Implementing Sustainable Development: Systems and Signalling Problems

Ian Wills*

Introduction

The idea of "sustainable development" or "ecologically sustainable development" is a consequence of the perception that current systems of resource allocation don't adequately account for:

- interactions between the economy and the environment, given increased recognition of the impact of the environment on people's quality of life, directly and via its effects on production;
- the consequences of people's current use of the natural environment for future generations (Pearce, Markandya and Barbier 1989).

If sustainability is to be a sensible goal of human activity within economic-environmental systems, we must agree on its definition, be able to measure it, and have the knowledge and the tools to reliably manipulate the systems towards greater sustainability. This paper begins with reviews of the interactions between the economy and the environment, and of the alternatives for providing information feedback and possible control of economic-environmental systems. This leads to consideration of the implications of the nature of these systems for the implementation of sustainability policies. The ecologically sustainable development (ESD) policy process undertaken in 1991 is then evaluated from a systems perspective. Lastly, I consider whether the ESD process is likely to have helped us to understand economy-environment interactions, and thus improved our ability to manipulate economic-environmental systems for the benefit of Australians.

The Nature of Economic-Environmental Systems

In an earlier paper in this volume, Common (Figure 1, p.256) shows the relationships between the economy and the environment. The environment provides three types of services to people; it is a source of inputs to production, serves as a receptacle for our production and consumption wastes, and is a direct source of positive (e.g., wildlife observation) and negative (e.g. sewage pollution of beaches) satisfaction. The diagram indicates that these services are not independent; commonly, constraints of space and of biology mean that more of one is likely to mean less of the others.

In principle, these relationships might apply to an isolated subsistence village, an autarkic and environmentally isolated nation-state, or the global economy. Even at the lowest level of aggregation, combined economic-environmental systems will be very complex. On the economic side, complexity is due to the numbers of human agents and goods and services, the diversity of preferences and technologies, and the ability of people to learn from experience. In the case of the environment, complexity is a consequence of biological diversity and variations in the physical environment.

The Idea of Sustainability

The interactions between the economy and the environment prompt the question whether, over time, continued expansion of economic activity is consistent with ecological stability - with continued operation of the environmental system as we know it. A growing economy will use resource inputs and discharge wastes, progressively changing the environment on which it depends; the resulting resource depletion and degradation will endanger continued growth and gains in human welfare, unless the system incorporates feedback mechanisms leading to timely corrective actions.

Few economists or environmentalists are prepared to argue that modern economies, market or centrally planned, are sustainable in the fundamental sense that mutually consistent, stable and productive economies and environments can continue to

* Monash University.

co-evolve long into the future. As Pearce and Turner (1990) put it:

> "We do not have an *existence theorem* that relates the scale and configuration of an economy to the set of environment-economy interrelationships underlying that economy. ... (thus) our planning of the workings of economic systems - and 'planning' here includes letting the economy operate with free markets - risks the running down, the depreciation of the natural environment's functions. ... if we are interested in *sustaining* an economy, it becomes important to establish some conditions for compatibility of economies and their environments." (p.42 -itals. in original).

Pearce and Turner believe that existing economies do not incorporate feedback and control mechanisms capable of ensuring productive and stable functioning of their economic-environmental systems. Thus sustainability, as broadly defined above, requires new feedback and control mechanisms.

Alternative Feedback and Control Mechanisms

In economic systems, feedback and control mechanisms take the form of information signalled to the human decision makers, and incentives for people to respond to those signals. The purpose is to coordinate human production and consumption activities in circumstances where resources are scarce relative to people's wants. The crucial requirements for efficient coordination of economic activities are (i), producers and consumers must receive information which reflects all the economic-environmental consequences of their decisions, for others as well as themselves, and (ii), they must have incentives which cause them to respond to the desires of others.

In modern economies, the signalling and incentive mechanisms necessary for economic coordination involve various combinations of (i), customary behaviour, where recognition of signals and appropriate responses are instilled as part of the culture; (ii), central planning, involving the collection of information, its dissemination in the form of production and consumption plans, and a system of penalties and rewards related to adherence to plans, and (iii), markets and private property, involving market signalling of information and responses to those signals aimed at maximising the returns from one's property. It appears that none of the current combinations of these provide adequate signals and incentives to ensure stable and productive evolution of economic-environmental systems into the future. In terms of Common's diagram, some beneficial and harmful consequences of people's use of resources, discharges of wastes and enjoyment of the environment are either not signalled to decision makers, or they have no incentive to respond to others' environmental concerns.

