SOCIO-ECONOMIC MODELLING

Method Indicator		
Bottom-Up	Hybrid	Top-Down
		YES

Summary of key issues

Issue	**Summary**
Description	Socio and environmental economics concern the effects of policy, plans and development projects on human well being. The effect on human well being is considered both indirectly when assessing the effects of change on the natural system (fisheries, nature conservation and biodiversity) and more directly when considering changes to the landscape and noise and air quality.
Temporal Applicability	Medium to long-term, decadal to century-scale.
Spatial Applicability	Region to UK wide.
Links with Other Tools	Socio-economic modelling provides information on the cost-benefit of estuary management activities and of the modelling of estuaries.
Data Sources	Dependent on the type of analysis.
Necessary Software Tools / Skills	Knowledge of the technique to be applied e.g. environmental economics, multi-criteria decision-making; the application of scenarios, and the DPSIR framework.
Typical Analyses	Cost benefit analysis of plan or scheme within EIA.

Socio and environmental economics concern the effects of policy, plans and development projects of human well being. In the context on a formal Environmental Impact Assessment (EIA) for a development project, it is considered best practice to assess changes to human well being as part of Socio-economic Impact Assessment (SIA). Although the degree to which this is covered in EIA is much debated (Morris & Therivel, 2001), it should probably be argued that the effect on human well being is considered both indirectly when assessing the effects of change on the natural system (fisheries, nature conservation and biodiversity) and more directly when considering changes to the landscape and noise and air quality.

The term ‘well being’ is frequently cited as the assessment end-point within environmental economics. Probably the most well known definition of sustainable development (SD) is that from the ‘Bruntland Commission’ (WCED, 1987) where SD is defined as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ and this can be re-presented as ‘generating human well being now without impairing the well being of future generations’ (Turner *et al*., 1994).

The objective of environmental economics is therefore to assist the decision making process where there are environmental choices with measurement typically considering the human welfare aspect.

The following short note provides a summary of some methods employed within environmental economics and further presents an overall framework within which the plans, projects and policy can be developed and assessed. The reader should refer to literature such as Turner *et al*. (1994) for a more complete reference to the subject.

Cost benefit analysis

Anything is a benefit that increases human well being, and anything is a cost that reduces human well being; individual gains and losses are examined to decide whether society as a whole is better or worse off. This aggregation of individual preferences can be achieved by measuring the willingness to pay (WTP) for a benefit and willingness to accept (WTA) to tolerate a cost for something an individual does not like. This provides a measure of the strength of individual preferences. Cost Benefit can be expressed for the whole of Society as the aggregation of individuals (i) Benefit (B) and Cost (C):

$$\sum_i [B_i - C_i] > 0 \qquad (1)$$

This social decision rule can be re-expressed as a fundamental equation of cost-benefit analysis to explicitly include discounting of preferences over time and environmental factors:

$$\sum_{t} (B_t - C_t \pm E_t)(1+r)^{-t} > 0 \qquad (2)$$

Equation 2 tells us that for any project or policy to be regarded as potentially worthwhile, its non-environmental benefits (B) less its non-environmental costs (C) plus or minus the value of the environmental change (E) all discounted to a present value, must be positive (where r is the interest rate).

Cost effectiveness analysis

Cost effectiveness analysis (CEA) can be applied to examine options which provide the same, or similar benefits and which assesses their relative merits by quantifying and comparing the cost of providing them.

Economic valuation

Economic value arises if someone is made to feel better off in terms of their wants and desires. What economic valuation does is to measures human preferences for or against changes in the state of the environment.

Valuation approaches can inform policy formulation and societal decision making where there are competing demands for environmental resources. The fundamental aim is to express the environmental change as a trade-off against other things society values. A key distinction is made between ‘use’ and ‘non-use’ values, the summation of which adds up to the Total Economic Value (TEV). Use values derive from the actual use of the environment whilst the non-use category is more complex but can include the concept of ‘existence’ value. For further discussion see Turner *et al*. (2002).

Multi-criteria decision analysis (MCDA)

Multi-criteria decision analysis can be applied to aid decision-making where a range of economic or environmental options (scenarios) require evaluation against a consistent set of criteria (i.e. management objectives). The aim of MCDA is not to elicit a single aggregated ‘value’, but to present rankings of different options and to test the effect of changing stakeholder preferences through sensitivity analysis. Stakeholder preferences are represented through the elicitation of weightings for each criterion (measure of importance) and in the choice of the criteria. In doing so stakeholders can examine alternative solutions and represent the trade-off between competing impacts and stakeholders with varying values and preferences.

