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Annex C

Glossary of key concepts and key players

This glossary provides a basic vocabulary for students of **environmental and natural resource analysis** from an economics perspective. The presentation includes relevant examples of the application of the defined concepts with special reference to **environmental economics** in small and island states. The text includes brief notes on the principal players in this field and sources for further study. Principal cross-references are in **bold**.

Accountability
The process and the measure of the extent of effective and justifiable responsibility in **governance**. The principles on which accountability are commonly based include transparency in reporting; probity and justice in the exercise of power, the use of finance and the implementation of regulations and procedures; and the operation of fair-minded discretion in the means of enforcement.

Adaptation
A change or process by which an organism or species becomes better suited to its **environment** in line with the theory of the survival of the fittest. In disaster management, the term is used metaphorically, in the evolutionary sense, that through adaptation people can modify their capacities and behaviour to increase the chance of survival in the face of specific hazards, such as cyclones, earthquakes or transport accidents, for example. Adaptation can be a process in building **resilience** through developing capacities that can reduce the extent of loss and damage and achieve rapid response, rescue, and recovery. In the climate change literature, adaptation, as against **mitigation**, is a process of adjustment with the objective of living with climate change and modifying plans to take into account new environmental information. (See also **mitigation**.)

Adverse selection
The outcome of offering a contract for services to all-comers, in which those most likely to benefit will apply. So that if, for example, a single rate of car insurance is offered to all, it will attract those who are the worst drivers with the heaviest accident rate. They are likely to benefit most at a common rate for all. In health insurance, those who are well may find it better to seek an insurance policy which rates the premiums in accordance with levels of health and assessed risk. For example, those who are alcohol-free, are non-smokers and are not overweight are likely to find health insurance companies offering

reduced premiums. People who live in places subject to cyclones, floods and earthquakes are best advised to seek insurers offering common priced premiums to all.

Africa
One of the five continents of the world, but variously defined by different organisations even within the UN. Africa, according to the United Nations **Environment** Programme (UNEP), includes 53 countries plus Réunion; WHO separates off part of north Africa into an Eastern Mediterranean region. The SIDS of Cape Verde, Guinea Bissau and Sao Tome and Principe – on the west coast of Africa; and the SIDS of Comoros, Mauritius and Seychelles are officially included in the UNEP region of Africa, but have been commonly marginalised in policy debates and analysis.

Analysis
(From Greek 'to unloose'). To resolve complex matters into simple elements. **Analysis** is distinct from **synthesis** which is the combining of elements to form a connected whole or compound. In philosophy, there are three stages of rational argument in which the final stage of **synthesis** resolves the two previous stages of **analysis:** these two previous stages are thesis *(the arguments for)* and antithesis *(the arguments against).*

Assets
Possessions of value, both real and financial. Real assets include land, buildings and equipment. **Environmental economics** stresses the importance of the value of natural assets and the services they provide, such as forests, water, sea, etc. Traditionally these have not been counted in assessments of national income accounts, such as Gross Domestic Product, but the importance of their sustainability, or substitution, is being increasingly recognised in the face of their non-replacement, over-use and degradation.

Atmosphere
The air and its constituent parts, including pollutants which alter its natural composition. The atmosphere is a complex system of gases which are essential to life for animals and plants. Air quality standards include definitions of the maximum concentrations of specific substances which present threats to life and of which standards may be enforceable by law. The standards commonly cover particulate matter, gases and other substances. Air **pollution** can arise from human activity or from natural disturbances in the atmosphere from dust storms, radon, natural fires and from volcanoes. Many pollutants have an adverse effect on the health of animals and plants.

Behavioural theory
The theory that sees the activity of organisations as a function not merely of market factors but of the complex interplay of the individual goals and activities of the managers and groups involved, their interactions and bargaining power, position and succession. This theory, commonly applied within the sectoral activities of 'the firm', contrasts with classical and neoclassical economic theories which are based on the assumption of the rational economic man and the long-run presumption of profit maximisation as the overriding goal at the levels of the firm, the sector and the national economy.

Behavioural theory has illuminated the process of analysis of political and managerial action but has proved elusive to define in testable form.

The theory is useful in understanding the complex interactions of institutions and other players in the public and private sector with interests in environmental governance and management.

Biodiversity
A measure of the variety of animal and plant species contained within a habitat. Whilst natural factors have determined over millennia the survival of species and their adaptation to changing circumstances, it is common for the variety of species to be reduced with the increasing presence of the human species as a result of predatory action, **pollution** and degradation of the **environment**. Species are scientifically classified according to their prevalence and risk of extinction with some failing, like the Dodo, to survive the impact of man. Conservation is designed to protect species and their habitat through a variety of measures including captive breeding and protected areas.

Capital
One of three factors classically considered to be contributing to productive activity; the others being labour and **natural resources.** It is increasingly recognised that capital includes a variety of elements not merely physical capital. The other elements include human capital, business capital, service infrastructure, natural capital, public institutional capital, knowledge capital. (See Sachs J. (2005) *The End of Poverty,* Penguin Books.)

Carbon footprint (see ecological footprint)

Carbon tax
A tax on the use of fossil fuels (which contain carbon) introduced to reduce the production of carbon dioxide in the atmosphere, which is believed to contribute to global warming, and adverse **climate change.** In some European countries the yield from the tax is used to target energy efficiency for business, or to offset corresponding reductions in taxes on labour, payroll or the insurance costs of business.

Carrying capacity
The optimum size of a population that a habitat can sustainably support. The economist **Thomas Malthus** (1766–1834) considered that whilst population tends to increase geometrically, food production tends to increase arithmetically; thus more people will be condemned to live in misery and poverty; an early application of the carrying capacity concept. The concept is especially relevant to the capacity of environmental services such as water resources, woodlands, arable and pasture land to cope with increasing human and animal use.

Classical economics
A school of thought principally based on the writings of **Adam Smith** (1723–1790) and David Ricardo (1772–1823) which focused on the production and distribution of wealth

from capital, labour and land, through a market system in which the interplay of supply and demand automatically (through the mechanism of **invisible hand**) promoted long term **economic growth**. The classical school was overtaken both by **neoclassical economics** and by the theories of **Karl Marx.** Whilst the concept of the marginal productivity of land was acknowledged in classical economics, later schools of thought gave more emphasis to **externalities,** market failure and environmental impact as essential components of economic analysis of the use of scarce resources.

Climate change
Large-scale alterations in the earth's climate (i.e. the average weather patterns in terms of seasons, temperatures, precipitation, wind direction and speeds, and the type and extent of clouds). The changes in climate are attributed to astronomical changes in solar radiation, long-term changes in the earth's rotation and orbit, to geological factors such as intercontinental plate tectonics and continental drift, as well as to human factors such as air **pollution**. Major changes such as in the Ice Ages are known to have occurred in past millennia; current observations show that systematic changes have been occurring in the past 100 years or more, leading to global warming, which the International Panel on Climate Change (IPCC) have concluded is principally promoted by human activity.

The IPCC Fourth report 2007 sets out the expected global impact as follows: rise in global temperatures of 0.45C to 3.11C, by 2100; increase in highland rain of 10–40 per cent; decrease in lowland rain by 10–30 per cent; more flooding, extreme weather conditions, greater ecosystem stress, threats to health, special threats to Africa and SIDS through water scarcity, food insecurity, increase in disease vectors, risks to endangered species, and sea level rise. The evidence base used by the IPCC is limited by the small number of meteorological monitoring stations outside the western world which affects the specificity of its projections in for example Africa and for SIDS.

Comparative advantage
The advantage gained by a country in international trade if it can produce specific goods or services at a lower resource input cost than other countries. A concept particularly associated with the David Ricardo**.** During colonial times the other continents were seen by Europeans as principally the sources both for exploiting free land by conquest and bilateral trade agreements. This brought to Europe at low prices vast volumes of commodities such as gold, copper, diamonds, timber, fruit and other agricultural products. The colonial system also created markets for manufactured European goods and for specialist services, such as engineering. This tended to bias the development of countries, especially small states and SIDS, to a narrow range of primary goods and related services. Much of their history, since most colonies achieved independence, has been in trying to reduce the adverse economic, social and environmental impacts of exploitation of a narrow range of commodities. A key element in post-colonial policy in **developing countries** has been to reduce imports by the production of substitute goods and services, often through franchise arrangements. (See **natural resource curse**.)

Consumer equilibrium
The point at which a consumer maximises his total **utility** or satisfaction from spending a

limited or fixed income. Neoclassical economics assumes that an individual selects that combination of goods and services in line with his preferences which maximises his total **utility**. Total **utility** is maximised when the individual's marginal **utility** from transferring a unit of expenditure from one item to another is equal.

National accounting practices commonly exclude environmental values. The introduction of **environmental accounting** is a device to ensure that the assessment of consumer equilibrium takes account of non-tradeable environmental use and non-use values. These values are becoming more explicit in stock market transactions and in public company reports in which environmentally-friendly activities are valued. The establishment of markets, for example for carbon trading and road use, are further examples of devices to correct for market failure, which otherwise biases the assessment of consumer equilibrium.

Cost

In economics, cost is a measure of the opportunity lost by preferring one use of scarce resources over another; it thus implies the evaluation of choices: guns or butter; food or drink; war or peace. It thus differs from the accountants' use of the term cost, which is the monetary price paid for goods or services or amount of money spent on producing them. In neoclassical economics, opportunity cost is determined by the consumer's indifference curve and the production possibility boundary between alternative goods and services. In **environmental economics**, specific devices are adopted for the fuller economic evaluation of choices in the use of resources, to account for the impact of trade in goods and services on environmental services and on ecological systems. (See also **opportunity cost**.)

Cost effectiveness

The ratio of effectiveness to cost, expressed in terms of the cost or the price of a given quantity of outputs or outcomes; sometimes the ratio is expressed in terms of the quantity of output for a unit of cost (effectiveness to cost ratio). A cost-effectiveness ratio may be distinguished from a cost-benefit ratio, as in the latter case both the inputs and the outputs are measured in money or cost terms. In coastal protection, for example, cost effectiveness may be expressed as the cost per kilometre of protecting a specific length of coastline (to a defined standard); in water distribution, it may be expressed in the cost of water supply per hundred new customers, or the number of customers served per thousand dollars or rupees spent. In assessing costs, economists will try to apply the concept of **'opportunity costs'** rather than merely the price of the goods or services. Given the budgetary constraints, cost effectiveness can help in choosing an environmental project from competing alternative projects.

Cost function

An equation that shows the elements that determine the cost of producing a given quantity of goods or services in terms of factor inputs and their prices. In forestry management, the cost function of sustaining the forest might be expressed in terms of the cost of capital equipment, labour, and land required per 100 acres of forest. Economists might try to add values for the foregone use of the forest land and timber for other uses such as for arable land agriculture or for timber.

Cost-benefit analysis, Social
An analysis in which the total social costs and total social benefits of a project are set out as a ratio in which both the costs and the benefits are expressed in monetary units. (See also **cost effectiveness**.) In a cost-benefit analysis of control legislation for preserving endangered species, it was found in the USA that to provide a 90 per cent chance of survival of the northern spotted owl would cost $33 billion (1990 values), excluding ecosystem and preservation benefits, the costs largely borne by losses by the producers of wood products. (See: Brown G.M. and Shogren J.F. (1998) *Economics of the Endangered Species Act*, Journal of Economic Perspectives, 12 93) 3–20 summer 1998.)

Critical natural capital
This consists of non-renewable **natural resources** that are necessary elements in sustained development, such as life-sustaining climate, ecological systems, water, land, and biodiversity. Exploitation of **natural resources**, especially through the processes of intensive industrialisation, frontier expansion, and climate change, can lead to degradation of critical **natural resources**, reducing the viability of human and animal habitation. Examples of threats to critical **natural resources** include: desertification, severe industrial air and land **pollution**, water-course and marine **pollution**, and degradation by invasive species of animals and plants. Market and policy failures can result in zero valuing these critical non-renewable resources.

Data (See also **information**.)
Data are numerical records representing properties of observed phenomena relating to their presence or absence or to their quantities or qualities. The word data is from the Latin and is technically the plural of datum; but these days it is commonly treated grammatically as a singular noun taking a singular verb: i.e. *The data comes from* the UN, rather than *the data come from* the UN; but both usages are still to be found in technical texts. The UN agencies are the principal international sources for data on **natural resources** including: The Food and Agriculture Organisation (FAO) which provides through www.Faostat.org a compendium of national data; the United Nations **Environment** Programme (UNEP) through its evolving data portal systems www.unep.org which includes the African **Environment** Information Network (AEIN) and a new website on SIDS. www.sids.unep.org; and the newly established www.AIMSNET.INFO which covers the SIDS AIMS region with hyperlinks to other regional and global sources.

Decision-making
The process of making conclusions or resolutions reached after reviewing choices. Theories of decision-making may be based on mathematical or behavioural models in which four broad aspects are considered:

- those factors (and people) that may be affected by the decision (costs and benefits) of the expected outcomes;
- those factors bringing about the current status or trends observed;
- the objectives or criteria to be used in the assessment; and
- the assumptions and risks associated with the circumstances and outcomes.

Demand
The need or desire for a product backed by the money to purchase it. In economics, effective demand is the willingness *and* the ability to pay and not just the want or need for the product.

In **environmental economics**, the concept of willingness to pay has been used extensively to assess environmental values. One example is in the assessment of the price local residents would be willing to pay to provide a pilot escort system in the Prince William Sound in South East Alaska to avoid further oil spills from tankers, following the Exxon Valdez disaster of 1989. In this way, willingness to pay is a measure of price and also an indicator of demand for that environmental resource.

Demographic transition (See also **epidemiological transition**, **economic transition**)
The change in the dynamics of a population, observed during the process of development, affecting the numbers of births, deaths and population growth over a period of time. Least developed countries have high birth rates and death rates and low population growth. Initial economic and social development is associated with a decline in the death rate, but with little reduction in the birth rate, thus giving rise to a major increase in the population growth rate. As development becomes established so the birth rate and the population growth rate eventually decline. Within many countries this pattern is uneven. Economic change brings with it rural poverty, associated with population increase. This, and other factors, promote a drift to urban areas and pressure on land and social services through informal squatter housing in the urban periphery. SIDS, as a whole, span the range of development transitions, from Guinea Bissau amongst the least developed to Malta and Singapore amongst the most developed.

The demography of many African and Asian countries is being further modified by the impact of HIV/AIDS, which affects both adults and children. It is reducing the survival of young adults and children, and leaving increasing numbers of orphans, whilst having less effect on older people. These changes are increasing the dependency ratio of the populations affected, with fewer working people alive.

Developing countries
Those countries in which the level of resources and income and their management has been inadequate to generate savings necessary for substantial investment programmes for social and economic progress. Such countries are typically characterised by a large agricultural sector in which the majority of people live at or near subsistence levels. Such countries may export raw materials (agricultural and mineral) for use by other countries but commonly gain or deploy insufficient funds from this trade to invest in internal development.

Development
The process of increasing productive capacity to achieve economic and social progress. **Meadows and Meadows** make the distinction between '**To grow** (which) means to increase in size and **to develop** (which) means to bring to a fuller, greater, or better state'. (Meadows D.H. and Meadows D.L. et al. (1992) *Beyond the Limits*, Earthscan, London).

In **neoclassical economics** the concept tends to be focused on economic and social development with little attention given to the adverse impact this may have on the **environment** and the value of **natural resources**. The Meadows's contribution to the debate on development was to give special emphasis to the use of environmental resources in the first review commissioned by the Club of Rome *Limits to Growth* (1972). This promoted in its wake the international recognition of environmental capital as a source of wealth and the rate at which it was being consumed and not renewed. (See also **sustainable development**.)

Development economics

The branch of economics concerned with how developing countries apply their resources to achieve economic growth. In neoliberal economics, development has come to mean the capacity of a national economy, whose initial economic condition has been more or less static for a long time, to generate and sustain an annual increase in its gross national income (GNI) at rates of 5 per cent to 7 per cent or more. This GNI growth would either 'trickle down' to people in the form of jobs and other economic opportunities, or create the necessary conditions for wider distribution of the economic and social benefits of growth. This view in policies, promoted by John Williamson, adopted by the IMF and the World Bank under the Washington Consensus, has been challenged by evidence that shows that whilst many developing countries have achieved high rates of growth, the standard of living of many people in them remained for the most part unchanged. This resulting inequity was typified by Hans Singer, a fierce critic of the neoliberal theories, as 'the lion's share going to the lions'.

By contrast, development can be seen as a process of involving changes in social structures, popular attitudes, and national institutions, as well as the acceleration of economic growth, the reduction of inequality and the eradication of poverty. From this perspective, three objectives of development are: to increase the availability and widen the distribution of basic life sustaining goods such as food, shelter, health and protection; to raise standards of living; and to expand the range of economic and social choices available to individuals and nations. The adoption of such objectives by policy-makers leads to policies that provide greater access by people to food, health, shelter, social protection, education and jobs. Thus development economics becomes focused on the choices in the use of scarce resources to achieve these ends. (See also **Development, Development theory, and Sustainable development**.)

Recent work re-appraising the theory and practice of development economics has distinguished between the models relevant to developed countries and those more applicable to developing countries. Arthur Lewis, Nobel Prize winning economist from Saint Lucia, strongly argued for a special approach to development for developing countries which would acknowledge the value of their cultures. He argued for greater emphasis on building an enabling environment for growth through infrastructure. Both Reinert and Chang draw attention to the adverse affect on developing countries of the frontier expansion model of past European colonial policy with its exploitation of their natural resources and the risk that the new welfare colonialism of aid support and the failure of the WTO negotiations can put poor countries permanently 'on the dole', thus failing to integrate them into the global economy. Peet decries the failure of the policies and governance of the IMF,

World Bank and WTO effectively to address the critical development issues including inequality and environmental protection. (See: Lewis, A. (1955) *The Theory of Economic Growth*, Homewood, Illinois; Jomo K.S. (2005) *The Pioneers of Development Economics*, Zed books London and New York; Todaro, Michael P. and Smith, Stephen C. (2009) *Economic development* (10th edition), Pearson Education: London; Reinert, E.S. (2007) *How rich countries got rich ... and why poor countries stay poor*, Constable and Robinson London; Chang, H-J. (2007) *Rethinking development economics*, Anthem Press, London; Peet, R. (2009) *Unholy trinity, the IMF, World Bank and WTO*, Zed books, London, New York.)

Development theory
That field of social and economic theory concerned with the factors that contribute to the improvement and sustainability of well-being of people in developing countries. Theories of development have substantially changed in the last fifty years, in the recognition that the best interests of the subject countries in 'the Third World' may not be to 'catch-up' with the Western countries in the 'first world' or to model their policies on those of the then Soviet block, 'the second world'. It has been increasingly recognised in this field that outcomes are closely related to the contribution of environmental factors, the management of **natural resources**, the quality of governance and the avoidance of counterproductive macro-economic policies conditional on aid programmes. Research increasingly shows the important distinction between national growth and the economic and social benefits of that growth between different sections of society, where despite national development, inequalities are widening in many countries in terms of disparate opportunities in education, health and standards of living within societies.

Diminishing returns
The economic law that posits that as equal quantities of one variable input factor of production are increased in production activity, the quantities of all other factors remaining constant, a point will be reached beyond which the marginal physical product of the variable factor will decline. This is called diminishing returns to a factor. When all factors of production are variable, diminishing returns to scale occurs provided all factors are increased in the same proportion. In environmental management, it is recognised that a population of animals that can be sustained with additions in food, in one defined habitat, is limited by its carrying capacity, after which point the marginal additional population will decline for each unit addition in food.

Disaster, natural
A significant impact on the **environment** from natural causes, a natural disaster can adversely affect normal human activities and cause sudden loss. It often exceeds the capacity of the local community resources effectively to respond in the rescue and rehabilitation of people and systems affected. Examples of disasters include the tsunami of 2004/5 in the Indian Ocean causing widespread loss of life and damage to many communities from Sri Lanka to the Maldives and the Seychelles; Hurricane Katrina which in 2005 devastated New Orleans in the USA and adjacent communities and territories; forest fires in Greece in 2007, which caused death and injury to resident population and

widespread property damage. Disasters also include man-made events such as marine oil-spills, industrial fires, meltdown of nuclear reactors, shipwrecks and airplane crashes.

