefore, non-use values are the largest component of the value for preserving the site.

Further, the contingent valuation method was selected in this case because of the importance of non-use values, and their potentially significant levels.

Alternative Approaches

Since non-use values are significant, and few people actually visit the site, other methods, such as the travel cost method, will underestimate the benefits of preserving the site. In this case, contingent choice methods might also be used, depending on the questions that must be answered, and whether contingent choice question formats are more effective than standard contingent valuation questions. This would be decided in the survey development stage of the application.

Application of the Contingent Valuation Method

Step 1

The first step is to define the valuation problem. This would include determining exactly what services are being valued, and who the relevant population is. In this case, the resource to be valued is a specific site and the services it provides – primarily wildlife habitat. Because it is federally owned public land, the relevant population would be all citizens of the US.

Step 2

The second step is to make preliminary decisions about the survey itself, including whether it will be conducted by mail, phone or in person, how large the sample size will

be, who will be surveyed, and other related questions. The answers will depend, among other things, on the importance of the valuation issue, the complexity of the question being asked, and the size of the budget.

In-person interviews are generally the most effective for complex questions, because it is often easier to explain the required background information to respondents in person, and people are more likely to complete a long survey when they are interviewed in person. In some cases, visual aids such as videos or color photographs may be presented to help respondents understand the conditions of the scenario that they are being asked to value.

In-person interviews are generally the most expensive type of survey. However, mail surveys that follow procedures that aim to obtain high response rates can also be quite expensive. Mail and telephone surveys must be kept fairly short, or response rates are likely to drop dramatically. Telephone surveys may be less expensive, but it is often difficult to ask contingent valuation questions over the telephone, because of the amount of background information required.

In this hypothetical case, the researchers have decided to conduct a mail survey, because they want to survey a large sample, over a large geographical area, and are asking questions about a specific site and its benefits, which should be relatively easy to describe in writing in a relatively short survey.

Step 3

The next step is the actual survey design. This is the most important and difficult part of the process, and may take six months or more to complete. It is accomplished in several steps. The survey design process usually starts with initial interviews and/or focus groups with the types of people who will be receiving the final survey, in this case the general public. In the initial focus groups, the researchers would ask general questions, including questions about peoples' understanding of the issues related to the site, whether they are familiar with the site and its wildlife, whether and how they value this site and the habitat services it provides.

In later focus groups, the questions would get more detailed and specific, to help develop specific questions for the survey, as well as decide what kind of background

information is needed and how to present it. For example, people might need information on the location and characteristics of the site, the uniqueness of species that have important habitat there, and whether there are any substitute sites that provide similar habitat. The researchers would also want to learn about peoples' knowledge of mining and its impacts, and whether mining is a controversial use of the site. If people are opposed to mining, they may answer the valuation questions with this in mind, rather than expressing their value for the services of the site. At this stage, test different approaches to the valuation question and different payment mechanisms would be tested. Questions that can identify any "protest" bids or other answers that do not reveal peoples' values for the services of interest would also be developed and tested at this stage.

After a number of focus groups have been conducted, and the researchers have reached a point where they have an idea of how to provide background information, describe the hypothetical scenario, and ask the valuation question, they will start pre-testing the survey. Because the survey will be conducted by mail, it should be pretested with as little interaction with the researchers as possible. People would be asked to assume that they've received the survey in the mail and to fill it out. Then the researchers would ask respondents about how they filled it out, and let them ask questions about anything they found confusing. Eventually, a mail pretest might be conducted. The researchers continue this process until they've developed a survey that people seem to understand and answer in a way that makes sense and reveals their values for the services of the site.

Step 4

The next step is the actual survey implementation. The first task is to select the survey sample. Ideally, the sample should be a randomly selected sample of the relevant population, using standard statistical sampling methods. In the case of a mail survey, the researchers must obtain a mailing list of randomly sampled U.S. citizens. They would then use a standard repeat-mailing and reminder method, in order to get the greatest possible response rate for the survey. Telephone surveys are carried out in a similar way, with a certain number of calls to try to reach the selected respondents. In-person surveys

may be conducted with random samples of respondents, or may use "convenience" samples – asking people in public places to fill out the survey.

Step 5

The final step is to compile, analyze and report the results. The data must be entered and analyzed using statistical techniques appropriate for the type of question. In the data analysis, the researchers also attempt to identify any responses that may not express the respondent's value for the services of the site. In addition, they can deal with possible non-response bias in a number of ways. The most conservative way is to assume that those who did not respond

Applying the Contingent Valuation Method

Applying the contingent valuation method is generally a complicated, lengthy, and expensive process. In order to collect useful data and provide meaningful results, the contingent valuation survey must be properly designed, pre-tested, and implemented. Contingent valuation survey questions must focus on specific environmental service(s) and a specific context that is clearly defined and understood by survey respondents. In other words, a CV survey to assess the dollar value of the results of an environmental improvement cannot be based on the environmental improvement itself, but on increases in specific environmental services that the improvement is expected to provide.

The results of contingent valuation surveys are often highly sensitive to what people believe they are being asked to value, as well as the context that is described in the survey. Thus, it is essential for CV researchers to clearly define the services and the context, and to demonstrate that respondents are actually stating their values for these services when they answer the valuation questions.

A good CV study will consider the following in its application:

Before designing the survey, learn as much as possible about how people think about the good or service in question. Consider people's familiarity with the good or service, as well as the importance of such factors as quality, quantity, accessibility, the availability of substitutes, and the reversibility of the change.

Determine the extent of the affected populations or markets for the good or service in question, and choose the survey sample based on the appropriate population.

The choice scenario must provide an accurate and clear description of the change in environmental services associated with the event, program, investment, or policy choice under consideration. If possible, convey this information using photographs, videos, or other multi-media techniques, as well as written and verbal descriptions.

Unlike ordinary survey questions, which sometimes ask respondents whether they are willing to pay x dollars to improve "air quality," the nature of the good and the changes to be valued must be specified in detail in a CV survey. It is also important to make sure that respondents do not inadvertently assume that one or more related improvements are included. For example, if people are asked to value only air visibility, it would be important to make sure that they do not include their value for health-related improvements in their stated willingness to pay amount. Similarly, if people have a tendency to think of environmental improvements in general, even when asked about water quality alone, it would be necessary to point out specifically that environmental quality, other than water quality, would remain the same.

Questions can be asked in a variety of ways, using both open-ended and closed-ended formats. In the open-ended format, respondents are asked to state their maximum willingness to pay for the environmental improvement. With the closed-ended format, also referred to as discrete choice, respondents are asked whether or not they would be willing to pay a particular amount for the environmental improvement, or whether they would vote yes or no for a specific policy at a given cost. The discrete choice format is generally accepted as the preferred method.

In addition to the hypothetical question that asks for willingness to pay, the survey must specify the mechanism by which the payment will be made, for example through increased taxes. In order for the question to be effective, the respondent must believe that if the money was paid, whoever was collecting it could effect the specified environmental change.

Respondents should be reminded to consider their budget constraints. Specify whether comparable services are available from other sources, when the good is going to be provided, and whether the losses or gains are temporary or permanent.

Respondents should understand the frequency of payments required, for example monthly or annually, and whether or not the payments will be required over a long period of time in order to maintain the quantity or quality change. They should also understand who would have access to the good and who else will pay for it, if it is provided.

In the case of collectively held goods, respondents should understand that they are currently paying for a given level of supply. The scenario should clearly indicate whether the levels being valued are improvements over the status quo, or potential declines in the absence of sufficient payments.

If the household is the unit of analysis, the reference income should be the household's, rather than the respondent's, income.

Thoroughly pre-test the valuation questionnaire for potential biases. Pre-testing includes testing different ways of asking the same question, testing whether the question is sensitive to changes in the description of the good or resource being valued, and conducting post-survey interviews to determine whether respondents are stating their values as expected.

Include validation questions in the survey, to verify comprehension and acceptance of the scenario, and to elicit socioeconomic and attitudinal characteristics of respondents, in order to better interpret variation in responses across respondents.

CVM can be conducted as in-person interviews, telephone interviews or mail surveys. The in-person interview is the most expensive survey administration format, but is generally considered to be the best approach, especially if visual materials are to be presented. Interview a large, clearly defined, representative sample of the affected population. Achieve a high response rate and a mix of respondents that represents the population.

Whatever survey instruments and survey designs are used, and whatever response rate is achieved, makes sure that survey results are analyzed and interpreted by professionals before making any claims about the resulting dollar values.

Advantages of the Contingent Valuation Method

Contingent valuation is enormously flexible in that it can be used to estimate the economic value of virtually anything. However, it is best able to estimate values for goods and services that are easily identified and understood by users and that are consumed in discrete units (e.g., user days of recreation), even if there is no observable behavior available to deduce values through other means.

CV is the most widely accepted method for estimating total economic value , including all types of non-use, or "passive use," values. CV can estimate use values , as well as existence values , option values , and bequest values .

Though the technique requires competent survey analysts to achieve defensible estimates, the nature of CV studies and the results of CV studies are not difficult to analyze and describe. Dollar values can be presented in terms of a mean or median value per capita or per household, or as an aggregate value for the affected population.

CV has been widely used, and a great deal of research is being conducted to improve the methodology, make results more valid and reliable, and better understand its strengths and limitations.

Issues and Limitations of the Contingent Valuation Method

Although the contingent valuation method has been widely used for the past two decades, there is considerable controversy over whether it adequately measures people's willingness to pay for environmental quality.

People have practice making choices with market goods, so their purchasing decisions in markets are likely to reflect their true willingness to pay. CV assumes that people understand the good in question and will reveal their preferences in the contingent market just as they would in a real market. However, most people are unfamiliar with placing dollar values on environmental goods and services. Therefore, they may not have an adequate basis for stating their true value.

The expressed answers to a willingness to pay question in a contingent valuation format may be biased because the respondent is actually answering a different question than the surveyor had intended. Rather than expressing value for the good, the respondent might actually be expressing their feelings about the scenario or the valuation

exercise itself. For example, respondents may express a positive willingness to pay because they feel good about the act of giving for a social good (referred to as the "warm glow" effect), although they believe that the good itself is unimportant. Respondents may state a positive willingness to pay in order to signal that they place importance on improved environmental quality in general. Alternatively, some respondents may value the good, but state that they are not willing to pay for it, because they are protesting some aspect of the scenario, such as increased taxes or the means of providing the good.

Respondents may make associations among environmental goods that the researcher had not intended. For example, if asked for willingness to pay for improved visibility (through reduced pollution), the respondent may actually answer based on the health risks that he or she associates with dirty air.

Some researchers argue that there is a fundamental difference in the way that people make hypothetical decisions relative to the way they make actual decisions. For example, respondents may fail to take questions seriously because they will not actually be required to pay the stated amount. Responses may be unrealistically high if respondents believe they will not have to pay for the good or service and that their answer may influence the resulting supply of the good. Conversely, responses may be unrealistically low if respondents believe they will have to pay.

The payment question can either be phrased as the conventional 'What are you willing to pay (WTP) to receive this environmental asset?', or in the less usual form, 'What are you willing to accept (WTA) in compensation for giving up this environmental asset?' In theory, the results should be very close. However, when the two formats have been compared, WTA very significantly exceeds WTP. Critics have claimed that this result invalidates the CVM approach, showing responses to be expressions of what individuals would like to have happen rather than true valuations.

If people are first asked for their willingness to pay for one part of an environmental asset (e.g. one lake in an entire system of lakes) and then asked to value the whole asset (e.g. the whole lake system), the amounts stated may be similar. This is referred to as the "embedding effect."

In some cases, people's expressed willingness to pay for something has been found to depend on where it is placed on a list of things being valued. This is referred to as the "ordering problem."

Respondents may give different willingness to pay amounts, depending on the specific payment vehicle chosen. For example, some payment vehicles, such as taxes, may lead to protest responses from people who do not want increased taxes. Others, such as a contribution or donation, may lead people to answer in terms of how much they think their "fair share" contribution is, rather than expressing their actual value for the good.

Many early studies attempted to prompt respondents by suggesting a starting bid and then increasing or decreasing this bid based upon whether the respondent agreed or refused to pay a sum. However, it has been shown that the choice of starting bid affects respondents' final willingness to pay response.

Strategic bias arises when the respondent provides a biased answer in order to influence a particular outcome. If a decision to preserve a stretch of river for fishing, for example, depends on whether or not the survey produces a sufficiently large value for fishing, the respondents who enjoy fishing may be tempted to provide an answer that ensures a high value, rather than a lower value that reflects their true valuation.

Information bias may arise whenever respondents are forced to value attributes with which they have little or no experience. In such cases, the amount and type of information presented to respondents may affect their answers.

Non-response bias is a concern when sampling respondents, since individuals who do not respond are likely to have, on average, different values than individuals who do respond. Estimates of nonuse values are difficult to validate externally.

When conducted to the exacting standards of the profession, contingent valuation methods can be very expensive and time-consuming, because of the extensive pre-testing and survey work. Many people, including jurist's policy-makers, economists, and others, do not believe the results of CV.

Summary of the Hedonic Pricing Method

The hedonic pricing method is used to estimate the value of environmental amenities that affect prices of marketed goods. Most applications use residential housing prices to

estimate the value of environmental amenities. The method is based on the assumption that people value the characteristics of a good, or the services it provides, rather than the good itself. Thus, prices will reflect the value of a set of characteristics, including environmental characteristics, that people consider important when purchasing the good.

The hedonic pricing method may be used to estimate economic benefits or costs associated with: environmental quality, including air pollution, water pollution, or noise environmental amenities, such as aesthetic views or proximity to recreational sites

The hedonic pricing method is relatively straightforward and uncontroversial to apply, because it is based on actual market prices and fairly easily measured data. If data are readily available, it can be relatively inexpensive to apply. If data must be gathered and compiled, the cost of an application can increase substantially.

Applying the Hedonic Pricing Method Using Housing Prices

In general, the price of a house is related to the characteristics of the house and property itself, the characteristics of the neighborhood and community, and environmental characteristics. Thus, if non-environmental factors are controlled for, then any remaining differences in price can be attributed to differences in environmental quality. For example, if all characteristics of houses and neighborhoods throughout an area were the same, except for the level of air pollution, then houses with better air quality would cost more. This higher price reflects the value of cleaner air to people who purchase houses in the area.

To apply the hedonic pricing method, the following information must be collected:
A measure or index of the environmental amenity of interest.

Cross-section and/or time-series data on property values and property and household characteristics for a well-defined market area that includes homes with different levels of environmental quality, or different distances to an environmental amenity, such as open space or the coastline.

The data are analyzed using regression analysis , which relates the price of the property to its characteristics and the environmental characteristic(s) of interest. Thus, the effects of different characteristics on price can be estimated. The regression results

indicate how much property values will change for a small change in each characteristic, holding all other characteristics constant.

The analysis may be complicated by a number of factors. For example, the relationship between price and characteristics of the property may not be linear – prices may increase at an increasing or decreasing rate when characteristics change. In addition, many of the variables are likely to be correlated, so that their values change in similar ways. This can lead to understating the significance of some variables in the analysis. Thus, different functional forms and model specifications for the analysis must be considered.

Advantages of the Hedonic Pricing Method:

1. The method's main strength is that it can be used to estimate values based on actual choices.
2. Property markets are relatively efficient in responding to information, so can be good indications of value.
3. Property records are typically very reliable.
4. Data on property sales and characteristics are readily available through many sources, and can be related to other secondary data sources to obtain descriptive variables for the analysis.
5. The method is versatile, and can be adapted to consider several possible interactions between market goods and environmental quality.

Issues and Limitations

The scope of environmental benefits that can be measured is limited to things that are related to housing prices.

The method will only capture people's willingness to pay for perceived differences in environmental attributes, and their direct consequences. Thus, if people aren't aware of the linkages between the environmental attribute and benefits to them or their property, the value will not be reflected in home prices.

The method assumes that people have the opportunity to select the combination of features they prefer, given their income. However, the housing market may be affected by outside influences, like taxes, interest rates, or other factors.

The method is relatively complex to implement and interpret, requiring a high degree of statistical expertise.

1. The results depend heavily on model specification.
2. Large amounts of data must be gathered and manipulated.
3. The time and expense to carry out an application depends on the availability and accessibility of data.

Development Indicators and Human Health

Usually Development Indicators is a numerical measure of quality of life in a country. Indicators are used to illustrate progress of a country in meeting a range of economic, social, and environmental goals. Since indicators represent data that have been collected by a variety of agencies using different collection methods, there may be inconsistencies among them.

World Development Indicators (WDI) is the primary World Bank collection of development indicators, compiled from officially-recognized international sources. It presents the most current and accurate global development data available, and includes national, regional and global estimates.

HDI & PQLI: The HDI (Human Development Index) is a way to measure well being within a country. This is mainly a social measurement because it takes into consideration education, which is adult literacy rate and years of schooling, health care which is judged by life expectancy and finally the economic factor of GDP.

Gross Domestic Product (GDP): GDP is s how much money a country makes from its products over the course of a year, usually converted to US Dollars: the sum of gross value added by all resident producers in the economy + product taxes - any subsidies not included in the value of the products.

Gross National Product (GNP): GNP is the GDP of a nation together with any money that has been earned by investment abroad minus the income earned by non-nationals within the nation.

GNP per capita: GNP per capita is calculated as GNP divided by population; it is usually expressed in US Dollars. It's a common indicator used for measuring

development, but is imperfect as the calculation doesn't take into account certain forms of production, such as subsistence production.

Birth and Death Rates: Crude Birth and Death rates (per 1000) can be used as an overall measure of the state of healthcare and education in a country, though these numbers do not give a full picture of a nation's situation.

1. The Human Development Index (HDI)
2. The HDI is a composite statistic calculated from the:
3. Life expectancy index
4. Education index
5. Mean years of schooling index
6. Expected years of schooling index

Income index: Countries are ranked based on their score and split into categories that suggest how well developed they are.

Infant mortality rate: Infant mortality rate is the number of infants dying before reaching one year of age per 1,000 live births in a given year.

Literacy rate: The rate, or percentage, of people who are able to read is a useful indicator of the state of education within a country.

High female literacy rates generally correspond with an increase in the knowledge of contraception and a falling birth rate.

Life expectancy

This simple statistic can be used as an indicator of the: healthcare quality in a country or province level of sanitation & provision of care for the elderly

2.4 Natural Resource Accounting

Resource accounting sometimes refers to a limited approach using satellite accounts where natural resources are measured, sometimes in purely physical terms, while the main monetary aggregates (particularly GDP) remain unmodified. Environmental accounting can refer to adjustments reflecting pollution or changes in environmental amenities, while 'Green GDP' explicitly refers to adjustment of the major economic indicator.

Resource and environmental accounting - definitions There is a definitional problem in distinguishing between "natural resource accounting" and "environmental accounting". This distinction is not simple because the two terms are used in different ways. In some frameworks environmental accounting is seen as a subset of natural resource accounting (for example, the Norwegian system); in others, the reverse holds (for example, Wei11er, 1983). Thus a set of data may be termed a resource account in one country or by one analyst, and an environmental account in another context. There are, in fact, three different types of analysis that occur under an "accounting" label corresponding to the three functions that the environment plays in the economy. These functions are: - an assimilator of residuals - for example, the sea as a sink for wastes - a source of goods - for example, air - a source of resources - for example, copper (Common & Pearce, 1981, p.291).