Perrings (1987) goes further. He argues that, due to the complexity of economy-environment interactions which evolve over space and time, comprehensive signalling of the consequences of resource use is impossible. We simply do not know what the range of future outcomes of today's use of the environment will be, let alone the probabilities to attach to particular outcomes. In this situation:

> "Von Mises' peasant burning a candle to increase his crops is ... the same as the resource economist applying the Hotelling rule to optimise the rate of extraction of some mineral deposit. Neither ensure, ex post, the realization of optimal results, but both satisfy the requirement that we do our best. The difference between them lies only in the range of variables considered as relevant and the linkages believed to exist between those variables." (pp.115-16).

Pessimistic stuff for those aiming at optimal decisions over time. To get a handle on the validity of Perrings' dismissal of optimising, think of an input-output matrix representing all material transformations in an economic-environmental system. The more interactions within the system (ie., the denser the matrix), the more extensive the system is in space, and, most important, the greater the changes within a given time span in the structure of the matrix (rows, columns, coefficients) due to changes in the biosphere and in human technology and knowledge, the more likely it is that Perrings is correct, and the consequences of resource use cannot all be signalled accurately by any economic system.

Even though comprehensive and accurate signalling may be impossible, alternative economic sys-

tems, involving different signalling and incentive mechanisms, can still be assessed according to their likely ability to promote sustainability of economic-environmental systems into the future.

Implications for the Measurement and Implementation of Sustainability

Sustainability is a property of an economic-environmental system operating over time. Implementing sustainability at any level of human society involves several steps, each dependent on knowledge of how the economy and environment function and interact.

Specifying system boundaries

Lynam and Herdt (1989), discussing sustainability in agricultural production systems, point out that discussions of sustainability frequently ignore the fact that systems can be defined at various levels of aggregation, with lower-level systems embedded in higher-level systems. Thus a village economic-environmental system is embedded in a regional system, which is part of a national system, which is part of the global economic-environmental system. The proponents of sustainable development are often vague about the level of spatial aggregation at which sustainability criteria are to be applied. Yet the level of aggregation determines the amount of adding up of resources and products across differently-endowed regions. For example, if the criterion is maintenance of at least a constant stock of native forests, it makes a big practical difference whether sustainability is implemented at the local government or state or national level.

The exchange of resources and products, and the mobility of people and of resources and wastes, mean that no sub-global economic-environmental system is completely closed. This raises the difficult problem of determining whether an open system, which trades resources and products and discharges and receives residuals across its boundaries, is sustainable or not. Lynam and Herdt conclude that sustainability must be defined starting at the highest system level and proceeding down to less aggregate levels; they also point to the corollary, that the sustainability of a system is not necessarily dependent on the sustainability of all its subsystems. Is sustainability a meaningful concept for any economic-environmental system below the global level?

Once we have worldwide communication and voluntary exchange, it is possible that the only sustainability that makes sense is global sustainability. Yet in a world where everything was subject to exchange, Hong Kong and Singapore could claim to be sustainable systems by reason of exchanging man-made inputs for environmental services. An important virtue of markets and other institutions which promote exchange is that they make it possible for sub-systems where human activity is ecologically unsustainable to maintain stable and productive societies. Lynam and Herdt (1989) point out that international food markets and other food distribution mechanisms create sustainable food systems in food deficit areas (p.391).

Following the above logic, if all parts of the world were economically and environmentally interdependent, and signalling and incentive mechanisms worked perfectly throughout the global system, sustainability would be achievable at all system levels, since every producer and consumer would be informed of all the economic-environmental consequences of his or her actions, and would have the incentive to respond accordingly. On the other hand, if a sub-system of the global system (say Australia) has major interactions with other regions, and signals and incentives concerning those interactions are absent or inappropriate (say Australians ignore overseas concerns about our ozone depletion and extinction of fauna), the sub-system cannot be defined as sustainable; sooner or later, the cumulative effects of neglect of the interaction will lead to instability within the sub-system, due either to internal environmental problems or to pressure from other regions for it to change its ways.