Disaster risk management
The process of policy development and decision-making to lessen the risks of disasters and their impact on people and on the **environment.** This may be based upon a conceptual framework of those elements considered most critical in producing adverse impacts of disasters and the most cost-effective measures for prevention, preparedness, adaptation and **mitigation** of the consequences. The UNISDR provides advice and support for disaster risk management. For the complete UN/ISDR 2008 guideline on building national resilience to disasters, see: http://www.unisdr.org/eng/about_isdr/isdr-publications/16-Towards-National-Resilience/Towards-National-Resilience.pdf:

Discounting
An accounting device to bring into comparison the cost or yield of projects spread over variable periods of time. This form of calculation of costs and benefits is commonly adopted in appraisal of projects. The method of discounting recognises that the value of benefits delivered now is greater than the same benefits delivered in the future, and that future costs are, similarly, of less importance than present costs of equal weight. In the field of environmental protection, for example, if a nuclear installation would have to be safely dismantled in 200 years time at a current cost of $300 billion, that cost in 200 years time discounted to the present at 5 per cent would be $0.017 billion now. This encourages us to build now and impose that cost on future generations without necessarily setting aside that discounted amount in current savings. The practice of discounting is controversial as it tends to appear that discounting operates to the disadvantage of future generations.

Dominant social paradigm (DSP)
A conceptual framework for economic and social development which underpins the industrial age. With this framework of thought, attributed to Pirages and Ehrlich (Pirages, D.C., and P.R. Ehrlich (1974). *Ark II: Social Response to Environmental Imperatives*. New York: Viking Press), economic growth and population growth are unchallenged norms, whilst the continuing exploitation of natural resources is of little account, despite increasing evidence of damage to the environment and the consequential adverse impact on human welfare. (See also **New environmental paradigm**.)

Dose-response relationship
The change in an outcome variable (response) associated with a specific level of introduction of an intervention (the dose). The metaphor which is applied to interventions to 'treat' environmental problems, is derived from clinical science which identifies the specific measures of outcome from the administration of specific levels of treatment, such as the dose of a drug, and its effect on blood pressure. Biological and ecological systems are complex, however, and other inter-related factors may affect the validity of any interpretation of simple one-on-one relationships in any case of treatment.

Ecological economics
Inter-disciplinary scientific study, involving ecologists, economists and other natural and social scientists, concerned with the complex inter-relationships between ecology and human activity. In particular, the studies have focused on ecological functioning, degradation and resilience and the implications for human welfare. Ecological functioning systems studied include regulation functions (such as climate regulation), production (such as oxygen, food, water), carrier functions (such as habitat, forestry, agriculture and aquaculture), and information functions (such as education and scientific research). This discipline is especially relevant to the needs of SIDS on account of their fragile ecological systems. It differs from '**environmental economics**' in so far as it involves the joint participation of many science disciplines.

Ecological footprint
A measure of the per capita use of **natural resources**, assessed by how much land is used to sustain a given population at its current levels of consumption, technical development and resource use efficiency. Carbon and water footprints are other widely used concepts in this context. They all derive from an idea developed by William Reese and Mathis Wackernagel at the University of British Columbia. The principal elements in the assessment are land to grow food, trees and bio-fuels, areas for ocean fishing and land required to support plant life needed to cope with waste such as carbon emissions from fossil fuels. The carbon footprint is a subset of the ecological footprint. Carbon footprint is the total set of GHG (greenhouse gas) emissions caused directly and indirectly by an individual, organization, event or product (see www.ecologicalfootprint.org).

Economics
From the Greek for a *'house steward'*. The study of scarcity (and abundance) of resources, and the choices in their use and distribution. Classical economics in the late eighteenth and early nineteenth centuries was concerned with the sources of wealth in the world, in which capital, labour and **environmental and natural resources** were separately identified. In the eighteenth and nineteenth centuries, economics tended to focus on capital and labour as the principal components determining wealth and development. Neoclassical economics laid more emphasis on the efficiency of the market system with minimal regulation from government sources. **Natural resources** in the production function appeared inexhaustible as they were continually being found in vast quantities in newly-explored continents. Since the second half of the twentieth century economists have become more concerned about both the external impact of the production of goods and services on **natural resources** and the rate of consumption, degradation and exhaustion of primary **natural resources** such as land, air, water, forests, fisheries, and fuel (wood, coal, oil). Small states whose economies depend greatly on the nature and extent of **natural resources** have become the focus of global concern, fresh frameworks for economic assessment and of initiatives to conserve and make better use of the **environment** as a source of wealth and a sector for employment (in food, tourism, pharmacological sectors for example).

Economic development
A process of economic transition and structural change of the economy (usually involving

a shift from agriculture to the industrial production of goods and services) which increases national income. Capital accumulation and investment are key components of economic development as they increase productive capacity, productivity and via the multiplier effect aggregate demand. National measures of economic development, such as growth in GDP per capita, ignore the distribution of both the benefits and costs of development between regions and people, and the cost of the **externalities** of economic development. Some costs of economic development are often hidden and can include, in many countries, low or zero valuation of human rights, the exploitation of vulnerable groups such as women, children, ethnic minorities and migrant workers, excessive hours of work and 'sweated labour', low pay and high unemployment, gaps in social security and labour protection, degradation of **natural resources**, intensive and unplanned urbanisation, dependence on non-renewable energy sources and inequality in the distribution of the growing wealth. Some economists have given special attention to many of these factors notably **Karl Marx**, the German economist in the nineteenth century, and **Gunnar Myrdal**, a Swedish Nobel prize winner in the twentieth century.

Economic growth
The growth of the real output of an economy over time. **Economic growth** is a function of growth of capital, labour, **natural resources**, allocative and technical efficiency, and the level of aggregate demand. **Economic growth** is usually measured by the **gross domestic product** and divided by the total population (GDP per capita); this allows for fluctuations in both the product and the population served. Different models of the critical factors in determining **economic growth** have been proposed, including those of **Domar, Harrod, Solow and Romer.** In assessing the importance of measures of **economic growth**, it is important to recognise that GDP includes only those outputs that are traded. All other goods and services are zero valued including many of the **natural resources** such as seas, lagoons, rivers and lakes, mountains, air and primary uncut forest, which may constitute the principal sources of wealth in small states and in SIDS.

Economic systems
Interconnected strategic and operational elements that provide mechanisms for dealing with the problems of scarcity and choice in the use of resources for promoting wealth and welfare in societies. The principal economic systems are commonly recognised as the market system; the centrally planned system; and the mixed economy, which has elements of the market and the planned system within it. These traditional economic systems tend to neglect the value of **natural resources**, since they normally zero value those **natural resources** that are not used, not included in plans and not traded. **Environmental and natural resource economics** provide methods for correcting such limitations in the traditional economic systems.

Economic theory
The presentation and development of a testable model of the way an economy functions, the relationship of the specific model to other models and the expected outcomes of the interplay between variables.

Economic transition
The transition from an economy dominated by subsistence agriculture to one with a wide range of activities. The transition normally includes the promotion of intensive mechanised agriculture, mining and manufacturing industry, and services (such as tourism, financial services and social services). This transition is associated with **demographi**c and **epidemiological** transitions. The process transition of an economy produces new stresses on **natural resources** and promotes a reduction in natural forests, and the degradation and **pollution** of land, water and air. It is often associated with unplanned urban development, the intrusion of infrastructure into rural areas, including electrical and communication pylons, roads, railways, sea and airports, together with energy production and waste disposal systems. In SIDS, these can become dominating features of what was otherwise landscape of outstanding natural beauty and a principal attraction for the key service industry of tourism. How far economic transition of SIDS can be accomplished within an island's ecological carrying capacity, without critical loss of the natural heritage and its non-use value as a setting for tourism, is a challenge for policy-makers and planners that is yet to be fully addressed.

Economies of scale
The effect of a reduction in the average and marginal costs of each item produced as the scale of production is increased. At some critical point in the increase of scale of the production function, however, average and marginal costs may rise when extra costs of management, maintenance and increased costs of capital equipment and infrastructure may be incurred. Traditional approaches to accounting do not include **externalities** and other 'economic' perspectives of cost in the assessment of economies of scale in the production function. **Environmental economics** provides concepts and methods of calculation for overcoming these limitations, including the valuation of environmental impact and the **opportunity costs** of natural capital. A characteristic of small states and SIDS is their limitation on achieving economies of scale across a wide range of goods and services, which contributes to their vulnerability, due to the small size of their local markets and the high transport costs attached to exports.

Ecosystem
The system of interdependence of living organisms and their natural **environment**, in which nutrients and matter move continually between the integral components in patterns that can be defined, often in cyclical pathways.

Ecological economics has especially focused on the ways in which human development affects the functioning of ecosystems and how ill-identified or ill-managed **externalities** adversely affect the sustainable delivery of essential **environmental goods and services**.

Efficiency
The micro level efficiency is the ratio of factor outputs of goods and services to the factor inputs measured in physical or in monetary terms. (See **Parkinson's Law** and X-inefficiency.) At the level of the market, optimal efficiency has been attained when it is not possible to reallocate resources to make one person 'better off' without making another

person 'worse off'. Classical economists assumed that in a perfect market the 'market mechanism' of the 'invisible hand' ensured that long run efficiency of allocation of resources was achieved. A distinction is commonly made between allocative efficiency and technical efficiency. The former is concerned with the best allocation of resources; the latter with the best use of resources once allocated. Welfare economists recognise that market failure is a common factor and that the principle of distributive justice is seldom achieved without external intervention especially with regard to the allocation of social products (sometimes called merit goods or public goods) such as education, health services, security and environmental services such as water, clean air and waste disposal. In these cases, the link between consumption, payment and ability to pay is often indirect or obscured. (See **public goods**.)

Elasticity of demand
The responsiveness of demand for a product or service when one of the principal determinants of demand is changed, such as price or income. Elasticity is presented as a ratio of demand over the dependent variable (price, income, etc). The demand for basic requisites for human life such as food, housing, water and public transport, tend to be inelastic with respect to price, the same applies to common drugs of addiction such as tobacco and alcohol. In these cases, if price increases by say 10 per cent, the demand will fall by less than say 5 per cent. Luxury goods and services such as private transport, eating out and foreign holidays, tend to be elastic with respect to price. In these cases, if the price rises by say 10 per cent, one can expect a similar fall in demand, other things being equal. (See also the **Veblen effect**.)

Emissions trading
Emissions trading (or emission trading) is an administrative approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. It is sometimes called cap and trade.

Environment
The external conditions that affect the life of organisms (persons, other animals, plants, etc.). These conditions include the non-living features and the relationships between living organisms and the ecosystems in which they exist. The concept of **Environment** may also be applied to the internal conditions within an organism which affect its life and which may be affected by external conditions. In economics literature, there are five factors of production: land, capital, labour, organisation and entrepreneur. Environment can be defined as land, as natural capital or as a combination of land and natural capital. Land is defined to include surface of land, anything residing below land and anything coming to land surface from above. Soil, surface-water and underground water, sunrays, rainfall, atmosphere and climate are different forms of land and are examples of environmental goods. Minerals and oil are exhaustible **natural resources**, and forest, bio-diversity and river water, underground water and ocean water are examples of non-exhaustible **natural resources**. The latter can be replenished under given conditions. All types of environmental goods and services are also called natural capital. (See Nath's chapter: *Concepts and public policy issues in environmental and natural resources analysis.*)

Environmental accounting
A system of accounting for the value and price of non-market goods and services. This includes many **natural resources** and environmental goods and services, which are not traditionally valued in accounts, if they are not directly traded in the market. Such methods start with a recognition that standard methods of accounting do not adequately include the value of depletion of **natural resources**, although depreciation of other capital resources are accounted for; nor do they include the external impact on the **environment** of the production, distribution, sale and use of other goods and services. Environmental accounting attempts to remedy these omissions and provides an assessment of how far the use and consumption of **natural resources** is sustainable. Merely accounting for loss of non-renewable **natural resources** is not considered by environmental accountants as sufficient as a policy tool. The cost of substitution has to be considered. Methods adopted to correct for these accounting issues include: adjustment of net cost and income to account for use of **natural resources**, and the **externalities** of trade upon them, and evaluation of **natural resources** as assets taking into account their direct use, indirect use, non-use values and intrinsic use values. (See Madhoo's chapter: *Valuation of non-market goods and services.*) It is a fashion these days to call environmental accounting 'green accounting'.

Environmental economics
That part of the study of public economics focused on scarcity and choice in the use of **natural resources** for securing human welfare. Major concerns of such studies include: the impact on the **environment** of the production, distribution and use of goods and services (as in the economics of **pollution** control and energy production); and the development and use of economic and other policy instruments for correcting **market failure**. This aspect of economics gives special attention to the use of **natural resources** as public assets which contribute to human welfare. The growing interest in environmental and natural resource economics is reflected in the *Journal of Environmental Economics and Management* (since 1974). The discipline has followed the lead in **welfare economics** given by **Pigou** and **Hotelling** through their analysis of **externalities.** Another area of interest has been the application of **cost-benefit analysis** to environmental concerns. Central themes of the discipline have been the extension of economics to environmental issues, the development of pricing of environmental assets and the evaluation of the impact of changes in **technology**. In **developing countries** there has been a special focus in these studies on **property rights**, social welfare, population displacement, **governance**, **information** and issues of the distribution of costs. A further area of study has been that of financial incentives for protecting the **environment**, compensation for loss of environmental resources, pricing the provision of environmental services such as water, sanitation, communications and waste disposal. The discipline has contributed greatly to the recognition of the neglect of valuation of **natural resources** as **natural capital**. This has placed natural resource valuation as a key element in the assessment of progress in development and human welfare. Concern for the rate of consumption of non-renewable **natural resources** has promoted fresh debates on the approaches to measuring progress in **development**, moving away from **GDP** to new indices which incorporate impact on the **environment** and a human welfare function. (See for example, **Happy Planet Index**.)

Environmental goods and services
Things derived from nature which ensure life support and which people prefer more of rather than less, such as clean air, animals, grazing land, fruits, sunshine, shade and water; whilst air **pollution**, water **pollution** and hazards, such as sea level rise, are bad. Environmental goods and services depend upon the proper functioning of the ecosystem and the continuous interactions within it between organisms, including man, and the physical, biological and chemical environments. Some environmental goods and services may be considered as capital (i.e. a stock of assets) such as land, seas, and even trees; whilst others can be considered as non-capital environmental products or services such as fruits, grass, fish, and fowl. Pearce and Barbier (2006, op.cit.), classify environmental goods and services into the support for four types of **ecosystem** functions:

- regulation functions (e.g. biodiversity control, climate regulation, storage and recycling of waste, continuous nursery and feeding habitat, watershed regulation);
- production functions (e.g. oxygen, food, drinking water, materials for physical construction, energy and fuel, medicinal uses, genetic resources, ornamental);
- carrier functions (e.g. habitat, agriculture and forestry, industry, recreation, conservation); and
- information functions (e.g. providing scientific, aesthetic and cultural benefits).

The balance between environment goods and bads determines the sustainability and efficiency of these environmental functions essential for ecological survival.

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

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

(See Nath's chapter: *Concepts and Public Policy Issues in Environmental and Natural Resource Analysis.*)

Environmental impact assessment (EIA)
An evaluation using a standard defined methodological framework to identify the expected impact on a particular **environment** by the introduction of a new process or infrastructure, to assess the extent to which it may adversely affect the existing ecosystem and to recommend either interdiction or mitigating action that could be taken to reduce the anticipated damage. (See also Strategic Environmental Impact Assessment in Madhoo's chapter, *Impact Assessment and Biodiversity Conservation: An Application of EIA and SEIA.*)

Environmental Kuznets Curve (EKC)
The EKC hypothesis is that the relationship between income per capita and environmental emissions has an inverted U-shape. In other words, at relatively low levels of income, emissions increase with income, but after some 'turning point' emissions decrease with income. The econometric methodologies used to empirically test the existence of EKC are subject to severe limitations and hence the existence of a U-shaped relationship remains controversial. Moreover, evidence suggests that the existence of an EKC appears to vary according to the pollutant.

Environmental performance
An assessment of the outcome of environmental management. A national level index developed jointly by Yale and Columbia universities in the USA, it combines reducing environmental stress on human health, promoting ecosystem vitality, and sound management of **natural resources** using 16 indicators across 133 countries and a proximity to target methodology. A pilot study was published in 2006. (See www.yale.edu/epi)

Environmental tax
Taxation is one of a number of **policy instruments** designed to achieve environmental improvements or the reduction of **pollution** and degradation. Taxation has been used in relation to a number of environmental protection issues including: energy tax, to reduce energy consumption; motor vehicle tax to discourage the use of high fuel consumption vehicles and to pay for the cost of road maintenance and development; congestion tax to reduce use of roads in high-use areas such as cities; reduced taxes and exemptions for environmentally-friendly products and services. Many countries are now initiating environmental tax reform (ETR) which aims to shift tax away from environmentally and socially-friendly activities whilst placing more tax on **pollution** and environmentally damaging activities. Examples include: Denmark's carbon tax with reduction in employer and income tax; energy tax with reduction in employer social security levy; Norway's eco-taxes with reduced environmentally harmful subsidies and payroll tax. (See also **Pigouvian tax**.)

Epidemiological transition
The transition, associated with development, of the pattern of diseases and death in a population. **Developing countries** have an epidemiological pattern of early death and disability, dominated by infectious diseases, infant death and maternal risk. Developed countries have a pattern of longer life resulting from the mastery of infectious disease, through public health measures and other aspects of social development (such as food security, decent housing and education). In developed countries that have passed through this epidemiological transition, people live longer and the pattern of diseases shifts to non-communicable diseases (such as heart disease and cancers) and to accidents and traumatic injury, as the dominant causes of death and disability.

Equilibrium
A state of balance. In the case of market prices it is achieved at the price where the quantity demanded of a good or a service is equal to the quantity supplied. Environmental

equilibrium is achieved where the supply of environmental services that is sustained, renewed or replaced is equal to that which is consumed.

Equity
Fairness and justice in the distribution of costs and benefits in human society and the mechanisms for adjudicating on claims. In **environmental economics**, inter-generational equity is a key concern in which the claims of future generations to enjoy the opportunities offered by plentiful **natural resources** are given due weight in assessing the costs and benefits of development policies. Intra-generational equity is achieved when these resources are fairly available to different social and income groups of the same generation.

Externalities
Cost and **benefit** factors which are not included in prices but which have an effect on human welfare. **Pollution** is a prime example of an external cost imposed on society by the production, distribution, and use or disposal of other goods and services. Other examples of external costs are accidents and injuries in work. Examples of external benefits are the use and non-use values of public and private parkland and protected environments. Training of workers in one firm or country who then become available to be used by another is an example of an external benefit not included in the cost or price paid. Depending on the benefits and costs, these externalities are called positive or negative externalities. Recognition of **externalities** is an important element in the adaptation of **economics** as a discipline in providing advice and support to **small states**, where their **natural resources** and the health of their populations are critical resources for **development**.

Fiscal policy
Government commitment to action on gathering income, and managing expenditure and debt as tools in macro-economic **policy** to influence economic activity, including production, consumption, employment, prices, trade, savings and investment.

The word fiscal derives from the Latin words (*fiscus*, *fiscalis*) for the public treasury of ancient Rome or the emperor's privy purse. Fiscal policy may operate through government commitments to expenditure, changes in liability to taxation and taxation rates, and the application of taxation, trade tariffs and economic incentives to affect the demand and supply of different types of goods and services.

Fiscal policy at national level is commonly reviewed and amended annually through the national Budget process. Following the global economic and financial crisis of 2008/9, many governments and international financial institutions have introduced supplementary fiscal stimulus packages before their annual Budgets. These have included emergency measures of taxation, subsidies, loans, public works and government management of elements of the financial sector, to respond to the collapse of banking and capital markets. In some cases these measures have included 'green taxation' to steer economies towards development that is more sustainable with respect to its impact on **natural resources**. (See also **Taxation, Green taxes,** and **Sustainable development**.)

Forest
A land area of more than 0.5 hectares with trees higher than 5 metres, with foliage cover of more than 10 per cent, excluding land that is predominantly used for agricultural purposes or for urban land-use. Forests can be naturally occurring or planted or both.

Free trade
International trade operating free of constraints such as tariffs, subsidies, quotas, and exchange controls. In the late eighteenth century and in the nineteenth century in Europe, free trade was a policy, indeed a 'political movement' in opposition to the previously existing mercantilism, a wide-spread eighteenth century system of trade controls and protectionism designed to produce balance of trade surpluses to increase money supply and thus stimulate the economy.