The overall preference score for each option is simply the weighted average of its scores on all the criteria. Letting the preference score for option i on criterion j be represented by s_{ij} and the weight for each criterion by w_j, then for n criteria the overall score for each option, S_i is given by:

$$S_i = w_1 s_{i1} + w_2 s_{i2} + \ldots\ldots + w_n s_{in} = \sum_{j=1}^{n} w_i s_{ij} \quad (3)$$

Environmental economic framework

It is recognised that socio-economic and biophysical systems are intrinsically linked and mutually co-adjust through complex feedback effects. The pressures of human use of environmental space and resources, particularly in the coastal zone may result in changes to biophysical systems which in turn will impact on future human use of coastal space and resources (Turner *et al*., 1998). Being able to understand the joint system change between socio-economics and the environment has considerable benefit in terms of sustainable management of the coastal zone and the development of sustainable policy.

Sustainability indicators

Sustainability indicators can be used to help inform policy decisions and help stakeholders understand what sustainable development means. Indicators of sustainability translate the concept of sustainable development into numerical terms, descriptive measures, and action-oriented signs and signals. However, measures and indicators of sustainability are set apart from economic indicators by the way they combine social, economic and environmental trends. They also help educate the public, inspire people to take individual action and press for change in sustainable directions.

The driving force-pressure-state-impact-response (DPSIR) model

A number of models have been proposed for developing indicators, and illustrating the links between issues, particularly for environmental indicators. The best known of these is the "pressure-state-response" model developed originally by (Organisation for Economic Cooperation and Development (OECD). This is also the basis of the United Nations Commission for Sustainable Development (UNCSD) framework of sustainable development indicators. It has been adapted by the European Environment Agency into the "DPSIR" model - driving forces, pressures, state, impact, responses (Turner *et al*., 1998; EC, 1999; Jesinghaus, 1999).

The "**D**riving forces – **P**ressure – **S**tate – **I**mpact - **R**esponse model" defines five indicator categories, explained below and the link between these categories is illustrated in Figure 1.

D **Driving forces** are underlying factors influencing a variety of relevant variables. Examples include the number of cars per inhabitant; total industrial production; GDP.

P **Pressure indicators** describe the variables which directly cause environmental problems. Examples include toxic emissions, CO2 emissions, noise etc. caused by road traffic, etc.

S **State indicators** show the current condition of the environment. Examples include the concentration of lead in urban areas; the noise levels near main roads.

I **Impact indicators** describe the ultimate effects of changes of state. Examples include the percentage of children suffering from lead-induced health problems; the number of people starving due to climate-change induced crop losses.

R **Response indicators** demonstrate the efforts of society (i.e. politicians, decision-makers) to solve the problems. Examples include the percentage of cars with catalytic converters; maximum allowed noise levels for cars; the price level of gasoline; the revenue coming from pollution levies; the budget spent for solar energy research.

