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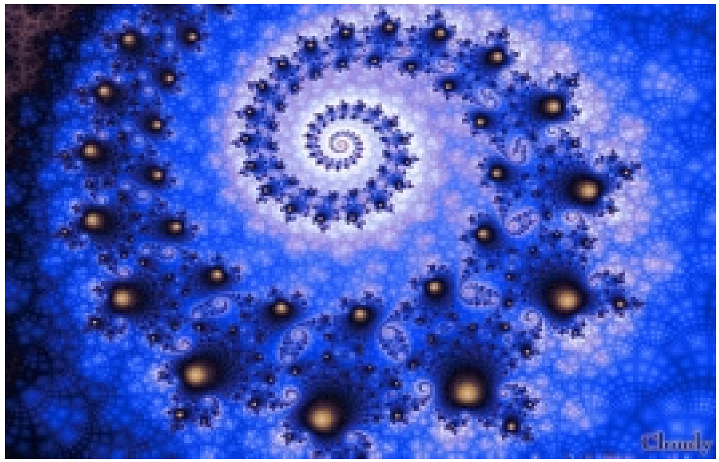

Conceptualising and Responding to Complexity

by Giuseppe Munda

Series Editors: Clive L. Spash & Claudia Carter

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This policy research brief draws on presentations and contributions made at the first workshop of the Concerted Action on Environmental Valuation in Europe (EVE) entitled 'Methodology and Approaches to Issues of High Complexity' held at the Autonomous University of Barcelona, Spain, 8–10 January 1999, organised by Giuseppe Munda and Joan Martinez-Alier.

This policy research brief was written by Giuseppe Munda and produced by the series editors Clive L. Spash and Claudia Carter.

Front cover: Fractal image by Stephen Reynolds. Fractal is a geometric pattern that is repeated at ever smaller scales to produce irregular shapes and surfaces that cannot be represented by classical geometry. Fractals grew out of the goal of mathematicians to completely describe the world using standard geometrical expressions.

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Overview

Multiplicity of scenarios and interactions, presence of ignorance and uncertainty, and conflicting interests and advice are all part and parcel of environmental management and policy. Accepting the complexity of natural and social systems is the first step in understanding how sustainability in human–environment interactions needs to be advanced (pp. 4–6). A second step is to choose appropriate management and policy tools: those that address rather than ignore complexity (pp. 7–14). Multiple criteria evaluation techniques, for example, have the potential to take into account conflictual, multidimensional and uncertain properties of decisions. They can therefore provide insights into the nature of conflicts and complexity and facilitate the process of reaching political compromises by explaining divergent values and increasing the transparency of the decision process (pp. 11–12).

As with people, assessment tools have a history. Becoming more knowledgeable and aware of the assumptions they are built upon and the context in which they have been developed will aid understanding of their specific advantages and limitations. Cost-benefit analysis (CBA) is a popular and well-established method in environmental policy although much attention within CBA focuses upon technical refinement while neglecting the restrictions implied by the methodology (pp. 7–8). Multiple criteria approaches appear more useful in the struggle to accept and address complex environmental problems, and may be inclusive of other approaches such as CBA and deliberative processes.

Several participatory processes for environmental valuation have been developed, such as consensus conferences, focus groups and citizens' juries. While they are in principle capable of addressing a wide range of values and scenarios, they too have their limitations. The need is to explore management alternatives. A shift away from focusing on the outcome and towards the decision process seems necessary (pp. 13–14). Thus participatory evaluation processes are currently seen as offering hope for assessing and managing complex situations.

Scientific assessments can be formally correct but still provide only a limited view of interactions.

Physical and Social Systems Complexity

The complexity of physical and social systems can be viewed in two ways. First, systems (due to increasing human impact, the rate of technological change and globalisation) are apparently becoming more complex. Second, attempts at understanding physical and social systems can be approached from the viewpoint of complexity, i.e. studied from multiple perspectives where a range of policy and management options is recommended.

Scientists coming from different disciplines of the natural and social sciences commonly fail to specify either the assumptions under which their analysis can provide valid indications or the goals that generated the choice of their particular type of analysis in the first place. Box 1 describes a case where assumptions and goals which were taken for granted by experts resulted in dramatic differences in policy recommendations.