These three functions give rise to three concerns: - pollution and its control - conservation of the natural state of the environment - depletion of natural resources Quantifying aspects of either of the first two in a systematic manner is frequently called "environmental accounting" whereas quantifying the third is frequently called "resource accounting". But this does not always hold. There appears to be an emerging viewpoint that such distinctions are no longer appropriate. "Scarcity" is increasingly being seen as including scarcity of common property resources such as air and water. Hunting terms this "the new scarcity" because it is the scarcity of clean air and water which is beginning to bite in

3.4 Life-Cycle Assessment

Life-cycle assessment (**LCA**, also known as **life-cycle analysis**, **eco-balance**, and **cradle-to-grave analysis**) is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. Designers use this process to help critique their products. LCAs can help avoid a narrow outlook on environmental concerns by:

1. Compiling an inventory of relevant energy and material inputs and environmental releases;

2. Evaluating the potential impacts associated with identified inputs and releases;
3. Interpreting the results to help make a more informed decision.

Goal and scope

An LCA starts with an explicit statement of the goal and scope of the study, which sets out the context of the study and explains how and to whom the results are to be communicated. This is a key step and the ISO standards require that the goal and scope of an LCA be clearly defined and consistent with the intended application. The goal and scope document therefore includes technical details that guide subsequent work:

the functional unit, which defines what precisely is being studied and quantifies the service delivered by the product system, providing a reference to which the inputs and outputs can be related. Further, the functional unit is an important basis that enables alternative goods, or services, to be compared and analyzed.[10] So to explain this a functional system which is inputs, processes and outputs contains a functional unit, that fulfills a function, for example paint is covering a wall, making a functional unit of $1m^2$ covered for 10 years. The functional flow would be the items necessary for that function, so this would be a brush, tin of paint and the paint itself.

the system boundaries; which are delimitations of which processes that should be included in the analysis of a product system.

Assumptions and limitations

The allocation methods used to partition the environmental load of a process when several products or functions share the same process; allocation is commonly dealt with in one of three ways: system expansion, substitution and partition. Doing this is not easy and different methods may give different results and

The impact categories chosen for example human toxicity, smog, global warming, Eutrophication.

Life Cycle Inventory (LCI) analysis involves creating an inventory of flows from and to nature for a product system. Inventory flows include inputs of water, energy, and raw materials, and releases to air, land, and water. To develop the inventory, a flow model of the technical system is constructed using data on inputs and outputs. The flow model is typically illustrated with a flow chart that includes the activities that are going to be

assessed in the relevant supply chain and gives a clear picture of the technical system boundaries. The input and output data needed for the construction of the model are collected for all activities within the system boundary, including from the supply chain (referred to as inputs from the technosphere).

The data must be related to the functional unit defined in the goal and scope definition. Data can be presented in tables and some interpretations can be made already at this stage. The results of the inventory is an LCI which provides information about all inputs and outputs in the form of elementary flow to and from the environment from all the unit processes involved in the study.

Inventory flows can number in the hundreds depending on the system boundary. For product LCAs at either the generic (i.e., representative industry averages) or brand-specific level, that data is typically collected through survey questionnaires. At an industry level, care has to be taken to ensure that questionnaires are completed by a representative sample of producers, leaning toward neither the best nor the worst, and fully representing any regional differences due to energy use, material sourcing or other factors. The questionnaires cover the full range of inputs and outputs, typically aiming to account for 99% of the mass of a product, 99% of the energy used in its production and any environmentally sensitive flows, even if they fall within the 1% level of inputs.

One area where data access is likely to be difficult is flows from the technosphere. The technosphere is more simply defined as the man-made world. Considered by geologists as secondary resources, these resources are in theory 100% recyclable; however, in a practical sense, the primary goal is salvage.[12] For an LCI, these technosphere products (supply chain products) are those that have been produced by man and unfortunately those completing a questionnaire about a process which uses a man-made product as a means to an end will be unable to specify how much of a given input they use. Typically, they will not have access to data concerning inputs and outputs for previous production processes of the product. The entity undertaking the LCA must then turn to secondary sources if it does not already have that data from its own previous studies. National databases or data sets that come with LCA-practitioner tools, or that can

be readily accessed, are the usual sources for that information. Care must then be taken to ensure that the secondary data source properly reflects regional or national conditions.

LCI Method

Process LCA

Economic Input Output LCA

Hybrid Approach

Life cycle impact assessment

Inventory analysis is followed by impact assessment. This phase of LCA is aimed at evaluating the significance of potential environmental impacts based on the LCI flow results. Classical life cycle impact assessment (LCIA) consists of the following mandatory elements:

Selection of impact categories, category indicators, and characterization models;

The classification stage, where the inventory parameters are sorted and assigned to specific impact categories; and

Impact measurement, where the categorized LCI flows are characterized, using one of many possible LCIA methodologies, into common equivalence units that are then summed to provide an overall impact category total.

In many LCAs, characterization concludes the LCIA analysis; this is also the last compulsory stage according to ISO 14044:2006. However, in addition to the above mandatory LCIA steps, other optional LCIA elements – normalization, grouping, and weighting – may be conducted depending on the goal and scope of the LCA study. In normalization, the results of the impact categories from the study are usually compared with the total impacts in the region of interest, the U.S. for example. Grouping consists of sorting and possibly ranking the impact categories. During weighting, the different environmental impacts are weighted relative to each other so that they can then be summed to get a single number for the total environmental impact. ISO 14044:2006 generally advises against weighting, stating that “weighting, shall not be used in LCA studies intended to be used in comparative assertions intended to be disclosed to the

public". This advice is often ignored, resulting in comparisons that can reflect a high degree of subjectivity as a result of weighting

Life cycle impacts can also be categorized under the several phases of the development, production, use, and disposal of a product. Broadly speaking, these impacts can be divided into "First Impacts,"[13] use impacts, and end of life impacts. "First Impacts" include extraction of raw materials, manufacturing (conversion of raw materials into a product), transportation of the product to a market or site, construction/installation, and the beginning of the use or occupancy. Use impacts include physical impacts of operating the product or facility (such as energy, water, etc.), maintenance, renovation and repairs (required to continue to use the product or facility). End of life impacts include demolition and processing of waste or recyclable materials.

3.5 Bio- Diversity Definition, Levels and Values

Biodiversity is derived from Greek words Bios meaning life and diversity meaning forms. Bio-diversity is the total variety of life on over planet. The total number of races, varieties or species i.e. the sum total of various types of microbes, plants and animals present in a system is referred to as biodiversity.

LEVELS OF BIODIVERSITY:

Genetic diversity (Alpha)

The total number of genes, also known as genetic diversity refers to variation of genes within a species which differ slightly from each other in one or more characters such as shape, size, disease resistance and ability to withstand vagaries of the environmental conditions. Genetic diversity is expressed in the form of breeds, races, varieties and forms.

Species diversity (Beta)

The biodiversity is usually studied in terms of species diversity. The total species or the

Species diversity refers to the variety of species in a region. A community consists of a variety of species of plants and

Animals- This 'variety' is referred to 'diversity' and is also known as species diversity of the community. Species diversity is dependent on two variables, the number of different species in the community (species richness) and distribution of individuals of species within the community (species evenness).

Ecosystem diversity (Gamma)

Ecosystem diversity involves both species as well as genetic diversity of the community. This type of diversity is found with different types of ecosystems like i) Terrestrial ecosystems e.g. forest, grassland and desert ecosystems. ii) Aquatic ecosystems e.g. freshwater and marine ecosystems. iii) Wetlands e.g. mangroves and estuarine ecosystems.

VALUES OF BIODIVERSITY

Commercial Values

Many of our products like cereals, spices and medicines came into existence accidentally as these plants and animals produce chemicals for their safety and attraction. Otherwise we would not have considered these plants and animals valuable. As humans we are wholly dependent on this diversity of plants and animals. A large number of products are derived from forests including timber, gum; resins, oils, waxes; dyes and rubber are of immense commercial value. The much of energy needs of the rural masses are still being met by forests. In China (2016) at one of the health resorts, fresh oxygen filled in the cylinders is provided to the tourists. The oxygen is filled at pollution free areas into the cylinders and is being provided to the tourists at a cost. Moreover, the animal products like hides, horns, ivory, fur etc are a good source of income. However, killing or capturing or uprooting etc. of any wild plant or animal is prohibited under law. A captured Rhinoceros costs more than rupees 35000/= and similarly monkeys are sold at a good rate in the market. Domesticated animals have given us hormones, enzymes and food products while the fungi and microbes provide life saving drugs such as antibiotics. From scientific experiments like testing of any new drug and new surgical methods are often tested on animals. The common Rhesus monkey has been subjected to many such tests.

ECOLOGICAL VALUES:

Healthy ecosystems are vital to life. They regulate many of the chemical and climatic systems that make available clean air and water and plentiful oxygen. Forests, for example, regulate the amount of carbon dioxide in the air, produce oxygen as a byproduct of photosynthesis (the process by which plants use sunlight to create energy), and control rainfall and soil erosion. These forests also provide humus to the soil through leaf litter and add nutrient strength to the soil. One of the strengths of our agriculture is the soil nutrients. These nutrients in the soil are being made available to the plants through biogeochemical cycles. These cycles are driven by soil microbes. A gram of fertile agricultural soil contains 2.5 billion bacteria, 4.0 lacs fungi, 50,000 algae and 30,000 protozoa. All these have their role to play in the soil and its fertility and they interact with each other. These micro organisms are also helpful in decreasing the toxicity of the soil which comes through the waste products. The wetlands which harbor rich

Plant diversity filter large amount of industrial and sewage waste helps in increasing the quality of run-off water from these wetlands. We depend on the micro-organisms in scavenging the organic and inorganic materials present in our

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Environment problems like solid waste decomposition by the action of bacteria. Recently in the year 2016 a new bacterial strain has been discovered which is responsible for the degradation of the plastic waste.

Social and Religious Values

An important place of honor has been given to animals in the galaxy of Hindu gods and their associates. There are animal gods like hanuman (Monkey), Ganapati (mice), Lord Vishnu sleeps on the snake, rides on the Garuda, while the God Ishwara and His sons Ganapathy and Subramanayam have the bull, mouse and the peacock as their Vahans (ride) and goddess Durga has selected the tiger as her animal to ride. The wild life of India has interacted with our culture as well. The early Indus civilization shows the use of animal symbols in their seals. Their mythology and literature are full of accounts of these animals.

Aesthetic Values

The ornamental plants are still a lucrative commodity today. Unusual and interesting flora and fauna can be very important attractions, especially when combined with scenic landscapes. The wildlife gives recreation to people of all walks of life. Bird watching is a very popular pastime among many people. The aesthetic value of the biodiversity also gives us some sort of feeling the pride. The Kashmir Stag is pride of the people of the state. Similarly the national animal tiger represents the country India. These protected indigenous plants and animals

Give people a sense of satisfaction that our place or region is still rich in the biodiversity. These wild places which harbor rich biodiversity are also aesthetically pleasant and provide shelter temporarily to get away from the hustle and bustle of the cities. There are many examples of the benefits and values of the biodiversity. Today scientists believe that more is unknown than known. These values of plants and animals including microbes are still unknown and awaits discovery. However, if this biodiversity is not conserved today, including the biodiversity which at present does not provide any benefit to us, may in future be a revolutionary item for the humans.

Biodiversity at Global, National and Local Levels

Biological diversity has been the back bone of human food, wealth and livelihood security systems, ever since the beginning of human civilization. Interaction between the living world and human societies led to the domestication of a wide range of plants and animals. Expansion of human settlements and increasing specialization of agriculture, particularly during the 20th century led to destruction of habitats rich in biodiversity and the narrowing of the composition of the food basket. The loss of biodiversity has to be seen against a greater need to produce food and other commodities under condition of expanding biotic and abiotic stresses and shrinking per capita availability of arable land and irrigation water. Also there are real possibilities for diverse changes in precipitation, temperature, ultraviolet-B radiation and sea level rise. The feedstock for the biotechnology industry is also biodiversity. Under such circumstances, the loss of every species and gene limits our options to shape our future. Therefore it is imperative upon all

the nations to prevent continuing genetic erosion and to promote concerted efforts to conserve biodiversity by

3.2. Threats to the Biodiversity

Main threats are:-

Population growth

Resource consumption

Climate change

Global warming

Habitat conversion]

Urbanization

Over exploitation of natural resources

Environmental degradation

Habitat loss

During the recent past, the habitat that too undisturbed have become rare and we are losing it at a very fast pace due to increased resource consumption. The growing needs of human beings require more food, housing, electricity and other materials for sustenance. Cutting of forest for agriculture and housing, construction of dams for electricity generation and construction of roads which resulted in shrinkage and fragmentation of habitat. All these factors threaten biodiversity at gene, species and ecosystem level hampering the provision of key products and services..

Poaching of Wildlife

The killing of animals for meat, skin and bones etc. is an age old practice. This has led to unlimited slaughter of many animals by man to meet his materialistic ends. For instance, elephants are poached for tusks, tigers and big cats for skin and rhinoceros for horns. The increasing costs of these products have placed these animals under threat. As a consequence of poaching, the populations of elephants, rhinos and other animals decreased considerably

Conflict between man and Wildlife

It refers to interaction between wild animals and people and the resultant negative impact on people or their resources, or wild animals or their habitat. It occurs when

growing human population overlap with reduction of resources, habitat destruction etc. Its main causes are:-

1. Dwindling habitats.
2. Man-eating tendency
3. Scarcity of food
4. Electric wiring
5. Lack of corridors

Pollution of Various Habitats

The pollution of the environment is one of the most horrible ecological crisis to which we are subjected today. We also know that three basic facilities for living organisms are air, land or soil and water. During the past these facilities were pure and almost undisturbed. However, the situation is different today. With the progress in the field of science and technology, the pollution of the environment and serious ecological imbalance is proving disastrous for the survival of the human beings as well as other living creatures which are necessary to withstand for the functioning of the ecological systems (Remember the role of animals in the food chain and food web). Pollution had invaded and has exploited every bit of natural resources. The craze of progress in agriculture, industry, transportation, and technology has created adverse effects on all living organisms on the biosphere.

Catastrophic Process

The demand for food has increased as a result of rise in human population and hence fertilizers were used to increase food production. Fertilizers have boosted the production of food grains and vegetables to many times but the world have discovered that this revolution had a costly side, the destruction of the environment. The fertilizers which were used got washed down into streams, rivers, lakes, seas and ocean. These at the first instance have depleted the oxygen of the water and made it difficult for fishes and other water animals to live in. Several lakes have been called as biologically dead which receive such kinds of wastes. In addition insecticides, pesticides have also caused the aquatic animals to perish. On the other hand radioactive pollution, thermal pollution, marine pollution, smoke pollution, smog pollution, metal toxicity, acid rain pollution has

arrested the fragile ecosystems on the biosphere and has posed the threat of extinction of mankind and several other species of life.

Accidental Cause

Calcutta, which is one of the most polluted cities in India, releases 1100 tonnes of particulate matter every day from industries, energy houses and other sources. It was estimated that carbon dioxide concentration of 38ppm due to auto exhausts during peak traffic hours at selected points was the highest intensity of air pollutants recovered in India. In China about 60million tonnes of coal was extracted which polluted the overall sky. In Beijing 39 tones of soot per sq.km.descends each month due to which it becomes dusty, sooty, cold and dry in winter. Here people wear masks of surgical cotton to prevent dust from entering the lungs. In many countries motor vehicles have no emission control equipment and so the emissions from their vehicle contribute to acid rain. The worst air pollution case in the Meuse Valley of Belgium in 1930 where 60 people died. A deadlier London smog in which about 4-5 thousand people died from respiratory ailments. The worlds worst nuclear disaster at Chernobyl in the Ukraine area. The Bhopal gas tragedy which took place in India in which almost 3200 people lost their life. There are other several hundred episodes which have resulted into loss of life and property due to pollution of the environment.

BIOLOGICAL INVASION

Definition

The process by which species (or genetically distinct populations), with no historical record in an area, breach bio-geographic barriers and extend their range

The entry of *Azolla* (water plant) in the Kashmir lake waters is a case of biological invasion. In Jammu the listed invasive species are 75% are herbs, 10% shrubs, 5% grasses, 4% trees and 3% climbers and sedges. Maximum contribution to the invasive alien species is from American region. In July 1996, the United Nations Conference on Alien Species identified invasive species as a serious global threat to biological diversity. Then in April 1997, more than 500 scientists called for the formation of a presidential commission to recommend new strategies to prevent and manage invasions by harmful exotic species in the United States. Already, many countries attempt to maintain their

biological heritage. Unfortunately, for a variety of reasons, such tactics have failed. Without greatly increased awareness and coordinated efforts, the devastating damages will continue. Exotic species have contributed to the decline of 42 percent of endangered and threatened species in the U.S. At least 3 of the 24 known extinctions of species listed under the Endangered Species Act were wholly or partially caused by hybridization between closely related exotic and native species. After habitat destruction, introduced species are the second greatest cause of species endangerment and decline worldwide far exceeding all forms of harvest. As Harvard

University biologist E. O. Wilson put it, "Extinction by habitat destruction is like death in an automobile accident: easy to see and assess. Extinction by the invasion of exotic species is like death by disease: gradual, dangerous, requiring scientific methods to diagnose."

Concept of Threatened Species

Threatened species are those which are under threat due to various natural and anthropogenic activities. If not protected all the species may become extinct if these casual factors continue operating. The International Union for Conservation of Nature and Natural Resources (IUCN) is maintaining a Red Data Book which contains a data of animals which are known to be in danger. The classification is based on the following factors:

1. The present and the past distribution of the species.
2. The decline in the population of the species.
3. The biology and potential of the species and
4. The availability and quality of natural habitat of species.

   The three categories depending upon the degree of danger to them includes the vulnerable, endangered and rare species as given below:

Vulnerable (VU): Species is vulnerable when it is not endangered but facing high risk of disappearance. Some of the common vulnerable animal species in India are: Golden languor, Leopard cat etc.

Endangered (EN): Species whose number has been reduced critically or whose natural habitats have been adversely affected by natural and artificial means. These are

near to extinction. The important ones from these are: Hanglu, Snow leopard, Nilgiri langur Red panda, Musk deer, Peacock, Himalayan monal pleasant etc.

Rare (R): Species which are less in number but are scattered throughout the world. This does not satisfy the criteria for endangered or vulnerable but they are at risk. Some Indian rare species are: Indian Desert cat, Wild yak, Markhor etc.

Concept of Endemic Species

Endemic species are those species which are confined to a particular area like country, island and mountain area etc. They are found in a particular environment only. Little variations are found in such species. Most of the endemic flowering plants in India are reported from North East India, the Western Ghats, North West Himalayas and Andaman and Nicobar Islands. Out of 45000 flowering plants found in India 15000 species (i.e. 33%) are endemic. More than 60% of amphibian species are endemic and half of the lizard species are endemic. Some examples of endemic species are: Banyan, Butter cup, Shisham, Bael (*Aegle*), Dhak (*Butea*) etc.

Concept of Exotic Species

The exotic species are called species or alien species or non-indigenous species. Exotic species are those species which live outside their native distributional range and which has arrived either accidently or intentionally. Examples are Water Hyacinth, Congress grass etc

Effects of species introduction

There are many instances when introduction of exotic species has caused extensive damage to natural biotic community of the ecosystem. Species introduction can have drastic social, economic and environmental effects. Some of these are positive but more often they are negative, such as the disruption of the natural balance of ecosystems.