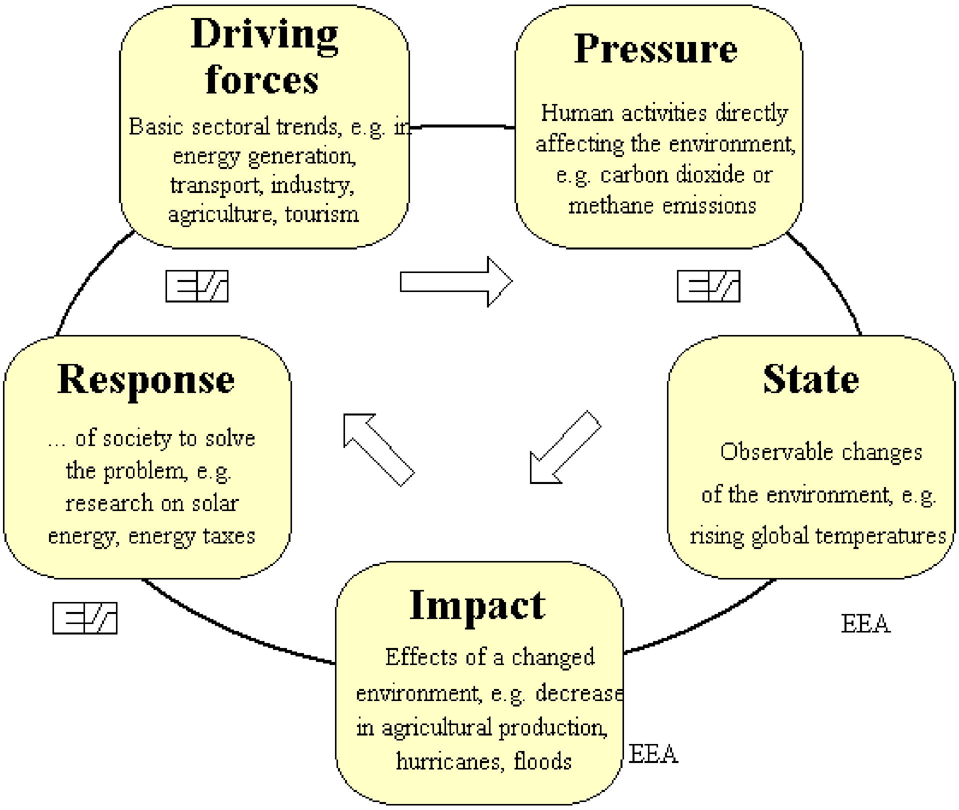

Figure 1. The Driving force-Pressure-State-Impact-Response model (Jesinghaus, 1999)

However, while the DPSIR framework deals with the changes in a system, it does not allow the system to be evaluated in terms of risk. Here the Source-Pathway-Receptor (SPR) model (DETR *et al.,* 2000) can be used. The SPR model provides a well-established framework for environmental risk assessment and here is explained using the concept of flood risk (Evans *et al*., 2002):

- *Sources* are weather events, or sequences of events that may result in flooding (e.g. heavy or sustained rainfall and marine storms);
- *Pathways* are the mechanisms that convey floodwaters that originate as weather events to places where they may impact on receptors. Pathways therefore include fluvial flows in or out of river channels, overland urban flows, coastal processes and failure of fluvial- and sea-defence structures or urban drainage systems;
- *Receptors* are the people, industries and built and natural environments that flooding affects.

Use of socio-economic scenarios for future policy analysis

The use of scenarios for policy analysis far into the future has been stimulated by the long-term uncertainties surrounding climate and socio-economic change. Socio-economic scenarios provide the context in which policy and practice will be enacted, including that for estuary management, and relate to the extent to which society may be impacted upon by environmental change or impacts, e.g. flooding. The Foresight Futures socio-economic scenarios (SPRU, 1999; OST, 2002) are intended to suggest possible long-term futures, exploring alternative directions in which social, economic and technological changes may evolve over coming decades (Figure 2). Under the Foresight Futures, one futures axis is concerned primarily with the scale of governance from global to local, while the other reflects values from those that are community orientated to individual consumerism.