Free trade is now a policy, in principle, promoted by GATT, WTO and the regional 'free trade areas' such as European Union, EFTA and NAFTA, but closer examination shows that even within these areas many trade constraints operate to the disadvantage of external competitors. In response to the 2008–2009 global financial and economic crisis, many voices have been advocating the rejection of free trade and a reversion to protectionism verging on the mercantilism of the eighteenth century. For **small states and SIDS** the recognition of their special and differential interests in adapting global free trade principles to the specificities of their development needs to be a key element in their dealings with WTO, GATT, UNCTAD and the EU to overcome the constraints of the un-level playing field of international commerce. (See Box 17 Chapter 8, p. 292, *The COMESA countries and the un-level playing field in African Environment Outlook 2,* Progress Press, Malta for UNEP, 2006 http://www.unep.org/dew/africa)

Frontier expansion model
A model encompassing the process of the opening of new land frontiers through trade and colonisation to promote **economic growth**. This process was a dominant feature of **economic growth** for European countries in the period 1870–1913. The European countries imported scarce **natural resources** (such as cotton, wool, other agricultural products and minerals) for use in industrial production and then exported manufactured goods (such as ships, steel, pottery, engineering products, railways and transport, electrical systems and components, household goods), and also services (such as education, health and engineering design) to assist the development of the colonies. But the impact of these polices on **developing countries** was in many cases unfavourable due to:

a lack of re-investment of income;
b low productivity of land after exploitation for the natural resources;
c lack of spill-over from technologies used in natural resource exploitation to other sectors of the economy;
d market and policy failure, corruption, the use of military power to impose exploitation of natural resources, and
e lack of commitment to sustainable development through regulation and re-investment.

Policy reform can however overcome this vicious circle by exposing such forms of exploitation, through greater transparency in policy-making and better governance.

Game theory

Use of logical analysis methods for exploring the outcomes of the interaction of competing players. The theory is loosely based upon deductive methods used in playing card games, chess and other games of chance and interactive play. The common feature is that the success of the pursuit of an objective by one player is constrained by the responses of other players. The theory had its early development in the 1940s and 1950s by a mathematician, von Neumann, and an economist, Morgenstern. It has had early applications in marketing and other aspects of management and in both positive (what decision-makers do) and normative (what decision-makers ought to do) perspectives. Around 1950, John **Nash** developed a definition of an 'optimum' strategy for multi-player games where no such optimum was previously defined, known as the **Nash** equilibrium. This concept was further refined by Reinhardt Selten. These men were awarded The Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel in 1994 for their work on game theory, along with John Harsanyi who developed the analysis of games of incomplete information. (See also **Nash** Equilibrium.) More recently game theory has been applied to **environmental economics**, especially in the management of fisheries and common land, by adaptation of the classic game theory concepts of interactive assessment of pay-off developed by A.W. Tucker (1950) in the 'prisoners' dilemma'. Examples of the application of this approach in **environmental economics** include: the management of emissions to reduce acid rain; the management of road congestion; farmers' use of common grazing; and fishermen who share the use of marine areas. The theory covers both competitive and cooperative games in which the common theme is to arrive at the best pay-off for the parties involved, which may be equivalent to a **Pareto** equilibrium. (See Hanley, N. et al. (2001) *Introduction to environmental economics,* Oxford University Press.)

Gross domestic product (GDP) (and real GDP)

Gross domestic product (GDP) is the aggregate monetary value of all goods and services produced in an economy in a given period, normally a year. The measurement can be made in terms of incomes, expenditures or added values. GDP excludes income from abroad and capital consumption. GDP normally takes no account of the value of **natural resources** consumed, expended or increased except those that appear in the income and expenditure accounts. Real GDP is a statement of GDP over a period of time to allow secular comparison taking into account inflation. **Environmental accounts** are now commonly being developed to adjust standard national accounts to reflect the use and value of **natural resources** and environmental services. National income accounts which capture the environmental and natural resource costs are known as green national income accounts.

GDP at purchasing power parity (PPP)

Purchasing power parity (PPP) figures are produced to adjust national figures in international monetary comparisons taking into account the differences in the cost of living in different countries that are not accounted for by exchange rate values of the national

currencies. The figures are based upon the local cost of a standard 'basket of goods and services'. In Mauritius in 2004, 2.7 times the number of goods and services could be purchased in Mauritius for each dollar when exchanged at the then existing rate for rupees. The difference partly reflects lower local prices of labour, housing, locally produced food, drink and textiles. It is also a function of the mechanism for determining local exchange rates. PPP has many limitations, especially as a surrogate measure for quality of life, not least because the quality of goods and services in the baskets may vary from country to country, and other factors may affect quality of life assessments such as security, schooling, health services, **pollution**, governance and the perceived quality of the physical and social **environment**, etc. Exchange rate values are also affected by the fact that currencies are traded for other reasons than to buy and sell goods and services; they may be traded in terms of their value as capital assets unrelated to their value in terms of consumer goods and services.

Globalisation

Globalisation is a term used in many different ways to express the idea that the rate of change in common aspects of our ways of life has rapidly increased, spreading a conformity world-wide in terms of economic, social, religious, cultural and political characteristics. The process is seen to be promoted by international public and private institutions. Some people consider this a boon, others a burden. This conflict of views has given rise to pro- and anti-globalisation movements. One key issue is the distribution of the gains and losses. People in many developing countries have expressed concern that they will remain poor whilst the richer countries and multinational companies will get richer. The rapid spread of dominant social, economic, religious, cultural and political systems has been a common feature of human history from the time of the Pharaohs, the Greeks, Romans, European Christian, Turkish Muslim and Soviet empires. The designation of globalisation today to refer to more recent trends in the spread of cultures has been influenced by the perceived power of mass media communication (telegraph, radio, cinema, TV, computer, internet). A large body of literature has been developed around the term, with much controversy about its meaning, its significance and how to identify and measure its spread and impact (for example, see Held, D. and Mcgraw, A. (2002) *Making sense of Globalization* Ch 1 in *Globalization/Anti-globalization*, Cambridge: Polity). Others have been more focused on its implications for sustainable development, international social justice, and the reform of development theory and practice (see Stiglitz, J. (2006) *Making Globalization work*, Allen Lane).

Global public goods (see also **Public goods**)

Gross national product (GNP)

The total money value of all final goods and services produced in an economy over a defined period (usually one year) plus net property income from abroad. It is distinguished from **gross domestic product** (GDP) by the inclusion of income from abroad. In many small states income from abroad through remittances can be a substantial proportion of national income making a large difference between GDP and GNP figures for such countries.

Goals, aims, objectives, activities (see also **Logical framework**)
Identified points of aspiration or desired achievements or outcomes of action, normally distinguished by increasing levels of specificity, with goals being general, aims and objectives being more specific, and activities being the action taken for their pursuit. These concepts are a common feature of rational planning which tries to define aspirations within a tightly presented framework. The underlying assumption of such systems is that change can be planned mechanically and that progress is a process of rational management in closed systems, with predictable linear progress though milestones of change. Examples of the use of the goals and logical framework systems for planning are in the UN system of the **Millennium Development Goals** and in standard EU procedures for programme and project planning. The logical framework approach is derived from the application of 'Systems Theory' to management, which has more recently been radically adapted in the light of approaches derived from 'Chaos Theory' and the concepts of complex adaptive systems. This more recent behavioural approach to planning and management recognises that organisations are sensitive to initial conditions and subject to unpredictable external forces, through which their sustainability is best protected by nurtured instability and continuing dynamic adaptive capacity. This adaptive **management** approach assumes that the future is unpredictable and the relationship between elements in a system are short-range, that any observation of a system is subjective and the people involved in and affected by any system have different mental models of it. This makes the pursuit of goals derived from a shared vision a complex, if not impossible and fruitless, undertaking.

Governance
A term used in economics and political science to cover the **management** process of states, corporate bodies, companies, assemblies, judicial bodies, etc. The term embraces common concepts such as openness, participation, accountability, transparency, probity, **effectiveness** and coherence. Various comparative measures of governance are available to show the relative levels of governance in different countries. The term is applied to the management of the **environment**.

Government failure
Where governments fail to act to correct for market failure or fail effectively to implement sound laws. Markets fail due to the presence of public goods and monopolistic tendencies. Environmental issues are strewn with examples of government failure, as a result of delayed or ineffective formulation of environmental protection laws and policies, or inadequate enforcement of them. This failure may result from legislative or bureaucratic incompetence, or from conflicting commercial pressures and political favouritism or direct corruption. The failures may involve a variety of areas of intervention including legislation, government expenditure, fiscal policy, exchange rate mechanisms, trade and capital controls, price controls, taxes, subsidies and lack of administrative probity. Such failure occurs technically where the private costs which result in adverse environmental degradation do not adequately reflect the full social cost of that damage.

Greenhouse gases (GHG)
A gas which, like a pane of glass in a greenhouse, absorbs solar rays, warming the earth's lower atmosphere and surface and thus, it is believed, contributing to climate change. Such gases include carbon dioxide, methane, nitrous oxide, chlorofluorocarbons and ozone. Burning fossil fuels such as wood, coal and oil in industrial and domestic processes and transport is thought to raise the temperature of the lower atmosphere and to contribute to the melting of the polar ice-caps, raising the level of the sea and increasing the frequency and intensity of extreme events such as cyclones and storms, floods and droughts. GHGs are also thought to be affecting the loss of the ozone layer that protects the penetration of ultra violet radiation through the lower atmosphere which can cause mutations in the genetic material of plants and animals.

Green taxes
Taxes whose objective is to promote environmentally-friendly behaviour by consumers and producers or to implement the 'polluter pays principle'. Examples include: carbon tax, landfill and energy taxes. The development of a package of 'green taxes' is referred to as environmental tax reform (ETR).

Habitat
The place where a population of organisms occurs and are sustained naturally. The sum of the environmental elements which constitute an interdependent community of living organisms and the natural home of animals and plants.

Happy Planet Index
A method of comparing relative human progress and its impact on the **environment**, developed by the New Economic Foundation (NEF) in the UK. The NEF presents national human welfare as assessed by the index function: mean National Life Satisfaction X mean National Expectation of Life/mean National Ecological Footprint. In this the SIDS come out well showing higher efficiency in producing human welfare per unit use of environmental resources than many more developed and larger countries. (See Marks N. et al. (2006) *Happy Planet Index, NEP*, http://happyplanetindex.org)

Hazard
An identified object, activity or event which could give rise to injury or damage to people or the **environment**. Hazards may arise from natural phenomena such as submerged rocks or icebergs at sea, volcanoes and avalanches, or from human activities, such as dangerous sports or industrial processes, from built infrastructure such as high-power electricity pylons and deep mines and quarries. Hazards may be classified in terms of their location, level of risk, and the frequency and extent of causing loss and damage.

Hedonic pricing method (HPM)
A method of pricing of goods or services using surrogate markets to estimate the values of non-marketed items. For example, the environmental value of houses in 'quieter' sites, overlooking parkland with low noise levels, good air quality, etc. may be assessed by comparison with prices of houses in different areas. The assumption is that people's values

for certain qualities can be inferred from what they are prepared to pay for them. The method of assessment using house prices for valuing environmental assets assumes perfect information, the analytical capacity to allow for other values, the stability of the housing market and zero valuing of benefits to people other than the house buyers.

Human capital
That aspect of **capital** that consists of knowledge and know-how, which is increased by education and training. Human capital is the stock of productive skills and technical knowledge in labour. It can be increased by investment in education, training and even health care. The term derives from **Karl Marx's** concept of labour power and the distinction made by **A.C. Pigou** between investment in material and in human capital. It has the characteristic of being expandable by experience, transportable through communication, but not transferable in terms of ownership like land and fixed capital. Many early theorists refer to it as labour, but in recent years it has become a specific aspect of the study of capital, notably through the work of the 1992 Nobel prize winner in economics Gary Becker through his perspectives linking sociology and economics. *'The Economic Way of Looking at Behaviour'* (Gary Becker, Nobel lecture 1992).

Human development index
A composite statistical index developed for the United Nations Development Programme (UNDP) which combines national **indicators** on income, education and health for the assessment of relative levels of human development as a measure of social and economic progress. The SIDS appear across the whole range of the classes of the index which is presented in annual Human Development Reports as both an index number and a rank order divided into three broad classes: high, medium and low human development. See www.undp.org

Increasing returns to scale
The increasingly greater rate of growth of an output associated with increasing level of input. To be more precise, if all inputs are increased by 10 per cent and output increases by more than 10 per cent, then it is a case of increasing returns to scale. It is often observed that this pattern of increasing returns to scale occurs during a particular phase of industrial or environmental production. In other phases, the returns to scale may be constant, diminishing or even negative. In environmental studies the carrying capacity of a habitat may determine the pattern of returns to scale of input factors; desertification and total loss of endemic species may be the final stage of over-exploitation of natural habitat.

Index number
A single value of a variable that allows comparison over time or between entities (such as countries or companies). An index is commonly a summary composite variable derived from a number of different variables such as in the retail price index (RPI) (combining the prices of a defined set of goods and services), the Human Development Index (HDI) (combining levels of education, income and health), the **Environmental Performance Index** (EPI) (combining different aspects of environmental governance), or **the Happy Planet Index** (HPI) (combining length and satisfaction with life and the **ecological footprint** of

populations). The elements in a composite index have defined weights whose values may be based on the results of social and market surveys of behaviour or opinion.

Indicative planning
A method of planning based upon the defining of objectives and the design of programmes to achieve these objectives, using performance indicators as measures of commitment and achievement. In a centrally planned economy, indicative planning replaces the market mechanism; in a mixed economy, indicative planning may supplement the market mechanism and be focused on overcoming specific aspects of market failure, such as support for underdeveloped regions (as in the EU), for environmental protection, for poverty relief and for minority groups. In the public sector, indicative planning may be the principal mechanism for planning in health, education, physical infrastructure and local community services (police, waste management, roads, etc.).

Indicators
Measures of quantities and qualities used for evaluation of states and trends in phenomena. In planning and evaluation, indicators in use are commonly divided into three groups: inputs to processes; service levels; and outputs and outcomes. The **Millennium Development Goals** (MDGs) system adopted by the UN includes 48 indicators for assessing the progress towards the achievement of 8 Goals. The indicators in the MDG system have target levels against which progress can be assessed. The UN, through its agencies, compile data on a variety of environmental features using national indicators collected by all countries in accordance with standard methods. FAO and UNEP are the principal sources for international comparative data on environmental indicators; the Commonwealth Secretariat compiles data on 60 small states and SIDS, with indicators covering population, economy, demand, trade, commodities, exports, agriculture, public finance, exchange rates, money supply, labour, demography, health, education, gender, transport and communications. The World Resources Institute, supported by UNDP, UNEP and the World Bank, maintains a regular biennial review of trends in environmental and related data and an analysis of environmental governance. (See www.wri.org for online version.)

Information
What is understood by a particular sequence of symbols. Sometimes defined as 'useful' data, or 'objective oriented' data, that is data for decision-making. The distinction between data and information is in the use to which it is put. (See also **data**.)

Information asymmetry
Where the actors in a market have different levels of **information** about the market, some more, some less, some better in quality, and others worse. This is a feature of imperfect markets. An essential condition of the perfect market is complete information amongst all the actors. In the absence of complete information it is common for actors in a market to engage specialist agents, or to undertake training to acquire specialist skills, or to use special tools, to overcome these information gaps. These devices allow the actors to operate more efficiently and also to compensate for market failure. Examples of imperfect markets with information asymmetry abound, but they include medicine, equities and futures.

The development of general education, encyclopaedias, the media, the telescope, the internet and mobile phones have all contributed to reducing information asymmetry. The invention of the telescope allowed buyers to identify ships safely approaching port as they were bidding for the merchandise the ships were carrying. Independent fishermen using mobile phones can now take their catch to those markets offering the best prices. Consumers, before making a purchase, can use the internet to check availability, prices and reviews by consumers' associations with their independent assessments of quality of goods and services. Patients, before going for a consultation, can use the internet to check their likely diagnosis and even the success rates achieved by a specific surgeon or hospital. Increasingly the internet and other media are overcoming the information isolation of SIDS in global markets.

Intangibles
Variables within economic assessment that can be identified as relevant and maybe important in appraisal but are difficult to quantify and value, such as scenic impact, risk of injury, and nuisances like noise and odour.

Interface
The linked surfaces between two elements in a system which may give rise to specific interactions. In governance there is an interface between policy and its implementation. At this interface there exist many conflicting and often powerful vested interests and pressure groups which may promote the policy or deflect it from its intended course.

Invisible hand
The image used by **Adam Smith** (author of the classic 1776 text *An Inquiry into the Nature and the Causes of the Wealth of Nations*) to characterise the mechanism by which market forces co-ordinate the actions of buyers and sellers in the market with the effect, he claimed, of maximising individual welfare and overall economic efficiency. Smith postulated that an individual, by pursuing his own good, tends to promote the good of the community, as those actions which are profitable for him will also be the most beneficial and efficient for the community. But the problems arising from market failure, especially in the field of child labour, health and safety, cartels, and the **environment** (see **Tragedy of the Commons**) have, since Smith's time, given rise to specific controls on the free market to protect human welfare and the **environment**. Examples of government intervention are manifold and include legislation against child labour, excessive hours of work, health and safety at work, minimum wages and physical planning. These illustrate the practical limits of the free market theory. Some of these issues were anticipated by Smith who recognised the need for government intervention. They have continued to be a focus for political debate and economic theory. (See Foley, D.K. (2006) *Adams fallacy, a guide to economic theology,* Belknap Harvard.)

Land
Those parts of the earth's surface, normally exposed above water and sea levels, providing opportunities for **habitat** for animal and plant life (see also **Environment**). **Africa** is the second largest land mass in the world with a total of over 3,000 million hectares, 3 times the

size of the USA. It contains 53 sovereign states, Sudan being the largest and Seychelles the smallest. Mauritius is the most densely populated state in Africa with 583 people per 100 hectares. Africa is rich in **natural resources** including forests, arable land, mountains, coastal and freshwater systems. Its mineral resources include gold, diamonds and copper, cobalt, and platinum. Desert and semi-desert zones cover 66 per cent of the African land area. Loss of forest cover, land degradation and desertification are major problems in land management in Africa, arising from population growth, cropland expansion, urban expansion, chemical contamination and war. Integrated policies for promoting improvements in land use for the protection of biodiversity and human well-being are explored in the UNEP core publications *Global Environment Outlook* and the *African Environment Outlook* which have special sections on SIDS. (See S. Nath Chapter, *Concepts and Public Policy Issues in Environmental and Natural Resource Analysis.*)

Limits to growth model
The model adopted by Donella Meadows in *The Limits to Growth* 1972 by the think tank the 'Club of Rome' to draw attention to the rate of use of global **natural resources**, the environmental impact and the implications of economic and population growth. Using a series of computer simulations on then current data and trends, the study concluded that if the growth trends continued unchanged *'in population, industrialization, **pollution**, food production and resource depletion, the limits to growth on this planet will be reached within 100 years'*. The publication was followed up with the 1992 re-assessment, *Beyond the Limits*, (Earthscan), which re-examined the doomsday scenario but set out the principles on which sustainable development might be technically and economically feasible, with an easing of population and **economic growth** and a sharp increase in the efficiency in use of energy and **natural resources**.

Logical framework (see also **Goals, aims and objectives**.)
A form of design of work programmes and their presentation, for the purposes of planning, and of programme and project management. The logical framework relates items of expenditure to activities linked to targets on measurable indicators, which are then used for monitoring progress towards the achievement of specific goals, aims and objectives, through specific activities. The process has been popular in US and in European planning within the management of programmes in the EU and elsewhere. The form used for presentation normally is a table in which the rows are the events that take place as a programme is implemented, that is via goals, purposes, outputs and activities. The columns of the table identify information about the events in each row, namely:

- narrative description;
- objectively verifiable indicators;
- means of verification; and
- assumptions.

The framework depicts the argument that if these assumptions hold, then these outputs will be delivered, and this purpose and goal will be achieved. Normally, the framework is linked to estimates of costs and timescales.

The process has many adherents but also critics who focus on a number of weaknesses including its inflexibility as a management tool where initial situations change and projects develop in unexpected and maybe more fruitful ways; the impact of external events and factors excluded from the initial deterministic framework; unrealistic timescales and prices; weaknesses in the evidence linking inputs to outputs; and the frequent dependence of the achievement of specific outputs on external multiple factors not included in the project, or the assumptions. The use of the framework for evaluation has similar weaknesses tending towards its use for audit rather than for learning about better programme processes and better management. The logical framework fits best where the evidence base for an intervention is well established and the assumptions on which performance is based are subject to direct control. Much of the work in environmental management is at present at the margin of science and more in the field of research and development, for which the established forms of logical frameworks are least likely to be appropriate to obtain useful results.