Hot Spots of Biodiversity

Definition: Hot spots are those sites that are characterized by high concentration of endemic species and are facing serious risk of disappearance due to rapid rates of habitat modification or loss. The concept of hot spots of biodiversity was given by Norman Myers in 1988.

Criteria: An area is designated as hotspot when it contains at least 0.5% or 1500 species of plant species as endemic and has lost at least 70% of its primary vegetation. Currently there are 34 hot spots of biodiversity all over the world that represents just 2.3% of earths land surface but they support more than half of the world's plant species as endemics. There are 49,955 endemic plant species or 20% of world's recorded species. Of the 34 global biodiversity hotspots, four are present in India represented by the Himalaya, the Western Ghats, the Northeast India and the Nicobar Islands. Some of the important global biodiversity hot spots are:

1. Brazil's Cerrado.
2. Central Chile.
3. California floristic province.
4. Madagascar.
5. West Afarican forests.
6. Cape floristic province.
7. South central China.
8. Eastern Himalaya of India.
9. Western Ghats of India.
10. Coastal forests of Tanzania/Kenya.

Hot Spots in India

Out of 34 identified hot spots, 4 are found in India. These are

I. **Eastern Himalaya** which extends from North Eastern India to Bhutan. The Eastern Himalayan hot spot is rich in endemic plants and the temperate forests are found at the height of 1780-3500 meters above sea level. Here many deep valleys are also found.

II. **Western Ghats** covers the evergreen forests in the states like Karnataka, Maharashtra and Kerela that lies at height of about 500-1500 meters above sea level. The two main centers of biodiversity are Agasthyamalai hills and Silent valley.

III. **Northeast India** is one of the most biodiversity rich regions of tropical forests in India. Northeast India, a part of the Himalayan and Indo-Myanmar "hotspots," is of special biodiversity interest.

IV. **Nicobar Islands** covering 8,249 km2 geographical area with a coastline of 1,962 km. The terrain of Andaman Islands (part of Indo-Burma Biodiversity Hotspot) that has been formed from the fragments of a continental land mass is in contrast to the Nicobar Islands (part of Sunderland Biodiversity Hotspot), which were formed due to volcanic activity. These are lying in North-South direction and simulating an arc stretching over a length of about 912 km and maximum width of 57 km.

UNIT – 4

THEORY OF ENVIRONMENTAL POLICY

Introduction

The neoclassical economics mainly deals with efficient allocation of resources through market mechanism. In the production process, in addition to the private (or public) good, public 'bad' also emerges in the form of solid, liquid, gas or noise pollution. For example, when production of cement takes place, there is emission of dust and harmful chemicals into the atmosphere. Neoclassical theory with its emphasis on market mechanism takes care of the production of cement (in this case) but ignores the management (production, pricing, control) of air pollution arising out of cement production. Public bad is produced not only during production activities .and Environment but also in the course of consumption. For example, when we consume packaged food, we throw away the polythene cover (which is not biodegradable) here and there as a result of which land pollution takes place. The management of public bad is beyond the scope of the neoclassical analysis and therefore is usually ignored.

In the present Unit weconcentrate on the issue of the divergence between social and private costs and themethods available in the literature to internalize the externalities, that is, development ofmechanism through which the social cost of pollution will be borne by the polluters

4.1 EXTERNALITY AND PIGOUVIAN TAX

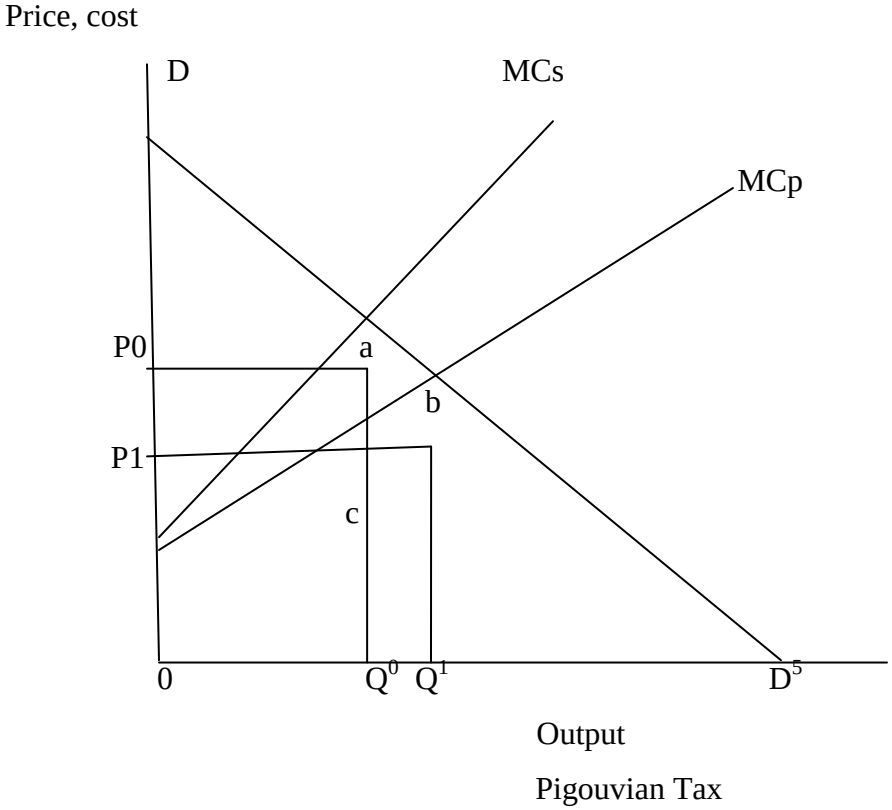
The basic principles of environmental policy are based on the theory of externalities. Theproblem of externality may be interpreted as an unintended and uncompensated side effectof a person's or firm's activity on others. In a formal way, environmental externalitiesoccur when the consumption and production choice of one person or firm enters the utility or production function of another entity without the said entity's consent orcompensation. Inmanyinstances, the problem of externality **creeps** into many government policies having spillover effects. For example, free electricity offered to farmers for irrigation purposes results in over-extraction of ground water, which depletes the watertable. In this case the private cost of lift irrigation borne by the farmer

is the price paid by him, but a larger social cost is involved in **terms** of reduced availability of water to others. Overall, there is a difference between private marginal cost and social marginal cost in the presence of externalities; social marginal cost of pollution being always higher thanprivate marginal cost. As the producer of a polluting good takes into account the privatecost while deciding on the level of output, there is excessive supply than the optimal level.

An economic solution to the problem was evolved as early as in the 1920s by the well known British economist Arthur Pigou in the form of pollution tax popularly known as ***Pigowian tax.*** According to Pigou, the social damage or the social cost imposed by a**firm** by its pollution activity on society may be neutralised by imposing a pollution **tax** onthe firm. The rate of the tax, according to him is equal to the marginal environmental costor marginal social damage by the polluting firm on society.

We explain the situation in **Fig. 4.1** where MC, is the social m-al cost while MC, isthe private marginal cost of production of a good. As more output is produced, MC, increases with the level of pollution. The demand for the pollution good is given by thedemand curveDD' (representing marginal revenue curve, MR). As per market mechanism, the equilibrium output is q, and price is P, where MCp = MR. Sociallyoptimum level of output, however, is q* and price P*, where MCS = MR. Ifthe producerwere made to pay for the social costs also, equilibrium output would have been at thelevel q'. We observe from Fig. 4.1 that the difference between MC, and MC, at thesocially optimum level output is 'ac'. In order to **internalize** the externalities Pigou ***suggests*** imposition of an t ax ***t*** per unit of output where ***t*** = ac. Here it is assumed that pollution emitted per unit of output remains unchanged as level of output changesprice, cost.

4.1 Diagram



Keeping in view the nature of the problem, externality may be classified into four broad types: a) relevant externality- when the unconcerned parties are affected by an activity and the parties in turn demand for suitable solution to reduce its effect; and externality - in the process of appropriate solution to the problem ,affected parties are made better off without adversely affecting any one; c) static and dynamic externalities - in a static situation, a group overexploits the natural resource by imposing externality on others (for example, over-fishing), while in a dynamic case, the exploitation would be on such natural resource which. has high future value (for example, fishing of juvenile fish species); and d) pecuniary externality - an activity which imposes higher price or lower cost on people or land (location of huge business, industry in a particular area).The

disposal of public bad under normal course is done in various forms through natural resources media like air, water and land by treating earth as a natural sink. In the process of disposal, if the pollution load of public bad exceeds the assimilative capacity of the natural resource, it will impose serious problem by impairing the ecological balance. Hence, the main issue is how to abate pollution to the required level in order to keep both living and non-living organisms in good health and prosperity.

4.2 COASE'S BARGAINING SOLUTION AND COLLECTIVE

There are two main approaches to solve the environmental externality: a) appropriate government policies, and b) well-defined property rights. Government policies pertain to direct regulation (or, command and control approach), and market-based approach in the form of economic instruments.

The property rights approach is applicable when either community or individual posses well defined property rights in carrying out the environment related activities. The property rights approach, developed by Ronald Coase in 1960, suggests that an efficient solution to the problem of externality may be arrived at if property rights are well-defined. This solution, popularly known as **'Coase** theorem', states that efficient allocation of resources and solution to Pareto relevant externality is possible under the following assumptions: i) zero transaction costs – the cost involved in the bargaining process between the two parties do not exists, ii) well defined property rights - either of the party or both the parties posses well-defined property rights, iii) perfect competition prevails in the market, iv) no income or wealth effects is imposed with the Coasean solution, and v) no free rider effects -- since the parties have well defined property rights. In this situation, let us illustrate the method of bargaining for feasible solution through an example.

Let us consider the case of a polluting factory which dumps its effluents to the nearby river as a result of which the water downstream gets polluted. The water pollution has adverse effects on the health and property of the nearby community who use the river water. Therefore, they want the pollution load released into the river to be zero. It is possible for the factory to adopt pollution abatement measures which can purify the effluents and reduce the pollution load to zero level. Installation of such technology,

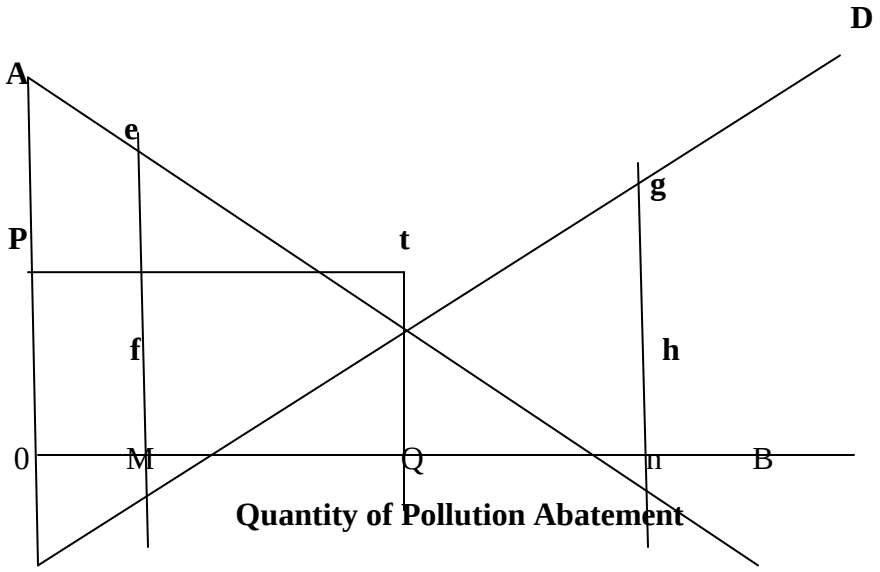
however, would increase the cost of production for the factory and keeping up with its objective of profit maximization the factory does not want to install pollution abatement measures. Thus a conflict in interest between the factory and the community is generated.

Let us explain the position through Fig. 9.2 using the typical economics analogy. On the x-axis we measure pollution abatement (that is, removal of pollution) by the factory and on y-axis we measure the level of pollution cost. The nearby community faces a downward sloping pollution abatement cost curve (AB). It indicates that as pollution abatement increases (that is, more amount is pollution is removed or, less amount is pollution is present in the river), there is a decrease in the pollution cost to the community. Thus, when pollution abatement reaches the level 'OB' (that is, all the pollutants are removed from the river), the pollution cost to the community is zero. On the other hand, the factory has an upward sloping pollution abatement cost curve indicating the increasing marginal cost of abatement (OD). When pollution abatement is zero, no pollution cost is borne by the factory. The factory would like to reduce its pollution abatement expenditure while the community would like the pollution level to be zero.

Let us take the situation that the community is holding the property rights for clean environment. Hence, the community can dictate terms to the factory about the pollution load to be released to the river. In this situation, the factory is generating pollution and creating problems for a community that demands zero pollution. For various welfare reasons, the factory cannot be closed down and financial constraints have made the factory to apply limited pollution abatement measures. In this context, negotiation is the only solution to resolve the conflict.

In the negotiation, let us assume that the community can accept a slightly lower level of pollution emission 'n'. At this level of pollution abatement, however pollution cost to the community is 'h' and pollution cost to the factory is 'g'. Hence, through negotiation, the factory is willing to give compensation up to the extent 'gh' to the community (see Fig. 9.2). The level of abatement reached through the negotiation in **this** case is anywhere between the optimum (t) and the maximum (B).

4.1 Diagram



Let us take the other situation where factory has the property rights. Since the polluter has the property rights, the starting point for negotiation is zero level of pollution abatement. Obviously, for welfare reasons, the community would like the pollution level to be reduced by the factory, which in turn implies higher pollution abatement expenditure by the factory. Suppose the community wants the pollution abatement to be 'm'. At this level, the pollution cost to the community is **'f** while pollution abatement cost to the factory is 'e'. It is, therefore, viable to the community to pay compensation to the factory to the extent of 'ef'.

We observe from fig. 9.2 that it is expensive to abate pollution beyond the level**'q'.** The government can regulate pollution abatement to be fixed at the level 'q'through command and control measures. Otherwise, it can impose taxes on the polluter (the factory, in this case) to the extent 't', which is equivalent to the pollution cost on the community. The Coasean principle, however, provides an alternative to pollution tax. Here externality can be internalized through well-defined property rights and compensation.

4.3 POLLUTION ABATEMENT OPTIONS

Control of pollution has been an important objective of governments in various countries, particularly since the second half of the twentieth century. Several policy measures have been undertaken by governments in this direction in the form of restrictions, incentives, dos, and don'ts for the polluting agents. Some of these measures have been effective incurring pollution while others have not. Accordingly, there are certain policy instruments that work while others do not. When we evaluate an environmental policy, it is logical to look into issues such as efficiency in production and effectiveness of the policy instruments in controlling pollution.

The degree of pollution depends upon the amount of pollutants dumped into the environment vis-a-vis its assimilative capacity. The amount of harmful chemicals dumped into the air and water through emissions and effluents determine the level of pollution of air and water. In order to control pollution, therefore, there are certain 'direct policy measures' which regulate the level of the pollutants directly. In many cases, however, it is difficult to measure the pollution load originating from a firm or other pollution sources. Nonetheless, it is easier to link certain output produced (or, input used) to the pollution load. For example, given the level of technology, the emission from a cement factory is proportional to the quantity of cement produced. Similarly, the effluents discharged from a paper mill would be proportional to the wood pulp used or energy consumed. By regulating the production of such output (or the use of inputs) we can keep pollution under check. Thus, there are certain 'indirect policy measures' where the impact point is not the pollutant itself but some other factor.

Globally three types of policies are pursued, viz., i) command and control (CAC) measures, ii) market-based instruments (MBI), and iii) government production or expenditure. There is several policy instruments under each of these policy options. These instruments can be of two types: direct and indirect. We present a taxonomy of policy instruments for pollution abatement in Table below.

Table4.1 Taxonomy of Policy Instruments for Reducing Pollution

Policies	Direct instruments	Indirect instruments
Command and control measures	Emission regulations (source-specific), standards, bans, non-tradable permit or quota	Regulation for equipment, processes, inputs and outputs
Government production or expenditure	Regulatory agency expenditures on purification, clean-up,waste disposal, and enforcement	Development of 'clean' technologies
Market-based instruments	Effluent charges Tradable permits Deposit refund systems	Input/output taxes and subsidies Subsidies for substitutes and abatement inputs

In earlier times pollution abatement was usually by means of regulatory approach also known as CAC measures, which were in the form of imposing bans, specifying quotas and laying down standards for polluting activities. Under the CAC approach certain economic activities, considered to be polluting, are prohibited. In other cases, a quota for many polluting activities are determined and allocated among firms through licensing. According to the CAC approach, either the government or its designated body fixes the standards for various pollutants (liquid, gas and noise) emerging out of various pollution sources. The standards are fixed by keeping in view the assimilative capacity of the ambient environment as well as the health impacts on human beings living in the area, and existing natural resources. In order to regulate the environmental pollution there could be two types of standards: a) ambient environment standards, b) industry specific standards. 171eambient environment standards refer to the limits set for various pollutants that is considered to be safe for living beings and property. These standards

have been prescribed for ingredients of the environment such as air, water and noise. For illustrative purposes, we present in Table 4.2 the National Ambient Air Quality Standards prescribed by the Central Pollution Control Board (CPCB). These standards have been determined keeping in view the air quality necessary to protect public health, vegetation and property. Different standards are laid down for industrial, residential and sensitive areas.

The industry specific standards refer to limits prescribed for the pollutants emerging out of specific industrial process. For example, the CPCB has set the maximum limits of the parameters such as acidity (pH), biological oxygen demand (BOD), and chemical oxygen demand (COD) contained in the effluents discharged into water bodies from various water-polluting industrial activities. Similarly, parameters are prescribed for suspended particulate matter (SPM) emitted by air polluting activities. These standards vary across industries keeping nature of the production activity and technology of production available in view. For implementation of these standards, appropriate legislations have been enacted along with penalties and punishments for noncompliance

In India three main pollution control acts are enacted for the purpose of environmental protection. These are the Water ('prevention and control of pollution) Act, **1974;** the Air(prevention and control of pollution) Act, **198** 1 ; and the Environment (protection) Act,1 986. These acts prescribe i) rules and regulation for pollution control, ii) duties and methodologies to be followed for environmental compliance, and ii) penalties and punishments for non-compliance. The evolution of environmental policies in India along with the important provision under various acts is given.

Government production or expenditure through its regulatory agencies on pollution abatement pertains to various activities undertaken for cleaning up water bodies (Ganga Action Plan in India, for example), treatment of effluents by setting up treatment plants, proper disposal of household wastes, etc. Moreover, government incurs expenditure on research and development activities for invention of less-polluting or clean technologies. A major hurdle for government production is the limited budgetary resource available for such activities. The CAC measures are found to be inefficient as it imposes higher cost on society for realizing a target. As the CAC approach does not

distinguish between polluting agents and puts a universal ban on certain activities, it does not leave any scope for innovation in clean technology. Studies have shown that similar objectives can be achieved at a much lower cost through MBIs. The major types of MBIs, both direct and indirect, **are** given in Table 4.1. As there **are** a number of instruments, each having its own importance and relevance or clean technologies? A major hurdle for government production is the limited budgetary resource available for such activities. The CAC measures are found to be inefficient as it imposes higher cost on society for realizing a target. As the CAC approach does not distinguish between polluting agents and puts a universal ban on certain activities, it does not leave any scope for innovation in clean technology. Studies have shown that similar objectives can be achieved at a much lower cost through MBIs. The major types of MBIs, both direct and indirect, **are** given in Table 9.1. As there **are** a number of instruments, each having its own importance and relevance.

