INTRODUCTION

A very brief economic history lesson

This book’s primary objective is to introduce to a general audience the basic concepts and principles of what has become known as environmental economics. For all practical purposes, the origins of environmental economics lie in the 1960s at the time of the first wave of modern popular ‘green’ thinking and policy perceptions within developed countries, known as **environmentalism** (O’Riordan, 1983). This is not to say, of course, that the foundations of environmental economics appeared *de novo* during the 1960s. It is a branch of economics and shares with its parent discipline a common history. Some of the fundamental ideas that provide a framework for environmental economics go back at least to the eighteenth century.

A minority of citizens have always worried about the state of, and rate of use of, the natural environment whether locally, nationally or internationally, and have usually been ignored by their contemporaries. But elements of their message may be more relevant today than ever before.

While seemingly obvious, it is of crucial importance for an understanding of environmental economics, that we recognize that our economic system (which provides us with all the material goods and services necessary for a ‘modern’ standard of living) is underpinned by and cannot operate without the support of ecological systems of plants and animals and their interrelationships (collectively known as the biosphere), and not vice versa.

Thus environmental economics views the real economy in which we all live and work as an **open system.** What this means is that in’ order to function economics analysis. We expand on the **materials balance model** of the economy in Chapter 1, but the crucial idea is that the economic system is not a *closed* system. As more resources are sucked into the economy from the environment so more wastes are pushed back into the environment. This puts pressure on its limited capacity to handle the waste without harm to humans, animals and plants.

Ecological limits bn the economy

There is a very real but ultimate sense in which economic activity is 'limited or 'bounded' by the capacities of natural environments. Now the 'limits' concept has its origins in the work of thinkers such as Malthus (1798), Ricardo (1817) and Marx (1867). Malthus worried about absolute *limits* or scarcity. He believed that as the economy developed, population growth would always tend to outgrow the means of subsistence (food produced by agriculture) and a state of misery, 'the stationary state', would be the inevitable end result. Ricardo took a more sophisticated and slightly more optimistic perspective when he argued that *relative limits* or scarcity was the real problem for a growing economy. In Ricardian analysis, limits are set by rising costs as the highest grade resources (i.e. best agricultural land, purest deposits of minerals, etc.), which are exploited first, become exhausted and have to be substituted for by successively lower grade resources. The costs of exploitation (including pollution costs, see Chapters 1 and 3) escalate as the 'grade profile' of resources declines.

Later in the nineteenth century, Marx highlighted the possibilities that economic growth might be limited because of social and political unrest within the national economy and associated society (this was later expanded by his followers into an international, global economic context). The 'social limits' to growth theme was picked up again by some economists during the development of environmental economics in the 1970s. In the early 1970s, opinion poll evidence in the developed countries, for example, seemed to indicate that despite huge absolute increases in the material standard of living, people on average said they did not feel much happier with their lives, the Easterlin paradox (Easterlin, 1974). It turned out that the 'feel good factor' was a complex phenomenon influenced as much by *relative* income and social status as by absolute quantities.

The 'social limits' theme was also further extended and elaborated on during the 1970s with the addition of *moral concerns* connected with economic growth and development. Ethical issues (i.e. questions of right and wrong) surfaced on the potentially negative impact of the fast growth modern economic system, the prospects of future human generations and non-human nature, as well as on exacerbating declining moral standards in contemporary society (see Chapter 2).

Our very brief historical survey should also include mention of one other influential nineteenth century thinker, J. S. Mill (1857). Mill, like previous political economists, believed that the economic growth process would end in the 'stationary state'. At this point there would be a static population level serviced by a fixed amount of housing, infrastructure, farms and other industrial plants. In economic terms, there would be a **constant stock of human capital** (people) and a **constant stock of physical capital** (machines, buildings, etc.). Incidentally, Mill argued that it was quite possible to conceive of this stationary state society as socially desirable, giving people the time and space to enjoy the spiritual, artistic and educational aspects of the human condition.

The 'constant stock' idea was another notion that reemerged during the 1970s, when it was popularized by Daly (1973) in a book advocating the deliberate creation of a no-growth **steady-state economy.** For Daly, the key policy question becomes, how big (i.e. physical scale or size of the human presence in the ecosystem) should the economy become (given that it is a subsystem of the environment) relative to the overall system (i.e. the biosphere, economies plus ecosystems and all their interrelationships)? He is critical of conventional economics because, as he sees it, the discipline fails to provide a proper analysis of the economic 'scale' issue (population x per capita resource use).