It therefore appears that measuring sustainability and implementing sustainability policies makes sense for any lower-level system which either, (i), has no major input-output interactions with the rest of the world, or (ii), where the major consequences of interactions are signalled across the system boundaries, and producers and consumers have appropriate incentives to respond to the desires of

people outside their own system.

Deciding what parts of the system are to be held constant

A society pursuing sustainability will not countenance unlimited change. To do so would risk the institutions which bind its members together. So it is necessary to decide which parts of the economic-environmental system must be held constant, and which may be altered.

The preceding discussion of economic-environmental systems emphasised that they evolve as a result of people's production and consumption choices. Those choices are guided by information and incentives that serve as a feedback and control mechanism. It follows that sustainability of an economic-environmental system is dependent on the institutions it chooses to inform and motivate producers and consumers, which may include property rights over resources and products, customs based on received culture, markets, law and a court system, administrative rules and penalties, elections, and so on.

If sustainability of a society is dependent on the institutions of that society, it is almost certain that pursuit of sustainability will involve changes to some established institutions - for example, it may be necessary to convert some open access resources such as fisheries to government or private property. Modest institutional changes, as are often required to deal with local or regional pollution problems, are not too costly or painful for a society, usually because it is obvious ex ante what those changes will be. However preliminary modelling of the implementation of proposed national and global sustainability policies suggests that the required institutional changes may not be small in terms of their impacts on people. If societies are defined by their institutions, implementing sustainability could endanger a society in the process of attempting to save it.

A sensible way to deal with the institutional change problem may be for government to specify in advance which institutions of the society are to remain unchanged during the process. Of course, this may preclude sustainability, if the wrong institutions are held constant, but societies may be capable of learning from temporary errors of this sort. In any case, it is difficult to imagine any policy makers implementing sustainability without at least implicit protection of certain institutions.

Choosing a sustainability criterion

The sustainability concept has to be boiled down to an evaluation criterion which can be measured reliably for the chosen economic-environmental system. This requires knowledge of how the system functions; otherwise, it is impossible to know whether economic and social and environmental changes indicate movements towards or away from sustainability.

Because the sustainability of systems into the future is likely to be substantially determined by the choice mechanisms they employ, it may be better measured by these mechanisms - by the types of signals and incentives used to coordinate production and consumption - than by current levels of, or trends in, natural or man-made resources or production. This is not to deny that decision makers will usually make use of such information; however the way they use it will depend on how they interpret the signals, and their individual incentives, both of which are influenced by the type of economic system in which they find themselves.

Measurement of the effectiveness of alternative signalling and incentive mechanisms involves comparative institutional analyses, drawing on ideas from the fields of 'market failure', management, public choice and political science. The extent to which alternative economic signalling and incentive systems encourage sustainability will depend on factors such as: precision in specification, monitoring and enforcement of the property rights of private and public decision makers (in part dependent on costs of exclusion and measurement for natural resources and amenities and pollutants); the ability of participants in market and political processes to distort information about the benefits and costs of alternative uses of resources; and the electoral and constitutional constraints on elected and bureaucratic decision makers. The process of comparison could begin by examining alternative signalling and incentive mechanisms for each of the main economy-environment linkages shown in

Common's diagram — resource flows, waste flows and amenity services.

Central planners aiming at sustainability in centrally-planned or mixed economies will require summary criteria to indicate progress towards sustainability. The most frequently suggested sustainability indicators have been adjusted values of net income, as estimated in the national accounts (see Common 1991), and the total stock of natural capital (Pearce and Turner 1990). Both these indicators involve valuation problems, partly due to the absence of market valuations for some resources, but also because, in the absence of an understanding of the total economic-environmental system involved, there is no way of knowing whether the actual or surrogate prices used to add up different resources and products are consistent across the system as a whole (Common 1991). In addition, the stock of natural capital is only a direct determinant of human consumption and welfare where it renders amenity services - its major contribution is indirect, via production of goods and services. If sustainability is about human welfare, one needs a strong case for using an indirect measure, as opposed to a criterion based on all the goods and services which make a direct contribution to welfare.