4.3.1 MARKET-BASED INSTRUMENTS

As mentioned earlier, there is a divergence between private cost and social cost in the case of polluting activities. In order to regulate these activities the CAC approach puts emphasis on imposition of bans and controls. The MBIs, on the other hand, use economic incentives or market stimuli for internalizing the environmental costs. The **main** aim of the MBIs is creation of a market mechanism where the social cost of pollution will be borne by the polluters. Thus, the divergence between private cost and social cost will be avoided and polluting goods will be produced at their socially optimum level. The MBIs are developed on the basis of the principles of the market structure, and attempt to remove the distortions emerging out of inefficient use of resources by removal of subsidies and introduction of environmental charges on emission, input and output.

4.3.2 Advantages of MBIs

There are several advantages of economic instruments such as: i) these are efficient in allocation of resources; ii) they provide incentives for innovations in clean technology; iii) they **are** more appropriate when policy emphasis is shifted towards a preventive measure, and iv) they can be an important source of revenue for the

government. In fact, the MBIs are considered to provide 'double dividend', in the sense that they control pollution on the one hand, and generate revenue on the other. The revenue generated through MBI scan **further** be utilized for environmental protection.

In order to achieve the objectives, MBIs use the market system to evolve two kinds of policy measures such as i) administered price, and ii) administered market. In the case of' administered price, existing price of polluting good is modified through policy measures to include the social cost of environmental degradation. In this situation obviously, environmental valuation **quires** special significance in advocating the administered price concept. Hence, administered price either creates price or modifies the existing price to reflect the environmental impact. Similarly, administered market creates a market for environmental pollution, which did not exist before. Tradable permits are the best example for this concept as it creates market for 'pollution abatement' **(that** is, removal of pollution) through emission trading. The flexibility of MBIs is reflected through selection of appropriate technology for pollution control which minirnises cost of compliance but, without any interference of the regulatory authorities.

4.3.3 Categories of MBIs

In Table 4.1, we have mentioned certain market-based instruments - both direct and **indirect.** The direct instruments, viz, effluent charges, tradable permits and deposit refund schemes, are imposed on the polluting activity itself. On the other hand, indirect instruments, as you can see from Table 9.1, **are** imposed on inputs used for production of the polluting good. The MBIs can be broadly put under seven categories on the basis Theory of Environmental of the type of economic instruments. These **are** i) **fiscal** instruments, ii) financial instruments, Policy iii) charge instruments, iv) deposit-refund system and bonds, v) market creations, vi) liability, and vii) redefining property rights (see Table 9.3).

Taxes and user charges have the advantage that they reduce the compliance cost of attaining a set target thereby enhancing economy wide performance. The disadvantage with taxes and charges, however, is that it is politically difficult to raise them to optimal level. Subsidies and soft loan/grants on pollution abatement inputs are highly popular

both in developed and developing countries. There is the danger of dead-weight loss (defined as the difference between the monetary values of what the government loses and what the beneficiaries gain due to the subsidy) largely due to high costs relative to benefits.

The MBIs have been based on the economic principles such as tax, user charge, incentive, markets, compensation, and property rights. It is worth distinguishing these instruments further on the basis of the instruments that follow polluter-pays principle and other instruments. The polluter-pays principle underlines the fact that the polluter should pay for the use, damage and scarcity of natural resources. The fiscal instruments and charge instruments on the basis of their implied command for the payment for having used the resources and contributed to their pollution level may be categorized as the instruments which follow polluter-pays principle (Table 9.4). On the other hand, other instruments work on the economic principles like incentives (financial instruments). creation of rights (redefining property rights), creation of markets (tradable emission permits, deposit-refund system and bonds), and compensation for inflecting the damage (liability).

In fact, in the environmental economics literature, both tax and charge are being used interchangeably indicating that a negative price is levied in proportion to the amount of damage imposed on society due ta pollution. It is also known as the price to be paid to internalize the social cost emerging out of environmental problems. While **tax** has a straightforward single connotation, however, user charge has many. The four broad types of user charges being practiced are:

a) Emission charge - charge levied on the pollutant to internalize the social damage emerging out of pollution activities.

b) User charge - fee levied for using the environmental resources.

c) Product charge -taxes are levied on the goods produced with polluting inputs. Carbon tax is the best example.

d) Administrative charge - fee levied by the government for implementation or monitoring various environment associated legislations.

In comparison with fiscal instruments, incentive mechanism performs better in controlling pollution. It has been theoretically proved that paying pollution tax is always costlier than adopting pollution control measures. Thus, it is cheaper for the firm to adopt pollution abatement measures (installation of clean technology effluent treatment plants and more efficient utilization of exhaustible resource) than paying the taxes. Financial instruments or subsidies are the incentives given to the polluting agents to abate pollution. As described, it may be in various forms such as financial subsidy, soft loan and grants, sectoral revolving funds, financial aid in installing new technology, subsidies for environmental research and development expenditure. It is an important instrument of environmental protection in developing countries. Surprisingly, subsidy is being promoted in the developed world too but in different forms. In developed countries, the environmental taxes imposed and collected on various environmental items are being exclusively used for environmental protection activities in the form of soft loans or grants (or the development of improved technologies and resources, and related infrastructure development. In a way, such an encouragement has been very effective in environmental management in developed countries.

4.3.4 Choice among MBIs

Economic instruments or MBIs influence decision-making in such a way that the chosen alternatives would lead to an environmentally more desirable situation than in the absence of the instrument. Hence, economic instruments allow the polluting agents the freedom to opt for instruments in a way they themselves think are most beneficial to abate pollution.

The presence of a number of policy instruments makes it difficult to choose the correct one. Some of the factors that should be taken into consideration while evaluating a policy instrument are given below.

a) **Effectiveness:** A policy instrument should be judged on the basis of its effectiveness in controlling pollution. If the particular policy instrument does not give intended results it should be avoided.

b) **Socio-economic efficiency:** The environmental objective should be realized at the minimum cost so that society's resources are utilized in an optimal way, i.e., without

any wastage or additional costs. For a policy should be considered 'efficient', the total costs (including costs to the government, individuals and firms) involved in implementing the policy must not outweigh the total benefits.

c) **Dynamic efficiency:** The policy instrument should provide incentives for environmental improvement over time and space. A policy instrument may also bejudged by the extent to which it can be adapted to changing market, technology, knowledge, social, political and environmental conditions.

d) **Equity:** The costs and benefits of the policy instrument should be distributed equitably among sections of society; particularly the interest of the poor and vulnerable sections should be protected. Moreover, the richer section should not be in a position to influence policy-making to safeguard their interest.

e) **Operational feasibility:** Given the level of socio-economic development of the economy, it should be feasible to implement the policy instrument. The political and bureaucratic machineries also should back its implementation.

f) Community acceptance: The success of a policy instrument critically depends on the degree to which the community accepts it. In order to make the community understand the objectives and benefits of the policy instrument there should be public consultations and education programmes.

4.3.4 MBIs in Developing Economies

In developing economies the market mechanism is not fully developed as production is often for self-consumption. There is considerable unemployment and underemployment that prompts people to venture into nearby forests to collect fuel wood and other forest products. Industries also are yet to develop fully in the sense that R&D expenditure is the barest minimum in developing economies. The scale of operation in many cases, particularly in small scale industries, is such that installation of pollution abatement technology is not cost effective. Moreover, many developing economies are more particular about growth than environmental concerns. In order to attract investment by the governments in developing economies compromise on the technology of production. Provision of subsidized raw materials and land to industries is a common

phenomenon in developing economies. Under such circumstances adoption of MBIs need to be with caution; particularly the following points should be paid attention.

a) There should be adequate knowledge base on benefits and costs of policy instruments in developing economies. Moreover, institutional and technological constraints should be kept in mind while designing MBls.
b) There should be a strong legal structure, clear definition of property rights, and the ability to transfer such rights
c) Many of the policy instruments, particularly tradable permits, require the existence of a competitive market. If competitive market does not exist, and cannot be created, the policy instrument may not be effective.
d) Enforcement is one of the major problem areas in developing economies. There should be adequate administrative capacity to design, implement, monitor and enforce the MBIs

We have mentioned earlier that MBIs offer double dividend. If environmental taxes are introduced mainly as revenue raising instruments than as an environmental protection measure, then it may boomerang, and lead to inefficiency in resource allocation. Notwithstanding the above limitations, MBIs are making their headwayin developing countries like Korea, Malaysia, Chile, China, Thailand and Taiwanand many Latin American and African countries.

4.4 INFORMAL REGULATIONS ON POLLUTION

It is observed that in developing countries environmental problems have been attributed, in addition to other constraints, to inefficient enforcement of pollution control measures by government agencies. This void has, to some extent, been filled by other agents like community, self-regulation by corporate sector (corporate responsibility for environmental protection), and judiciary who have turned out tobe very powerful in regulating environmental problems. Communities have taken initiatives in ***regulating*** pollution activities in developing countries; this has happened in counties like India, Indonesia, and Bangladesh. It has been identified **that** socio-economic characteristics of communities such as literacy, household income, and participation in election have significant influence in regulating industrial pollution. Increasing public awareness on

adverse effects of environmental degradation has also resulted in several social movements for protection of environment. Narmada Bachao Andolan (save Narmada movement) and Chipko movement are examples of public concern for environment protection.

4.4.1 Green Technology and stock Market Performance

Of late, **markets** have played significant role specially in regulating pollution. This has been achieved by publishing environmental performance of industries in the form of raw materials used, production process, pollution abatement policy adopted, conservation of resources, and methodologies adopted for output use and disposal. On the basis of such information, the stock markets evaluate the environmental performance of industries through stock values. Some countries including India have generating of pollution.

The regulation process works as follows: Normally an investor will look into overall performance of a unit before investing in it. If its production is not efficient due to various environmental problems, this will obviously reflect on the overall performance, and hence, the financial benefits. As a result, the environmentally inefficient industrial units with weak performance are rated low compared to the units with good performance In other words, the industrial units with bad environmental performance have significant negative impact on stock values. Though relevant to both developed and developing countries, this practice has yielded good results in developing countries by effectively regulating the pollution activities of the industrial units. Some of the studies have estimated the loss of polluting firms in the stock market to be up to 11 per cent. (see Table 9.5).

4.4.2 ISO-14001 Certification

Of late, corporate sectors have realized that pollution control has greater benefits in achieving overall development of a firm in the form global recognition in terms of marketing opportunities, better profits, and increased production due to smooth functioning of the units. As a result, several leading corporate firms throughout the globe have started the process of self-regulation in meeting the environmental **standards** on their own without the compulsion of the regulatory bodies. In fact, this has become more

popular in developing countries in order to achieve the global recognition for marketing strategies. The process has got identified with the IS0 certification in the form of ISO: 1400 1. If an industry is holding the ISO- 1400 1 certificate it has all the characteristics of global competence in the environmental standards. The firms have **an** incentive to obtain ISO-14001 certificate, as it provides a firm with greater access to international market. This certification is issued by the global organization called the International Organization for Standardization (ISO), the world's largest developer of quality standards on various aspects of production and service. This certification involves sophisticated elaborate process in order to meet the international standards. However, it is purely a voluntary one. As on April 2005, almost 88,800firms have acquired this certification and interestingly majority of the firms ***are*** in the developing countries (Table 9.6). Hence, self-regulation has also emerged as an instrument for pollution control.

4.4.3 Judiciary and Pollution Control

The judiciary has been very active in environmental protection throughout the world in recent years. Notwithstanding the fact that there **are** several limitations of the judiciary in handling environmental issues, it has several advantages also. We discuss some of the issues related to the involvement of judiciary in environmental protection.

a. Judges are usually non-specialists in environmental aspects, which limit their capabilities in dealing with environmental issues. Nonetheless, they have broad vision of national development based on the existing national policies of the country- concerned.
b. Whenever judicial process is involved in environmental protection, due to various technological clarifications, by and large environmental protection expenditure will be on the higher side.
c. Judiciary has its limitations in protecting the environment holistically as it responds only against the litigation brought to the court by the affected party'
d. Judiciary, by its very nature, is not continuously involved in environmental protection process and hence, judicial verdict relating to environment protection may be difficult to integrate into the national policy process.

e. Judges are not involved in electoral politics and are free from political interventions, and hence, they can take extreme steps in pronouncing judgments to protect the environment.

In India judiciary is involved in several landmark judgments concerning environment protection such as the Bhopal Gas Tragedy, Pollution of River Ganga, Tehri Dam project. Narmada valley project, Delhi air pollution, and forest protection in Jammuand Kashmir. Though judiciary has been involved in environmental protection sincelong, the involvement has been more prominent since the mid-1990s. As we observefrom Table 9.7, of the 409 environment-related cases handled by the judiciary in India, 163 (that is, nearly 40 per cent of the total) are handled during the period1996-2000. In terms of the environmental issues handled, although it has handled allrelated issues, the issues relating to the ecosystem (27.6 per cent of the total) followed by urban development and air pollution (see Table 9.8) have been prominent.

4.4 GLOBAL ENVIRONMENTAL EXTERNALITIES

Global environmental issues can be classified under three heads: (a) trade-related, (b) pollution, and (c) biodiversity. Greenhouse gas emissions, ozone depletion and biodiversity are global public bads. Here, collective action and binding agreements are needed to avoid free-rider problems. On trade and environment, there is a consensus on the need for regulation of movement of hazardous chemicals, trade in endangered species, and exports of goods causing environmental problems in importing countries. On issues such as whether developed countries can prescribe their own environmental standards on imports from developing countries, whether processes and production methods requirements are legitimate under GATT rules and whether use of mandatory or voluntary environmental requirements amount to non-tariff barriers remain contentious. In all these cases the relative roles and responsibilities of developed and developing countries assume significance because they are in different stages of development and their tradeoffs between environment and development differ. In this context it is worth remembering the Rio principles.

The Rio Declaration contains the following principles for international cooperation 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, the least developed and those most environmentally vulnerable, shall be given special priority.

Principle 7: States shall cooperate in a spirit of global partnership to conserve, protect and restore 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 cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge and by enhancing the development, adaptation, diffusion and transfer to technologies, including new and innovative technologies.

Principle 12: States should cooperate 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 problems of environmental degradation. Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade.

The common but differentiated responsibilities principle is recognized in multilateral agreements relating to trade (Uruguay Round), ozone depletion (Montreal Protocol), climate change (Framework Convention on Climate Change) and biodiversity (Convention on Biodiversity). There are also special programmes for capacity building and financial support in environmental management for developing countries through agencies such as United Nations Development Programme, United Nations Environment

Programme and Global Environment Fund,. But there is a limited success in the transfer of environmentally sustaining technologies to developing countries on concessional concerns. Many developing countries are also concerned about uses of environmental standards by certain developed countries as non-tariff barriers. Such attempts would erode the comparative advantage of developing countries in exports of labour-intensive manufactured products such as processed food, leather and leather products and textiles.

Externalities are everywhere, and government policy to deal with them, at best, is mixed. Just to remind readers, an 'externality' occurs when a market transaction affects people who are not involved in that transaction. For example, when we buy power from my electricity company, a generator somewhere in Victoria's Latrobe valley works a little bit harder and makes someextra greenhouse gases. we pay for the electricity and that money compensates the electricity retailer, distributor, transmission company and the generator. But people who are adversely affected by the pollution receive no compensation. They suffer a 'negative externality'.

With a negative externality, like pollution, the market tends to over produce the relevant commodity. Too much electricity is produced using coal because the buyers of that electricity do not face the full costs of their actions. If they did, they would buy less.

Externalities also can be positive. For example, basic research creates knowledge that can be used by many people even if they do not pay for using the knowledge. This 'spillover' from the research is a positive externality and the market will tend to produce too little research

4.4.1 Positive Externality

Pollution emitted by a factory that spoils the surrounding environment and affects the health of nearby residents **is an example** of a negative **externality**. The effect of a well-educated labor force on the productivity of a company **is an example** of a positive **externality**.

4.4.2 Negative externality

A **negative externality** is a cost that is suffered by a third party as a result of an economic transaction. In a transaction, the producer and consumer are the first and

second parties, and third parties include any individual, organisation, property owner, or resource that is indirectly affected.

4.4.3 POLICIES FOR INTERNALISING ENVIRONMENTAL EXTERNALITIES IN INDIA

India has been playing a proactive role on international environmental cooperation since 1972. Constitutional sanction was given to environmental concerns through the 42nd Amendment, which incorporated them into the Directive Principles of State Policy and Fundamental Rights and Duties. Beginning with Water (Prevention and Control of Pollution) Act 1974, a series of environmental Acts have been enacted, including the umbrella legislation, the Environment (Protection) Act 19868. Also, India has a legal framework for dealing with environmental issues relating to forests and biodiversity. The Ministry of Environment and Forests is the apex regulatory and administrative agency for all matters relating to environment. India has also developed the institutional capacity for documentation of flora and fauna, forest cover, biospheres, land degradation, and traditional knowledge. The Ministry's publication Agenda 21 An Assessment (2002) documents India's experience in implementing Agenda 21India's efforts in implementing Agenda 21 in terms of creation of legal and legislative framework, capacity building in science and technology and institutional setup are noteworthy. However, India needs environmental policy reforms both in pollution prevention and control and natural resource management in order to internalize environmental externalities.

4.5 Reforms in Pollution Control Policy

India's pollution control policy regime may be characterized as command and control regime. The emphasis is on criminal jurisprudence rather than encouraging sustainable development. Enforcement of the laws is generally weak because of information problems relating to prosecution and conviction of non-complying units, especially small scale units. From an economic angle, the enforcement problem arises because the penalties are unrelated to the extent of violations. Our law considers only compliance or non-compliance and not the extent of compliance. As the cost of compliance

increases with the level of pollution abatement, we need a penalty structure where the penalty must be linked to the extent of violations.

The Judiciary has been playing a proactive role in the recent years in the environmental regulations. In cases dealing with pollution enforcement of from tanneries, it directed the tanners to install treatment plants or face closure or relocation, and bear the remedial cost as well as compensation to the victims of pollution. In cases dealing with pollution in Delhi, the Court directed the government to facilitate a switch from diesel to compressed natural gas for buses, cars and auto rickshaws in Delhi within a specified period. The Court also gave directions to central and state government to ensure compliance with the laws, to create new authorities for implementation Court decisions and offered advice on environmental protection.

Full internalization of environmental externalities in a market economy can be achieved voluntarily by polluters only if they realize that compliance with regulations is a better option than non-compliance. The advantage of an economic instrument is that a pollution charge or a penalty is linked to the extent of violation. The Ministry of Environment and Forests issued a Policy Statement for Abatement of Pollution in 1992. It recommends the adoption of polluter pays principle and new approaches for considering market choices 'to give industries and consumers clear signals about the cost of using environmental and natural resources'.

At present, there is little prospect of introducing a pollution permit trade scheme in India. Indian law provides only usufruct rights for natural resources while implementation of a tradable permit scheme requires that the rights are exchangeable.

The Supreme Court gives the right to clean environment to citizens. Further, the design and implementation of a tradable permit scheme requires a good information system about the sources of, extent of and geographical dispersion of pollution, a fairly large market so that competitive outcomes would result, and administrative capacity to design the system, certification of credits and so on.

It may not be feasible to introduce pollution charges now. Our environmental legislations, except the Water Cess Act, are not in the nature of money bill. Even in the case of the Water Cess Act, the preamble says the purpose of the cess is to finance the

activities of Pollution Control Boards and not environmental protection. We need a comprehensive environmental legislation for introduction of tradable permit scheme and pollution charges, wherever they are feasible and desirable.