Management

The process of being in charge of an undertaking and controlling the use of resources for defined ends. It can include policy development, planning, resource mobilisation, resource allocation, control of supply, production, marketing, sales, distribution, employment, capital investment, maintenance, public relations, finance, monitoring, evaluation and performance appraisal, customer and public relations and succession. In the twentieth century, management as a process of professional activity was promoted by three broad global transitions in institutional arrangements. In the private sector, ownership became separated from management and a new managerial class emerged distinct in the social structure from the classes of workers and capitalists. Second, in the public sector, procedure-based administration of services was increasingly transmuted into objectives-oriented management, with defined goals, monitored by targets and fuelled by performance-related pay and appointment and promotion on merit. Universities supported this through their masters programmes and new business schools. Thirdly, in national and international NGOs, especially in the UN and intergovernmental organisations, new protocols for service provision were emerging based on defined goals, with activities and budgets set within a **logical framework** for achievement. Management of **natural resources** are now being fundamentally influenced by these global trends in the oversight of programmes concerned with the principal areas of concern (**land, water, fuel and energy, coastal and marine, biodiversity, and environmental conservation**). These have become increasingly developed areas of professional management and economic and scientific enquiry world-wide as part of the process of global economic and social development. The professional, evidence-based management of **natural resources** is becoming a vital component in national and international governance. (See also **goals, aims, objectives; managerial theories**.)

Managerial theories

Theories devised to explain the behaviour of companies which do not conform to **classical economic theory** since they do not evidently pursue the long term end of profit maximisation, through the process of optimally combining quantities of factor inputs to produce goods and services. The principal alternative management theories are:

- the Marxist theory that the capitalist system in the long run leads to bankruptcy of firms, the impoverishment of labour, the collapse of the state and the essential conditions for social revolution;
- the corporate managerial theory in which the separation of management from ownership leads to the substitution of managerial-linked objectives such as maximising sales or managerial income instead of the maximisation of the profits of the firm; and
- the behavioural theories of the firm in which the long-term behaviour of the firm is a function of its complex social organisation, conflicts and inconsistencies arising from the functioning of the social groups within and related to the firm.

The application of managerial theory to environmental governance is in its infancy. Much effort has been given to the identification of outputs and outcomes (such as through the development of performance indicators, the monitoring of **climate change** and the development of specific economic and regulatory instruments); less attention has been given to the institutional framework for management, the public private sector interface, the study of management behaviour and the micro economics of production functions for environmental goods and services.

Marginal analysis
The examination of the quantitative implications of the increase or decrease of one unit of a specific variable such as an input or an output on other variables. The changing slope of the relationship between two variables such as cost and output can be of critical importance in determining the optimum volume of production. In **environmental economics,** it also has relevance in assessing the critical point in monitoring environmental trends, where the carrying capacity of an ecology in supporting a species is reaching its limit and where the rate of renewal of the ecology and the reproduction of the species begins to slow and then declines. Marginal analysis, for example, can be of use in the monitoring of fish stocks in relation to volume of fishing, and in the monitoring of tourist arrivals in relation to volume of tourists in situ. It has been found that social attitudes of support for the protection of an endangered species, expressed as the marginal willingness to pay for protection of that species, vary inversely with the number of that species alive.

Marginal cost
An increase in total cost due to production of an additional unit of output. Since most economic decisions are taken at the margin, marginal analysis and the concept of marginal cost are extremely useful tools in all branches of economics.

Market
The mechanism of exchange between buyers and sellers of goods and services. The theory of markets recognises different markets according to their characteristics of organisation and structure. The market for environmental services is increasingly recognised as a special field of study and management and as a condition for sustainable development. The environmental market includes: the operation of utilities such as water, sanitation, and power; the provision of environmental governance through conservation, protection and

regulation; the monitoring of environmental trends; the implementation of environmental laws; environmental research and development; the institutional organisation of the market in terms of the public private split; the role of NGOs; trading in environmental goods and services (such as carbon, waste, transport systems); and **environmental accounting**.

Market failure
An outcome of the operation of the market revealing long run sub-optimal performance or persistent bias in any of its principal functions. The failures may arise from lack of productive efficiency, allocative efficiency, technical progressiveness or product performance. Market failure may result from flaws in performance arising from weaknesses in **market structure** or market conduct. Markets fail in the presence of **externalities** and information asymmetry and in the provision of public goods and goods produced under conditions of decreasing cost (water and electricity, for instance).

Market performance
The efficiency of a market in maximising human welfare. The dimensions of efficiency of performance may include: production, distribution, resource allocation, technology, and product quality in relation to price. The performance of the market for environmental services can be evaluated by the same criteria as used for any other market, but more emphasis may be given to the intergenerational sustainability of the market and the extent to which environmental values are adequately included in the assessment of the output of goods and services and the use and renewal or substitution of natural capital.

Market structure
The organisation of the market defined in terms which are thought to affect its conduct and performance. The principal structural characteristics may include: the concentration of sellers and buyers and their relative size; the conditions of entry and barriers to entry; the differentiation of the products for sale, and the extent of vertical integration and diversification. It is expected that market structure interacts with market conduct and performance and with public policy which may, in turn, aim to control all or any of these other aspects the market.

Environmental services and resources are subject to their own market conditions and are affected by the market for other goods and services and the public policies which engage them. In recent years there has been a shift in the delivery of many environmental services, such as water, sanitation, waste management and energy production from the public to the private sector and the break-up of public sector monopoly supply. This has had mixed results in terms of performance. But it has been accompanied by the extension of the principle and practice of 'the market regulator' with the aim of promoting efficiency and protecting consumer interests and value for money.

The markets for other goods and services have also been affected by firms adopting more environmentally-friendly policies, by public policy requirements and by shareholders seeking 'green' shares as part of 'ethicals' trading. ('Ethicals' were formerly largely restricted to shares in companies that excluded alcohol, tobacco and arms trading). Many companies now publish environmental accounts which identify the payments they have

been required to make as penalties for environmental infringements and the investments they have made for environmental protection.

Millennium Development Goals (MDGs)
Strategic Goals agreed through the UN in 2000 for achievement of greater global development. The MDGs have associated indicators and targets for each country to achieve by a target date, for most Goals by 2015, against a 1990 baseline. The eight Millennium Development Goals relate to poverty reduction, education, gender equality, child health, maternal health, control of major diseases, environmental sustainability and partnerships for development. Their pursuit is being integrated into the design of National Strategies for Sustainable Development and Poverty Reduction Strategy Papers. The environmental targets and indicators include forest cover, protected areas, energy use, CO_2 emissions, safe water, sanitation provision, and reduction of slum property and insecure housing tenure. The environmental issues concerned with coastal and marine management, biodiversity, waste management, and natural disasters, all of critical importance to SIDS, are not included in MDGs. The MDG system is coming under increasingly critical review as a tool for policy, planning and management. (See for example *Nature* (2007) Millennium Development Holes, 446, 347 March editorial: *'The MDGs could be buried in the history's graveyard alongside other well-intentioned but failed development efforts …'*) (See Roberts J.L. Chapter, *Making Sense of Millennium Development Goals: Implications for Environmental Governance.*)

Mineralogical threshold
The point at which the energy cost of extracting minerals (metals, stones and oil) steeply rises as the concentration of those minerals in any site decreases through exploitation. With the increase in energy use there can be a corresponding increase in adverse environmental impact depending on the source of the energy. Policy intervention may be necessary to address situations where the market does not account for environmental damages.

Mitigation
Mitigation and adaptation are two foundational concepts that have emerged in climate change literature. Mitigation of climate change involves taking actions to reduce greenhouse gas emissions and to enhance carbon sinks. This is distinct from **adaptation** which involves taking action to minimize the effects of climate change. Scientific consensus is leading to increased efforts to develop new technologies and sciences and carefully manage others, in an attempt to mitigate climate change. Carbon capture and storage (CCS) is a plan to mitigate climate change by capturing carbon dioxide (CO_2) from large point sources such as power plants and subsequently storing it away safely, instead of releasing it into the atmosphere. (See also chapter by Munro: *Climate Change Policy and SIDS.*)

Moral hazard
The risk that the removal of prices at the point of consumption may promote changes in consumer behaviour and over-use of products and services. For example, 'free' access to parkland, beaches, roads, seaways, cities, and health services may promote patterns of use, especially over-use by some, which neglects the adverse impact on the quality of

those services, and the opportunity of access by others whose marginal benefit from the use may be greater. The introduction of road charges in congested cities, health charges in overcrowded health services and excess elements in insurance policies, are policy instruments directed at reducing the adverse social and economic impact of the moral hazards of such goods and services otherwise offered free at the point of use. Even in the Soviet Union, which created 'free' public transport, a small user charge was introduced to limit excessive use.

Multinational firm

A business (firm) that produces and sells in more than one country. The incentives for multinational business arise from firms having specific advantages (such as monopoly from patents or unique protected products); locational advantages (through local production and distribution and responsiveness to changes in demand and taste); country specific advantages (whereby businesses adjust production and distribution systems to avoid tariff quotas and other regulations and to take advantage of cheaper labour and local skills and other financial advantages such as grants and tax write-offs). Those concerned with environmental protection may encounter special problems in regulating the activities of multinational firms whose headquarters may be beyond local jurisdiction or where particularly hazardous production systems may be located in countries with less restrictive, environmental control systems. Examples of such difficulties occur with marine and fisheries management and the regulation of disposal of hazardous waste. Some multinational companies, however, promote best practice in their international activities and have become pioneers in environmental accounting and health and safety management. They are increasingly involved in global negotiations on sustainable development policy and programmes with international and intergovernmental organisations.

Multiplier

The multiplier is classically linked to the observation in macroeconomics that a small change in national expenditure may lead to a larger change in national income. The process however is cumulative and interactive. The concept may also be applied to changes in environmental conditions where a small change in **pollution** levels may lead to a much larger change in biodiversity. Evidence from the creation of marine-protected areas, for example, shows that the reduction in fishing and **pollution** can lead to a very rapid and large change in fish stocks and this then spreads to provide a beneficial impact on non-protected areas.

Municipal solid waste

The 1992 Earth Summit defined a waste management hierarchy from the most desirable to the least desirable: source reduction; re-use; recycling; waste to energy (incineration), and land-fill. This is based on engineering principles largely relevant to the safe disposal of hazardous waste. Economic analysis (within the EU) suggests that such a hierarchy, taking into account total external and private costs, should be: recycling; landfill; incineration; and composting (for agricultural use). The position of each element in the hierarchy is subject to variation in costs and benefits and depends on the methods of collection, especially the transport costs and the composition of waste.

Nash equilibrium

In game theory, **Nash** equilibrium (named after John Forbes Nash) is a solution concept of a game involving two or more players, in which each player is assumed to know the equilibrium strategies of the other players, and no player has anything to gain by changing only his or her own strategy unilaterally. If each player has chosen a strategy and no player can benefit by changing his or her strategy while the other players keep theirs unchanged, then the current set of strategy choices and the corresponding payoffs constitute a **Nash** equilibrium. **Nash** strategy describes a more restrictive game situation than dominant strategy. A strategy is dominant if, regardless of what any other players do, the strategy earns a player a larger payoff than any other. Hence, a strategy is dominant if it is always better than any other strategy, for any profile of other players' actions. (See chapter by Gangopadhyay and Gangopadhyay on *Intellectual Property Rights and Anti-competitive Behaviour: Major Deterrents to Economy and Ecology of SIDS.*)

National income

The total money value of goods and services produced over a period of time (usually one year) less capital consumption. Traditionally, the loss of the capital value of non tradeable **natural resources** is not included in accounts of national income. In **environmental economics**, methods of accounting can be used to value **natural resources**, the extent of replacement of renewable capital such as woodland, fish stocks, water resources and the substitution of non-renewable stocks such as oil and coal with other facilities such as hydro-electrical systems, wind power, solar energy, etc.

National plans

Integrated, definitive proposals at country level for determining economic and social development over a defined time-period, usually five years. Institutionally, they can give rise to national planning departments whose remit is complementary to that of Ministries of Finance, the latter being more concerned with short-term fiscal policies and expenditure programmes. In many countries the two functions are combined in one ministry. The UN has promoted both National Strategies for Sustainable Development and Poverty Reduction Strategies, which have a similar purpose and format to traditional national plans with elaboration of targets for a range of national indicators of performance. Central planning, as an integrated system for sector-wide national plans, has tended to fall into disuse following the demise of the Soviet Union and the discredited process of false reporting of performance it engendered. There is a continuing debate about the accuracy and value of data on environmental quality and about the assessment of the costs and benefits of environmental protection to enhance national and global plans for **sustainable development**.

Natural capital

In classical economics, wealth was seen to be determined by three elements of production, capital, labour and land. **Natural resources** included land, basic raw materials such as water, cotton, wool and wood and commodities such as iron, copper and gold. More recently, through the emerging concept of 'productive power' associated with Friederich List, a

nineteenth century German political scientist, three kinds of capital were seen to contribute to productive power: natural capital (**natural resources**), material capital (machinery and equipment) and mental or human capital. The designation of **natural resources** as 'capital' has important implications for their management and treatment in economics. Like other capital they need maintenance and replacement. Their accumulation or protection represents foregone consumption and this needs to be accounted for in any valuation. (See Hamilton, K. and Rashid, Hassan (2006) *Measuring Development Prospects by 'Greening' the National Accounts:* in Lopez, R. and Toman, M.A., *Economic Development and Environmental Sustainability,* Oxford University Press, ISBN 0-19-929799.) Classical economics tended to treat **natural resources** as inexhaustible and non-degradable with no **externalities** as a consequence of their use. **Environmental economics** recognises that **natural resources** may be renewable or non-renewable and subject to **pollution** affecting their use. (See also **Natural resources**.)

Natural resources

These include land, basic raw materials and commodities such as oil, iron ore, trees, plants, etc. As part of natural resources, the importance of the productive capacity of environmental services such as that provided by water, wetlands, climate and biodiversity is increasingly recognised. Natural resources can be classified as renewable and non-renewable, actual and potential, biotic and abiotic natural capital. The rate of sustainable use of natural resources is a function of the replacement and substitution rate and the amount of standing stock. The stock of a natural resource is a known quantity whereas reserves may be an estimate in the form of geological evidence. Natural resources can become a 'curse' where access and distribution are dominated by corrupt practices and by increasing conflict and social inequality in wealth and power. (See **Natural resource curse**.) Many developed and developing countries, especially small states, are facing pressure on and even exhaustion of their natural resources. They then become more dependent on external sources or on substitution by manufactured goods, such as man-made fibres, plastics, recycled water, etc. Conservation of natural resources is a major focus of natural capitalism, environmentalism, the ecology movement and political 'green parties'. Edward Barbier is associated with the development of the theory of the natural capital basis of economic development in poor and middle income countries, in which he presents the following propositions:

- Low and middle income countries have natural resource dependent economies.
- Such resource dependence is associated with poor economic performance.
- Development in such countries is associated with increased land conversion and stress on available water resources.
- In such countries a significant share of the population is concentrated on fragile lands.
- This combination of pressures gives rise to the need for frontier expansion into more fragile land areas and the greater degradation of natural resources with lower income yield (the vicious circle of the frontier expansion hypothesis). All these issues are of critical importance to small states and SIDS as they move through the stages of demographic, economic, epidemiological and social transition.

- New concepts in development policy which address the social and economic implications of this theory include:
  - land reform;
  - the dismantling of fiscal policies that have promoted the adverse environmental effects of unsustainable exploitation of natural resources such as woodlands, wetlands and marine areas; and
  - the exposure of political and commercial corruption that has traded quick financial returns on natural resource harvesting against the long term impact of natural resources depletion and degradation. (See Barbier, E.B.: chapter 'Natural capital, resource dependency and poverty in developing countries', in: Lopez, R. and Toman, M. (2006) *Economic Development and Environmental Sustainability*, Oxford.)

Natural resource curse

The adverse effect on economic growth, political and social relations that can arise from any large supply of scarce and thus high value natural resources, such as farmland, oil, natural gas, gold, diamonds, poppies (for heroine), cacao (for cocaine) and even water. This 'curse' can sometimes result in extreme and long-lasting economic decline and wide-scale poverty alongside small numbers of very rich people, continuing levels of conflict, violent disputes, civil war, secession or invasion and conquest movements to control the access to the benefits of the valued resource. The concept is attributed to Richard M. Auty in**:** *Sustaining Development in Mineral Economies: the Resource Curse Thesis*, Routledge, London and New York. (See also: Stiglitz, J. (2006) *Lifting the Resource Curse,* chapter 5, in: *Making Globalization Work*, Allen lane, Penguin Books, London.) The history of colonialism has been replete with the unfolding tragedy of this 'curse' which has in many countries spilled over into the post-colonial era through corruption and conflict over the share-out of the riches. Currently, countries affected by the 'curse' include the oil-rich Eastern Region (Biafra) and its conflict with federal Nigeria, oil-rich Shiite and Kurdish areas of Iraq, North Sudan without oil and oil-rich southern Sudan, Sierra Leone and Mozambique (over diamonds), and the Congolese province of Katanga (rich in cobalt, copper tin, radium, uranium and diamonds) in conflict with the rest of the Congo.

Resource-rich **developing countries** are also subject to exploitation by multinational companies. The multinationals are specialised in extracting **natural resources** at low prices through contractual arrangements that impose adverse conditions on the countries concerned. Thus, the host countries have little or no access to the 'rents', surplus or profits, resulting from any increases in world prices for the **natural resources** extracted.

Stiglitz, J. (2006 op.cit.) makes proposals to resolve these problems including: transparency in extraction contracts; reduction in arms sales in such conflict areas; certification of the source of **natural resources** to advise buyers; targeted financial assistance to aid local development; international contracting standards to protect developing countries; limitations on environmental damage in extraction contracts; and better enforcement of international law and standards. Increasingly, host countries are renegotiating extraction contracts under the threat of nationalisation of the industries concerned. (See also Humphreys, M., Sachs, J.D. and Stiglitz, J.E. (2007) *Escaping the resource Curse*, Columbia University Press.)

The natural resource curse is also explained in terms of the 'Dutch Disease'. Netherlands witnessed the discovery of off-shore oil and gas in the late 1950s and early 1960s. This resulted in an upswing in exports of natural gas which led to appreciation of the Dutch guilder. This development hurt other exports for a while and acted as a threat of de-industrialisation, with adverse macroeconomic effects. The problem proved short-lived, but the name 'the Dutch Disease' stuck.

Neo-classical economics

The neo or 'new' classical economics derives principally from the writings of Alfred Marshall and others working in late nineteenth century Europe. Fresh concepts were developed such as 'marginal analysis' derived from the application of calculus to economic data, and a new focus on the choices in the allocation of resources to alternative ends. The use of geometrical diagrams to illustrate the implications of algebraic formulae was an essential feature of Marshall's contribution to teaching in economic theory and its practical application to management both in macro and in micro-economics, respectively. The neo-classical school of thought developed principles from their application of the analysis to corporate decision-making. These principles associated with Marshall include 'diminishing marginal **utility**', 'economies of scale', 'elasticity of demand', the 'life cycle of the firm' and the methods of comparative static equilibrium analysis, which are continuing as central features of the inheritance from this school. The crux of neo-classical economics is: lack of government regulation, free trade, and efficient markets due to the 'invisible hand'. Marshall's contribution to **development economics** is less well known. He wrote; 'the growth of mankind in numbers, in health and strength, in knowledge, ability and richness of character, is the end of all our studies.' (*Principles of Economics* first published in 1890.) Marshall's framework of analysis can be applied to **environmental economics**, especially in the management of environmental services.

New environmental paradigm (NEP)

A conceptual framework for economic and social development, underpinning the movement for sustainable development. With this framework of thought, attributed to Dunlop and Van Liere (Dunlap, R.E.; Van Liere, K.D. 1978. *The new environmental paradigm*. Journal of Environmental Education. 9: 10–19), the value of natural resources and their conservation is seen as a necessary condition for **sustainable development**.

New growth theory

In economics, **new growth theory** or **endogenous growth theory** was developed in the 1980s as a response to criticism of the neo-classical growth model which posits that the long-run rate of growth is exogenously determined by either assuming a savings rate (the Harrod-Domar model) or a rate of technical progress (Solow model). Endogenous growth theory tries to overcome this shortcoming by building macroeconomic models out of microeconomic foundations. Households are assumed to maximise **utility** subject to budget constraints while firms maximise profits. Crucial importance is usually given to the production of new technologies and human capital. The engine for growth can be as simple as a constant return to scale production function (the AK model) or more complicated set ups with spillover effects, increasing numbers of goods, increasing qualities, etc.