A significant caveat is in order at this point in the introductory discussion of the evolution of environmental economics. While the 'limits' and 'constant stock' (steady-state) concepts have been and remain important foci for analysis and debate, a belief in them is not a necessary feature of modem environmental economics. Indeed our position is that it is not necessary to totally embrace the steady-state philosophy (we set out the reasons why in Chapter 3) in order to adequately safeguard the environment on which we all depend.

It is also the case that environmental economics is not a static body of knowledge but an ongoing process of change, refinement and debate. Most recently, over the last five years or so, a split has occurred which has led some analysts to comment that a potentially separate subdiscipline called **'ecological economics'** has begun to emerge. There is, however, no clear consensus on what ecological economics embraces or how it differs from environmental economics. We will not in this introductory text attempt to set out in any rigorous way the possible differences between the two approaches. At the risk of great oversimplification, it is, we suppose, possible to argue that ecological economics can be viewed as a reaction to, and rejection or modification of, certain of the assumptions that tend to characterize environmental economics. Daly's advocacy of the steady-state economy and the vital importance of the 'scale' issue, is an example of how ecological economics might diverge from environmental economics. We will flag some other potential points of divergence in succeeding chapters (see in particular

Chapters 2, 4 and 8) but will stop well short of any comprehensive position. The bulk of the analysis in this text is devoted to an elementary exposition of the principles and policy perceptions of environmental economics.

Before we outline the basic structure and organization of the succeeding chapters we return to our historical survey in order to highlight a number of other important concepts which have been assimilated into modern environmental economics thinking.

Environmental pollution as an external cost

Because the economy is an open system its three basic processes (extraction, processing/fabrication and consumption) all involve the generation of waste products that eventually find their way back into the environment (the air, water or onto land). Too much waste in the wrong place at the wrong time (or over too long a time) will cause biological and other changes in the environment (known as **contamination)** which themselves may then cause harm or damage to animals/plants and their ecosystems **(pollution).** If these environmental damage effects then serve to harm human health or negatively affect human wellbeing in some other way (i.e. reduce the pleasure of outdoor recreation, etc.) economists would recognize the existence of **economic pollution.**

The economic definition of pollution is dependent upon both some physical effect of waste on the environment and a human reaction to that physical effect. In economic parlance, there has been an uncompensated loss of human welfare (wellbeing) due to the imposition of an **external cost** (i.e. health damage, morbidity or mortality increases, less pleasurable recreation experiences, etc.) related to the emission to the air or discharge to water or onto land of waste substances. So the physical presence of pollution does not mean that ‘economic pollution’ exists. Further, even if economic pollution was present, it is far from always being the case that it should be eliminated. We expand on this argument in Chapters 5 and 10.

It was Pigou (1920) who first formalized the impact of pollution on the working of the economy. His analysis distinguished between the *private costs* of production and consumption activities (encapsulated in fuel, raw material, **labour** costs, etc.) and the full *social costs* (i.e. on society as a whole) of such activities. What he saw was that pollution gives rise to external costs, which drive a wedge between private and social costs. So the social costs of production or consumption are made up of private costs plus any external costs that may be present. The socially optimal level of external costs is unlikely to be zero (zero pollution) because of the natural capacity of the environment to absorb some waste and the cost of controlling pollution. Zero pollution is desirable, however, when the predicted damage from the disposal of certain toxic and hazardous substances is thought to be catastrophic in some sense. Unfortunately, real world pollution situations are often beset by a lack of data and/or understanding over just how dangerous some released substances will turn out to be over the long run. Making decisions under uncertainty is a complex task and we outline some of the issues involved in Chapters 9 and 14.

Non-renewable and renewable resource use

On the basis of the materials balance model of the economy/environment interface, resource extraction (and harvesting) activities start off the process of economic activity. Resources may be simplistically classified as **exhaustible** (or more properly **non-renewable)** or as **renewable.** The former are fixed in overall quantity, so that use of them in a given time period means that there is less of them available for other time periods. The basis of the economics of non-renewable resources was formulated by Gray (1914) and Hotelling (1931). Their analysis was developed in the context of the underlying historical concern that the world's exhaustible resources (minerals, forests and other resources – renewable and non-renewable) might be being extracted too rapidly and sold too cheaply.