A few other economic instruments have been in vougue. They include fiscal incentives for erection of effluent treatment plants, eco-labelling scheme, green rating on experimental basis, environmental audit in Gujarat, bank guarantee schemes in West Bengal and a few other states for compliance with Court verdicts and fulfillment of obligations under the consent to establish and consent to operate schemes implemented by the State Pollution Boards. Even in establishment of common effluent treatment plants for small polluting units in industrial clusters, the focus is more on technology and administration and no effort has been made to introduce incentive-based cost sharing agreements.

4.6 The Economic Effects of Climate Change

Climate change is the mother of all externalities: larger, more complex, and more uncertain than any other environmental problem. The sources of greenhouse gas emissions are more diffuse than any other environmental problem. Every company, every farm, every household emits some greenhouse gases. The effects are similarly pervasive. Weather affects agriculture, energy use, health, and many aspects of nature which in turn affects everything and everyone. The causes and consequences of climate change are very diverse, and those in low-income countries who contribute least to climate change are most vulnerable to its effects. Climate change is also a long-term problem. Some greenhouse gases have an atmospheric life-time measured in tens of thousands of years. The quantities of emissions involved are enormous. In 2000, carbon dioxide emissions alone (and excluding land use change) were 24 billion metric tons of carbon dioxide (C0t2).

The Global Warming Problem Human (industrial) production entails emissions of GHG. Given scientific evidence like the results presented in the 4th report of the Intergovernmental Panel on Climate Change (IPCC), such emissions impact the world climate negatively. An increase in the concentration of GHG is projected to increase the mean atmospheric temperature implying a higher frequency of disasters and natural

catastrophes (such as droughts, floods, and heat waves), higher mortality rates, and a significant loss of biodiversity. These consequences have economic costs, the most apparent being a loss in the productive capacity of the world economy. The world climate represents a public good as its benefits (or its consumption) are non rival and non-excludable. Consequently, global warming is a public bad. The presence of public goods leads to inefficiencies since economic agents do not perceive the true cost of their actions and do not equalize (social) marginal costs and benefits. In our case the representative agent is over-emitting GHG, since she perceives the marginal cost of doing so (to her as an individual) is zero. Under the perfect foresight assumption, she is able to correctly predict the path of GHG (mainly CO2) concentrations given her (and everybody else's) consumption, production, and investment choices. Although she is aware of the collective consequences of her actions, she thinks her individual contribution to the overall result is negligible. Consequently, she will not reduce her production-related emissions, either through producing less or investing in mitigation, because she knows that nobody else will do so (as they believe their actions to be insignificant, too). All agents end up choosing the same inefficient allocation. This point was made in Foley (2008). Such socially sub-optimal outcomes are well known from simple strategic games, the most prominent being the Prisoners' Dilemma.

Given the inefficiency of over-accumulation of GHG stock in the atmosphere as a result of capital stock accumulation, the world economy is not operating at the inter-temporal production possibility frontier (PPF). Future generations would appreciate lower stocks of CO2 which implies that current generations should accumulate less conventional capital and consume more (of it) today. There is no intergenerational trade-off despite the fact that such a trade-off is posited in most of the global warming related economic publications. The mutual gains can be illustrated by moving the economy from a point inside the PPF to its boundary. This movement to an efficient equilibrium can be achieved by cost transparency (which amounts to increasing the cost of emitting to its true value).

Creating the correct price signal for GHG emissions (by whatever means, including trade permits, Pigouvian taxes, or direct regulation) is sufficient to internalize the

negative externality of global warming. As a result our agent will start to invest into mitigation. These mitigation costs, however, are small compared with the gain of obviating GHG emissions. As is shown below, averting climate change can represent a non-trivial Pareto improvement.

4.7 What's a carbon tax?

A carbon tax is a fee imposed on the burning of carbon-based fuels (coal, oil, gas). More to the point**:** a carbon tax is the core policy for reducing and eventually eliminating the use of fossil fuels whose combustion is destabilizing and destroying our climate**.**

A carbon tax is a way — the *only* way — to make users of carbon fuels pay for the climate damage caused by releasing carbon dioxide into the atmosphere. If set high enough, it becomes a powerful monetary disincentive that motivates switches to clean energy across the economy, simply by making it more economically rewarding to move to non-carbon fuels and energy efficiency.

Carbon chemistry is potent but also simple. The amount of CO2 released in burning any fossil fuel is strictly proportional to the fuel's carbon content. This allows the carbon tax to be levied "upstream" on the fuel itself when it is extracted from the ground or imported into the U.S., which vastly simplifies its administration.

The energy essence of every fossil fuel is its carbon and hydrogen atoms. Oxidizing (combusting) those atoms releases their heat energy but also converts carbon to carbon dioxide. Natural gas, with a high ratio of hydrogen to carbon, is the least carbon-intensive fuel, while coal is the most. The CO2 released from burning these fuels rises into the upper atmosphere and remains resident there — typically for around a century — trapping heat re-radiated from Earth's surface and causing global warming and other harmful climate change.

The carbon content of every fossil fuel, from anthracite or lignite coal to heating oil and natural gas, is precisely known. A carbon tax obeys these proportions, taxing coal more heavily than petroleum products, and much more than natural gas. This makes a carbon tax.

4.7.1 **How is a carbon tax implemented?**

Utilizing existing tax collection mechanisms, a carbon tax is paid "upstream," i.e., at the point where fuels are extracted from the Earth and put into the stream of commerce, or imported into the U.S. Fuel suppliers and processors are free to pass along the cost of the tax to the extent that market conditions allow. Placing a tax on carbon gives consumers and producers a monetary incentive to reduce their carbon dioxide emissions.

Carbon that is chemically bound into manufactured products such as plastics but is not burned will not be taxed. Similarly, any CO2 from energy production that is permanently sequestered rather than released into the atmosphere won't be taxed (or will receive an offsetting tax credit). Additionally, some carbon tax proposals include exemptions for export-dependent businesses to help them remain competitive in global markets.

UNIT 5

ECONOMIC IMPACT OF ENVIRONMENTAL POLLUTION AND ENVIRONMENTAL REGULATIONS

Introduction

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat or light. Pollutants, the components of pollution, can be either foreign substances/energies or naturally occurring contaminants.

Environmental pollution is "the **contamination** of the physical and biological components of the earth/atmosphere system to such an extent that normal **environmental processes** are adversely **affected**".

Pollution is the introduction of **contaminants** into the environment that cause **harm** or **discomfort** to humans or other living organisms, or that damage the environment" which can come "in the form of chemical substances, or energy such as noise, heat or light". "**Pollutants** can be naturally occurring substances or energies, but are considered contaminants when **in excess of natural levels**.

Pollution is "the **addition** of any substance or form of energy (e.g., heat, sound, and radioactivity) **to the environment** at a rate **faster** than the environment can accommodate it by dispersion, breakdown, recycling, or storage in some harmless form". "**Pollution** is a special case of habitat destruction; it is **chemical destruction** rather than the more obvious physical destruction. Pollution occurs in all habitats—land, sea, and fresh water and in the atmosphere."

"Much of what we have come to call **pollution** is in reality the non recoverable matter resources and waste heat." "Any use of natural resources at a rate higher than nature's capacity to restore itself can result in **pollution** of air, water, and land."

Introduction to Environmental Pollution

Although pollution had been known to exist for a very long time (at least since people started using fire thousands of years ago), it had seen the **growth** of truly **global proportions** only since the onset of the *industrial revolution* during the 19th century.

The industrial revolution brought with it technological progress such as discovery of **oil** and its virtually universal use throughout different industries.

Technological progress facilitated by super efficiency of capitalist business practices (division of labour – cheaper production costs – overproduction – overconsumption – overpollution) had probably become one of the main causes of serious deterioration of natural resources.

At the same time, of course, development of natural sciences led to the better understanding of negative effects produced by pollution on the environment.

Environmental pollution is a problem both in **developed** and **developing countries**. Factors such as *population growth* and *urbanization* invariably place greater demands on the planet and stretch the use of natural resources to the maximum.

It has been argued that the **carrying capacity** of Earth is significantly smaller than the demands placed on it by large numbers of human populations. And overuse of natural resources often results in nature's degradation.

Environmental pollutants

Environmental pollutants are constituent parts of the pollution process. They are the actual "*executing agents*" of environmental pollution. They come in ***gaseous***, ***solid*** or ***liquid*** form.

It is interesting to note that, as of 1990, there were around **65,000** different **chemicals** in the marketplace, i.e. potential environmental pollutants that were to be released into air, water and land on a regular basis. We assume that, as of 2011 - 2012, this number may be significantly higher.

Renowned author Miguel A. Santos identifies at least **three** general *characteristics of environmental pollutants*

1. Pollutants **don't** recognize **boundaries**, i.e. they are *transboundary*;
2. Many of them **can't** be **degraded** by living organisms and therefore stay in the ecosphere for many years; and
3. They **destroy biota** and **habitat**.
4. These points emphasize that pollutants present a serious long-term ***global*** problem that affects more or less every country and, therefore, can only be solved by

a *coordinated set of actions* and *unwavering commitment* of nations to international environmental agreements.

5. In order to develop and implement an effective international policy for pollutants' management, it is important, among other factors, to understand their decomposition mechanisms.
6. We know that **decomposition** of pollutants can occur either *biologically* or *physicochemically*.

Effects of Environmental Pollution

The pollution of the environment & its natural resources such as water, air or land with different pollutants is known as environmental pollution. The biggest & main harmful effect of pollution is on the environment as it breaks up the environment & also the different ecosystems present in it. Environmental pollution has adverse effects on both the humans & the other environmental living and non-living things. Environmental pollution is a worldwide problem & it causes hazardous effects on humans & natural resources. Environmental pollution is defined as the state of contamination of different natural resources of the environment with the introduction of the poisonous chemicals & gases in the atmosphere of the earth which leads towards the destruction of natural resources of the environment such as land, air or water. The different pollutants which pollute the environment may be regarded as primary or secondary pollutants & the pollutants having short term or long term effects on the environment due to their vitality & nature of causing damage to the environment. It is the state of the buildup of toxic chemicals & poisonous gases in the breathing zone of the atmosphere of the earth which leads to many harmful disorders & discomforts to all the life species relying on natural resources of the environment. Environment pollution occurs in pollution of different forms of the environment such as land, water, air, noise, thermal, radioactive or light pollution. When the pollutants enter in the different zones of the environment, the species dependent on these natural resources would suffer & face difficulties in surviving. The environment is polluted when the different types of pollutants such as greenhouse gases, harmful heavy metals & harmful chemicals. The pollutants cause the long term as well

short-term changes in the environment which have very dangerous effects. The different kinds of environmental pollution are listed below:

1. Water pollution
2. Land or soil pollution
3. Air pollution
4. Noise pollution
5. Light pollution
6. Thermal pollution
7. Radioactive pollution

The wide spreading pollution problem in the environment causes both the physical & biological effects which vary from mild to severe in the intensity of causing problems. The different physical effects of pollution are such as the effects which are visible to us or direct physical damage to the environment & humans. For example the splitting of oil into the earth's resources like land or water from the pipelines or oil ships which will produce deadliest of the effects on the aquatic ecosystems & the different ecosystems flourishing on the land masses. Also, the emission of air pollutants in the atmosphere also produces physical effects on the earth's atmosphere by producing the different diseases of lungs in humans by the taking of polluted air. The different biological effects can be seen in the human population & on the different food chain of animals. The pollution produces biological effects by the destruction of the natural balance of environment very seriously & in extreme cases also leads to the death of human & animal species. Biological effects will be produced on the environment by the use of pesticides, herbicides, synthetic fertilizers etc. for the crop production in the farm lands will lead to the determinant effects on the humans & other biological species of nature. The various effects of pollution are shown in the diagram below:

The different harmful effects of environmental pollution on the different living or non-living things of earth are discussed in detail below:

1. **Environmental degradation**: Pollution cause very dangerous & hazardous effects on the environment which depletes the natural balance of the environment. The environment is degraded due to the addition of pollutants in the natural

resources of the environment such as air, water or soil. The different examples of environmental degradation are as:

1. The emission of greenhouse gases by various means into the atmosphere will lead to the global warming & the depletion of natural ecosystems of earth.
2. Carbon dioxide emissions in the oceans leading to the acidification of water resources by the large concentrations of carbon dioxide in water.
3. Biomagnifications: It is defined as the addition of several toxins like those of heavy metals in the food chains or trophic levels of different species of environment causing depletion of species.
4. Sulphur dioxide & different nitrous oxides will lead to acid rain which decreases the pH value of soil making it difficult for crop production purposes.
5. The formation of smoke & haze will reduce the sunlight received by the plants leading to the decrease in photosynthesis & the production of tropospheric ozone which damages the plants.
6. The addition of heavy metals & oil splits in oceans will lead towards the pollution of land masses & water resources making them unsuitable for use.

Effects on human health: The decrease in quality of air will lead to several respiratory problems like asthma or lung cancer, different cardiovascular diseases, chest pain, congestion, throat inflammation etc. in humans due to the ingestion of polluted air. The consumption of polluted water due to different contaminant addition will cause skin problems like skin cancer or rashes on the skin, water-related diseases such as diarrhoea, malaria, several fevers etc. Noise pollution in the environment will also lead to the production of different psychological effects on the humans & also on the environment. The effects of different gaseous pollutants on humans are shown below in table:

Health Effects at very high levels

	Pollutant	Health Effects
1	Nitrogen Dioxide	This gas irritate the airways of the lungs, increasing the symptoms of those suffering from lung diseases
2	Sulphur Dioxide	This gas will irritate the airways of the lungs, increasing the symptoms of those suffering from lung diseases
3	Ozone Carbon Monoxide	This gas will irritate the airways of the lungs, increasing the symptoms of those suffering from lung diseases. This gas prevents the uptake of oxygen by the blood. This can lead to a significant reduction in the supply of oxygen to the heart, particularly in people suffering from heart disease
4	Particles	Fine particles can be carried deep into the lungs where they can cause inflammation and a worsening of heart and lung diseases

Global warming: It is the emission of greenhouse gases in the environment leading towards the increase in their concentration in the atmosphere causing the global increase in earth's temperature which has many hazardous effects on precipitation quantities & on other harmful effects. Global warming occurs due to the emission of several greenhouse gases like those of methane, sulphur dioxide, nitrous oxide, carbon monoxide, carbon oxide etc. from the industrial infrastructure or from agricultural units by different means. The melting of ice caps or glaciers of the earth is also an effect of pollution as the rise in earth's temperature will result in melting of ice.

1. Ozone layer depletion: It is also an adverse effect of pollution. It occurs due to the emission of the CFCs in the environment from the use of different commercial & household products by humans which will destroys the ozone layer present in stratosphere leading to the entry of high wavelength UV rays directly on earth & resulting in many skin related diseases like skin irritation, skin cancers, allergies in humans & animals.
2. Infertility of land: The increased use of herbicides, fertilizers, pesticides or synthetic manures for the performance of increased crop production will lead to the depletion of soil fertility due to the addition of harmful chemicals or heavy metals into the soil. Also, the addition of untreated sewage or industrial wastes

directly or indirectly into the soil will also make it infertile for crop production or for the growth of vegetation.

3. Effects on animals: The increased levels of pollution will also adversely affect the different animal species of the earth due to the depletion of the natural resources such as air, water or land units on which the wildlife depends fully for habitat & food. Also, the addition of toxicants into the food chain of animals will destroy them.
4. Effect on plants: The increased level of pollution will have hazardous effects on the all kinds of vegetation present on the earth. The pollution of land will destroy the growth & development of plants as they will do not flourish on the land containing harmful heavy metals and chemicals. The roots of plants do not absorb the polluted water due to different contaminants added into water bodies supplying water to plants. Also, the leaves of plants do not prepare food in the polluted air of atmosphere due to less reception of sunlight.
5. Effects on buildings or infrastructure formed by humans: The most important example of the effect of pollution on the human buildings is on one of the world heritage monument, the Taj Mahal in India which has a depletion of the wall sandstones due to polluted air around it. It also changes the colour of the monuments or buildings and damages them.
6. Eutrophication of water & land bodies: The rain water will increase the addition of a nitrogenous pollutants concentration in the land & water resources which will lead to the algal growth on large scales causing depletion of naturally present nutrients in those resources which will cause harmful conditions for the growth of other species & organisms.
7. Destruction of different ecosystems: The pollution of atmosphere will also lead to the destruction of different ecosystems present in the environment like those of water bodies such as lakes, rivers, oceans, seas etc. due to water pollution & of crop lands, wastelands, forest lands etc. due to land or soil pollution.
8. Depletion of earth's atmosphere: The atmosphere of earth is depleted due to the presence of high quantities of polluted gases into the atmosphere by their large

scale emissions from the industries & household sectors. These large emissions will produce harmful effects on the atmosphere by the changes in gaseous concentrations of earth.

Economic Impact

An **economic impact analysis** (**EIA**) examines the effect of an event on the economy in a specified area, ranging from a single neighborhood to the entire globe. It usually measures changes in business revenue, business profits, personal wages, and/or jobs. The economic event analyzed can include implementation of a new policy or project, or may simply be the presence of a business or organization. An economic impact analysis is commonly conducted when there is public concern about the potential impacts of a proposed project or policy.

An economic impact analysis typically measures or estimates the change in economic activity between two scenarios, one assuming the economic event *occurs*, and one assuming it *does not occur* (which is referred to as the counterfactual case). This can be accomplished either before or after the event

Sources of Economic Impacts

In addition to the types of impacts, economic impact analyses often estimate the sources of the impacts. Each impact can be decomposed into different components, depending on the effect that caused the impact. *Direct effects* are the results of the money initially spent in the study region by the business or organization being studied. This includes money spent to pay for salaries, supplies, raw materials, and operating expenses.

The direct effects from the initial spending creates additional activity in the local economy. *Indirect effects* are the results of business-to-business transactions indirectly caused by the direct effects. Businesses initially benefiting from the direct effects will subsequently increase spending at other local businesses. The indirect effect is a measure of this increase in business-to-business activity (not including the initial round of spending, which is included in the direct effects).

Induced effects are the results of increased personal income caused by the direct and indirect effects. Businesses experiencing increased revenue from the direct and indirect effects will subsequently increase payroll expenditures (by hiring more employees,

increasing payroll hours, raising salaries, etc.). Households will, in turn, increase spending at local businesses. The induced effect is a measure of this increase in household-to-business activity. Finally, *dynamic effects* are caused by geographic shifts over time in populations and businesses

Impact of Climate change

Climate change impacts can be measured as an economic cost . This is particularly well-suited to market impacts, that is impacts that are linked to market transactions and directly affect GDP. Monetary measures of non-market impacts, e.g., impacts on human health and ecosystems, are more difficult to calculate. Other difficulties with impact estimates are listed below:

1. **Knowledge gaps**: Calculating distributional impacts requires detailed geographical knowledge, but these are a major source of uncertainty in climate models.
2. **Vulnerability**: Compared with developed countries, there is a limited understanding of the potential market sector impacts of climate change in developing countries.
3. **Adaptation**: The future level of adaptive capacity in human and natural systems to climate change will affect how society will be impacted by climate change. Assessments may under- or overestimate adaptive capacity, leading to under- or overestimates of positive or negative impacts.
4. **Socioeconomic trends**: Future predictions of development affect estimates of future climate change impacts, and in some instances, different estimates of development trends lead to a reversal from a predicted positive, to a predicted negative, impact (and *vice versa*).

