## Figures

1.1 Choice and trade-off between supply of man-made goods and those provided by the natural environment 5

1.2 Choosing between goods provided by the natural environment and man-made goods subject to constraints or minimum ‘standards’ 7

1.3 Ricardian model of limits to economic growth emphasising importance of population levels and of technological change 13

2.1 Difference in constrained optimum for welfare maximisation (in relation to conservation and development) which pay no attention to differences in absolute welfare 28

3.1 In the absence of environmental spillovers, competitive markets result in supplies of private goods that efficiently satisfy human wants 57

3.2 When unfavourable environmental spillovers occur, market systems usually result in excessive environmental damage from a social economic viewpoint 58

3.3 An illustration of some situations in which public intervention may be required on economic grounds to reduce or eliminate an environmental spillover, even though the externality is infra-marginal 59

3.4 Illustration of divergence between social and private marginal cost due to externalities or spillovers and consequent social ‘deadweight’ losses 61

3.5 Private net benefit gained by land clearing compared with various social net benefit curves with differing implications for the optimality of the extent of private land clearing 62

3.6 Pursuance of private gain may result in too much natural vegetated land being developed for commercial purposes. This is so if favourable externalities arise from natural vegetation cover and a social viewpoint is adopted 64

3.7 The optimal level of conservation of the population of a species considered as a pure public good on the basis of its existence value 71

3.8 In the above case, the higher is the rate of interest used for
discounting the more likely development is to be preferred to conservation of a natural resource

3.9 Monopoly in this case has no conservation advantages and results in a deadweight social loss

3.10 Illustration of how majority voting may lead to insufficient or too much conservation judged by the Kaldor-Hicks economic efficiency test

4.1 Conservation of living natural resources in a developing country to some extent provides a global public good. Hence, an optimal amount of conservation may not occur in developing countries if LDCs follow their own self-interest

5.1 Species of wildlife sometimes provide a mixed good. In such cases, private harvesting of species to supply private goods is unlikely to maximise economic welfare because the social marginal cost of harvesting diverges from the private marginal cost of harvesting the species

5.2 The mere fact that the private cost of harvesting a species diverges from the social cost of harvesting it does not imply that its level of harvest is always socially inappropriate or suboptimal

5.3 The social marginal cost of harvesting a species may be so high that no harvesting is socially optimal. In such cases, all private harvesting is inappropriate

5.4 A wildlife species may be regarded as a pest by some social groups and as an asset by others. Using the Kaldor-Hicks criterion, the level of harvesting of the species can be adjusted to take this into account

5.5 The socially optimal combination of populations of interdependent species may differ from their natural combination and encourage human intervention to change the population mix

5.6 Strengthening of the global property rights of individual nations in their genetic material may provide an incentive to conserve this material

6.1 Open-access results in resources being allocated in accordance with the value of their average product rather than the value of their marginal product and this leads to a deadweight social loss indicated here by the hatched triangle

6.2 Backward-bending supply curve for the harvest of species to which there is open-access. This can result in perverse conservation decisions and a smaller population of the species than is desirable for minimising the cost of the actual harvest
6.3 Sustainable harvesting levels as a function of the level of population of a species 139
6.4 In an open-access industry, technological progress which reduces per unit harvesting costs might reduce economic welfare and threaten the existence of a species 139
6.5 Taxes on the catch or tradeable permits may be used to improve allocative efficiency in the case of an open-access resource. But if economic gains are to be made, the cost of administering such schemes must not exceed the benefits otherwise obtained 141
6.6 As the demand for a renewable harvested resource, to which there is open-access, rises, the social economic costs of its ‘excess’ harvesting increases. In addition, the stock of the resource declines and as shown by Figures 6.2 and 6.3, the resource faces increasing risk of extinction as a result of overharvesting 144
6.7 While farming may favour the conservation of wild stock of a species, it is not bound to do so. This is because it can increase demand for the use of the species and it may cause the supply schedule of supplies from the wild of the harvested species to move upward and to the left (note that this shift in the supply schedule is not illustrated) 148
6.8 Farming has altered the global genetic stock. It has resulted in losses as well as additions to the stock 150
7.1 Zoning of areas depending upon travel distance to an outdoor attraction A 159
7.2 Relative frequency of visits (demand for visits per capita) as a function of the (travel) cost per visit 160
7.3 Demand curve for visits to an outdoor area. Consumers’ surplus in the absence of an entry fee is shown by the hatched area 161
7.4 Evaluation of alternative land-use taking account of total economic values 170
7.5 Marginal evaluation curves of conservationists and developers in relation to the percentage of natural area developed 172
7.6 Under provision of public goods (protected areas in this case) leaves scope for their provision by non-governmental organisations 174
8.1 Quantity of timber production available from a forest as a function of its age 182
8.2 Determining the optimal growing period or harvest cycle for a forest in order to maximise its economic sustainable yield 184
8.3 The economics of mixed land-use (multiple purpose use of forested land) depends only partially on biological production possibilities. But if the production transformation curve is of the form of KLMN, economic efficiency requires mixed production and mixed land-use.

8.4 Solutions to transboundary or transfrontier pollution, such as air pollution causing acid rain, are difficult to achieve. The polluter may either pay to pollute or be paid not to pollute. The Kaldor-Hicks solution can be achieved by either policy but the income distributional consequences are different.

8.1 A case in which activities by one group of agriculturalists has negative spillovers on another group of agriculturalists.

8.2 Economic loss resulting from negative spillover on downstream agriculturalists of water use by upstream agriculturalists.

9.3 Free access to water from an (underground) water basin can result in inefficient reduction in the availability of the resource.

9.4 Two agricultural systems with different degrees of sustainability.

9.5 Sustainability or otherwise of agricultural systems from a different point of view to that considered in Figure 9.4.

9.6 When chemical agricultural systems are adopted agricultural yields or returns become very dependent on them. Withdrawal of chemicals results initially in marked depression of these yields or returns. So agriculture tends to become locked into such systems once they are adopted.

9.7 Illustration of how the introduction of GM crops could lead to a net loss in social economic welfare.

10.1 A case in which the number of tourist visits to an area is influenced by aversion to crowding.

10.2 As the cost of visiting a tourist area declines, consumers’ (tourists’) surplus may not increase but decrease. This can occur if there is aversion to crowding because lower costs of a visit will usually bring more visitors.

10.3 Consequences for tourism demand of deterioration of a tourist asset due to tourist visits.

10.4 Typical tourism area cycle according to Butler (1980).

10.5 Tourism area cycle not caused by environmental damage due to tourist loads.

10.6 Illustrations of loss caused to the tourist industry and to tourists by pollution.
10.7 A case in which pollution from sources outside the tourism industry imposes external economic costs on tourism in terms of losses in producers’ and consumers’ surpluses 235

10.8 A case in which defensive environmental expenditures (on pest control) are economic because of their impact in increasing tourism 236

10.9 Total economic value: economic conflict and non-conflict zones between benefits from tourism and other economic values 237

11.1 Dependence of human welfare on the ratio of man-made to natural capital and implications for conversion and use of natural capital 250

11.2 Hypothetical optimal path for maximising human welfare of the ratio of man-made capital to natural capital 251

11.3 Some alternative views of the relationship between population levels, economic activity levels and the length of existence of the human species 252

11.4 Alternative sustainable economic solutions depend on objectives which in turn depend on ethics 255

11.5 Two production or economic systems with different degrees of sustainability 258

12.1 Environmental Kuznets curves are widely believed to be typically of the form shown. They are often used to support the view that economic growth will eventually result in environmental improvement and a sustainable future 272