Most of the non-renewable resource theory relating to the activities of mineral extracting firms is primarily concerned with the best ('optimal') *rate* at which resource deposits or fields should be extracted, and also with the optimal amount of the resource that should be extracted. What Gray and Hotelling showed was that in the case of, for example, the minerals-extraction industry, the production in any given period is not independent of production in any other period. They proved that because the current rate of extraction of a mineral actually affects the amount of that mineral that may be extracted in future periods, the current costs of extraction (and rates of extraction) are subject to a set of quite complicated forces. Thus, current extraction costs depend on current input costs (fuel, labour, etc.), and also on past rates of extraction and on the effect of current extraction on the future profitability of the mineral deposit. The owner of the mineral deposit will try to maximize total profits over a given time horizon (known as the 'net worth') rather than simply maximize profit in any given period.

Because of the assumption of a fixed amount of a given mineral resource, Gray reasoned that extraction costs (usually analyzed in terms of marginal cost, i.e. costs per unit of additional output) would include an additional element. He developed a concept that we now call **user cost,** the notion that possible future use of a non-renewable resource is necessarily sacrificed if units of the resource stock are exploited and used today. So in strict economic terms the cost of using a non-renewable resource (e.g. coal, gas, oil and other mineral deposits) is therefore made up of the sum of its extraction costs (e.g. cost of mines, drilling rigs, etc.) and the user cost element.

It was noted that the owner of a mineral deposit might well maximize total profits by postponing extraction (conserving resources for the future) if, for example, it was expected that the price of the mineral would increase substantially in the future (i.e. increase in user costs); or if extraction costs due to a new technology were thought likely to fall in the future. On **the** other hand, if current interest rates paid out on financial investments were to increase then this would serve to increase current rates of mineral extraction in known deposits. The owner could now invest any current profits derived from extraction and gain the higher rates of interest. Profits now have been made more valuable relative to **future** profits, with the latter now being more heavily **discounted** by the owner. Discounting is a very important general concept in economic analysis and it reflects the fact that we tend to regard costs and benefits in the future as being of less importance than costs and benefits now (see Chapter 7). It turns out that the discount rate (how much less valuable future costs and benefits are) is of prime importance in determining the rate at which non-renewable and renewable resources are used (see Chapters 15 and 16). Hotelling (1931) showed that under certain conditions the **rent** or **royalty** on a resource (the price net of extraction costs) would increase over time at a percentage rate equal to the resource owner's discount rate.

Changes in the ***rate*** of interest in the real world will affect not just the value of profits, but also the level of effort that mineral firms will put into exploring for and developing new sites for future extraction. They also influence investment in new capital equipment, both in deposits already being worked and at new deposits. There can therefore be a number of offsetting forces to the increased rates of extraction of known deposits.

Carlisle (1954) brought the question of the **optimal amount** of the total resource deposit to extract to the fore. He emphasized the point that no mining/drilling firm would ever extract the entire amount of a deposit. Carlisle's analysis showed that the optimal rate of extraction varies with the level of extraction and vice versa, and that the existence of uncertainty complicates the problem even further. Modern economic optimal resource use analysis reflects these complications and we deal with it in outline form only in Chapter 16 (the published literature is technically very demanding).

Hotelling's work served to highlight another important set of factors in environmental economics analysis. He showed that in situations related to free or easy access/entry to the resource deposit (or for that matter to a renewable resource such as a forest or a fishery) too rapid a rate of extraction would result. **Open access** is possible because either **property rights** do not exist or are easily challenged. So if many firms can drill an oil field, for example, no firm is induced to hold back and the field is exploited too rapidly; oil and gas are also lost. The open access problem has, unfortunately, been confused in the environmental economics literature by frequent references **to** the **common property problem** and the **tragedy of the commons**

problem. In fact common property is property owned by a community and is often subject to usage rules or social norms (see Chapter 15). We therefore prefer the term the 'tragedy of open access' and link it not just to the problem of the best rate of resource exploitation, but to the problem of pollution and the rate at which the environment's **assimilative capacity (i.e.** its ability to 'absorb' wastes produced by the economy without exhibiting signs of excessive change and stress and therefore physical and economic pollution) could itself be depleted or destroyed (see Chapters 10 to 14).

In the case of renewable resources (e.g. fisheries, forests or livestock, and rangeland), the rules for optimal use over time were first comprehensively formulated by Gordon (1954). He compared the utilization of a fishery under open access and single ownership conditions and showed that under the former regime, resource rents would be exhausted and the resource itself would be pushed close to extinction. In the renewable resource case, decisions about the optimal amount of the resource to harvest and when to harvest it are interdependent. This is because the resource itself (strictly its biomass stock) grows through time and this increases the potential harvest yield the longer is the delay in harvesting.