    In a literature assessment, Smith *et al.* (2001:957-958) concluded, with medium confidence, that:

5. Climate change would increase income inequalities between and within countries.
6. A small increase in global mean temperature (up to 2 °C, measured against 1990 levels) would result in net negative market sector impacts in many developing countries and net positive market sector impacts in many developed countries.

With high confidence, it was predicted that with a medium (2-3 °C) to high level of warming (greater than 3 °C), negative impacts would be exacerbated, and net positive impacts would start to decline and eventually turn negative.

Economic pollution

The economics of pollution, we see that there is a point where both society and the environment have some satisfaction, or in other words, there is an optimum amount of pollution. The optimum amount of pollution can be defined as the point where the marginal benefit equals the marginal cost of pollution.

How does the pollution affect the Economy

The Effects: Economy. Nutrient pollution can have severe economic impacts on recreational fishing, businesses, and tourism. Nutrient pollution causes millions of dollars in losses to the commercial fishing industry.

Marginal Cost of Pollution

Marginal cost is a term that comes from the study of economics that is defined as the change in total cost that arises due to producing one more unit of a good. For example, if a widget factory decides to produce a new line of widgets, the marginal cost of the new widget line would include all of the additional costs that come with extra materials, added production and more worker hours.

ENVIRONMENTAL POLLUTION REGULATIONS

Environmental regulations are rules and requirements that generally cover two things: Pollution control: regulating how much pollution (chemicals or other undesirable materials such as "heat", "suspended particulates") a facility releases.

Meaning of Environmental Pollution Regulation

The word “environment” is commonly used to mean “surroundings”. It always refers to a certain object that is surrounded by its environment. Albert Einstein provided a simple definition of environment as “…the environment is everything that isn’t me”. Therefore, the term “human environment” conveys the sense of the “surroundings of human beings”. Although this seems to be a fascinatingly simple definition, it cannot be used as an operational definition especially in the context of legal issues. Clearly, for the

purposes of environmental legislation, there must be a legal definition of “environment”. The legal definition carries a more specific meaning and is understood to be the physical surroundings that are common to human beings including the natural resources of land, air and water, and the flora and fauna that inhibit them.

Definition of “pollution” is difficult as water, air or land is never pure in their natural states. The identification and assessment of pollution is also very difficult. However, there is general agreement on two essential features of environmental pollution: that pollution is of human origin, and that excessive pollution can cause harm to human health or the quality of environment. This philosophy is reflected in the European Commission Directive on Integrated Pollution Prevention and Control, which defines “pollution of the environment” as:

“... the direct or indirect result of human activity, of presence of substances, vibration, heat or noise into the air, water or land which may be harmful to human health or quality of the environment, and which may result in damage to material, property, or interfere with amenities and other legitimate use of the environment”.

The words “harmful” and “damage” play important roles in the definition of pollution. Mere presence of a substance in a certain medium is not enough to cause harm or damage. There must be an unwanted effect to cause harm or damage. Extraneous substances, while present in the media, must exhibit through their distribution, concentration and physical or chemical behavior that there is a harmful or damaging consequence. Often it is not the nature of the pollutant itself that makes it a pollutant. Rather, it is the circumstance in which it is present, and often the attitude of the people affected by it and on their value judgments.

Regulation is essentially a process that controls some substances or processes for different reasons. In the present context it is understood to be the prime legal tool to combat environmental pollution. It is essentially the use of a certain set of specific rules to prevent or reduce pollution and its consequences. These rules may be those of criminal or civil law, private non-legal rules, or the rules of the free market. However, when one talks of direct regulation of environmental pollution, it is understood as the use of rules by public bodies to combat pollution. On the basis of the above, environmental pollution

regulations may be defined as a set of specific rules (of criminal or civil law, private non-legal rules, rules of free market, etc.) designed, implemented and enforced by local, regional, national or international bodies to prevent or reduce harm to human health and environmental quality, and to reduce damage to material or property arising out of the direct or indirect human activity leading to the introduction of harmful or damaging substances, vibration, heat or noise into the air, water or land.

History and trends of environmental pollution regulation

The historical context

Environmental resources, their utilization by human beings and the consequence of such utilization has led to the evolution of environmental protection regulations that are broadly divided in two groups: regulation pertaining to the conservation of natural resources, and regulations for controlling environmental pollution.

As far as environmental pollution regulations are concerned, the first known attempt to protect people from the consequences of human activities endangering the environment was made in 1273 when King Edward I of the United Kingdom issued a decree prohibiting the burning of sea coal in order to protect the health of his subjects.

Some such sporadic, local and largely ineffective attempts were made at that time, in the eighteenth century and during the Industrial Revolution. Manufacturing industry was at its infancy at that time, and economy was based almost exclusively on rural agriculture. Thus it was not possible for man, and the technology upon which he relied, to cause any radical or perceptible change to the environment. At that time there were only local environmental problems in areas of high population density.

However, with the dawning of the Industrial Revolution, expansion of colonies and the need to maintain them, as well as the need to satisfy certain basic preconditions for a viable economy, the focus shifted to the following considerations:

1. The environment is the source of energy and materials that can be transformed into goods and services.
2. The environment acts as a vast sink for wastes and polluting substances generated by human activities.

3. Environmental resources are the basis of all human development, and, therefore, limits should be set to such development.

4. High rate of depletion of environmental resources, and increased pollution and wastes, are at the root of many environmental problems faced by society.

Thus the second phase of environmental pollution regulation was ushered by the need to deal with growing pollution, wastes, and other problems that often created totally unpleasant social conditions. In the United Kingdom, this was witnessed by the revival of the tort of nuisance, The Alkali Act of 1863, establishment of the Alkali Inspectorate (the world's first pollution control agency), water pollution statute of 1861, Clean Air Act of 1956, and others. During this phase comprehensive statutory control regimes were developed, but the objectives of such legislation were limited to the nature and quantity of the pollutant themselves. There was little or no understanding of how pollution could degrade the wider natural environment of entire nations, regions or continents.

Concern for the environment grew substantially after Second World War. Starting from the 1960s, a series of activities can be identified that were of concern for the environment. This provided the impetus to regulate the impacts of pollutants on the biosphere as a whole by imposing appropriate quality standards. The other contributory factor has been the emergence of OECD and the United Nations, as well as pressure groups in the United States and the European Community, to initiate environmental actions and influence policy.

However, the regulatory regime for pollution prevention naturally suffers from many defects, notably that compliance with regulations, conceived as a set of criminal and civil rules of law administered by public bodies, are costly to enforce and monitor. The standards in pollution regulations are the minimum requirements to be complied with, and sanctions are applicable when they are not.

The polluters take those legal standards as norms and make no effort for further environmental improvement. The standards that are used to restrict emission levels of pollutants are based on technical feasibility and are wrapped up in terms such as "best practicable means", "best available technology not entailing excessive costs", etc. The

use of such terms leads one to believe that technical and economical reasons may override the environmental priorities.

Considering the cost of the regulatory process (set of rules enforced by public bodies) and its inherent flaws, it might be necessary to find acceptable alternatives. But whether such alternatives could be found remains an open question.

Environmental Laws

Environmental law, also known as environmental and natural resources law, is a collective term describing the network of treaties, statutes, regulations, common and **customary** laws addressing the effects of human activity on the natural environment. The core environmental law regimes address environmental pollution

'Environmental Law' is an instrument to protect and improve the environment and to control or prevent any act or omission polluting or likely to pollute the environment. An environmental legal system is essentially a set of laws and administrative rules which regulate the relationships and conflicts between all the people concerned with the environment, as well as defining the relationships between people and the environment itself. The Honourable Supreme Court in K. M. Chinnappa v. Union of India defined "Environmental Law" as an instrument to protect and improve the environment and control or prevent any act or omission polluting or likely to pollute the environment. In the Constitution of India, it is clearly stated that it is the duty of the State to "protect and improve the environment and to safeguard the forests and wildlife of the country". It imposes a duty on every citizen "to protect and improve the natural environment including forests, lakes, rivers, and wildlife". Reference to the environment has also been made in the Directive Principles of State Policy (Part IV) as well as the Fundamental Rights (Part III). The Department of Environment was established in India in 1980 to ensure a healthy environment for the country. This later became the Ministry of Environment and Forests in 1985.

Ministry of Environment and Forests (MoEF): The MoEF is the nodal agency in the administrative structure of the Central Government for planning, promotion, coordination and overseeing the implementation of India's environmental and forestry policies and programmes. The primary concerns of the Ministry are implementation of policies and

programmes relating to conservation of the country's natural resources including its lakes, rivers, biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution.

The broad objectives of the Ministry are:

1. Prevention and control of pollution;
2. Protection of the environment; and
3. Ensuring the welfare of plants & animals

The Constitution of India The 'Right to Life' contained in Article-21 of the Constitution of India includes the right to clean and human environment. It means you have the right to live in a clean and healthy environment. Article-38 of our Constitution requires State to ensure a social order for the welfare of people, which can be obtained by an unpolluted and clean environment Article-48A of the Constitution, declares "The State shall endeavour to protect and improve the environment and safeguard forests and wildlife of the country." Article-51A(g) of the Indian Constitution says: "It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures."

The Water (Prevention and Control of Pollution) Act, 1974

The Water (Prevention and Control of Pollution) Act was enacted in 1974 to provide for the prevention and control of water pollution, and for maintaining or restoring of wholesomeness of water in the country. This is the first law passed in India whose objective was to ensure that the domestic and industrial pollutants are not discharged into rivers, and lakes without adequate treatment. The reason is that such a discharge renders the water unsuitable as a source of drinking water as well as for the purposes of irrigation and support marine life. In order to achieve its objectives, the Pollution Control Boards at Central and State levels were created to establish and enforce standards for factories discharging pollutants into water bodies.ent only

The Air (Prevention and Control of Pollution) Act, 1981

The Air (Prevention and Control of Pollution) Act, 1981 was enacted to provide for the prevention, control and abatement of air pollution in India. It is a specialized piece of legislation which was enacted to take appropriate steps for the preservation of natural

resources of the earth, which among other things include the preservation of the quality of air and control of air pollution.

The prime objectives of the Act are the following:

1. Prevention, control and abatement of air pollution;
2. Establishment of central and state pollution control boards to implement the aforesaid purpose; and
3. To maintain the quality of air

The Environment Protection Act, 1986

It was the Bhopal Gas Tragedy which necessitated the Government of India to enact a comprehensive environmental legislation, including rules relating to storing, handling and use of hazardous waste. On the basis of these rules, the Indian Parliament enacted the Environment Protection Act, 1986. This is an umbrella legislation that consolidated the provisions of the Water (Prevention and Control of Pollution) Act of 1974 and the Air (Prevention and Control of Pollution) Act of 1981. Within this framework of the legislations, the government established Pollution Control Boards (PCBs) in order to prevent, control, and abate environmental pollution.

The objective of the Environment Protection Act is to protect and improve the environment in the country

The Noise Pollution (Regulation and Control) Rules, 2000

There was no direct provision for 'noise pollution' under the Environment Protection Act, 1986 or any other legislation. The increasing ambient noise levels in public places from various sources like industrial activity, generator sets, loud speakers, vehicular horns etc. have harmful effects on human health. It was the need of the hour to come with a law which would regulate and control noise producing sounds with the objective of maintaining the ambient air quality standards in respect of noise. Therefore, the Central Government framed 'The Noise Pollution (Regulation and Control) Rules, 2000'.

These rules have been laid down by the government to reduce environmental noise pollution. Certain standards, such as the ambient air quality standards, have been set by the government. The permissible levels of noise are different for different areas,

such as industrial, commercial, residential areas and silence zones (area within the vicinity of hospitals, educational institutions or courts).

The Public Liability Insurance Act, 1981

This Act aims to provide immediate relief to the persons affected by accident occurring while handling any hazardous substance. It provides that every owner shall take out, before he starts handling any hazardous substance, one or more insurance policies providing for contracts of insurance. The objective of taking insurance is that the compensation resulting from the possible future accident is guaranteed.

The collector of the area has been empowered to verify the occurrence of any accident at any place within his jurisdiction and also cause publicity to be given for inviting applications from the victims for any compensation.

Apart from the insurance contract, the funding for the purpose of compensation is also generated by the Central Government by the establishment of "Environment Relief Fund." This fund may be utilized by the collector for paying the compensation.

The National Environment Tribunal Act, 1995

This Act is aimed to provide for strict liability for damages arising out of any accident occurring while handling any hazardous substance and for the establishment of a National Environment Tribunal for effective and expedition disposal of cases arising from such accident, with a view to giving relief and compensation for damages to persons, property and the environment and for matters connected with it.

The beauty of this Act lies in the fact that the liability of the owner of hazardous substance has been made strict in case of any accident and the resultant injury to public. In any claim for the compensation, the claimant is not required to plead and establish that the death, injury or damage in respect of which the claim has been made was due to any wrongful act, neglect or default of any person. So, the burden of proof does not rest upon the claimant of compensation which is a big relief for the victims.

The National Environment Appellate Authority (NEAA) Act, 1997

The National Environment Appellate Authority (NEAA) was set up by the Ministry of Environment and Forests to address cases in which environment clearance is required in certain restricted areas. It was established by the National Environment

Appellate Authority Act 1997 to hear appeals with respect to restriction of areas in which any industries, operations, processes or class of industries, operations or processes shall or shall not be carried out, subject to certain safeguards under the Environment Protection Act, 1986.

The Ozone Depleting Substances (Regulation and Control) Rules, 2000

The Ozone Depleting Substances (Regulation and Control) Rules have been laid down for the regulation of production and consumption of ozone depleting substances. The main objective of this rule is protection of the Ozone layer. The rule restricts unauthorized sale, purchase, import, export and use of ozone depleting substance.

In the Constitution of India it is clearly stated that it is the duty of the state to 'protect and improve the environment and to safeguard the forests and wildlife of the country'. It imposes a duty on every citizen 'to protect and improve the natural environment including forests, lakes, rivers, and wildlife'. Reference to the environment has also been made in the Directive Principles of State Policy as well as the Fundamental Rights. The Department of Environment was established in India in 1980 to ensure a healthy environment for the country. This later became the Ministry of Environment and Forests in 1985.

The constitutional provisions are backed by a number of laws – acts, rules, and notifications. The EPA (Environment Protection Act), 1986 came into force soon after the Bhopal Gas Tragedy and is considered an umbrella legislation as it fills many gaps in the existing laws. Thereafter a large number of laws came into existence as the problems began arising, for example, Handling and Management of Hazardous Waste Rules in 1989.

General

1986 - The Environment (Protection) Act authorizes the central government to protect and improve environmental quality, control and reduce pollution from all sources, and prohibit or restrict the setting and /or operation of any industrial facility on environmental grounds.

1986 - The Environment (Protection) Rules lay down procedures for setting standards of emission or discharge of environmental pollutants.

1989 - The objective of Hazardous Waste (Management and Handling) Rules is to control the generation, collection, treatment, import, storage, and handling of hazardous waste.

1989 - The Manufacture, Storage, and Import of Hazardous Rules define the terms used in this context, and sets up an authority to inspect, once a year, the industrial activity connected with hazardous chemicals and isolated storage facilities.

1989 - The Manufacture, Use, Import, Export, and Storage of hazardous Micro-organisms/ Genetically Engineered Organisms or Cells Rules were introduced with a view to protect the environment, nature, and health, in connection with the application of gene technology and microorganisms.

1991 - The Public Liability Insurance Act and Rules and Amendment, 1992 was drawn up to provide for public liability insurance for the purpose of providing immediate relief to the persons affected by accident while handling any hazardous substance.

1995 - The National Environmental Tribunal Act has been created to award compensation for damages to persons, property, and the environment arising from any activity involving hazardous substances.

1997 - The National Environment Appellate Authority Act has been created to hear appeals with respect to restrictions of areas in which classes of industries etc. are carried out or prescribed subject to certain safeguards under the EPA.

1998 - The Biomedical waste (Management and Handling) Rules is a legal binding on the health care institutions to streamline the process of proper handling of hospital waste such as segregation, disposal, collection, and treatment.

1999 - The Environment (Siting for Industrial Projects) Rules, 1999 lay down detailed provisions relating to areas to be avoided for siting of industries, precautionary measures to be taken for site selecting as also the aspects of environmental protection which should have been incorporated during the implementation of the industrial development projects.

2000 - The Municipal Solid Wastes (Management and Handling) Rules, 2000 apply to every municipal authority responsible for the collection, segregation, storage, transportation, processing, and disposal of municipal solid wastes.

2000 - The Ozone Depleting Substances (Regulation and Control) Rules have been laid down for the regulation of production and consumption of ozone depleting substances.

2001 - The Batteries (Management and Handling) Rules, 2001 rules shall apply to every manufacturer, importer, re-conditioner, assembler, dealer, auctioneer, consumer, and bulk consumer involved in the manufacture, processing, sale, purchase, and use of batteries or components so as to regulate and ensure the environmentally safe disposal of used batteries.

2002 - The Noise Pollution (Regulation and Control) (Amendment) Rules lay down such terms and conditions as are necessary to reduce noise pollution, permit use of loud speakers or public address systems during night hours (between 10:00 p.m. to 12:00 midnight) on or during any cultural or religious festive occasion

2002 - The Biological Diversity Act is an act to provide for the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources and knowledge associated with it

Forest Policy

Over the years, many rules and regulations were introduced by India. In 1980, the **Conservation** Act was passed, which stipulated that the central permission is required to practice sustainable **agro-forestry** in a forest area.

Historical Background of Forest Policies:

Policies are guidelines for the government and the people and help in making various decisions. Forests are a vital part of any nation, not only for the commercial value, but also for the quality of life that it guarantees. Hence it was considered imperative, even during the British Rule, that India must have a Forest Policy.

The British were the first to officially recognize the natural wealth of India and it was they who initiated the process of forming a forest policy during the second half of the 19th century.

Their scheme was to plunder the natural wealth of the nation as much as possible, since timber trade was a highly lucrative trade during those times. Hence, their policies were aimed at putting themselves in an advantageous position and to exploit the resources to the extent possible.

The sequences of their efforts in this direction (by means of Acts and Policies) are given below:

a. The first Conservator of Forests was appointed in the year 1850 by the British, in Bombay, and the first Forest Department was set-up in the year 1864.
b. In order to generate income, the Forest Act of 1865 was brought out, which classified the forests into reserved forests and unclassified forests. The former were out of bounds of the local people and the latter un-surveyed forests were progressively reclassified as reserved forests before the end of the century and the process was speeded up to contain the provision in the revised Forest Act of 1878.
c. The Forest Act, 1865 was first enacted to counteract various local population.
d. By the Forest Act of 1878, even the village forests were closed, and what was the right of the people was translated into privileges, and that to for a fee.
e. The first Forest Policy was in the year 1894, which gave priority to agriculture over forests.
f. The next Forest Act was enacted in the year 1927, which made the rules more stringent and the people's privileges were curtailed further.

Aims of the Forest Policy

The basic issue is to protect the forests, wherever they are situated within the boundaries of the nation. The Forest Policies in India aim at three main areas in the

context of protection and preservation of the forests. The principal aim of forest policy must be to ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium, which are vital for sustenance of all life forms, human, animals and plants. The derivation of direct economic benefit must be subordinated to this principal aim.