Endogenous growth theory demonstrates that policy measures can have an impact on the long-run growth rate of an economy. For example, subsidies on research and development or education increase the growth rate in some endogenous growth models by increasing the incentive to innovate. Some contend that new growth theory has proven no more successful than exogenous growth theory in explaining the income divergence between the developing and developed worlds (despite usually being more complex). (http://en.wikipedia.org/wiki/Endogenous_growth_theory)

New International Economic Order
A policy adopted by the UN in 1974, which set out principles for promoting support for improvements in developing countries. The policy included support for access of primary products, special trade concessions for manufactured goods, transfer for economic aid, and an increase in economic co-operation from **developing countries** to developed country markets. This policy has been pursued largely through UNCTAD, but has met with mixed results. The process is now being overtaken by WTO policies and the ending of preferential treatment for many low and middle-income countries. The impact of the erosion and loss of preferential trade arrangements is hitting small states and SIDS hard and over a short period of time. Many are trying to renegotiate special and differential treatment. This is a principle that has been endorsed by the UN including through the UN SIDS Mauritius Strategy of 2005. (See www.sidsnet.org/docshare/other/20050201154324-Mauritius)

Normative economics (see also positive economics)
The study of what ought to be in economics programmes, based upon value judgements about the ideal state of the world. In the field of environmental economics, a normative view might be expressed by designating an optimal (norm) amount of road tax that would minimise pollution and increase social welfare. In other words, road taxes should be introduced to ensure that the land value of roads and the externalities of road use are introduced into the market for road use. Normative economics is distinct from 'positive economics' in which the question of road taxes would be considered in terms of the specific yield from, or estimated yield from, road tax and its actual impact on road use, travel times, choice of alternative means of transport, etc. Normative economics includes those approaches to **welfare economics** whose focus is how economic activity should be organised to maximise human welfare. **Environmental economics** can be pursued from a normative or a positive perspective depending on the purpose of the study. It is important to ensure a clear distinction between the two, although any method of measurement contains value judgements, often concealed. At the simplest level, value judgements are inherent in any use of numbers; for example, to say a family consists of five people, a factory produces five tonnes of waste or a country has five million square kilometres of land, implies that each member or unit counted is equal to each other unit despite the difference in individuals, the composition of waste, and the variation in the quality, use and non-use value of each unit of land.

Opportunity cost
Sometimes called the 'economic cost', it is the sacrifice made in using scarce resources to produce one good or service expressed in terms of the alternatives forgone. An example of opportunity cost assessment in **environmental economics** would be in the cost of building

a road. This can be expressed in terms of the contract price or in economic terms as the loss of agricultural land, of habitat, of biodiversity and of other environmental services entailed from both the use of the land on which the road is built and the **natural resources** extracted for use as materials for building the road. In addition, the opportunity cost involves the economic costs of the labour and the capital in designing and building the road which are thus lost for alternative uses such as providing environmental protection.

Optimising resource use (See also **Bentham, Pareto and Kaldor**.)
Seeking the highest value in social welfare through major economic and social objectives such as full employment, macro-economic stability in prices, **economic growth** and balance of trade. The optimising approach may not lead to sustainable development, unless proper account is taken of the state and use of **natural resources** as part of natural capital now and into the future. These are increasingly seen as essential factors in the production of goods and services and in non-use values in any society.

Ozone layer
A layer of ozone gas in the upper atmosphere of the planet Earth. Ozone is a highly reactive gas formed by the recombination of oxygen with ultraviolet radiation from the sun. The ozone layer protects the earth from the adverse effect of ultraviolet rays from the sun on animal and plant life. In the lower atmosphere **pollution** can damage the ozone layer by the build up of chlorofluorocarbons (CFCs). Scientific observations suggest that the earth's ozone layer has been increasingly damaged and within 50 years could cause substantial **climate change** with, in particular, melting of the Arctic ice caps. (See also **Climate change, Greenhouse Gases**, **Public goods**.)

Paradox of value
The notion that the value of a good or service is determined by its scarcity rather than its usefulness. The classical contrast is between diamonds and water. Diamonds (except for industrial diamonds) are of little practical use but, because of scarcity and demand for decoration, they are expensive; water is of indispensable use and yet in many countries where it is plentiful it is provided at a low price. In recent decades, with water scarcity arising from greater agricultural, industrial and domestic demand, the marginal **utility** of water and its price has continued to rise. This has also been affected by rising marginal costs of extraction, treatment and distribution as remoter areas are covered and the greater per capita demand affects the market.

Pareto optimality
The maximisation of the economic welfare of a population which satisfies the following criteria: that, as a result of a change in resource use, the welfare of a person cannot be raised by changing the distribution of benefits, without reducing the welfare of any other person. This principle derives from a concept of ordinal **utility** developed by Vilfredo **Pareto** an Italian engineer and economist. The criteria have the merit that they avoid the need for interpersonal aggregation of welfare. In many cases, however, these criteria are so difficult to meet that in practice a complementary concept developed by Nicholas **Kaldor** and John **Hicks** is adopted. In this modified Pareto assessment, a choice in the

deployment of resources can be considered beneficial, if, after the change, the gainers can compensate the losers and still be better off. This divides the assessment process into two parts: a) the assessment of costs and benefits or efficiency gains and losses; and b) their distribution. This modified view has been further developed by Paul **Samuelson,** with the construction of a social welfare function, but Kenneth **Arrow** has challenged the validity of the social ordering method on which it depends.

Parkinson's law
The stylised or satirical notion derived from the sayings of Professor C. **Northcote Parkinson** that 'work expands to occupy the time available for doing it'. This notion is also recognised in the concept of X-inefficiency, that is the gap between the actual and the minimum supply cost for a good or service. This gap arises in many large mature organisations, in the public and the private sectors, which are not subject to competition and whose supply costs are raised by inefficient factors such as restrictive labour practices, staffing unrelated to output and workload, the monopoly position of certain supply systems, and bureaucratic practices. These factors are common in large historic private businesses (such as western motor car manufacturing, traditional sea-ports) and in state-run organisations, such as state railways, the civil service, state utilities and other monopolies such as state transport, water, telephone and electricity companies, schools and health services. Supply side inefficiency was a commonplace in the Soviet centralised economic system which lacked any competitive elements. The use of work-study, other systems of work measurement, and contracting-out within the public and the private sectors can increase productivity and reduce supply costs. The application of management sciences is beginning to penetrate into the management of environmental services, especially through competitive bidding and the evaluation of contracted services required in international aid programmes.

Perfect competition
A stylised market in which there are many sellers and many buyers, non-differentiated products, free entry and exit to the market and complete knowledge of the market by buyers and sellers. Theory asserts that such a market would produce more efficient performance than any other, such that market output is optimised with minimum supply costs and suppliers receiving an acceptable return on their outlays (including capital, labour and **natural resources**). Such markets scarcely exist, since all the conditions seldom apply. But the model serves to identify critical factors in the imperfections of existing markets. The absence of perfect competition and the recognition of market imperfections and market failure frequently define the point of entry for government intervention. This is especially so in the market for land and **natural resources**. There, the interests of 'buyers' are inadequately represented and the knowledge of their willingness to pay is obscured. However, government intervention does not necessarily, resolve the problem and planners and managers must anticipate the risk of policy failure, where intervention may not provide effective or cost-effective correction to the recognised failures of the market.

Pigouvian tax
Taxes and subsidies to remedy market failure and its impact on resource allocation, where prices failed to reflect the social as well as the private values for goods and services. In

environmental economics literature, such taxes are extensively employed to charge for negative **externalities** created by polluters. (See Chapters in the book by Madhoo: *Environmental policy instruments and governance* and by Nath and Schroeder: *Tax instruments for Environmental Management in Tourist Destinations*.)

Photosynthesis
The process by which green plants use sunlight to convert nutrients from the soil, carbon dioxide from the air and water to produce glucose, whilst releasing oxygen as a beneficial by-product for the respiration of plants and animals. This process is adversely affected by air **pollution** and especially by damage to the **ozone layer** in the upper atmosphere which inhibits ultra-violet radiation from the sun penetrating into the earth's atmosphere.

Planning (See also **National plan**)
A process of preparing and presenting a detailed proposal for doing something over a period of time with defined resources in relation to anticipated events. The process can be applied both in the public and the private sectors, at national, community, family or personal levels. It is consistent with many theories of economic systems. The time scale can be short, medium or long term and may include various levels of intention and aspiration expressed in terms of aims, goals, objectives, targets and outputs and outcomes. There are many applications for planning in environmental management especially in relation to the protection of endangered species, the provision of water and sanitation systems, the control of air **pollution** and global warming, the management of settlements and the systems of regulation of industry to avoid adverse environmental impact. Planning has been seen to be a necessary process for protection against market failure. Experience has shown, however, the gross errors that planning can give rise to through policy failure both under centralised planning systems and in the mixed market economies.
(See also **Logical framework** and **Programme, planning, budgeting** (**PPB**))

Policy
A formal declaration of a commitment made by a government or a corporate body for the pursuit of a general or specific objective. Examples of policy objectives in the field of **natural resources** management include: reducing greenhouse gas emissions; conserving endangered species; providing safe water and sanitation for all; and promoting the use of renewable sources of energy. Policy statements may, but do not always, define the means for their achievement, nor the timescale. Policies can be classified in a number of different ways. For example, they can be classified by the sectors to which they apply (education, finance, commercial, environmental) or the function they entail (distributive, regulatory, organisational).

Policy analysis
Policy analysis is the review of existing or prospective policy to evaluate its structure, logic, inter-relationship with other policies and potential for fulfilment. It differs from programme evaluation in that its focus is on the nature, scope and content of the policy and is not restricted to its measured performance. The analysis commonly examines the institutional context and the process of development of the policy. This may include identification of problems to be addressed and the method used in developing and formulating the policy.

These methods can include consultation, political debate, expert evidence, legislative process, method of enactment and enforcement, public opinion survey, etc; evaluation of expected outcomes, cost-benefit analysis, pilot studies, comparative analysis, needs assessment, feasibility assessment, etc. Policy analysis may be set out in reports which identify the strengths and weaknesses of the policies themselves, their viability, the support they have and the processes from which they have emerged. It may also review the capacities and conflicting interests of policy-makers and the impact this may have on policy formation and its implementation. (See also **Behavioural theory**.)

Policy failure

Policy failure occurs where a government or other corporate body has intervened to correct for market failure, but where the intervention is ineffective, inefficient or inequitable. In the field of environmental policy, policy failure may arise through the failure of governments or corporate bodies to provide adequate measures, such as through regulations or economic instruments, which achieve efficient and sustainable management of natural capital. The failure may arise from the absence of intervention, the inadequacy of the regulatory instruments, or through flaws in implementation arising from inadequate funding, inefficient management or corruption. For example, the government may provide for an environmental impact assessment of proposed industrial initiatives, but the EIA may fail to identify serious adverse environmental impact and allow the initiative to go ahead irrespective of the adverse environmental implications.

Policy instruments

A tool used for implementing policy. At macro economic level this may be a monetary or fiscal tool, such as reduction of money supply, the use of a tax, or price or quantity controls on goods or services; in administration, this might include legislation with legally enforceable penalties or restrictions on action, such as penalties for environmental damage, planning regulations requiring set-back, waste controls or ecological protection of endangered species (broadly known as command and control measures). Policy instruments may also include education, training, R & D and institutional development to influence proper information gathering and use, attitudinal changes, supplier and consumer behaviour and capacity building for promoting technical skills. Market-based instruments can include product and emissions charges, deposit–refund schemes, subsidies, performance bonds, emissions trading, product recycling standards, and debt-for-nature swaps.

Policy instruments have been developed in the field of **natural resources** management principally to correct for global and local market failure. But some policy instruments may have adverse side-effects where the impact of the intervention is worse than the problems addressed. They may also be adopted at local level through by-laws or by corporations for advancing their policy objectives, such as the introduction of environmental accounting to assess environmentally friendly policies and practices and to promote greater transparency of the environmental impact of operations in response to or anticipation of shareholder concerns. (See Pearce, D. (1997) *Integrating the Economy and the Environment, policy and practice*, Commonwealth Secretariat, London; and Hargroves K.C. et al. (2006) *The Natural Advantage of Nations*, Chapter 11, The Role of Government, Earthscan, London, ISBN 10: 1-84407-340-8)

Political economy
The term political economy reflects the belief that politics and economics are inseparable, and that political factors are crucial in determining economic outcomes. Political economy literature is divided into positive and normative political economy.

Positive political economy The relatively recent approaches to political economy – sometimes referred to as the new political economy – borrow economic approaches for modelling incentives as a way of understanding the political and economic forces that shape public policy. An example of positive political economy would be investigating the role of interest groups in explaining environmental policy. Therefore, new political economy models can help us understand how environmental and natural resource regulations come about.

Normative political economy identifies 'good' policy outcomes (consistent with a particular value system) and investigates how, given the existing political constraints, these good policy outcomes can be realised, such as designing a carbon tax on Pigouvian principles in order to capture negative **externalities**.

Polluter pays principle
The principle was initially seen as a post-**pollution** payment punishment, that is whoever pollutes should pay the cost of cleaning up the **pollution** caused and any other damage. This has proved difficult to apply except in cases of single source **pollution** such as a major oil spill from a tanker or damage following a nuclear power station accident. The principle, however, can be implemented from within companies as an ex-ante prevention programme. Many companies (such as 3M – in their **Pollution** Prevention Pays; and Texaco in their WOW – Wipe out Waste) have been finding that reducing **pollution** can increase efficiency and have internalised the process by investing in **pollution** control. Shareholders of public companies are increasingly insisting on environmental audits to reveal in annual accounts the balance between company payments for infringements of **pollution** control and company investment in preventing **pollution** as part of ethical business and trading.

Pollution
Contamination of natural resources and systems with poisonous or harmful substances causing changes in the physical, chemical and biological strata detectable in impaired performance, reduced growth, lowered renewal capacity and ultimately the eradication of organisms and entire species. **Pollution** is one aspect of the **externalities** of human activity in agricultural, industrial and service sectors. Intervention to control **pollution** has been a common aspect of state activity through education, training and regulation. Modern approaches to corporate management accept responsibility for pre-emptive action to reduce **pollution**, to avoid contraventions of **pollution** law and seek ways to achieve productive gains in the process. Examples are in recycling materials, reducing emissions from engines with compensating efficiency gains, re-using waste material such as sugar bagasse for fertiliser or energy production, and reducing packaging. The adoption of the '**polluter pays principle**' puts the burden of the cost of the **externalities** of pro-

duction on the producer rather than the community. The **Coase** theorem offers a basis for private negotiated settlement to reduce **pollution** where specific productive activities are adversely affected by local single point identifiable emissions. The Coase theorem may work when the number of affected parties is small and transaction cost is zero. Otherwise, government regulation is warranted and command-and-control and market-based instruments are employed.

Pollution haven
A location to which, in the absence of effective **pollution** control systems, polluters migrate to avoid the costs of regulation. Typically this process is a threat to **developing countries** that lack the regulatory capacity required for **pollution** control or who may be tempted to accept the price for taking the trade. The result may be no net reduction of global **pollution** but merely a migration of it from rich to poor countries. The **pollution** haven effect may be so strong that it promotes the migration both of polluting substances and investment capital, with the re-location of polluting industries moving from countries with strong controls to others with weak. (See Copeland, B.R. and Gulati (2006) *Trade and the environment in developing countries*, In Lopez, R. and Toman, M.A. op.cit) A similar trend may occur within countries where the **pollution** is concentrated in areas where poor people live and who have little political power to protest.

Population trap
Where the population growth rate exceeds the **economic growth** rate and thus **economic growth** per capita remains constant or declines. It is a common feature of **developing countries** when, in the first stage of demographic transition, the death rate declines but the birth rate does not decline in proportion. Population growth may also be affected by increasing length of life and by immigration, especially where countries with marked **economic growth** attract migrants from less developed countries, fleeing from poverty, conflict, corruption and poor governance. Africa abounds with conditions which produce population traps, putting a heavy pressure on land and **natural resources** and promoting poverty, land degradation, and conflict for scarce **natural resources**.

Porter hypothesis
Hypothesis of P.R. Porter (1990) 'America's Green Strategy' *Scientific American* 264:168, that tighter environmental standards only slightly affect production costs, as they trigger innovations that may increase a firm's competitiveness and outweigh short-run costs to firms of complying with the regulations. This hypothesis has been supported by some empirical evidence and is used by policy-makers to justify intervention but it may also provide a supporting case for protectionism and curbs on competitive imports.

Portfolio of investments
A collection of financial securities (stocks, shares and bonds) with the aim of spreading risk, by putting together some which offer high short-term income and others longer term capital gain. The concept can be applied metaphorically to environmental initiatives, some with short-term gain and low cost (quick fixes such as pit latrines and filtering of

water supplies), and others more costly and with longer term benefits such as early warning systems for tsunamis.

Positive economics
The study of the choices people make in the use of resources, the interactions of these choices, and the general laws that can be derived from such studies. (See also **normative economics**.)

Poverty
Poverty exists where households cannot meet their basic needs for survival. The concept is not confined to money income but includes the lack of basic services and facilities such food, water, sanitation, shelter, clothing, health care, education and security. The World Bank has used per capita income of US$1 dollar a day ($365 a year) assessed at **purchasing power parity** (PPP) as a measure of extreme poverty; and $2 a day ($730 a year) as a measure of moderate poverty. In high income countries, lack of access to cultural goods and services such as entertainment, recreation, quality education and other prerequisites for upward social mobility are identified as elements in relative poverty (see Sachs, J.D. (2005) *The End of Poverty,* Penguin books). Poverty is linked to environmental degradation through contamination of water supplies, unplanned urbanisation in squatter areas, deforestation for expanding cultivated land for food and the use of wood for cooking, heating and habitations. Theoretical models explaining the links between poverty and environmental degradation include the frontier model in which population growth rates, debt crisis and GNP per capita are critical factors in promoting unsustainable use of natural resources.

Prisoners' dilemma
Co-operation is usually analysed in game theory by means of a non-zero-sum game called the 'Prisoner's dilemma' (Axelrod, 1984). The two players in the game can choose between two moves, either 'co-operate' or 'defect'. The idea is that each player gains when both co-operate, but if only one of them co-operates, the other one, who defects, will gain more. If both defect, both lose (or gain very little) but not as much as the 'cheated' co-operator whose co-operation is not returned.

Product life cycle
The core concept of the theory that seeks to explain changes in international trade over time. The life cycle of a product is considered to have four phases:

1. innovation and development of a new product;
2. production and penetration into existing markets at home and abroad, displacing existing products;
3. diversification of production with competing producers and displacement of the original country's market share; and
4. migration of production to countries with lower production costs when the original innovators shift to other products as they lose market share.

The concept may be applied to the life cycle of environmental products, services and policies. North-South and South-South transfer of technology is a key process in the management of environmental technology. Some aspects of the life-cycle process can be recognised in health and safety, emissions control, energy production, water and sanitation services, ecological tourism, marine management and nature protection, etc. In the process of transfer from the original market to another, the specificities of the new market have to be assessed (reviewing market structure and performance), especially the differences arising from the stages reached in economic, epidemiological and social transition of the new host countries. The risk for developing countries is that they are encouraged to adopt environmental policies and processes from the North, but this process of migration is not most effective or efficient in their new specific environments.

Production function

Production function describes the underlying technology, that is, the physical quantities of in-put factors necessary for the production of a defined quantity and quality of output of goods or services, with specified technology. In environmental management, the production function consists of capital, human and **natural resources** required for achieving the objective in accordance with a specified technology (or means). For example, for saving an endangered species in a sanctuary, the technology includes the physical capital of sanctuary buildings and equipment, skilled staff, nutrition for the species, land and other **natural resources** to provide a habitat for breeding. These are the resources required for producing the product of conservation of a species. The environmental impact of the process of production also needs to be assessed having regard to the complexity of the ecological process and the inherent capacity for unexpected outcomes. (See for example: Fuggle, R.F. (2004) 'Lake Victoria: a case study of complex interrelationships' in Nightingale, D. et al. (eds) (2004) *African Environmental Outlook*, case studies, Earthprint for UNEP ISBN 92-807-2365-0).

Productivity

The ratio of outputs to inputs in a production process. These ratios can be calculated in marginal, average and total terms. For example, total factor productivity is a ratio of total value of output to total value of inputs. Sources of increases in productivity may be through improvement in any of the factors of production capital, labour, and **natural resources**. Additionally, productivity may be increased by fresh applications of science and knowledge bringing about greater productivity through changes in technology. Improvements in technology for producing energy from renewable resources have resulted in reduction in cost per kilowatt hour of over 90 per cent in the past twenty years. (See 'Energy', Ch. 11, in Lomborg, B. (2006) *The sceptical environmentalist, measuring the real state of the world*, Cambridge UP.)