From 'cowboy economy' to 'Spaceship Earth'

In 1966 Boulding wrote an essay on 'Spaceship Earth' which combined economics and some science in order to bring together the view of the economy as a circular resource flow system, and of the environment as a set of limits, resource stocks (or **sources)** and natural assimilative capacities (or **sinks)** for wastes. Boulding argued that we must cease to behave as if we lived in a 'cowboy economy', with unlimited new territory (i.e. resources, sources and sinks) to be conquered and learn to treat planet earth as a 'spaceship'. The spaceship is a circular system in which every effort has to be made to recycle materials, reduce wastes, conserve exhaustible energy sources and tap into potentially limitless energy sources such as solar power.

Boulding's synthesis work was formalized in the materials balance models of Ayres and Kneese (1969) and Kneese et *al.* (1970). Their additional contribution was to show that wastes are pervasive throughout the economic system. Since the discharge and emission of wastes into the environment is inevitable, pollution externality effects are also potentially pervasive. Some form of government intervention to 'control' the rate and extent of pollution is therefore required. Control could be exercised via regulations and laws and/or via economic incentive instruments such as taxes and permits (see Chapters 10 to 14). Government intervention is, however, no panacea for environmental degradation problems and uncoordinated policies (intervention failure) can make matters worse (see Chapter 6).

Because environmental economics has accepted the hypothesis that there is an extensive interdependence between the economy and the environment, some of its analysts have also pointed out that the design of economies (free market, planned or mixed) offers no guarantee that the **life support functions** of natural environments will persist. The materials balance model shows clearly that the environment provides three basic functions: it supplies resources (renewable and non-renewable); it assimilates waste products; and it provides humans with natural services such as aesthetic enjoyment, recreation and even spiritual fulfilment. These three functions can also be regarded as components of one general function of natural environments – the function of life support.

All these environmental functions are economic functions because they all have a **positive economic value:** if we bought and sold these functions in the market-place they would all have **positive prices.** Mistreatment of natural environments often arises because we do not recognize the positive prices for these economic functions, as there are no markets and therefore no market prices for many environmental goods and **services (market failure, see** Chapter 5).

We lack information and analysis that could demonstrate whether any particular economy is consistent with the natural environments, which are necessarily linked to that economy. We do not have what we could call an **existence theorem** that relates the scale and components of an economy to the set of environment-economy interrelationships underlying that economy. Without this theorem we run the risk of degrading and perhaps destroying environmental functions. If we are interested in sustaining our economy over time, it becomes important to establish some principles and then practical rules for **sustainable economic development** (see Chapter 4).

The valuation of environmental functions, which are generally unpriced, is an important task in order to help correct economic decisions which treat natural environments as if they were free goods and services, and therefore lead to overuse. Some of the methods and techniques that have been developed in order to value these environmental assets in monetary terms are reviewed in Chapter 8. Economists generally advocate what they call **cost-benefit thinking,** which can be applied to individual projects (new dams, roads, power plants, etc.) or to policies or even wider courses of action. Simply put, the idea is to compare all the relevant benefits from, say, the building of a new water supply reservoir with the costs (construction and running costs) of such a project (including the environmental effects). Both costs and benefits are translated, as far as is feasible, into monetary terms and discounted over a given time horizon. Only projects with benefits greater than costs are acceptable (see Chapter 7).

Environmental economics merely deploys cost-benefit thinking in the context of environmental problems and issues. So ‘benefits assessment’, i.e. the monetary evaluation of the environmental benefits of environmental policy, or its obverse ‘damage cost assessment’, has had two main uses: first, to integrate the unpriced but valuable functions of natural environments into cost-benefit analysis of real world projects, and, second, to illustrate the kinds of economic damage done to national economies by resource depletion and pollution (see Chapter 3).

Once society has decided on an 'acceptable' level of environmental quality assisted by, among other factors, economic cost-benefit analysis, there are still further problems to be resolved. To transform the decision into reality requires a change of behaviour on the part of producers and consumers. Again a continuing debate exists in environmental economics concerning the relative merits of **command and control regulations** (CAC) and **market-based incentives** to control pollution.

Norton (1984) has summarized the position as follows. In choosing a pollution control policy, we need to determine:

(a) what policy instruments and technologies for abatement of pollution are available;
(b) what the objectives of the pollution control policy are, with particular reference to the type of pollution and the degree of environmental risk posed, the extent and reliability of pollution control methods, the full social costs of pollution control, and the social incidence of the costs and benefits (i.e. distributional effects);
(c) how cost-effective are the different policy instruments with respect to these objectives.