Box 1: Complexity in Social Perspectives

At an international conference[1] the problem of food security for humankind in the 21st century was debated with the aim of reaching a consensus on policy recommendations. Six policy suggestions were provided within three fields: (i) food policies within countries; (ii) international trade policies; and (iii) social policies dealing with the role of women. Pairs of contrasting recommendations were given in each one of the fields, although all perfectly sound and legitimate relative to the viewpoint taken:

(i) Food policies – One suggestion was to keep the prices high, the other to keep the prices low.
(ii) World trade – One suggestion was to reduce agricultural imports from the South while the other was to increase exports from the South.
(iii) Role of women – One suggestion was to preserve local heritage while the other was to fight local customs.

Scientists coming from different social contexts (e.g. industrial *versus* agricultural economies) based their analyses on descriptions that generated different readings and explanations and which affected the policy recommendations. Scientists operating in industrialised economies tended to suggest policies aimed at preserving the current steady-state (keeping prices low, stopping trade, keeping cultural diversity at any cost); whereas scientists coming from less industrialised countries suggested policies aimed at changing, as fast as possible, the current situation of the steady-state (i.e. boosting the evolutionary rate of the system).

[1] International Conference on Food Security, Zurich, Switzerland, 9–10 October 1996, as reported by Mario Giampetro. Source: Cardoch and Munda (1999), pp. 3–9.

The example illustrated in Box 1 raises several important points:

- Scientific assessments can be formally correct (i.e. consistent with a declared set of axioms and procedures) but still provide only a limited and biased view of social and/or environmental interactions. When dealing with complex systems operating in parallel on several hierarchical levels the existence of contrasting 'correct' scientific assessments is unavoidable.
- Policy discussions based on assessments and models derived from adopting only one type of description – a particular scientific mapping – are misleading, and fail to clarify the issues under discussion. Non-equivalent descriptions of a problem are required to reflect alternative perspectives and catch side-effects occurring on different scales. This will recognise that what is deemed good on one scale (e.g. a household will appreciate paying less taxes) can be bad on another (e.g. public services will suffer as community revenues fall).
- There is an unavoidable political dimension in any scientific description in as much as some decision is required regarding how to frame the problem. A scientific procedure cannot decide *a priori* how to define a system (e.g. its scale, boundary, behaviour, interactions). This introduces epistemological bias in that any scientific description will select (i) what the system is, (ii) what it does and (iii) what variables should be considered as relevant for describing its behaviour.

Example 1: Sustainability Indicators for Urban Areas

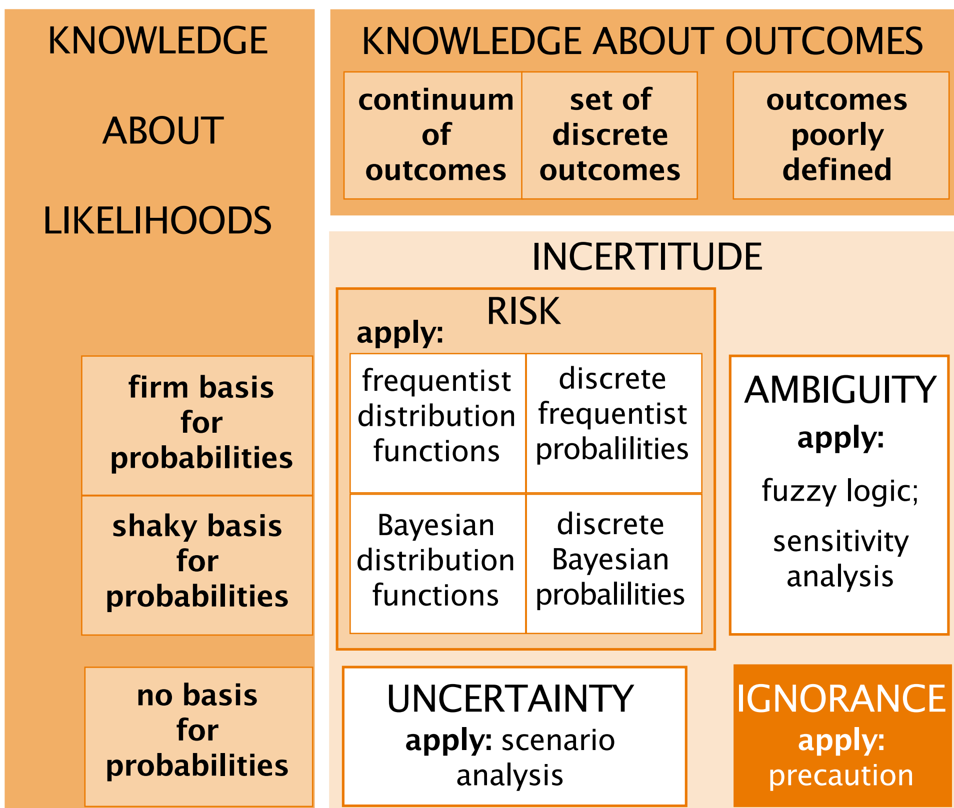
The multidimensional representation of an urban system requires the use of a set of various indicators and indices which are conflicting and incommensurable (i.e. they cannot be judged by the same standard). However, behind a list of indicators there is always an history of scientific research and political controversy. Moreover, one should note that a list of indicators is far from being a list of targets and lower limits for those indicators. These would depend upon the social evaluation processes and reflexive practices, which lead to the choice of concrete indicators and target setting. Thus, choosing any particular operational definition for value involves making a decision about what is important and 'real'; other definitions will reflect the commitments of other interest groups and social perspectives.