Determining and implementing sustainability policies

As in the case of measurement of sustainability, this requires knowledge of how the chosen system functions. If economic-environmental systems are poorly understood, the above steps will not be possible. The system will be specified only at the global level, and it will be unclear which institutions are necessary to sustainability, what criterion is appropriate to measure it and what sustainability policies are required.

In this situation, the only plausible means of moving the global system towards sustainability is to concentrate on improving worldwide information signalling and incentives.

The Relevance of the ESD Process

How well does the ESD process correspond to the implementation process just described? Consider the above steps in turn.

Specifying system boundaries

The initial political decision to divide the task by industry sectors, rather than starting with an examination of economic and environmental interactions Australia-wide, pre-empted community discussion about the nature of such interactions, and hence the appropriate focus and scope of sustainability policies. None of the Working Group Reports, including the Working Group Chairs' Report on Intersectoral Issues (1992), has addressed the question of specifying system boundaries.

The Agriculture Report (ESD Working Groups 1991) does discuss agricultural systems and different levels of systems. However the systems perspective in the Agriculture Report does not carry over into its discussion of sustainability issues in agriculture. Individual resource use issues in agriculture are treated as at least partly separable among themselves, and substantially separable from activities outside agriculture. Yet agriculture is implicated in major environmental problems, such as salinity and algal blooms in the Murray-Darling, which impact on people in other sectors. For water and chemical use, systems based on river catchments may be more appropriate than sectorally-based systems.

Of course it is not necessarily more appropriate to specify economic-environmental systems by catchments than by industry sectors. The point is that systems should be chosen after careful studies of the product, resource, waste and environmental amenity linkages throughout the national economy; as explained above, a system can sensibly be treated as separate if it has no important input-output linkages with the rest of the nation, or if the benefits and costs of such linkages are signalled across the system boundaries. As suggested by Lynam and Herdt (1989), this process should begin at the highest system level and work down. Using this procedure, it is possible that the Murray-Darling Basin would prove a more sensible system for implementing sustainability than the agricultural sector. Since the ESD process did not address the system boundaries issue, it is uncertain whether the

recommendations emerging from the separate Reports would be consistent if implemented nationwide. Perhaps more important, the Working Groups have missed the opportunity to educate the public about the extent and importance (or unimportance) of non-market linkages across the nation.

Deciding what is to be held constant

The ESD Reports do not spell out which institutions of the society are to remain unchanged in implementing sustainability. The division of the ESD task by industries, and the composition of the Working Groups, with members representing governments, industry, unions and conservation groups, suggest that the ESD discussions have proceeded on the basis that the major features of the institutional status quo will remain. The nine industry Reports and the Intersectoral Issues Report do not include any recommendations for major changes in property rights in resources, or changes in the respective responsibilities of the Commonwealth and the States, or major changes in the structure of Commonwealth departments, yet changes of such nature might well be expected as means of improving signalling and incentives in energetic pursuit of sustainability (ESD Working Groups 1991). Consistent with their emphasis on the institutional status quo, the Reports pay greater attention to the incentives and information (or lack of it) of private than of public decision makers, though both contribute to environmental outcomes.

The Agriculture Report devotes far more space to descriptions of environmental problems, and to discussion of their on-farm causes, than to the incentives and information of agricultural decision makers, who include not only farmers, but also politicians and officials who define and enforce property rights and often determine farm input and product prices. It also pays more attention to farm decision making than to political and bureaucratic decision making. This leaves the unfortunate impression that agriculture's environmental problems are more often the result of 'bad management', than logical responses to the information farmers receive and the incentives they face - for example, settlement blocks which are too small, and irrigation water provided at less than its opportunity cost.

Choosing a sustainability criterion

The ESD Reports do not propose single measures of sustainability. On the contrary, the Working Group Chairs have dodged the issue:

> " ... what constitutes sustainable development in a specific context can often by determined only in that context. ... ESD can thus be seen in a sense as a frame of mind, a conceptual framework against which things need to be assessed, rather than a precise standard. Assessments are likely to be based on judgements, including political judgements, for some time to come." (ESD Working Group Chairs 1991, pp.2-3).

This is convenient for politicians who prefer choosing their own performance criteria to having them chosen by others. In defence of the Chairs, the Working Groups could hardly choose a single measure, because the Prime Minister's instructions specified multiple goals of ESD.