They can be generalized as

a. Protecting the forests from illicit felling, encroachment, forest fires, grazing, etc.
b. Reducing the damage to the forests from insects/fungus/diseases, etc.
c. Reforesting areas that may need trees for the ecological balance of the region.

3. Organization of the Forest Sector in India

The forests in India are almost owned by the government and any afflictions to the forests must be reported to the Forest Departments, which are agencies of the Government of India. In each state, the forestry sector is headed by a Principal Chief Conservator of Forests.

The Ministry of Environment and Forests is the key administrative agency for planning and co-ordination of environmental and forestry programmes. The Ministry of Environment and Forests can be contacted at: Paryavaran Bhavan, CGO complex, Lodhi Road, New Delhi 110003, India, Under the Ministry of Environment and Forests come the various agencies that cater to a variety of needs of the forest sector, like.

i. Research
ii. Conservation
iii. Consultancy
iv. Education, and
v. Direct involvement in the reforestation process.

The basic objectives that govern the national forest policy are the following:

a. Maintenance of environmental stability through preservation and, where necessary, restoration of the ecological balance that has been adversely disturbed by serious depletion of the forests of the country.

b. Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country.
c. Checking soil erosion and denudation in the catchment areas of rivers, lakes and reservoirs in the interest of soil and water conservation, for mitigating floods and droughts and for the retardation of siltation of reservoirs.
d. Checking the extension of sand dunes in the desert areas of Rajasthan and along the coastal tracts.
e. Increasing substantially the forest/tree cover in the country through massive afforestation and social forestry programmes, especially on all denuded, degraded and unproductive lands.
f. Meeting the requirements of fuel-wood, fodder, minor forest produce and small timber of the rural and tribal populations.
g. Increasing the productivity of forests to meet essential national needs.
h. Encouraging efficient utilization of forest produce and maximizing substitution of wood.
i. Creating a massive people's movement with the involvement of women, for achieving these objectives and to minimize pressure on existing forests.

Strategies for Achieving the Objectives

The Government had provided the following strategies for the achievement of the objectives

a. Increased implementation of afforestation, social forestry and farm forestry programmes.
b. Efficient and effective management of the State Forests.
c. Rights and privileges for the tribals living in that area.
d. Corporate participation in the compensatory afforestation and regeneration processes.
e. Special care to be given to wildlife protection.

f. Reducing forest encroachments by stricter monitoring of the forests and also against forest fires and overgrazing.
g. To emphasize the forest based industries to look for the raw material as far as possible outside the forests.
h. Forest extension programmes like urban forestry is to be encouraged.
i. Forestry education and awareness to be given more importance.
j. The use of modern technology to improve the quality of periodical collection and publication of reliable data on forests.
k. The enactment of appropriate legislation that will help in speeding up the process of forest conservation.

(IV) Appraisal of the National Forest Policy 1988

It is beyond doubt that this policy is comprehensive. Yet the policy does negate some of the important areas. The appraisal is intended to give the positive and the negative areas in the policy.

They are

(a) The Positive Areas

a. This policy considers the importance of conservation of the forests, which is a national wealth.
b. The policy emphasizes that 1/3rd of the plains and 2/3rd of the hilly regions must be covered with forests.
c. This policy reiterates the need to carry out afforestation, social and farm forestry on a large-scale to see the results.
d. This policy recognizes the customary privileges that belong to the people living in the forests and has enacted clauses to protect the rights and concessions of these people.
e. The policy also tries to prevent the problem of encroachment of the forest lands by better monitoring.
f. There are efforts taken in the policy to counteract any form of political intervention.

g. This policy does not take up a "pro-industrial" stand, but focuses more on the conservation of the forests.

(b) The Negative Areas

a. There is no scope for peoples participation in the policy and no effort has been made to ensure the co-operation of the people, neither urban nor rural.
b. The policy has ambitious programmes, but there is a lack of strong machinery to co-ordinate the activities of the department.
c. The forest policy has not been region specific.
d. There is dearth of programmes for spreading awareness about the programmes.
e. The forest policy does not in any way fix any targets, nor does it prescribe any sure-fire methods for the success of the programmes.

The forest policies of India are evolving with the times. Of course, there are differences among the policy profiles during the different times, starting with the British Rule in India and coming to the latest stage of liberalization of the Indian economy. To consider any policy to be useless and obsolete, would be to jump to wrong conclusions.

The policies have been highly time and circumstance – specific. Hence, the forest policies in India have served their purpose, but were a little rigid in their content to change to the demands of the changing times. It would be proper to take note of the legislative significance of the forest policies—the forest officials are nor endowed with enough powers to punish the offenders.

Though the Forest Policy of 1952 was considered to be incompatible with the changing circumstances, we must look at the policy as being in its infancy. But with regard to the next policy of 1988, the policy has no doubt been very comprehensive, but it lacks clear-cut ideas and is not futuristic in its approach.

Forest and wildlife

1927 - The Indian Forest Act and Amendment, 1984, is one of the many surviving colonial statutes. It was enacted to 'consolidate the law related to forest, the

transit of forest produce, and the duty leviable on timber and other forest produce'.

1972 - The Wildlife Protection Act, Rules 1973 and Amendment 1991 provides for the protection of birds and animals and for all matters that are connected to it whether it be their habitat or the waterhole or the forests that sustain them.

1980 - The Forest (Conservation) Act and Rules, 1981, provides for the protection of and the conservation of the forests.

Water

1882 - The Easement Act allows private rights to use a resource that is, groundwater, by viewing it as an attachment to the land. It also states that all surface water belongs to the state and is a state property.

1897 - The Indian Fisheries Act establishes two sets of penal offences whereby the government can sue any person who uses dynamite or other explosive substance in any way (whether coastal or inland) with intent to catch or destroy any fish or poisonous fish in order to kill.

1956 - The River Boards Act enables the states to enroll the central government in setting up an Advisory River Board to resolve issues in inter-state cooperation.

1970 - The Merchant Shipping Act aims to deal with waste arising from ships along the coastal areas within a specified radius.

1974 - The Water (Prevention and Control of Pollution) Act establishes an institutional structure for preventing and abating water pollution. It establishes standards for water quality and effluent. Polluting industries must seek permission to discharge waste into effluent bodies.

The CPCB (Central Pollution Control Board) was constituted under this act.

1977 - The Water (Prevention and Control of Pollution) Cess Act provides for the levy and collection of cess or fees on water consuming industries and local authorities.

1978 - The Water (Prevention and Control of Pollution) Cess Rules contains the standard definitions and indicate the kind of and location of meters that every consumer of water is required to affix.

1991 - The Coastal Regulation Zone Notification puts regulations on various activities, including construction, are regulated. It gives some protection to the backwaters and estuaries.

Air

1948 – The Factories Act and Amendment in 1987 was the first to express concern for the working environment of the workers. The amendment of 1987 has sharpened its environmental focus and expanded its application to hazardous processes.

1981 - The Air (Prevention and Control of Pollution) Act provides for the control and abatement of air pollution. It entrusts the power of enforcing this act to the CPCB.

1982 - The Air (Prevention and Control of Pollution) Rules defines the procedures of the meetings of the Boards and the powers entrusted to them.

1982 - The Atomic Energy Act deals with the radioactive waste.

1987 - The Air (Prevention and Control of Pollution) Amendment Act empowers the central and state pollution control boards to meet with grave emergencies of air pollution.

1988 - The Motor Vehicles Act states that all hazardous waste is to be properly packaged, labeled, and transported.

References

1. The above laws have been sourced from;

1. Environmental policy-making in India – The process and its pressure, TERI report.

2. Indian Environmental Legislations, list from the MOEF web site.

3. Strengthening Environmental Legislations in India, document by Centre for Environmental Law, WWF.

Questions

1. The Ministry of environment and Forests (MOEF) is the nodal agency for planning, promotion, cooperations and overseeing the implementation of India's environmental and forestry policies and programmes. (True/False)
2. The Water (Prevention and Control of Pollution) Act, 1974 was enacted to provide for the prevention and control of water pollution. (True/False)
3. The Air (Prevention and Control of Pollution) Act, 1981 was enacted to provide for the prevention, control and abatement of air pollution in India. (True/False)
4. The objective of the Environment Protection Act, 1986 is to protect and improve the environment in the country. (True/False)
5. The Noise Pollution (Regulation and Control) Rules, 2000 lays down rules to reduce environmental noise pollution. (True/False)
6. The Public Liability Insurance Act, 1981 aims to provide immediate, relief to the persons affected by accident occurring while handling any hazardous substance. (True/False)
7. The main objective of the 'Ozone Depleting Substances (Regulation and Control) (ODS) Rules, 2000' is protection of ozone layer. (True/False)

Biosphere

"The Biosphere" is a must-read for anyone interested in a better understanding of the global environmental picture. It is suitable for study by high school and college science students, scientists in all specialties, and lay people with some background in chemistry and biology. However, it is easy-to-read and presents its major concepts in a way that makes them understandable to modern readers regardless of

Three empirical generalizations exemplify his concept of the biosphere:

1. Life occurs on a spherical planet. Vernadsky is the first person in history to come to grips with the real implications of the fact that Earth is a self-contained sphere.
2. Life makes geology. Life is not merely *a* geological force, it is *the* geological force. Virtually all geological features at Earth's surface are bio-influenced, and are thus part of Vernadsky's biosphere.

3. The planetary influence of living matter becomes more extensive with time. The number and rate of chemical elements transformed and the spectrum of chemical reactions engendered by living

The biosphere also known as the ecosphere is the worldwide sum of all ecosystems. It can also be termed as the zone of life on Earth, a closed system (apart from solar and cosmic radiation and heat from the interior of the Earth), and largely self-regulating. By the most general biophysiological definition, the biosphere is the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere, geosphere, hydrosphere, and atmosphere. The biosphere is postulated to have evolved, beginning with a process of biopoiesis (life created naturally from non-living matter, such as simple organic compounds) or biogenesis (life created from living matter), at least some 3.5 billion years ago.

Narrow definition

Geochemists define the biosphere as being the total sum of living organisms (the "biomass" or "biota" as referred to by biologists and ecologists). In this sense, the biosphere is but one of four separate components of the geochemical model, the other three being *geosphere*, *hydrosphere*, and *atmosphere*. When these four component spheres are combined into one system, it is known as the Ecosphere. This term was coined during the 1960s and encompasses both biological and physical components of the planet.

The Second International Conference on Closed Life Systems defined *biospherics* as the science and technology of analogs and models of Earth's biosphere; i.e., artificial Earth-like biospheres.[7] Others may include the creation of artificial non-Earth biospheres—for example, human-centered biospheres or a native Martian biosphere—as part of the topic of biospheres.

Artificial biospheres

Experimental biospheres, also called closed ecological systems, have been created to study ecosystems and the potential for supporting life outside the earth. These include spacecraft and the following terrestrial laboratories:

1. Biosphere in Arizona, United States, 3.15 acres (13,000 m^2).

2. BIOS-1, BIOS-2 and BIOS-3 at the Institute of Biophysics in Krasnoyarsk, Siberia, in what was then the Soviet Union.
3. Biosphere J (CEEF, Closed Ecology Experiment Facilities), an experiment in Japan.
4. Micro-Ecological Life Support System Alternative (MELiSSA) at Universitat Autònoma de Barcelona

Extraterrestrial biospheres

No biospheres have been detected beyond the Earth; therefore, the existence of extraterrestrial biospheres remains hypothetical. The rare Earth hypothesis suggests they should be very rare, save ones composed of microbial life only. On the other hand, Earth analogs may be quite numerous, at least in the Milky Way galaxy, given the large number of planets. Three of the planets discovered orbiting TRAPPIST-1 could possibly contain biospheres. Given limited understanding of a biogenesis, it is currently unknown what percentage of these planets actually develops biospheres.

It is also possible that artificial biospheres will be created during the future, for example on Mars. The process of creating an uncontained system that mimics the function of Earth's biosphere is called terraforming.

The importance of the biosphere

The continued functioning of the biosphere is dependent not only on the maintenance of the intimate interactions among the myriad species within local communities but also on the looser yet crucial interactions of all species and communities around the globe. The Earth is blanketed with so many species and so many different kinds of biological communities because populations have been able to adapt to almost any kind of environment on Earth through natural selection. Life-forms have evolved that are able to survive in the ocean depths, the frigid conditions of Antarctica, and the near-boiling temperatures of geysers. The great richness of adaptations found among different populations and species of living organisms is the Earth’s greatest resource. It is a richness that has evolved over millions of years and is irreplaceable.

It is therefore startling to realize that our inventory of the Earth’s diversity is still so incomplete that the total number of living species cannot be estimated more closely

than between 3 and 30 million species. Decades of continuous research must be carried out by systematists, ecologists, and geneticists before the inventory of biodiversity provides a more accurate count. The research has been slow. Only recently, as the extinction rate of species has been increasing rapidly, have societies begun to realize the interdependence of species. To sustain life on Earth, more than the few animal and plant species used by humans must be preserved. The flow of energy and the cycling of nutrients through ecosystems, the regulation of populations, and the stability of biological communities, all of which support the continued maintenance of life, rely on the diversity of species, their adaptations to local physical conditions, and their coevolved relationships.

Despite the limited scientific knowledge of most species, ecological studies during the 20th century made great headway in unraveling the mechanisms by which organisms coevolved with one another and adapt to their physical environment, thereby shaping the biosphere. Each new decade has produced a steady stream of studies showing that the biological and physical elements of the Earth are more interconnected than had been previously thought. Those studies also have shown that often the most seemingly insignificant species are crucial to the stability of communities and ecosystems. Many seemingly obscure species are at risk worldwide of being dismissed as unimportant. The effect that the loss of species will have on ecosystems is appreciated only by understanding the relationships between organisms and their environments and by studying the ecological and evolutionary processes operating within ecosystems.

The need to understand how the biosphere functions has never been greater. When human population levels were low and technological abilities crude, societies' impact on the biosphere was relatively small. The increase in human population levels and the harvesting of more of the Earth's natural resources has altered this situation, especially in recent decades. Human activities are causing major alterations to the patterns of energy flow and nutrient cycling through ecosystems, and these activities are eliminating populations and species that have not even been described but which might have been of central importance to the maintenance of ecosystems.

The biologist Edward O. Wilson, who coined the term *biodiversity*, estimated conservatively that in the late 20th century at least 27,000 species were becoming extinct each year. The majority of these were small tropical organisms. The impact that this freshet of extinctions would have on the biosphere is akin to receiving a box of engine parts and discarding a portion of them before reading the directions, assuming that their absence will have no negative repercussions on the running of the engine. The following sections describe how many of the biological and physical parts fit together to make the engine of the biosphere run and why many seemingly obscure species are important to the long-term functioning of the biosphere.

Ecological Imbalance: Its Causes and Effects in the Biosphere

Ecosystem is the environment where biotic/ living things live and interact with nonliving things/abiotic factors such as coral reef, forest, grassland, farm etc. In 1935, the word "ecosystem" was invented by a British ecologist Sir Arthur George Tansley, who depicted natural system in "constant interchange" among their biotic and abiotic parts.

1. Biotic parts such as plants, animals and bacteria etc.
2. Abiotic parts such as the soil, air, water etc.

Ecology is a branch of science that was developed by scientist to make the study easier about the relationship between biotic things and their physical environment which is the abiotic factors and ecosystem is part of the concept of ecology in an organized view of nature.

Biosphere is the earth's zone of air, water and soil that has the capability in supporting life. This zone reaches about 10 km into the atmosphere and down to the lowest ocean floor. In simpler term, the biosphere is the surface of the hierarchy on earth where living environment and organism thrive. It contains various categories of biotic communities known as biomes that is described by their overbearing vegetation such as deserts, tropical rainforest and grasslands. The biomes are in turn composed of various ecosystems.

Ecosystem has processes which sustain ecological balance:

1. The cyclic flow of materials from abiotic environment to the biosphere and then back to the abiotic environment.
2. Upholding the equilibrium of interaction inside food webs.

These processes must be maintained in the ecosystem; any interference with these cycles disrupts and affects ecological balance. Below are some of the reasons and causes of ecological imbalance in the living world.

Introduction of Synthetic Products

Synthetic products are materials that are made by chemical processes that are formed artificially by chemical synthesis such as plastic bags, chairs, toys, etc. These synthetic materials can last for years and cannot be decomposed by decomposers. These synthetic products like different plastic products are made up of plastic; this creation of man hinders the flow of materials in the biosphere.

Improper disposal is one of the reasons why synthetic products become of the problems and causes of ecological imbalance. It destroys ecosystem that can kill the organism and at the same time it causes various problems in the living world such as pollution

Throwing Toxic Waste into the Bodies of Water

Because of the conversion of agricultural land into industrial estates or residential subdivisions more toxic waste are created by man. Industries uses chemicals in making their products and some industries are very irresponsible in disposing their waste. Some of them even release toxic waste in the bodies of water like rivers and lakes which leads to death of marine animals and microorganisms. A decrease of decomposers can cause delay of materials to return from the living to the nonliving environment.

Environmental Issues Caused by Human Activities in the Biosphere

Ecological succession is the abrupt changes in the condition of the environment to which organism needs to adapt in order to survive. Some of these changes are fast and vicious that cause vast extinction of diverse organism in the biosphere. These “drastic changes” are the cause why some plants and animals suffer great loss in number and might end up to extinction of the whole specie. Some of these drastic changes are natural phenomenon such as:

1. Earthquakes
2. Volcanic eruptions
3. Landslide and cave-ins
4. Floods
5. Pollution

These natural changes are somewhat out-of-control by people and mostly brought about by disastrous natural calamities in the biosphere. A natural calamity such as volcanic eruption can wipe-out plant and animal population in an area, an ecological succession slowly takes place until finally the dilapidated area is brought back to life. People do have control over the changes in the biosphere which are brought about by their activities.

Air Pollution

This is a condition where additional vile substances in the atmosphere are added that may results to damage environment, human health and the quality of life. It is caused by human activities inside homes, schools, offices, industries and cities that can spread across continent and even globally.

Air pollution is a serious problem in many countries in this era of industrialization. It is true that industrialization is a means to achieve better socioeconomic conditions. But it is also a fact that industrialization is accompanied by problems which endanger the health of the people and the lives of plants and animals.

The term *smog* refers to the mass of smoke or fumes containing poisonous gases and particles of various industrial wastes that blackens the horizons of a highly polluted are. Smog comes from the exhaust pipes of vehicles and from the chimneys of factories. Smog's travels far and wide from its sources. Noxious gases and particulates these are small solid particles in the air released from steel and chemical plants of West Germany have been carried to as far as London, Copenhagen and Stockholm, a radius of more or less 150 kilometers. Look at the map of Europe and locate these cities.

Water Pollution

This is the contamination of streams, lakes, underground water, bays, seas and oceans by substances that is harmful to living things. This commonly occurs in industrialized countries all over the world just like air pollution. The famous Rhine River which cuts through several countries from Austria to West Germany has been known as *"Europe's largest open sewage system."*

Marine biologist will forever sadly remember the worst oil spill in the United States which occurred in Valdez, Alaska in 1989. The Exxon Valdez tanker spilled over 41 million liters of oil which killed thousands of marine organism in the waters of Valdez.

In the Philippines, five major river systems in Metro Manila and practically all rivers in highly industrialized cities like Cebu, Iloilo, Baguio and Davao are already biologically dead.