Profit

The difference between total income and total cost. If negative, the result is termed 'loss'. In economic terms the calculation of income and cost goes beyond that normally entered by accountants in the books of a firm. The economic calculation should include the 'costs' of capital, labour and **natural resources** not put to other uses, and the **externalities** in

terms of the impact on the **environment** and on health and safety. The economic cost may also include an element for risk-bearing by investors. The adoption by many companies of environmental accounts provides a bridge between the 'cost accountants' assessment of profit and the assessment from a broader economic and community perspective. The development of the concept of business sustainability is attracting the attention of members of the International Chambers of Commerce as an alternative model to profit maximisation. (See the management helix for the sustainable organisation, Chapter 10 in Hargroves, K.C. and Smith, M.H. (2006) *The Natural Advantage of Nations*, Earthscan; www.naturaledgeproject.net)

Programme, planning, budgeting (PPB)
A planning framework which became popular in the 1970s and 1980s in public sector financial management and resource allocation. In PPB, the budget lines are defined in terms of programmes with measurable outputs (such as number of households with waste collection services), rather than budget lines defined in terms of inputs (number of waste collection operatives). The programme statements include objectives, activities for achieving objectives, resources required for the delivery of specific levels of service, and the expected outputs. The framework can also be used within the private sector. The approach can be equally applied in the development of environmental services, but it ultimately depends upon an established evidence base of the linkage between outputs and inputs which tends to be lacking, except in specialised areas such as energy production, water services, forestry and some aspects of protection of biodiversity. It is the nature of many problems in **natural resources** that they are complex and the results of intervention uncertain. So-called rational planning tends to be based on the model of the relationship between mankind and nature as one of conquest and control, rather than one of respecting ecological limits, managing problems, expecting surprises and adapting to them. (See Funtowicz, S. and Ravetz, J. (2002) *Environmental policy under conditions of complexity*, Post-Normal Science, EC-JRC/ISIS, Ispra, Italy/RMC Ltd London.)

Property rights
A moral or legal entitlement to have or to do something with land, open access resource or other assets including securities, intellectual items such as ideas, artistic products, books, films, stories, recipes, designs, patents, etc. Deeds, securities certificates, registered patents and copyrights identify the rightful owner of the assets and laws define the terms under which licences may be granted for use of the assets, with breaches being subject to legal penalties. The assets themselves may be bought and sold and inherited. (See the Gangopadhyays' chapter: 'Intellectual Property Rights and Anti-competitive Behaviour: Major Deterrents to Economy and Ecology of SIDS'.)

Protectionism
A policy adopted by governments involving the use tariffs, quotas and other trade barriers to shield their local industries from external competition. This has been a key element in development policy for assisting infant industries to thrive and to respond to overcome those elements which contribute to vulnerability, such as small size (lack of economies of scale) and remoteness (high transport costs for exports). Similar controls may be used to shield a

country from importing products that may damage the **environment**, either in the country of origin or once imported. For example, they may include controls on importing vehicles that do not meet local emission standards, banning the import of dangerous waste, or excluding the import of timber except from certified renewable forest sources. It has become a controversial issue as some countries turn to protectionism in response to the global economic and financial crisis of 2008–9. WTO rules oppose protectionism in general but allow some controls on environmental grounds where there is evidence to support them.

PSIR analysis
A framework for policy analysis adopted by UNEP in its assessments of environmental outlook for the world, which includes examination of Pressures, States, Impacts and Reponses in environmental policy and management. The DPSIR framework adds Drivers to the basic PSIR framework. The Opportunities framework adds Opportunities to the PSIR framework. The Drivers are the factors which promote pressure, such as population growth, consumption of goods and services and technological developments. The Opportunities explore the potential for promoting sustainable development by building on best use of **natural resources** to overcome poverty, to promote employment, to reduce vulnerability, to reinforce sustainable **environment** and to promote human well-being. An economic perspective is now embraced within this framework covering environmental use and non-use values, and current and future conditions; this further development of the framework for policy analysis is called Integrated Environmental Assessments and Reporting (IEAR). (See http://www.unep.org/geo)

Public finance
Income and expenditure of public bodies. Traditionally concerned with income and tax, the field has been extended now (since **J.M. Keynes**) to include government intervention in promoting economic and social progress. This commonly includes securing economic stability, growth, employment, reducing inflation, attracting investment, and providing services to overcome market failure (such as education and health services). It also includes developing essential infrastructure and 'utilities' such as roads, gas, water, electricity, postal services, and emergency services. Public finance is applied to the development of regulatory measures covering the private sector (such as factory inspection, health and safety). In most countries it includes police, prison services and other security services, some of which are privatised. More recently public finance has been increasingly directed to protect the **environment** (**pollution** control, national parks and protected areas) using a variety of economic instruments (subsidies, incentives, trading systems). Public finance is also directed to the implementation of international treaties at national level (law of the seas, Kyoto Protocol on global warming and greenhouse gas emissions, controls on desertification) and R & D in these fields.

Public goods
Sometimes called 'merit goods' or 'social goods', are goods and services provided by community action (by the state or public financed organisations) for the benefit of most or all of the population served (such as national defence, radio and TV, roads, police, education, low income housing and health services). They are commonly paid for out of general pub-

lic funds and not by the users at the point of use of the services. Thus, there is generally no link between the consumption of these goods and services and the payments made for them, unlike goods in the private sector. In principle, a public good is one where a person cannot be excluded from its provision (non-excludable) and where the consumption of it by one person does not reduce its availability to anyone else (i.e. it is a 'non-rival' good). A distinction is made by economists between 'pure' and 'impure' public goods. 'Pure' public goods are those to which use is 'non-excludable' and 'non rival'. Examples are the climate we have, the ozone layer, and the high seas, for the benefits of these are without rival, they belong to all and none are excluded. By contrast 'impure' public goods may be either partially non-excludable or partially non-rival. Examples of 'impure' public goods are the natural elements of common land, private parks, rivers and coastlines. They are 'impure' because they have rival consumers, or they may be operated to exclude some people from benefiting wholly from them.

The concept of benefit area can be invoked to classify public goods into local, national and global public goods. The benefit emanating from a public good provided by a local community government may be contained within the geographical boundary of that locality and hence such public goods are called local public goods. Similarly, the benefits of national defence will be nation-wide and benefits of international peace will be global, so these public goods are called national and global public goods, respectively. (See Nath's Chapter 1 on **concepts**.)

In theory, open access to goods and services presents the moral hazard of unregulated demand, overuse of services, supply of ineffective services, queues and pressure for immediate rather than longer-term benefits. This is the *Tragedy of the Commons,* identified by Garrett Hardin in 1968 in which the users do not take into account the effect of their use on others, now, or in the future. The effect can be found in over-fishing and over use of common land and forests, where the interest of other users, especially future generations is commonly subordinated to current selfish over-exploitation. (See the chapter by Madhoo: 'An illustration of the tragedy of the commons: The demise of the Aral Sea'.)

The optimal level of provision of public goods, the Lindahl equilibrium, is where the marginal social benefit equals the marginal social cost. The existence of 'free riders' who may benefit from or degrade a public good, like air quality, without paying for it, results in the market failure of a sub-optimal provision. This provides a case for external intervention either through private 'club' provision or through corporate, voluntary or government intervention. Philanthropic action has commonly promoted government action to follow the lead, for example in the provision of public parks, recreational facilities, education, health and social services, environmental research and the protection of habitat for conserving biodiversity. The creation of markets for environmental protection is currently the subject of extensive activity with some successes and failures (e.g. emissions trading, the EU Common Agricultural Policy). Self governance may also play an effective part in negotiations between competing parties in a **property rights**' dispute.

Quality of life

A measure of the value placed upon the way of life of a person or population. A concept

closely linked to 'well-being' and to 'happiness' which has attracted a variety of approaches to definition and to measurement. One approach has been through subjective 'life satisfaction' surveys in which each person is asked 'how satisfied are you with your life in general?' and they are asked to assign a score to the value. This has been used by the New Economics Foundation as part of their study for the inter-country **Happy Planet Index** (HPI). An alternative approach has been adopted by the Economist Intelligence Unit which presents inter-country quality of life scores derived from a composite index of elements including material well-being, health, family life, job security, social and community activity, political freedom and security, and gender equality. The 2005 UN Millennium Ecosystem Assessment defined well-being in terms of security, basic material for the good life, health, social relations and freedom of choices and action.

The composite approach to the assessment of quality of life has limitations in terms of the quality of data from the different countries, the variation of values within countries, the value judgements imbedded in the choice of indicators and the weights given to them in the final index. Moreover, the use of mean values for countries obscures the distribution of values which for people with socialist views may present the most important aspect of well-being for a country. From an environmental perspective, the HPI purports to show the efficiency with which life satisfaction and length of life are extracted in a population per unit use of **natural resources** (the ecological footprint). From the 2005 NEF study, many SIDS emerge as the most efficient in this function, with the people of Vanuatu in the Pacific being the top of the league and many of the large developed countries such as the USA, France and the UK being near the bottom.

Rate of interest (discount rate)
The level of payment, usually expressed as a percentage per year, made by borrowers to lenders for the use of money. It represents a benefit to lenders for forgoing current consumption and for the risk of loaning money which may not be repaid. The rate of interest may be used also as a device for discounting the value of future benefits and costs in project assessment, on the grounds that benefits now are more valuable than in the future and the loss of the interest attained from investment is the opportunity cost of delay in receiving the benefit. The use of interest rates in discounting is a common practice in the assessment of the value of environmental and other public and private sector projects. High rates of interest used in discounting, however, may be considered to undervalue the benefits of a project accruing to future generations or the costs to them of future outlays. For example, nuclear energy provides current high benefits, but the disposal of waste from nuclear energy projects in the distant future, say 200 years time, involves deferred future high costs, which today appear modest when discounted at normal rates of interest but place a burden of risk on future generations.

Regression analysis
A statistical analysis which estimates the equation that best fits a set of observations of two related variables, which may be represented on a scatter diagram. For a linear equation the form is $C = a + bY$, where coefficients of the equation a and b are based on paired observations of the two variables C and Y (simple regression equation). The equation can

then be used to estimate the value of C with respect to any value of Y. The slope b of the regression line indicates the rate of change in the dependent variable (C) associated with one unit change in the independent variable (Y). This simple linear regression model can be generalised by including more independent or explanatory variables on the right hand side (multiple regression equation). Now the coefficients on each explanatory variable will indicate the partial effect of that explanatory variable on the dependent variable while keeping other explanatory variables constant. In these formulations it is assumed that the interrelationships between dependent and explanatory variable(s) are linear. A linear equation implies that the rate of change between the variables remains constant. In many economic circumstances, as with **diminishing returns to scale**, the rate of change in the dependent variable varies at different points on the range of the independent variable. This has great importance both in economics and in environmental phenomena, where at a certain point in the value of a dependent variable, the rate of change increases sharply with respect to the independent variable, having reached what is called the 'tipping point'. In ecology, this is observed when a specific habitat reaches its **carrying capacity** and is unable to sustain itself, experiencing unabated decline or degradation. This occurs to air quality when exposed to excessive pollutants or arable land regeneration when overgrazed. Another example of a non-linear relationship is the Environmental Kuznets Curve. For such cases, non-linear regression equations are used.

Research and development (R & D)

R & D is the process of scientific study seeking to produce innovation in products or services and to apply the results to economic purposes. It is conducted both in specialised public funded centres, most notably in universities and public institutes, and in the private sector, linked to specific industries. It is a fundamental tool in economic development process. In environmental management, it is focused on the technologies for sustaining and improving environmental services. It is also used for reducing adverse impacts on **natural resources** of industrial and other human activities and on early detection and effective intervention to reduce the adverse human and ecological impact of environmental disasters. One specific environmental application of R & D is in improving the efficiency of energy production from non-renewable sources such as coal and oil and in substituting increasingly efficient means of using renewable sources such as biomass, wind, solar, geothermal and nuclear fission.

Resilience

The capacity to recover from shocks (from the Latin 'to leap back'). It has been explored from an economics perspective with respect to small states by Briguglio and colleagues (2006, *Building the economic resilience of small states,* University of Malta and the Commonwealth Secretariat). They defined economic resilience in three dimensions as the ability of an economy: a) to recover quickly; b) to withstand shocks; and c) to avoid shocks. In constructing an index of resilience, they included the following variables: macroeconomic stability (covering fiscal deficit, inflation and unemployment, external debt); microeconomic market efficiency (covering regulation of credit, labour and business); good governance; (covering judicial independence, impartiality of the courts, the protection of intellectual **property rights**, military interface in the rule of law, political sys-

tem and the integrity of the legal system); social development (covering education and health). The concept of resilience in this approach is seen as a nurtured capacity, whilst vulnerability is considered inherent. Environmental resilience is similarly the capacity to respond to ecological shocks. Professor Albert Binger, formerly of the West Indies University Department of Environment and Development (WSSD 2002) has argued that SIDS are inherently vulnerable in so far as they depend upon the unsustainable use of non-renewable **natural resources** and are exposed to natural disasters; their resilience depends upon developing alternative economic structures which reduce their exploitation of non-renewable **natural resources** and invest in environmental regeneration. The development of tourism can offer this alternative but can also have an adverse impact on the **natural resources** the tourists come to enjoy. (See Nath and Schroeder's Chapter, *Tax instruments for Environmental Management in Tourist Destinations*.)

Risk, non-financial

The probability of damage or loss resulting from the impact of hazards on human life and the **environment**. The UN agency concerned with disaster risk management strategy (UNISDR) defines risk by the equation: Risk = Hazards x vulnerability/capacity for effective response. (See Roberts, J.L. Chapter: *Disaster risk reduction: Practical adaptive options.*)

Risk analysis

Risk analysis is concerned with the assessment of the nature and extent of risk, the probability that an adverse event might occur, the factors that affect that chance and its environmental and human consequences. The function of risk analysis is to identify the nature of risks, their economic, social and environmental impact, people's perception of risk, how society can manage risk and the role of analytical techniques such as economics in illuminating such questions. There are four components to risk assessment and its analysis, hazard identification, dose-response estimate, exposure assessment, and risk characterisation; the latter includes safe exposure levels, acceptable risk level, uncertainty and data limitations. The process of risk analysis reviews the technical features of hazards (location, intensity, frequency and probability), the physical and social extent of vulnerability and the capacity for prevention, **mitigation** and rehabilitation in relation to expected impact.

Scenarios

Used in planning in the public and private sectors as a method for envisaging the future and its implications for policy based upon projections from current trends. 'Scenario' is derived from an Italian word for the list of scenes in a play and the entrances and exits of the players. In planning, it is used to list the expected future unfolding events and states of markets and resources. A scenario may be the output from a series of computer simulations using clearly defined data and mathematical projections, as undertaken for the Club of Rome in the *The Limits to Growth* (Meadows, D.H. et al. 1972) and *Beyond the Limits* (Meadows D.H. and Meadows D.L. 1992), which reached a wide audience, provoked great controversy, and made iconic contributions to debates on development policy of those times.

In UNEP's *African Environment Outlook 1* (2002) and *2* (2006) the use of scenarios formed a substantial element in the presentation of the future regional environmental prospects in the face of a set of broad policy options. The UNEP scenarios, however, were less the product of evidence-based analysis and computer simulation of official data than was the work of the Club of Rome. The principal aim of UNEP was to alert policy-makers and planners to current trends and policy options to give greater attention to the impact of development policy on environmental degradation. The Global Scenario Group has produced a series of scenarios on the issue of planetary sustainability (1997: *Branch points: Global Scenarios and Human Choice*; 1998: *Bending the Curve: Toward Sustainability*; 2002: *Great Transitions: the Promise and Lure of the Times Ahead*). The worst-case scenario in these reviews is a planet with impoverished people, cultures and nature; the best case is the Great Transition towards a future of enriched lives, human solidarity and environmental sustainability. Many of these types of scenarios tend to lack a rigorous economic framework and estimates of the costs of achieving the transition to produce new outcomes. The Meadows's projections for sustainable development in 1992 included proposals for developing fresh tools for restructuring including: 'visioning; networking; truth-telling; learning; and loving'. They concluded then with the warning '… no time to waste. There is just exactly enough energy, enough real material, enough money, enough environmental resilience, and enough human virtue to bring about the revolution to a better world'. Thus, the use of such scenarios merges beyond economic planning and politics into the field of ethics and concepts of the good life.

Small island developing states (SIDS)

The term small island developing states is mostly used in the United Nations system in relation to the Barbados Programme of Action and the 10-year follow-up Mauritius Strategy for the Further Implementation of the Programme of Action for the Sustainable Development of SIDS.

Fifty-one countries are classified as SIDS by the UN. This SIDS group is not homogeneous. A common feature is their environmental susceptibility.

Small states

In the World Bank and The Commonwealth Secretariat, the term used is small state. Small states are defined as sovereign developing states with populations of less than 1.5 million. Small states are characterised by a high degree of economic openness, due to their heavy dependence on exports and imports, which renders them highly exposed to changing conditions in the rest of the world. Thus, they are likely to suffer from global crises. Exposure to external conditions exists in all countries, but in the case of small states such vulnerability is more intense, and is often manifested by high levels of fluctuations in GDP, import costs and export earnings.

The seminal April 2000 Commonwealth Secretariat–World Bank Joint Task Force Report on small states: 'Small states meeting the challenges of the global economy', started a new international partnership on small states, where a number of international partners (IMF, World Bank, ComSec) agreed on a framework to assist small states and initiated the 'small states forum' which meets during the IMF–World Bank Annual meetings.

There are 45 small states. All these countries follow the definition of 1.5 million. However, the Commonwealth includes larger states in its reviews such as Botswana, Lesotho, Namibia, Jamaica, and Papua New Guinea, because they share many of the characteristics of smaller states.

Social attitudes
The mental state of a population in relation to general or specific matters. The concept commonly embraces three components: cognitive (knowledge and beliefs), affective (liking, preferences), and behavioural (action, tendency, purchase intentions, willingness to pay and willingness to accept compensation). In **environmental economics**, social attitudes to natural and environmental resources are a key element in the assessment of opportunity costs – the notion that the value of something is dependent on what we are willing to give up for it.

Standard cost
An estimate of the expected cost of production using normally efficient methods of production and normal prices of materials. A standard cost may be used in an estimate of expected production costs or the prices of contracted work as a bench-mark. The establishment of standard costs in certain aspects of environmental services is common. It is used in assessing expected costs of extending water supply, renewable energy production, waste management and carbon trading. The practice is less well developed in other areas including beach management, fisheries protection, and natural disaster protection. The method is one element in the establishment of a production function for the delivery of environmental goods and services. For example Ellis, G. and Fisher, A. (1987) 'Valuing the **environment** as an input', *Journal of Environmental Management*, 25: 149–156, demonstrated the 'cost' of increasing the yield from crab fisheries in terms of the increase in protected wetlands and the number of traps set.

Standard of living
A measure of the value of quality of life of an individual, family or community. A common unit of measure is monetary income adjusted for purchasing power. This approach to measurement does not include those values that derive from non-traded goods and services such as the quality of environmental services enjoyed, which may include housing location, travel time, air quality, noise exposure, scenery, ecology, etc. Some of these values may be reflected, however, in house prices and the willingness to pay for environmental benefits. These may all be included in assessment of the standard of living.

Statistics
The theory and methods of collecting, tabulating and analysing data. A key function in government and business for planning and for assessing the state and trends in trade and political, economic, social and other aspects of community life. Statistics are commonly classified into different specialised fields including trade, health, population and vital statistics. The World Resources Institute, sponsored jointly by UNDP, UNEP and the World Bank, publishes a biennial report and set of environmental and related statistics on the

global **environment** with case studies of current issues and interventions. (See www.wristore.com)

Supply side economics
The aspect of economics concerned with productive capacity, efficiency, output and sales. Special focus has been given to the inhibiting impact on supply of market interventions by trade unions and governments in influencing the determination of terms and conditions of employment, wages, welfare and social security provisions which increase the production costs to the firm. The supply side dimension of economic appraisal tends to ignore human and environmental **externalities**, market failure and the existence of a market in such social values. Industries dominated by supply side economics include: the arms trade, 'big' tobacco, alcohol, other drugs of addiction and European agriculture under the Common Agricultural Policy.

Surplus value
An excess of income from a factor in production over and above its supply price. **Karl Marx** identified surplus value as 'exploitation of labour', calling for capitalists to pay workers the full value of their outputs. He saw wage exploitation of workers as one of the defining features of capitalism and the principal element in the dialectical conflict between capital and labour, and the source of the pressure for a 'workers revolution'. **Marshall** identified the surplus as a quasi rent for the use of capital. The concept of surplus value is a key element in **environmental economics** where the **externalities** of production may not be included in the supply price. For example, the price of timber may not include the loss of forest cover with timber harvesting.