From a systems point of view, the Working Groups do not have a basis for establishing sustainability criteria, since the extent of the economic-environmental systems they are dealing with, and the functioning of those systems, have not been systematically examined. Sustainability of the individual industry sectors makes no sense, since each has major interactions with the rest of the nation, including environmental interactions where appropriate signals or incentives are absent or inadequate.

Determining and implementing sustainability policies

With an incomplete understanding of how the economy and environment interact, the ESD policy recommendations are inevitably based on a 'partial equilibrium' analysis of environmental problems - the identification of immediate causes of problems and measures to eliminate or reduce those causes. However, because the recommendations focus on immediate causes, their impacts on other parts of the economy and environment, and their consistency across sectors, are unclear.

Most of the recommendations in the Agriculture Report are designed to improve the information available to farmers and other agricultural decision

makers, or to increase their incentives to respond to the concerns of others. In other words, the recommendations are directed at solving particular externality and public good problems, rather than manipulating complete systems. Examples include recommendations for provision of additional information to agricultural decision makers, and the recommendations of full transferability of water rights and of government payments of fees to land holders managing conservation areas on private land.

Has the ESD Process Helped?

The initial decision to base the Working Groups on industry sectors was made on the basis that it would encourage detailed input from interested parties and facilitate ESD policy making (ESD Working Group Chairs 1992, p.v). It also signalled to concerned parties that the Commonwealth was not contemplating major changes in the institutional status quo. The price has been to divert attention away from a better understanding of interactions between the economy and the environment Australia-wide.

Assuming that the implementation of ESD only makes sense where the functioning of economic-environmental systems is well understood, the ESD policy process will have little positive effect on the management of economy-environment interactions in the future. This is not to deny that it has probably raised community consciousness about economy-environment interactions and this generation's responsibility to future generations, or that Working Group participants have benefited from the direct dialogue with members of other interest groups. However without greater understanding of economic-environmental systems, raised consciousness is unlikely to produce solutions to environmental problems.

Given the composition of the Working Groups and an emphasis on reaching consensus, it is unsurprising that the recommendations which have emerged represent only incremental changes in existing policies, plus recommendations to collect more information and improve existing management. The disappointing result is that the ESD process is unlikely to have a substantial effect on the thinking of the major interest groups involved - politicians, bureaucrats, industry, economists, greens - because most of the recommendations would cover familiar territory, where group positions are well staked out.

If Perrings (1987) is correct in arguing that economic-environmental systems are so complex that it is impossible to know what actions will promote sustainability, then, as previously argued, the choice mechanism itself may be the best sustainability indicator. Because the ESD Reports concentrate on incremental improvements in signalling and incentives, the Working Groups' strategy is broadly consistent with the idea of moving towards sustainability by progressive improvements in society's choice mechanisms. This may be a conscious incremental strategy, based on the Groups' recognition of their limited knowledge. However, since the Reports do not discuss the choice between a holistic or systems approach to implementing sustainability and the incremental approach which was adopted, this seems doubtful.

References

COMMON, M. (1991), "Natural Resource Accounting and Sustainability", Intersectoral Paper 91/2, Ecologically Sustainable Development Working Groups, Canberra.

ECOLOGICALLY SUSTAINABLE DEVELOPMENT WORKING GROUPS (1991), *Final Report - Agriculture*, AGPS, Canberra.

ECOLOGICALLY SUSTAINABLE DEVELOPMENT WORKING GROUPS (1991), *Final Report - Executive Summaries*, AGPS, Canberra.

ECOLOGICALLY SUSTAINABLE DEVELOPMENT WORKING GROUP CHAIRS (1992), *Intersectoral Issues - Report*, AGPS, Canberra.

LYNAM, J.K. and HERDT, R.W. (1989), "Sense and sustainability: sustainability as an objective in international agricultural research, " *Agricultural Economics* 3, 381-398.

PEARCE, D., MARKANDYA, A. and BARBIER, E. (1989), *Blueprint for a Green Economy*, Earthscan, London.

PEARCE, D. and TURNER, R.K. (1990), *Economics of Natural Resources and Environment*, Harvester Wheatsheaf, Hemel Hempstead.

PERRINGS, C. (1987), *Economy and Environment*, Cambridge University Press, Cambridge.