In solving this problem you must consider the major sources of pollutants in your community. Some of the causes of water pollution are:

1. Improper waste disposal by industries and even household
2. Additional harmful substance in water

Water pollution does not only greatly reduce marine vegetation and animal life along the coastline, it is also contributes to the destruction of aquatic ecosystem like coral reefs and mangroves.

Environmental Institutions and Gross Root Movement

Environmental Institutions

An environmental organization is an organization coming out of the conservation or environmental movements that seek to protect, analyze or monitor the environment against misuse or degradation from human forces.

National Bodies

1. Ministry of Environment & Forests:

• The Ministry of Environment & Forests is the nodal agency in the administrative structure of the Central Government, for the planning, promotion, co-ordination and overseeing the implementation of Environmental and Forestry programmes.

• The Ministry is also the Nodal agency in the country for the United Nations Environment Programme (UNEP).

• The principal activities undertaken by Ministry of Environment & Forests consist of

a) Conservation & survey of flora, fauna, forests and Wildlife,

b) Prevention & control of pollution,

c) Afforestation & regeneration of degraded areas,

d) Protection of environment in the framework of legislations,

e) Welfare of animals.

• The main tools utilized for this include Environmental surveys, impact assessment, control of pollution, regeneration programmes, support to organizations, research to solve solutions and training to augment the requisite manpower, collection and dissemination of environmental information and creation of environmental awareness among all sectors of the country's population.

2. Central Pollution Control Board:

• The Central Pollution Control Board (CPCB), is statutory organisation, was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974.

• CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.

• It serves as a field formation and also provides technical services to the Ministry of Environment and Forests of the provisions of the Environment (Protection) Act, 1986.

• Principal functions of the CPCB, as spelt out in the Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981, to

(i) Promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution, and

(ii) Improve the quality of air and to prevent, control or abate air pollution in the country.

• In India, states do not pursue independent environmental policy of their own but adopt the policies formulated at the national level subject to such variations as may be necessary to suit to the local conditions. The central government has also been issuing guidelines to the states on various environmental matters.

3. Indian Board for Wildlife (IBWL)

• National Board for Wild Life is a "Statutory Organization" constituted under the Wildlife Protection Act, 1972.

• Primary function of the Board is to promote the conservation and development of wildlife and forests.

• It has power to review all wildlife-related matters and approve projects in and around national parks and sanctuaries.

• No alternation of boundaries in national parks and wildlife sanctuaries can be done without approval of the NBWL.

4. National Green Tribunal

• The National Green Tribunal has been established for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected there with or incidental thereto.

• It is a specialized body equipped with the necessary expertise to handle environmental disputes involving multi-disciplinary issues.

• The Tribunal shall not be bound by the procedure laid down under the Code of Civil Procedure, 1908, but shall be guided by principles of Natural Justice.

• The Tribunal's dedicated jurisdiction in environmental matters shall provide speedy environmental justice and help reduce the burden of litigation in the higher courts.

• The Tribunal is mandated to make and endeavour for disposal of applications or appeals finally within 6 months of filing of the same.

5. National Tiger Conservation Authority

• The National Tiger Conservation Authority is a statutory body under the Ministry of Environment, Forests and Climate Change constituted under enabling provisions of the Wildlife (Protection) Act, 1972, as amended in 2006, for strengthening tiger conservation, as per powers and functions assigned to it under the said Act.

6. Wildlife Crime Control Bureau

• The Government of India constituted a statutory body, the Wildlife Crime Control Bureau in 2007, by amending the Wildlife (Protection) Act, 1972, a special Act to protect the wildlife in the country.

• The bureau would complement the efforts of the state governments, primary enforcers of the Wildlife (Protection) Act, 1972 and other enforcement agencies of the country.

7. Genetic Engineering Approval Committee

• It functions under the Ministry of Environment and Forests.

• It is the apex body to accord environmental approval of activities involving large scale use of hazardous microorganisms and recombinants in research and industrial production.

• It is also mandated with approving the release of genetically engineered organisms and products into the environment, including experimental field trials.

8. Central Zoo Authority

• The Central Zoo Authority of India (CZA) is the body of the government of India responsible for oversight of zoos.

• It is an affiliate member of the World Association of Zoos and Aquariums.

• The Central Zoo Authority has been constituted under the Wild Life (Protection) Act.

• The main objective of the authority is to complement the national effort in conservation of wild life.

• Every zoo in the country is required to obtain recognition from the Authority for its operation.

9. National Afforestation And Eco-Development Board

• The National Afforestation and Eco-Development Board (NAEB) is responsible for promoting afforestation, tree planting, ecological restoration and eco-development activities in the country, with special attention to the degraded forest areas and lands adjoining the forest areas, national parks, sanctuaries and other protected areas as well as the ecologically fragile areas like the Western Himalayas, Aravallis, Western Ghats, etc.

• It evolve mechanisms for ecological restoration of degraded forest areas and adjoining lands through systematic planning and implementation, in a cost effective manner.

• It restore fuelwood, fodder, timber and other forest produce on the degraded forest and adjoining lands in order to meet the demands for these items.

• It sponsor research and extension of research findings to disseminate new and proper technologies for the regeneration and development of degraded forest areas and adjoining lands;

10. Wildlife Institute Of India

• The Wildlife Institute of India (WII) is an autonomous institution under the Ministry of Environment Forest and Climate change, Government of India.

• WII carries out wildlife research in areas of study like Biodiversity, Endangered Species, Wildlife Policy, Wildlife Management, Wildlife Forensics, Spatial Modeling, Eco-development, Habitat Ecology and Climate Change. WII has a research facility which includes Forensics, Remote Sensing and GIS, Laboratory, Herbarium, and an Electronic Library.

11. Compensatory Afforestation Fund Management and Planning Authority

• Compensatory Afforestation Fund Management and Planning Authority (CAMPA) has been created by the Ministry of Environment and Forests.

• It creates Compensatory Afforestation Fund (CAF) by the Ministry of Environment and Forests.

• The CAMPA Bill has established a Permanent National Compensatory Afforestation Fund under the Public Account of India. It also allows states to

establish State Compensatory Afforestation Funds. The National Fund will be under the central government, and managed by a National Compensatory Afforestation Fund Management and Planning Authority (CAMPA). The central government will appoint a State CAMPA in each state. The State CAMPA will be responsible for the management of the State Fund.

12. Zoological Survey of India

• The Zoological Survey of India (ZSI) was established to promote the survey, exploration and research of the fauna in the region.

• The activities of the ZSI are coordinated by the Conservation and Survey Division under the Ministry of Environment, Forest and Climate Change, Government of India.

• Primary objectives are: Exploring, Surveying, Inventorying and Monitoring of faunal diversity in various states, selected ecosystems and protected areas of India; Taxonomic studies of the faunal components collected; Status survey of Threatened and Endemic species; Preparation of Red Data Book, Fauna of India and Fauna of States.

• Secondary objectives are: GIS and Remote Sensing studies on recorded animal diversity as well as on threatened species; Chromosomal Mapping and DNA Barcoding.

13. Botanical survey of India

• The Botanical Survey of India (BSI) is the apex research organization under the MOEF for carrying out taxonomic and floristic studies on wild plant resources of the country.

• The prime objectives of the Botanical Survey of India (BSI) is to undertake intensive floristic surveys and collect accurate and detailed information on the occurrence, distribution, ecology and economic utility of plants in the country.

14. Forest Survey of India

• Forest Survey of India (FSI) is engaged in the assessment of the country's forest resources on a regular interval.

• It is involved in forest cover assessment of the country on biennial basis by

interpretation of satellite data on a two-year cycle and presents the information in the form of 'India State of Forest Report'.

• It also form inventory of forests and Trees Outside Forests (TOF) in both urban and rural areas.

15. Animal Welfare Board of India

• The Animal Welfare Board of India (AWBI) scheme relates to provision of assistance for the following type of activities:

a) Financial assistance to animal welfare organizations for maintaining the stray animals in distress and for their treatment (financial assistance based on the number of animals kept for their fodder, water, minor treatment etc).

b) Human education programmes for the welfare of animals are implemented by the AWBI. Capital expenditure at the Board's headquarters i.e. expenditure on non-recurring items such as purchase of assets/equipments.

c) Expenditure on a variety of other animal welfare activities such as rescue of cattle from illegal smuggling and transportation, rehabilitation of rescued circus animals, lab animals, inspections, legal expenses in connection with court cases pertaining to animal welfare, mobile clinics is also incurred.

International Bodies

1. IPCC

• The Intergovernmental Panel on Climate Change (IPCC) is the international body for assessing the science related to climate change.

• The IPCC was set up in 1988 by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.

• IPCC assessments provide a scientific basis for governments at all levels to develop climaterelated policies, and they underlie negotiations at the UN Climate Conference – the United Nations Framework Convention on Climate Change (UNFCCC).

2. WMO

• The World Meteorological Organization (WMO) is an intergovernmental organization with a membership of 191 Member States and Territories.

• WMO provides a framework for international cooperation in the development of meteorology and operational hydrology and their practical application.

3. UNEP

• The United Nations Environment Programme (UNEP) is the leading global environmental authority that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system and serves as an authoritative advocate for the global environment.

• UNEP work encompasses: Assessing global, regional and national environmental conditions and trends; Developing international and national environmental instruments and Strengthening institutions for the wise management of the environment.

4. SCAR

• The Scientific Committee on Antarctic Research (SCAR) is an inter-disciplinary committee of the International Council for Science (ICSU).

• SCAR is charged with initiating, developing and coordinating high quality international scientific research in the Antarctic region (including the Southern Ocean), and on the role of the Antarctic region in the Earth system.

5. Global Environment Facility

• It unites 183 countries in partnership with international institutions, civil society organizations (CSOs), and the private sector to address global environmental issues while supporting national sustainable development initiatives.

• The GEF provides grants for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants.

• The GEF also serves as financial mechanism for the following conventions:

a) Convention on Biological Diversity (CBD)

b) United Nations Framework Convention on Climate Change (UNFCCC)

c) UN Convention to Combat Desertification (UNCCD)

d) Stockholm Convention on Persistent Organic Pollutants (POPs)

e) Minamata Convention on Mercury

6. International Union for Conservation of Nature and Natural Resources:

• It is an international organization working in the field of nature conservation and sustainable use of natural resources.

• It is involved in data gathering and analysis, research, field projects, advocacy, lobbying and education.

7. World Nature Organization

• The organization is focused on promoting activities, technologies, economies, and renewable energies which are regarded to be environment friendly; and reducing the impact of climate change.

8. World Wide Fund for Nature

• It is an international non-governmental organization founded in 1961, working in the field of the wilderness preservation, and the reduction of humanity's footprint on the environment.

Concept of Environmental Movement

The **environmental movement** (sometimes referred to as the **ecology movement**), also including conservation and green politics, is a diverse scientific, social, and political movement for addressing environmental issues. Environmentalists advocate the sustainable management of resources and stewardship of the environment through changes in public policy and individual behavior. In its recognition of humanity as a participant in (not enemy of) ecosystems, the movement is centered on ecology, health, and human rights.

The environmental movement is an international movement, represented by a range of organizations, from the large to grassroots and varies from country to country. Due to its large membership, varying and strong beliefs, and occasionally speculative nature, the environmental movement is not always united in its goals. The movement also

encompasses some other movements with a more specific focus, such as the climate movement. At its broadest, the movement includes private citizens, professionals, religious devotees, politicians, scientists, non-profit organizations and individual advocates

Environmental movement is a type of "social movement that involves an array of individuals, groups and coalitions that perceive a common interest in environmental protection and act to bring about changes in environmental policies and practices" (Tong, Yanki 2005: 167-168).

Definitions of Environmental Movements

According to Rootes, Christopher (1999): The environmental movements are conceived as broad networks of people and organizations engaged in collective action in the pursuit of environmental benefits. Environmental movements are understood to be very diverse and complex, their organizational forms ranging from the highly organized and formally institutionalized to the radically informal, the spatial scope of their activities ranging from the local to the almost global, the nature of their concerns ranging from single issue to the full panoply of global environmental concerns. Such an inclusive conception is consistent with the usage of the term amongst environmental activists themselves and enables us to consider the linkages between the several levels and forms of what activists call 'the environmental movement (Rootes, Christopher: 1999: 2).

Origin of Environmental Movements in India:

Genesis of concern for environmental protection in India, "can be traced back to the early twentieth century when people protested against the commercialization of forest resources during the British colonial period"(Sahu, Geetanjoy 2007: 3). Again, he notes that, "It was only in the 1970s a coherent and relatively organized awareness of the ecological impact of state-monolithic development process started to develop, to grow into a fully fledged understanding of the limited nature of natural resources and to prevent the depletion of natural resources" (Ibid). At the international level, growing salience of environmental crisis was brought out by four important events. The first event was the United Nations Conference on 'Human Environment' held in Stockholm, Sweden (1972). The second event was publication of the report "Limits to Growth". The

third, release of the report of the Brundtland Commission entitled 'Our Common Future' (1987). Fourth, event was the 'Earth Summit' in 1992 ((Vig, Norman J. and Regina S. Axelrod 2006: 29; Salunkhe, S. A., 2008: 38-40).

Reasons of the Emergence of Environmental Movements in India: Major reasons of the emergence of environmental movements in India have been discussed by Sharma, Aviram (2007) which include reasons such as i) control over natural resources, ii) false developmental policies of the government, iii) socioeconomic reasons, iv) environmental degradation/ destruction and, v) spread of environmental awareness and media. (Sharma, Aviram, 2007).

Major Environmental Movements in India

As pointed out above, a large number of environmental movements have emerged in India especially after 1970s. These movements have grown out of a series of independent responses to local issues in different places at different times. The emergence of environmental movements is not restricted to any particular part of the country. As pointed out by Karan, P. P. (1994: 32-33): the environmental movements have emerged from the Himalayan regions of Uttar Pradesh to the tropical forests of Kerala and from Gujarat to Tripura…..…The main environmental movements are Chipko Andolan, Save the Bhagirati and Stop Tehri project committee in Uttar Pradesh, Save the Narmada Movement (Narmada Bachao Andolan) in Madhya Pradesh and Gujarat, youth organizations and tribal people in the Gandhamardan Hills whose survival is directly threatened by development of bauxite deposits, the opposition to the Baliapal and Bhogarai test range in Orissa, the Appiko Movement in the Western Ghats, groups opposing the Kaiga nuclear power plant in Karnataka, the campaign against the Silent Valley project, the Rural Women's Advancement Society, formed to reclaim waste land in Bankura district and the opposition to the Gumti Dam in Tripura Local movements are working against deforestation, water-logging, salinization and desertification in the command areas of dams on the Kosi, Gandak and Tungabhadra rivers and in the canal-irrigated areas of Punjab and Haryana. Some other local movements like Pani Chetna, Pani Panchyat and Mukti Sangharsh advocate ecological principals for water use.

Some of the best known environmental movements in India have been briefly described below:

1) **Bishnoi Movement**: This movement was led by Amrita Devi in which around 363 people sacrificed their lives for the protection of their forests. This movement was the first of its kind to have developed the strategy of hugging or embracing the trees for their protection spontaneously (Nepal, Padam 2009: 136).

2) **The Chipko Movement:** The Chipko is one of the world known environmental movements in India. The Chipko movement focused world attention on the environmental problems of the Alaknanda catchment area in the mid Western Himalayas (Santra, S. C. 2009: 827). As Reddy (1998) notes that, "Chipko movement, launched to protect the Himalayan forests from destruction, has its roots in the pre-independence days. Many struggles were organized to protest against the colonial forest policy during the early decades of the twentieth century. The main demand of the people in these protests was that the benefits of the forests, especially the right to fodder, should go to local people"(Reddy, Ratna V. 1998: 686)

3) Narmada Bachao Andolan: The most popular movement in the environmental history of India is the movement against the Narmada River Valley Project (Reddy, Ratna V, 1998: 688). The Narmada is the largest west-flowing river on the Indian peninsula…The Narmada winds its 1,312 km long course to the Arabian Sea through lovely forested hills, rich agricultural plains and narrow rocky gorges in a series of falls (Kothari, Ashish and Rajiv Bhartari 1984: 907).

4) Appiko Movement: Appiko Movement is one of the forest-based environmental movements in India. The movement took place in the Uttara Kanada district of Karnataka in the Western Ghats. Sheth, Pravin (1997) pointed out that, "the Appiko movement succeeded in its three-fold objectives include 1] protecting the existing forest cover, 2] regeneration of trees in denuded land, and 3] utilizing forest wealth with proper consideration to conservation to conservation of natural resources…..The Appiko movement saved the basic life sources for the people- trees like bamboo useful for making handcrafted items which they could sell for earning a few rupees. It also saved medicinal trees for their use by the local people"(Sheth, Pravin 1997: 222). Further he

also notes that, "the movement created awareness among the villagers throughout the Western Ghats about the ecological danger posed by the commercial and industrial interests to their forest which was the main source of sustenance"

5) Silent Valley Movement: Silent Valley in Kerala has a rich 89 sq. km biological treasure drove in the vast expanse of tropical virgin forests on the green rolling hills. In 1980s, a 200 MW hydroelectric dam on the crystal clear river Kunthipuzha under the Kundremukh project was to come up (Sheth, Pravin 1997: 216). The proposed project was not ecologically viable, as it would drown a chunk of the valuable rainforest of the valley and threaten the life of a host of endangered species of both flora and fauna (Nepal, Padam 2009: 105). The Kerala Sastra Sahitya Parishad (KSSP) an NGO, was working for three decades among masses of Kerala for growing environmental awareness…….The 14 campaign to save Silent Valley turned out to be a public education programme in many respects. The movement in many ways saves the ecosystem of Silent Valley area (Santra, S. C. 2000: 827).

6) Tehri Dam Conflict: One of the most protracted environmental movements in the recent years is the movement against the Tehri Dam. The 260.5 meter high Tehri Dam on the Bhagirathi in the Garhwal-Himalayas…….It will prosperity by generating 2,400 MW peaking power, which according to the dam builders, will help in establishing 140 industries cities……The project has generated controversy since its inception. In spite of objections of several scientists of national and international repute, the project is yet to be modified or stopped (Santara, S. C. 2000: 829).

Linkages between Environmental Movements and NGOs

The most significant feature of environmental movements in India is that, there is involvement of local voluntary organizations or Non-Governmental Organizations (NGOs) in these movements. Many examples can be cited. In case of the famous Chipko movement, the work of Dasholi Gram Swarajya Mandal (DGSM), Gopeswar, which was engaged in social work in the Uttarakhand, was significant. The volunteers of the DGSM realized that forest and land, and forest and man were intricately linked. Then they started educating the people about the ill effects of deforestation in the hill slopes and gradually they geared themselves in the movement. The same is true in case of Silent Valley

Movement. The Kerala Sastra Sahitya Parishad (KSSP), an NGO, was working for three decades among masses of Kerala for growing environmental awareness. This voluntary organization was working with people in popularizing science and appropriate technology and in campaigning against the environmentally destructive development projects. The KSSP launched a campaign against the Silent Valley Project. Many NGOs are also connected with the Narmada Bachao Andolan (Salunkhe, S. A. 2011: 17-18).

During last some years, "voluntary organizations have been increasingly viewed as an integral part of India's development process. Hundreds of NGOs are working at the micro level, and although environmental concerns are relatively new, they are an overwhelming phenomenon. Indeed, since the beginning of the last decade, almost all Indian NGOs have been working with environmental issues. Community organizations have emerged through local rights and environment. NGOs are local or external interveners that create and support community groups in protecting local rights and environment" (Swain, Ashok 1997: 829).

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