The **regulatory approach** (CAC) is based on the issuing of orders by some central government agency to do or not to so something (i.e. install and operate a piece of equipment or new process), known in the United Kingdom as the application of **Best Practicable Means** (BPM) and **Best Available Technology Not Entailing Excessive** Cost (BATNEEC), or in the United States as **Best Available Control Technology** (BACT) (see Chapter 14). The regulations may also cover the following issues:

(a) limits in terms of maximum rate of discharge from a pollution source;
(b) pollution discharge bans related to pollution concentration measures or damage costs;
(c) specification of inputs or outputs from a given production process.

Economic incentives require not action but payments, and, in principle, encourage the economically rational polluter to change behaviour by balancing reduced payments (of say a pollution tax) against increased costs incurred in reducing pollution discharges. Early economic work in the field of pollution control stressed the desirability of the economic incentive approach (Kneese, 1964). Given certain assumptions it can be shown that the most efficient (strictly the most cost-effective) way of achieving some predetermined level of environmental quality is via the imposition of a pollution tax or related economic incentive instrument. However, when some of these assumptions are relaxed and criteria such as distributional equity and ethical considerations are introduced, the case in favour of the incentive approach is much less clear cut (Bohm and Russell, 1985).

The rest of this book is organized in the following way:

- Part I (Chapters 1 to 4) covers a range of basic issues ending up with a discussion of the concept of sustainable economic development.
- Part II (Chapters 5 and 6) deals with the causes of environmental problems which are analyzed in terms of two interrelated 'failures' concepts, market failure and government policy failure.
- Part III (Chapters 7 to 9) covers cost-benefit analysis and its application to environmental issues. The methods and techniques that have been applied, in the absence of market-based price/value data, in order to value environmental assets in monetary terms are reviewed, and the section ends with a discussion of the problems caused by uncertainty.
- Part IV (Chapters 10 to 14) deals with various forms of government intervention that are possible in order to protect environmental quality. A range of policy instruments, taxes, charges, permits and regulations are appraised in terms of their economic efficiency and other criteria.
- Part V (Chapters 15 and 16) cover the basic analytics of natural resource usage and sustainable management.
- Part VI (Chapters 17 to 23) is composed of a series of mini case study chapters on various 'local' and 'global' scale environmental management topics.

References

R. Ayres and A. Kneese, 'Production, consumption and externalities', *American Economic Review 59: 282-97,* 1969.

P. Bohm and C. Russell, 'Comparative analysis of alternative policy instruments', in A. Kneese and J. Sweeney (eds), *Handbook of Natural Resource and Energy Economics,* North Holland, Amsterdam, 1985.

K. Boulding, 'The economics of the coming Spaceship Earth, in H. Jarrett (ed.), *Environmental Quality in a Growing Economy,* Johns Hopkins University Press, Baltimore, 1966.

D. Carlisle, 'The economics of a fund resource with particular reference to mining', *American Economic Review 44: 595-616,* 1954.

H. Daly, *Steady State Economics,* Freeman, San Francisco, 1977; second edition, Island Press, New York, 1991.

R. A. Easterlin, 'Does economic growth improve the human lot?', in I'. David and R. Weber (eds), *Nations and Households in Economic Growth,* Academic Press, New York, 1974.

H. S. Gordon, 'Economic theory of a common-property resource: the fishery', *Journal of Political Economy 62: 12442, 1954.*

L. Gray, 'Rent under the assumption of exhaustibility', *Quarterly Journal of Economics 28: 466-89,* 1914.

H. Hotelling, 'The economics of exhaustible resources', *Journal of Political Economy* 39, 137-75, 1931.

A. Kneese, *The Economics of Regional Water Quality Management,* Resources for the Future, Johns Hopkins University Press, Baltimore, 1964.

A. Kneese, R. Ayres and R. d'Arge, *Economics and the Environment: A Materials Balance Approach,* Resources for the Future, Washington DC, 1970.

T. Malthus, *An Essay on the Principle of Population,* first published in 1798, reprinted by Macmillan, London, 1909.

K. Marx, *Capital,* Vols I, II and III, Lawrence and Wishart, London, 1970, 1970 and 1972; but see R. Freeman (ed.), *Marx on Economics,* Penguin, Harmondsworth, 1962.

J. S. Mill, *Principles of Political Economy,* Parker, London, 1857.

G. A. Norton, *Resource Economics,* Edward Arnold, London, 1984.

T. O'Riordan, *Environmentalism,* 2nd edition, Pion Press, London, 1983.

A. C. Pigou, *The Economics of Welfare,* Macmillan, London, 1920.

D. Ricardo, *Principles of Political Economy and Taxation,* Everyman, London, 1926.