Sustainable development
Defined by the UN Bruntland Commission 1987 in *Our Common Future* (Oxford University Press) as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. This concept avoids the false conflict between human progress and environmental loss and is sometimes referred to as ecological modernisation. In economic terms the concept of a sustainable economy is one where physical capital, labour, natural resource endowments and technology lead to constant or increasing economic opportunities now and in the future, so that potential human welfare does not decline. This approach allows allocative and technical efficiency to exist with sustainable development. In terms of the sustained availability of **natural resources**, there are two views in **environmental economics**. One view depends on the concept of 'strong sustainability' which requires any used natural resource to be replaced over time. The other depends on the concept of 'weak sustainability' which accepts substitution through new technical transformation of any non-renewable natural resource. Thus, if the same level of energy production from oil can be achieved through wind power, this is, other things being equal, an acceptable substitute under the concept of weak sustainability, but not under that of strong sustainability, since the former oil resources have been depleted and cannot be replaced.

A complication in the measurement of sustained total capital is population change. This

raises the question of whether we should be sustaining total capital or total capital per head of population. It has been postulated that economies naturally generate their own (endogenous) capacity for sustaining growth. This is possible through technical progress which allows for a reduction in the adverse impact on the environment as the economy grows through the substitution of capital and labour for the use of natural resources (the phenomenon of 'Environmental Kuznetz' curve). Evidence to support the theories of endogenous growth and the Kuznetz transformation is fragmentary but, if true, it could produce a self-sustaining potential for economic growth and a declining degradation of natural resources. Pearce and Barbier (2006, *Blueprint for a sustainable economy*, Earthscan) have argued that we cannot rely on the invisible hand of the market mechanism, un-aided, to provide the basis for sustainable development; new economic tools and regulations are necessary to correct for market and policy failure. Solow, R. (1992, 'Sustainability: an economist's perspective', in Stavins, R.N. (2005) *Economics of the Environment*, Norton) has suggested that one economic rule to promote intergenerational justice in sustainable policy is that the return on the use of any non-renewable **natural resources** should be re-invested into capital formation.

Taxation

Government receipts from imposition of charges on income of persons and corporations (direct tax) and on trade in goods and services (indirect tax). Taxes are used for pursuing a variety of government objectives, including: to raise government income, to alter the distribution of wealth, to control the level and distribution of spending, to control the level of imports and exports and for the pursuit of social and environmental ends (e.g. funding of health services, the arts, protection of the **environment**, etc.). Taxation has been used in many countries for environmental protection. (See also **Pigouvian tax/Green taxes**.) The objectives of such taxes have been to encourage technological innovation, to promote changes in supplier and consumer behaviour, and to achieve environmental goals in a cost effective manner. The use of taxation as an economic instrument has been largely focused on single point **pollution** reduction. Taxation has been used to reduce emissions in energy production or in energy use and on sources of water **pollution**. Environmental tax reform (ETR) aims to shift tax penalties away from environmentally and socially-sound practices (taxes on employment) and place it on polluting and environmentally-damaging practices (carbon taxes, car tax related to engine size or emissions). Property tax can be used to recoup costs of the **externalities** of tourism. (See Nath and Schroeder chapter: *Tax instruments for Environmental management in Tourist Destinations.*)

Technical efficiency

The level of output achieved as a ratio of the factor inputs, for example the number of pink pigeons produced per acre of managed protected habitat. In this example the factor inputs in protected habitat may include capital equipment and buildings, labour and land. The efficiency ratio may be affected by external and internal inhibiting factors in the production function. The external inhibiting factors may include: adverse climate, predators, and disease. The internal inhibiting factors may include: equipment maintenance, profes-

sional and managerial skill, and the suitability of habitat. Technical efficiency is usually measured in terms of total factor productivity. (See **Productivity**.)

Technology
The methods used to produce goods and services, including the specific use of capital, labour and **natural resources** in different proportions. The pattern of technology use is affected by both supply-side and demand-side practices. In energy production, the technology involved adopts widely different methods of production each with its own level of environmental impact, depending on the fuel used and the method of energy production and emission control adopted. Apart from switching to renewable sources of energy production such as hydro-electricity, wind and wave power, low emission technology is now increasingly applied in energy production from fossil fuels such as coal and oil. The technology of the demand-side in the energy market also has an impact on emissions. Total emissions are affected by the extent of recycling, by lower energy use methods in the construction industry, by greater domestic energy efficiency practices, such as thermal insulation, by longer life lighting, and by greater use of public transport promoted through road use charges.

Theory of consumer behaviour
Theory which addresses the issue of how consumers allocate their resources between alternative goods, services, savings and investment. The impacts – both economic and non-economic (such as psychological) – on the consumer are analysed. In environmental policy, a new focus has been given to sustainable consumption recognising the global growth in population, the disparity between rich and poor, the unsustainable consumption of **natural resources** such as water, food and fossil fuels and the impact of such consumption on environmental degradation. (See Meadows and Meadows (1992), *Beyond the Limits*; Hargroves, K.C. and Smith, M.H. (2006) *The Natural Advantage of Nations*.)

Theory of markets
Theory which addresses how scarce factors of production are allocated to products and services in the market place. This process determines prices and volumes of outputs and also the prices and allocation of the factors of production (capital, labour and **natural resources**). **Environmental economics** addresses the issue of the market for environmental goods and services. In doing so, it examines the impact on **natural resources** of the market for other goods and services. A key concern in **environmental economics** is that certain **natural resources** are un-priced or under-priced in market transactions. This leads to the unsustainable use of such resources. **Environmental economics** exposes the failure of the theory of markets adequately to take account of the scarcity and vulnerability of **natural resources**.

Trade integration
The reduction of barriers to trade between countries and regions with the objective of achieving international economic and social advantage. Common stages involving increasing levels of integration include the establishment of:

a a free trade area;
b a customs union;
c a common market;
d an economic union; and
e a monetary union.

The USA is an example of an economic and monetary union of federated states; the EU is a common market with differences in fiscal and monetary policies between member states; EFTA is a free trade area; and COMESA is establishing a customs union. Environmental restrictions on trade in the EU are binding on all EU countries and affect the EU position in WTO negotiations, including such matters as recycling, packaging, emissions standards, eco-labelling and carbon trading.

Tragedy of the Commons
Derived from an iconic paper in 1968 by **Garrett Hardin**, this metaphor identifies the disastrous end result of unrestrained freedom in the use of common pool resources such as common land and the sea, in which people become trapped by their own competitive impulses and ultimately destroy the use of the common inheritance. The common resource can only be sustained by agreed regulation which limits the freedoms previously enjoyed. Examples are to be found in the use of common grazing, forest land and marine resources. In these cases, as demand increases with population growth, so the **carrying capacity** is reached and limitations have to be placed on use, through some regulatory control such as through price, rationing by volume, or the introduction of new forms of **property rights**.

Utility
The value that a person gets from the consumption of a good or service. Some economists such as Jeremy Bentham and other Utilitarians considered that utility was measurable on a cardinal scale and additive across populations allowing the calculation of 'the greatest happiness of the greatest number'. Others, in the neo-classical school, consider that **utility**, measurable on a cardinal scale, is neither possible, nor necessary, since each person's marginal utility varies inversely in relation to units of consumption of any good or service. As against cardinal measurement, it was argued that ordinal ranking serves the purpose better, that is to arrange goods and services in order of preferences. **Environmental economics** has further developed the concept recognising the existence of willingness to pay (WTP) for non use values (**utility** without consumption).

Vulnerability
Literally, the extent of exposure to attacks or harm (from the Latin word 'to wound'). Social, economic and environmental vulnerability is the inherent condition of being exposed and susceptible to loss and damage from conflict, social, economic, natural and other hazards. The level of exposure can be affected by isolation and the location, frequency and extent of hazards. The economic and environmental risks arising from vulnerability may be increased by the frequency and severity of hazards and relieved by developing resilience through prevention, mitigation and other adaptive capacities that can reduce

the extent of loss and damage. Economic vulnerability, especially in small states, arises from extreme dependence on exports and imports, high dependence on capital inflows, and, in some cases, lack of natural resources.

The issue of small states vulnerability was given formal expression within the Commonwealth at the 1977 Commonwealth Finance Ministers' Meeting in Barbados. In response, the Secretariat prepared a programme designed to assist in overcoming 'the disadvantages of small size, isolation and scarce resources which severely limit the capacity of such countries to achieve their development objectives or to pursue their national interests in a wider international context'. This was endorsed by Commonwealth Heads of Government at their 1979 Meeting in Lusaka and reaffirmed at their 1981 meeting.

In 1983, with the political repercussions of the US invasion of Grenada still resonant, Commonwealth leaders, at their New Delhi meeting, felt that the problems of small states 'deserved consideration on a wider basis, including that of national security'. A Commonwealth Consultative Group was commissioned to examine the special needs of small states for economic development including issues relating to national security. The report – *Vulnerability: Small States in the Global Society* – was published in 1985. The report was the first to note that small states are 'inherently vulnerable to external interference'. The report outlined measures that can be used to reduce vulnerability such as underpinning economic growth and diplomacy and foreign policy management.

Following this publication, the Ministerial Group on Small States was formed to discuss issues of importance to small states. In 1995, ministers recognised that the international context faced by small states had changed dramatically since the Cold War ended. The Secretary-General constituted a Commonwealth advisory group of eminent persons led by Dame Eugenia Charles of Dominica. Their report – *A Future for Small States*: *Overcoming vulnerability* – was published in 1997.

(See also Briguglio, L. et al. (2006), *Building the resilience of small states*; Islands and Small States Institute of the University of Malta and the Commonwealth Secretariat, London, ISBN 99909-49-23-9 who define economic vulnerability as 'exposure to external shocks arising from intrinsic features of the economy, measured by economic openness, export concentration, and dependence on strategic imports'.

Washington Consensus

A set of policies developed in 1989 by John Williamson, for the Institute for International Economics, to promote economic development in Latin America. These policies were subsequently adopted by proponents of neo-liberal economic **globalisation** and later opposed by the anti-**globalisation** movement. The policies covered ten major areas of economic reform, including fiscal discipline, redirection of public spending to education, health and infrastructure, tax reform to reduce the burden on high income earners, market determination of interest rates, competitive exchange rates, trade liberalisation, openness to FDI, privatisation of state enterprises and legal security for **property rights**. The set of neo-liberal economic policies were criticised by Hans Singer (with colleagues), in *The Economic North-South Divide* (2001) as ones likely to promote rising inequality in **developing countries** and greater poverty. Singer opposed the **Washington Consensus** and called for a new

approach and 'economics as if people mattered'. International bodies now refer to a post-**Washington Consensus** which includes support for the global **environment** and the relief of poverty especially in the least developed countries.

Water
A naturally-occurring liquid substance combining hydrogen and oxygen, essential for animal and plant life on earth derived from oceans through evaporation and atmospheric precipitation and found in marine and fresh water courses. Water is both essential for sustaining life through ingestion and a natural habitat for animals and plants. The circulation of the earth's water driven by solar energy and affected by differences in seawater density is determined by temperature and salt content of the oceans. Inland fresh water systems are major contributors to water distribution, energy production, irrigation of land for agriculture, and for transport. Human pressures on water through overexploitation and **pollution** adversely affect the sustainability of animal and plant life. These pressures are degrading inland ecosystems in rivers, streams and floodplains; in lakes and reservoirs, marshes, wetlands, oases and aquifers. They also adversely affect coastal and marine systems, including mangrove forests, coral reefs, estuaries and mudflats, sea-grass and algae beds, and fish ecosystems. Management of water systems is concerned with provision of water for drinking, and for other purposes, taking into account both supply and demand aspects and the protection of water supplies in the face of adverse natural and man-made pressures.

Welfare economics
A normative school of economics concerned with how economic activity ought to be carried out to maximise economic welfare of the society. The school embraces the work of Vilfredo **Pareto**, Nicholas **Kaldor** and John **Hicks**. It may be claimed that health, environmental and **ecological economics** have developed from this school via the route of public economics.

Key figures in development policy and environmental and natural resource analysis

Bentham, Jeremy, 1748–1832
British political economist, scholar and pamphleteer, he was the founding father of the word 'utility', a notion congruent with the modernist concept of private happiness, and for promoting the idea of 'the greatest happiness of the greatest number' as a standard for assessing the impact of political policies. His concerns for economic and social progress and equality of opportunity persuaded him to favour death duties to establish redistribution of wealth without undermining current incentives for the rich. He founded and endowed University College London, leaving in his will his embalmed body to be dressed in his own clothes and exhibited for posterity in a glass case in the entrance hall of the College. It is moved into the Board room for governors' meetings.

Burnham, James, 1905–1987
Noted for '*The Managerial Revolution*' (1942), which was a rejoinder to the Marxist theory

of the dialectic process giving rise to a workers' revolution. Burnham predicted that a new elite would gain power, and that managers and technocrats would not own but would run the capitalist businesses, the army and government, especially in the USA, Germany and Japan. This reflected the fundamental changes in the market structure emerging in the twentieth century and the behavioural approach to the positive theories of management and of economics.

Coase, Ronald, 1910–
A British-born, Nobel Prize-winning economist, he devised a theorem (1960) for resolving competing claims in **property rights** to achieve a Pareto equilibrium. The theorem states that if transaction costs are zero parties affected by an externality will agree on an allocation of resources that is both Pareto optimal and independent of any prior assignment of **property rights**. For example, fishermen adversely affected by a farm's **pollution** of a river can negotiate to pay the farmer an amount to reduce the **pollution** up to the increased value of the fish caught. Professor Coase is currently Clifton R. Musser Professor Emeritus of Economics at the University of Chicago Law School.

Daly, Herman, 1938–
Former Senior Economist in the **Environment** Department of the World Bank, and editor of the *Journal of Ecological Economics*. Noted for his 1977 *'Steady State Economics'* and 1996 *'Beyond Growth'*. He proposed the Utopian target of zero population growth as a necessary condition for sustainable development (SD). This was included in a set of other necessary conditions for SD which included: ensure harvest rates are equal to or lower than growth rates; ensure investment from income from non-renewable resources goes into renewable substitutes; keep the time period of emissions less than assimilative capacity; and put global limits on aggregate emissions, energy use, resource use and population growth.

Domar, Evsey, 1914–1997
Polish-born economist, professor at MIT USA, who collaborated with Sir Roy **Harrod** in developing the Harrod–Domar model of **economic growth**. Also an expert on Soviet economics during the Cold War.

Hardin, Garrett, 1915–2003
Biologist who wrote *'The Tragedy of the Commons'* in 1968, using the example of overgrazing of common land as the inescapable result of the free market. Opposed to the notion of 'the invisible hand' guiding the free market to the optimum economic position for all, he was a key contributor to thought on environmental policy and regulatory management.

Harrod, Sir Roy, 1900–1978
A British economist jointly credited with the 'Harrod–Domar **economic growth** model' which introduced the concepts of warranted growth and actual growth, taking into account changes in savings and the size of the labour force and productivity. He was noted for stimulating thought about the nature and determinants of growth and refinements of Keynes's notion of economic equilibrium. From an environmental perspective, it has to be recognised that whilst he accepted the importance of improvements in physical capital

through savings and investment, he did not address issues of the special constraints of developing and small states, nor the impact of **economic growth**, measured in terms of income, on the depletion of natural capital, nor the **externalities** of **economic growth** on health and the **environment**.

Hicks, John, 1904–1989
Key contributor to the theory of **welfare economics** and, with Nicholas Kaldor, introduced the complementary notion of compensation to be used with the Pareto principle of welfare gain. The concept of the potential Pareto improvement (PPI) states that any economic change is beneficial to welfare, if the 'gainers' could compensate the 'losers' and still be better off. This concept embraces both the assessment of efficiency gain and its distribution. This conceptual development may be seen as foreshadowing cost-benefit analysis and environmental impact assessment in which the loss of natural capital and its services can be assessed against economic gains from physical capital investment and labour productivity.

Hotelling, Harold, 1895–1973
In *The Economics of Exhaustible Resources* (1931) Hotelling proposed a rule (known as Hotelling's rule) that **natural resources** should be treated as capital and then the optimal rate of extraction would be where the return is equal to the interest rate for capital, that is the opportunity cost of capital. This notion is a key element in the development of natural resource analysis while analysing exhaustible / non-renewable **natural resources**.

Huntingdon, Samuel, 1927–2008
A Harvard Professor of mathematics, noted for his 1996 *Clash of Civilizations and the Remaking of the World Order*, he predicted that future conflict would not be between nation states but between cultures. 'The fault lines between civilizations will be the battle lines of the future.' Seen by some critics as the political justification for US intervention in foreign lands, especially in Islamic countries, and an excessive simplification of the white Anglo-Saxon Protestant influence on Western thought and politics. Under President Nixon he was an adviser who proposed bombing Vietnamese villages to drive peasants into the towns. Amartya Sen's rejoinder in 2006 *Identity and Violence, the Illusion of Destiny*, should be taken as an antidote and Omae Kenechi's *The End of the Nation State* an alternative exploration of the idea of the impact of globalization on national identity and sovereignty.

Jevons, W. Stanley, 1835–82
A key contributor to the development of **neo-classical economics** and the marginal analysis framework. Also noted for his analysis of the impact of economic activity on non-renewable **natural resources**, such as coal. In *The Coal Question,* he examined the implications of limited resource stocks as a constraint to sustained economic development.

Keynes, John Maynard, 1883–1946
Noted principally for his 1936 publication on *The General Theory of Employment, Interest and Money*, which addressed the policy and theoretical implications of the 1930s economic depression in Europe and the USA. His theory and policy proposals challenged the classical

theories of the operation of the market economy and the neo-classical, micro-economic theories of the firm. He dismissed the notion of the self-correcting capacity of the market to respond to critical falls in demand, mass unemployment and hyperinflation. He argued for government intervention through fiscal policy, public works and deficit funding to redress market failure, stimulate employment and aggregate demand. Keynes promoted new departures in fiscal policy by his notion of the multiplier effect, which stimulates demand many times greater than the initial level of investment. Keynes is acknowledged as a forerunner of **development economics**, through ideas inherent in the Bretton Woods developments of the IMF and the World Bank. He is also noted for his influence on other economists such as Joan Robinson and James Meade. They adapted his theories to the specificities of rural economies of developing countries. His influence can also be traced in the ideas of Nicholas Kaldor and John Hicks who extended his theories into supply-side **economic growth** and **welfare economics**.

Kuznetz, Simon, 1901–1985

A macro economist and Nobel Prize winner noted for his contribution to the measurement and compilation of data on national income, its distribution between rich and poor and its value in the assessment of **economic growth**. He proposed the notion that there exists an inverted 'U' shape relationship between the equality of income distribution and income levels. This idea has been adapted into the field of **environmental economics** in the Environmental Kuznetz curve. (See *World Development Report 1992,* the World Bank) which claims that a similar inverted curve relationship exists between income levels and environmental quality. The effect in an expanding economy is in stages. At first, as income increases so does environmental **pollution**. Then, with further increases in income, **pollution** reaches a peak. In the later stages of increases in national income, **pollution** declines as new technology intervenes to increase efficiency and to reduce degradation of the **environment**. This process is stimulated by a growing demand for a cleaner **environment**, which imposes regulations for constraint on environmental depletion. With each stage of **economic growth**, structural change in the economy reduces the level of dependence on **natural resources** and industrialised production, and there is a shift towards the development of non-industrial services. This is sometimes referred to as 'buying your way out of environmental degradation'. This structural change in a developed country may serve to remove the polluting industries and processes to less developed countries, Evidence for supporting the general adaptation of the Kuznetz hypothesis to the relationship between **economic growth** and environmental impact is conflicting. For despite **economic growth**, and technical innovation, **market failure** and **policy failure** continue to occur to sustain a pressure on environmental resources. Kuznetz was born in Russia, and became head of a statistical office in the Ukraine before migrating to the USA where he taught in the Universities of Pennsylvania, Harvard and Johns Hopkins. He was president of the American Economic Association in 1954.