Photo: C. Spash

Types of Uncertainty

A key feature related to the provision of information and complexity concerns uncertainty. Where various future states of the world are possible, dependent upon a given action, stochastic uncertainty exists. Such uncertainty has been thoroughly studied in probability theory and statistics. Where uncertainty does not concern the occurrence of an event but the understanding or description of an event itself, then ambiguity, or 'fuzzy' uncertainty, exists. This sort of situation is readily identifiable in complex systems. A reflexive complex system, characterised by subjectivity, incompleteness and imprecision will be subject to fuzzy uncertainty. Little is known about ecological processes or their sensitivity to stress factors such as various types of pollution. Thus a wide spectrum of uncertainty concepts can be defined and these are summarised in Figure 1.

Figure 1. Risk, uncertainty and ignorance.
Source: Stirling 1998, p. 102



Complexity and Environmental Valuation

No single perspective can fully encompass the whole system or issue at hand.

Environmental policy and science, including economic science, have to address complexity in different contexts. Context changes with the length of time frames, the inseparability of scales and uncertainty. When moving from the scientific to the social dimension, a plurality of perspectives, conflict and dissent are found, along with the unpredictability of outcomes. For example, climate change modelling uses mathematical representations of selected physical properties of the Earth's climate. While legitimate in its own terms, a model of the Earth's climate is insufficient to represent and predict all climate properties. Similarly, a purely social or institutional perspective would prove too narrow to capture the complexity of the climate change issue. No single perspective can fully encompass the whole system or issue at hand. In general, while reductionism has proven a useful methodological tool, abstracting from the many perspectives which are relevant to any given environmental problem can prove misleading.

Box 2: Awareness of Complexity

The classic Victorian science-fiction and social parody *Flatland* by E.A. Abbott provides a useful analogy of multiple dimensions and awareness of complexity as illustrated by Funtowicz and Ravetz: "There, the inhabitants of spaces with more dimensions had a richer awareness of themselves, and also could see beyond and through the consciousness of the simpler creatures inhabiting fewer dimensions. At this stage it is not unfair to reveal the denouement of the story, namely that the Sphere of three-dimensional space was just as limited in his consciousness as were the pointlanders and linelanders; for he felt existentially threatened by the attempted generalization of reality to dimensions beyond three. By the use of the metaphor of phase space, [... Funtowicz and Ravetz] hope to enable people of our time to become more aware and then transcend their own defensive limitations and imagination." (pp. 574–575).

Source: Funtowicz, S. and J.R. Ravetz (1994) 'Emergent Complex Systems', *Futures,* 26(6): 568–582.

Economic valuation studies have become popular as a means of putting environmental resources – their degradation, conservation and restoration – into the equation of economic 'development' and on the agenda of policy-making. However, environmental values can be a combination of many different values, including social, cultural, ethical, religious and financial. Thus, accepting the multidimensionality of environmental valuation means accepting complex descriptions.