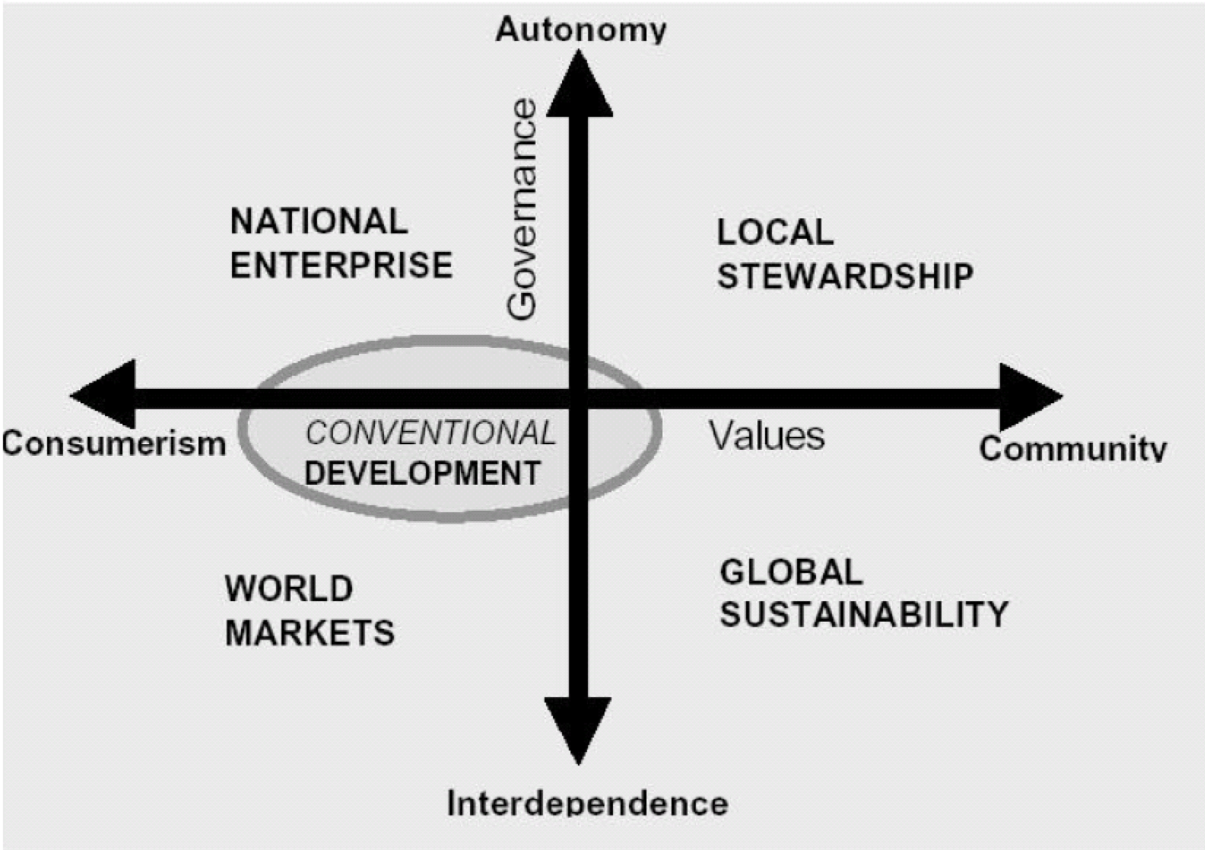

Figure 2. Foresight futures (OST, 2002)

References

DETR, Environment Agency, Institute for Environment and Health, 2000, Guidelines for Environmental Risk Assessment and Management. DETR. http://www.defra.gov.uk/environment/risk/eramguide/index.htm

EC, 1999, Towards environmental pressure indicators for the EU, European Commission, Luxembourg.

Evans, E., Ashley, R., Hall, J., Penning-Rowsell, E., Saul, A., Sayers, P., Thorne, C. and Watkinson, A., 2004, Foresight. Future Flooding. Scientific Summary: Volume I. Future risks and their drivers. Office of Science and Technology, London.

Jesinghaus J, 1999, A European system of environmental pressure indices, First Volume of the Environmental Pressure Indices Handbook: The Indicators. Part I: Introduction to the political and theoretical background, European Commission, Joint Research Centre, Institute for Systems, Informatics and Safety (ISIS), Luxembourg, Report No: TP 361.

Morris P, Therivel R, 2001, Methods of environmental impact assessment, Spon Press.

Office of Science and Technology, 2002. *Foresight Futures 2020: Revised Scenarios and Guidance*. Department of Trade and Industry, London.

SPRU, CSERGE, CRU, PSI, 1999. Socio-economic futures for climate impacts assessment, Final Report. University of Sussex.

Turner K, Paavola J, Cooper P, Farber S, Jessamy V, Georgiou S, 2002, Valuing nature: lessons learned and future research directions, CSERGE Working Paper, Centre for Social and Economic Research on the Global Environment, University of East Anglia, Norwich, UK, Report No: EDM 02-05, 30pp.

Turner RK, Adger WN, Lorenzoni I, 1998, Towards integrated modelling and analysis in coastal zones: principles and practice, Land-ocean interactions in the coastal zone (LOICZ), LOICZ International Project Office, Texel, The Netherlands, Report No: LOICZ Reports and Studies No.11, 122pp.

Turner RK, Pearce D, Bateman I, 1994, Environmental economics: An elementary introduction, Harvester Wheatsheaf.

WCED, 1987, Our Common Future, Oxford University Press, Oxford.