Lewis, Sir Arthur, 1915–1991

Nobel Prize-winning economist noted for his work on **development economics** from a developing country perspective. Noted for his 1955 Theory of Economic growth. In this work, the core concept was that of the 'dual economy'. In the economies of **developing**

countries he observed that, on the one hand, the agricultural sector survives at subsistence level, with low wages, no saving and low productivity, whilst on the other, investment in industrial projects produces profits, creates savings and promotes growth. Industrialisation reaps benefits from the use of surplus labour from the primary sector. It develops by promoting import substitution of domestic products which gives rise to increasing wages as surplus labour is reduced. But he observed that rapid industrialisation creates problems of sustainability for those countries and inequitable distribution of wealth and services. Intervention is necessary to ensure a balanced provision of physical infrastructure for transport, communications, education, etc. as pre-requisites for sustained growth. Lewis is often credited with the birth of the academic discipline of **development economics** along with others such as Raúl Prebisch, working in Latin America, and Gunnar Myrdal, a Swedish Nobel Prize-winning economist, from his work in India. Lewis also explored the paradox of the sugar and wheat industries. He observed that the sugar industry is highly productive in developing countries where 'the rate of productivity is unparalleled by any other major industry in the world – certainly not by the wheat industry. Yet the workers continue to walk barefoot and to live in shacks while workers in wheat enjoy among the highest living standards in the world'. He explained the paradox as an intersection between labour supply and the terms of trade. (Lewis, A., 1954 *Economic Development with Unlimited Supplies of Labour.*)

Lomborg, Bjorn, 1965–
Associate Professor of Statistics, University of Aarhus, Denmark, noted for his deconstructive critique of environmentalism and its claims for a doomsday scenario for the world, especially in his 2001 book *The Skeptical (sic) Environmentalist, measuring the real state of the world.* His conclusion is that 'children born today will live longer and be healthier, they will get more food, a better education, a higher standard of living, more leisure time and far more possibilities, without the global **environment** being destroyed'. It is an antidote to the environmentalists' worst-case scenario. It stimulates thought about the **opportunity cost** of investment in environmental improvement.

Malthus, Thomas, 1766–1834
Noted for his 1798 *Essay on the Principle of Population as it Affects the Future Improvement of Society.* He saw the exponential growth in population outstripping the linear growth in food supplies and condemning most people to live in poverty with only epidemics, war and famines curbing the population increase. His views on economics contributed to it the cachet 'the dismal science'. Whilst this view was much discredited by Keynes who observed that fertility declined with **economic growth**, poverty remains a core global development issue.

Marshall, Alfred, 1842–1924
Noted for his 1890 *Principles of Economics,* which became in its many revised editions a standard textbook for students and commercial managers in what is referred to as the new or 'neo' classical economics. He expressed concern about the simplistic interpretation of the geometric approach that he developed using two-dimensional diagrams to show the differential relationship between, for example, price and demand. But these

brought a new transparency to the subject of micro-economics and the application of classical economic theory to the realm of practical business. Core concepts for Marshall were the marginal (differential or the slope of the) relationship between variables, marginal **utility**, elasticity of demand with respect to price, and diminishing returns to scale. His principles continue to be applied in business economics and in **environmental economics**, for example in the examination of abatement costs and emissions reduction, and to road use and transport costs.

Marx, Karl, 1818–1883
Social scientist from Germany who in *Das Capital* challenged the framework of classical economics, drawing attention to key areas of market failure and the economic and social gap between rich and poor. His analysis was based upon observations of the working of capitalism in mid-nineteenth century Germany and in England, where he spent much of his time studying the 'blue books' and the reports by the implacable British factory inspectors of the problems in implementing the then-new British regulations on health and safety at work. With Frederick Engels, he developed a meta theory of the historical process of development. He saw the history of man as being continually determined by a conflicting power relationship (a dialectic) between two competing classes of society: firstly, the landowners against the urban industrial capitalists; and then the capitalists against the workers. The inescapable conflict arose, he asserted, from the economic status of each in relationship to the ownership of the means of production. Each phase in history was punctuated by revolution. The revolution of the capitalist against the land-owning aristocracy was the feature of the French and other republican revolutions. He claimed that a spectre hung over Europe in his time and predicted this would result in an inevitable convulsion and a revolution of the proletariat (the workers) over the capitalists. This would ultimately give rise to a new millennium under communism in which all assets would be owned by the state, which itself would ultimately wither away. Marx considered that the market would be replaced by social and economic supply-based planning. Marx's theories were a dominating theme in much radical thinking about political economics in the late nineteenth and twentieth centuries, worldwide. His analysis of market failure, however, remains one of his few surviving legacies, the collapse of the Soviet Union having discredited much of the rest of his meta thinking on the determinants of social and economic development and the value of long-term, state supply-side planning.

Meade, James Edward, 1907–1995
Nobel Prize-winning economist in 1977 and British professor of Economics at the London School of Economics (LSE) and at Cambridge. He worked with the League of Nations and with the British Cabinet Office. He is noted for his social and economic study of Mauritius in the 1950s and for his Theory of International Economic Policy. In his Nobel banquet speech he said: 'The well balanced economist is a normal human being with his warm heart on the Left, his practical work-a-day hand on the Right, and his clear and thoughtful head in the Centre'.

Meadows, Donella ('Dana'), 1941–2001
Lead author of the ground-breaking 1972 study, *The Limits to Growth*, commissioned by

the Club of Rome, a German-based think-tank. The book, which sold over 30 million copies, was followed up with a further study publication *Beyond the Limits.* Both studies, using computer-based models, addressed the issue of the impact of **economic growth** and population growth on the use of finite **natural resources** – a kind of Malthusian analysis with a computer. The authors proposed mitigative and adaptive action that can avert the doomsday end-game painted in their worst-case scenario. Adaptation would include cleaner technology, better education and environmental friendly governance.

Mill, John Stuart, 1806–1973
Noted for his seminal 1848 work *Principles of Political Economy with some of their Applications to Social Philosophy,* and for his work as a social reformer to lighten the impact of unregulated markets on social well-being. He promoted the desirability of government intervention in the free market to correct against market failure, especially for the fairer distribution of income and for the temporary protection of infant industries. This had an important influence on the early thinking about the special economic and social needs of developing countries.

Myrdal, Gunnar, 1898–1987
Swedish economist and politician and Nobel Prize winner in economics, he worked closely with the UN Economic Commission for Europe. He is noted for his contributions to **welfare economics**. These can be explored principally through his studies of inequality in the USA, the divergence in wealth between rich and poor countries, and through his analysis of issues of economic and social underdevelopment in Asia in *Asian Drama, An Enquiry into the Poverty of Nations,* 1968. He is generally considered one of the key influences, with his wife Alva Myrdal, also a Nobel Prize winner, on social welfare policy in western Europe in the twentieth century.

Nash, John Forbes, 1928–
Joint Nobel Prize winner in economics for his application of game theory to problems of non-co-operative games such as the prisoners' dilemma and the identification of the Nash equilibrium point. This work had the effect of challenging the neo-classical methods of exploring economic issues. It has had a penetrating impact on economic theory and its application to business and government policies and practice. Nash was the subject of the unauthorised biography *A Beautiful Mind* by Sylvia Nasar, and an Oscar-winning film of the same title, which broadly reflected his life, his mental illness and his special contributions to mathematics and economics.

Nordhaus, William D, 1941–
Professor of Economics at Yale University USA since 1973, and regarded as an expert on the economics of climate change and non-market accounting and integrating environmental values into national accounts. He is joint author with Paul Samuelson of the classic textbook, *Economics,* now in its 18th edition. His research has concentrated on **economic growth** and **natural resources**. He has constructed the RICE computer-based model on the subject of adapting to climate change. He supports the use of carbon taxes for controlling carbon emissions rather than arbitrary targets as in the Kyoto Protocol. He has

also published a study on the costs of the war in Iraq. See Nordhaus, W. (2007) *The Challenge of Global Warming; economic models and environmental policy*, Yale University.

Pareto, Vilfredo, 1848–1923
Noted for his contribution to the theory of economic welfare, in which he asserted that equilibrium exists in the exchange of goods when the welfare of one person cannot be improved except by reducing the welfare of another. He accepted that **utility** could not be measured but that a purely ordinal notion of **utility** (a is better than b) was a sufficient basis on which to construct a theory of choice and welfare. To overcome the obvious practical constraint on the use of the concept, **John Hicks** and **Nicholas Kaldor** proposed the modification known as the 'Potential Pareto Improvement', which allows compensation for loss to be assessed and the improvement to be conceded if after allowing for compensation for any losses (whether paid or not) people are not less well off.

Pearce, David, 1941–2005
Noted for his 1989 *'Blueprint for a Green Economy'* and 2001 *'Blueprint for a Sustainable Economy'* (with Edward Barbier). These books set out a framework for multidisciplinary ecological economics. He promoted through teaching at University College London and through policy advice to governments in UK and abroad the concepts of 'internalising **externalities**' through the use of economic instruments – such as road pricing, now operating effectively in London – and the creation of markets for environmental improvements – such as carbon trading, now operating in the EU. Through the Commonwealth Secretariat in the Pacific and Caribbean SIDS, he established training for integrating economic and environmental policies and practices for environmentally sustainable development.

Petty, William, 1623–1687
Petty was a notorious exponent of the brutal subjugation by the English of the peasantry and the neo-feudal expropriation of their agricultural land in the Cromwellian re-conquest of Ireland in the seventeenth century. He is also noted for his early historical contribution to the analysis of economic transition as part of the infancy of **development economics**. Whilst pirating the Irish, he explored notions of establishing national accounts, the price of labour, including non-wage earnings, economic planning and the three-fold division of the economy into capital, labour and land as the factors of production. The context of his writing was fiscal-military dictatorship starting in Ireland and subsequently transferred as a model for the colonies at large. This system of control was a key part of the European imperial **globalisation** in the Americas, South West Asia, Australia, New Zealand and Africa. The amoral predatory political intent of his economics was parodied by Jonathon Swift in 1729 in *A modest proposal for preventing the children of poor people from being a burthen for their parents or country, and for making them beneficial to the public.* This was a satire envisaging breeding children, like animals, for human consumption. Whilst acknowledged as a founding father, Petty has thus become an iconic challenge to all development economists concerned with equity and the distributional aspects of wealth and power.

Pigou, Arthur Cecil, 1877–1959
Successor to Professor Alfred Marshall at Cambridge, Pigou is noted for his 1919 *The Economics of Welfare.* He advocated the use of taxes and subsidies to remedy market failure and its impact on resource allocation, where prices failed to reflect social as well as private values for goods and services. He also promoted the policy of income redistribution on the grounds of the diminishing marginal **utility** of income. These notions underpin much subsequent theory and practice in **development economics**. They are also part of the intellectual underpinning of the welfare state, policies of international aid and of economic integration at regional, sub-regional and national levels. These mechanisms have been an integral part of development practice in the EU, USA, UK provinces and in France with its peripheral Departments, such as Réunion.

Polyani, Karl, 1886–1964
As a radical revisionist critic of classical and neo-classical economics, Polyani developed fresh insights from comparative studies of anthropologically-based economic analysis. He is noted for his 1944 *Great Transformations, the Political and Economic Origins of our Time,* and his deconstruction of the conceptual framework of the self-regulating market economy. This title has been adopted by UNEP to embrace sound policies for sustainable development in scenario planning. Polyani wrote of the 'free market', *'... such an institution could not exist for any length of time without annihilating the human and capital substance of society'.* He saw the process of regulation in the nineteenth century by different governments throughout Europe as a means of checking unbridled capitalism advancing under the protection of the misplaced classical economic theories. Such intervention was manifested through legislation on public health, factory conditions, social insurance, public utilities, municipal services, and trade union rights. His notion of *The Great Transformation* was that of halting the advance of economic liberalism by restoring social values as the guiding principles for political economics. He did not see this dual mechanism, market economics v. social economics, as a regulating process, akin to the invisible hand, nor as a dialectic process akin to the Marxist view of history. His legacy to **development economics** is the notion that markets are only sustainable if they are 'embedded', that is if they operate within an institutional framework of dominant social and political values, which regulate, stabilise and legitimise market outcomes. In the twenty-first century, in the face of market **globalisation**, it is increasingly evident that the necessary national institutions for promoting the countervailing social and political values, identified as essential for sustainable development by Polyani, have yet to be established at global and regional level. In many countries, at national level, though evident in law, they remain in practice weak, suffering under severe limitations which frustrate the process of implementation.

Quesnay, Francois, 1694–1774
French economist of the Physiocratic school and contributor to the French *Encyclopaedia*. Noted for his economic table published in 1758, which is one of the first analyses of the workings of the economy. He met and influenced **Adam Smith.** He was adviser to Louis XV and many of his ideas on policy were developed and implemented by Jacques Turgot, French Minister of Finance. In opposition to the Mercantilists, the Physiocrats, the first organised group of economists, considered that wealth is derived not from gold but from the size of the

net product, principally of agriculture; from this concept was later developed the **labour theory of value**. The Physiocrats supported the concept of 'laissez-faire' in trade and were also opposed to the Mercantilist policies of monopolist charters, trade controls, restrictions on the movement of labour and protective tariffs. Physiocracy means literally 'the rule of nature' and the Physiocrats considered that the state should have merely an enabling role to allow the state of nature to flourish.

Rawls, John, 1921–2002
Noted for his 1971 *Theory of Justice* and its later restatement in his 2003 *Justice and Fairness*. His theory has been influential in both politics and economics. His framework of social justice for a democratic pluralistic society was built on two principles, liberty and difference. The first asserts the equality of claims to liberty. The second asserts that social and economic inequality should satisfy two conditions that are attached to offices and positions. They should be open fairly to all and they should be of greatest benefit to the least advantaged members of society. Rawls' theory has assisted **development economics** in its consideration of disparities in the distribution of wealth and of political power. His mission was to find a theory that would provide the basis for a stable, democratic, pluralistic society. For this purpose, he proposed a process of overlapping consensus that would provide the glue for cohesion and the resolution of conflict, yet would allow dissent, individualism and the pursuit of the interests of minority groups, including different political philosophies and different religious faiths.

Sachs, Jeffrey D, 1954–
Sachs is currently director of the Earth Institute and Professor of Sustainable Development, and of Health Policy and Management at Columbia University, USA. He is noted for his 2005 *End to Poverty* (Penguin Books). He was also chairman of the WHO Commission on Macroeconomics and Health. He subsequently was Chairman of the UN Millennium Development Project. He is engaged in the Millennium Villages Project in Africa which promotes cost-effective sustainable development initiatives at community level and the pursuit of the **Millennium Development Goals.**

Schumacher, E.F., 1911–1977
Schumacher is noted for his 1973 *Small is Beautiful, Economics as if people Mattered*. In this and other papers and books he provided a critical analysis of factors for sustainable development, overturning Keynesian concepts of **economic growth** and applying what he called 'Buddhist principles' to economic theory and practice. He was founder of what may be called the 'humanist economic movement' and was a prime mover in the adoption of 'appropriate technology' for industrial and social progress, especially in developing countries. In this work, his core notion was 'the aim ought to be to obtain the maximum amount of well-being with the minimum of consumption.' He attacked the political economic assumptions that 'growth is good' and 'bigger is better'. He denounced the focus on output and technology as dehumanising. Many of his ideas have been subsequently absorbed into environmental and ecological economics. They anticipated the use of the **'ecological footprint'** as the denominator for assessing the impact of human activity on **natural resources**.

Sen, Amartya, 1933–
Nobel Prize winner in economics in 1998, Sen is noted for his contributions to **welfare economics**, to the analysis of causes and remedies of famine, of gender inequalities, and to human **development theory**. His principal works include in 2000 *Development is Freedom*, and in 2006 *Identity and Violence, the Illusion of destiny,* a retort to Samuel Huntingdon's 1997 *The Clash of Civilisations*. He was also influential in the establishment of the Human Development Index of the UNDP and the conceptual approach of the annual *Human Development Reports*. He is currently Professor at Harvard University, USA.

Singer, Hans, 1910–
Noted for his establishment of the Institute for Development Studies, Singer was a student of J.A. Schumpeter, in Austria. As an émigré from Nazi Germany, he subsequently settled in the UK becoming a research assistant to **J.M. Keynes**, examining the causes and effects of unemployment. After a period in local government planning he joined the UN and was instrumental in setting up the UN Special Fund, the World Food Programme, and the African Development Bank. He supported the emergence of the UNDP from the UN Special Fund and the UN Expanded Programme for Technical Assistance. These were administered at that time by Paul Hoffman, formerly the administrator for the US post-war European Marshall Plan. Singer was influential in the ILO policies on the informal sector and promoted the use of growth as the source of funds for redistribution. He was a stern critic of **John Williamson** and the **Washington Consensus**. One focus of concern, with Raul Prebisch, was the greater rate of growth in developed countries compared with developing countries, which he attributed to their declining terms of trade. This he saw created an ever-widening gap between North and South with the 'lion's share going to the lions'. His pet themes were 'redistribution of the fruits of progress', and 'assuring equitable participation in economic improvements'. These, when translated into economic concepts, were 'distributive justice and distributive efficiency'. He believed that a key to the development of the South was a combination of import substitution and industrial production for export. This combination would overcome declining commodity prices. Both these policies were implemented in Mauritius after independence, supported by an analysis of economic and social factors in development undertaken in the 1950s by James Edward Meade.

Smith, Adam, 1723–1790
Father of classical economics through his hugely influential 1776 publication *An Inquiry into the Nature and Causes of the Wealth of Nations.* He stressed in this the benefits of the division of labour, specialisation and exchange, and the market mechanism of the price system. He introduced the metaphor of the **'invisible hand'** of market forces which would ensure that the right goods and services were produced, provided that markets were freed from the kind of government intervention of the then prevailing Mercantilist system in Europe. The wealth of nations, he considered, depended on capital, labour and land as the factors of production. But he acknowledged that the self-seeking behaviour of producers could only be harnessed to the common good in markets through competition. Smith opposed monopolies – at the time commonly in the gift of governments, and he promoted the notion of national and international free trade. His theories were readily adopted by

those who argued that the ruthless pursuit of personal gain by capitalists inescapably led to the greatest good of all. He asserted, 'It is not from the love or goodwill of the butcher or baker that we get our dinner, but from our appeal to their self interest through our paying for meat and bread.' His theories, combining moral and economic precepts, largely masked the practical fallacies of his thinking, arising from market failure and the unequal distribution of wealth within and between countries. Despite his achievements in advancing economic theory, he did not address the question of the non-economic values attached to ways of living, the depletion of non-renewable **natural resources** and the adverse impact of economic and population growth on the **environment** and on human life and welfare.

Solow, Robert Merton, 1924–
Awarded the Nobel Prize in Economics in 1987 for his contributions to the theory of **economic growth**. He is noted for identifying the diminishing return to capital investment and the critical importance of technological innovation, called the Solow residual, which he claimed accounted for 80 per cent of **economic growth**. Solow was reputedly a witty critic of interventionist and non-interventionist economists. He was a senior economist with US President Kennedy's Council of Economic Advisers. Environmental economists have criticised Solow's theory for lack of attention to the impact of **economic growth** on **natural resources**.

Stiglitz, Joseph, 1943–
He was a Nobel Prize winning economist in 2002, for his work on the asymmetric nature of information in market economies, its adverse effect on efficiency and its implications for more interventionist government policy. Noted also for his 2002 *Globalization and its Discontents*, and in 2006 for *Making Globalization Work.* A former chief economist at the World Bank, he became the centre of a fierce debate about World Bank and IMF economic policies during the economic transition of former Soviet countries and their wider damaging application to the Third World. He has called for greater attention to be given to the international problems of environmental degradation, poverty and disease, having served on the IPCC. Under President Clinton he was an advocate for the political economic policies of the 'Third Way' providing a bridge between socialist state intervention and reforms of the free market. He has now extended this approach in proposals for reform of international institutions such as the UN, the IMF and the World Bank. His reform proposals call for greater transparency, more involvement of **developing countries** in policy-making, improved accountability, better judicial procedures (for example, to penalise the USA for its failure to act on global warming as an implicit trade subsidy), renewed commitments for meeting aid targets (0.7 per cent GDP), greater debt forgiveness to developing countries, more accountability of multinational companies for environmental damage, and a reduction in arms sales to **developing countries** that undermine fledgling democracies. He is currently Professor of Finance and Economics at Columbia University.

Williamson, John, 1937–
As an adviser to the IMF and the UK Treasury he is noted for his initiative in defining the 'Washington Consensus' which was used by the IMF and World Bank as a framework of

support for **developing countries** in the 1990s. It also became a key element in neo-liberal Western policy towards developing countries. Engulfed in subsequent fierce controversy, following failures of the policy in many continents on account of its disappointing impact on poverty, unemployment and even **economic growth**, Williamson developed adaptations to the framework. These recognised the need for greater attention to the role of the informal market, institutional and infrastructure development, equity and the distribution of wealth. Williamson is senior fellow at the Institute for International Economics. (See 2002 *Did the Washington Consensus fail?*: www.iie.com)

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