Analytic techniques such as **cost benefit analysis (CBA)** lose a considerable amount of information in trying to reduce the environmental complexity to a unique and unidimensional value. The use of precise, quantitative data based on monetary valuations (such as market prices) where complexity and uncertainty are pervasive can be misleading. There is a certain degree of comfort associated with precise numbers despite the fact that the unidimensional answer can lack any actual relevance, i.e. being precise but wrong. Quantitative data is often erroneously regarded as more rigorous than qualitative information. By presenting results in monetary terms, this misconception is reinforced by the message that quantitative results are 'true' representations while qualitative data are less important and more uncertain.

Similarly, from a theoretical perspective, the **optimising principle** is elegant since it provides an unambiguous tool for evaluating alternative strategies on the basis of their contribution to community welfare. From an operational point of view, the value of the optimising approach can be rather limited, because the specification of a community welfare function requires complete information about all possible combinations of actions, and the relative trade-offs between all actions and constraints. Such information is generally unavailable in the context of environmental decision-making and, in any case, the validity of the proposed trade-offs is likely to be contested by affected interest groups, as has been empirically established by the literature on lexicographic preferences (see Spash 1998).

Box 3: Cost-Benefit Analysis of the Galapagos Islands and the Dutch Wadden Sea

As monetary valuation is biased toward use value, the type of use prescribed to each place thus affects decisively final values. For example, a national park under a special regime of restricted use (e.g. the Galapagos Islands) will by definition be given a lower value for its environmental functions. The current economic profits of fisheries (fish and shrimp) will determine the functional values in terms of uses as a nursery or for aquaculture (e.g. the Dutch Wadden Sea). Since fishing is strongly restricted in the Galapagos Islands national park, its final monetary value will tend to be assessed as low, independently of local biological productivity. Paradoxically, environments having a restricted regime of use, because they are considered more valuable, will tend to be given a lower monetary value.

Source: Muradian, R. (1999) 'Is monetary valuation of the environment ecologically sound?' In Cardoch and Munda (1999), pp. 32–35.

Example 2: Bias in the Valuation of Ecosystems

Environmental valuation studies based upon a narrow utilitarian approach emphasise population density and the kind of human settlements in areas bordering a site will play a decisive role in determining 'final numbers'. Remote and isolated ecosystems are treated as being less important and easily monetisable values are emphasised (e.g. flood prevention, commercial fisheries, tourism). Thus, the closer the ecosystem is to human settlements, the larger the value it may receive although this is contrary to a criterion of environmental valuation for a pristine or virgin ecosystem being more valuable than an altered one. Environmental functions dealing with direct human use seem to be overvalued in monetary assessments simply because these functions are measurable. This is illustrated by the case study comparing the 'value' of the Galapagos Islands with that of the Dutch Wadden Sea described in Box 3.

Complexity in Applying Assessment Methods

The traditional analytical approach – implicitly or explicitly reducing all goods to commodities – can be recognised as one perspective among several. This may be legitimate as a point of view and as a reflection of existing power structures, but is an incomplete picture. "The issue is not whether it is only the marketplace that can determine value, for economists have long debated other means of valuation; our concern is with the assumption that in any dialogue, all valuations or 'numeraires' should be reducible to a single one-dimension standard" (Funtowicz and Ravetz 1994, p. 198). In asking questions, a new problem of valuation arises where measurements cannot pretend to be independent of methodology and ethics.

Measurements cannot pretend to be independent of methodology and ethics.

Scientifically sound conversion factors, that can transform disparate features (e.g. land, energy, money) into one common term without distorting the original value concept are impossible to find. This is a problem which applies equally to natural science approaches as it does to socio-economic ones. For example, the concept of an ecological footprint is a case of ecological reductionism where socio-economic and cultural aspects are completely neglected. Thus, to transform the centre of Rome into a wooded area would improve the ecological footprint of that city but ruin its cultural and socio-economic heritage (see Munda 1999).

In practical terms, intrinsic complexity in appraisal can translate into a wide variability of results depending on factors, such as the boundaries, chosen for the observed system. For example, studies assessing the environmental externalities of coal power show enormous variability in the monetary estimates of pollution damages. As shown in Figure 2 estimates vary by a factor of more than 50 000. This illustrates that evaluations are structured and bounded by assumptions (and by considerations of the quality of the study) that have profound influence on the results. The choice of analytical conventions then determines the rank ordering. Yet the choice of one convention is often no more reasonable than another.

Awareness of the consequences of assumptions requires transparency with regard to:

- mathematical and descriptive properties which make the models used conform to given requirements;
- the way such models are used and integrated in a decision process.

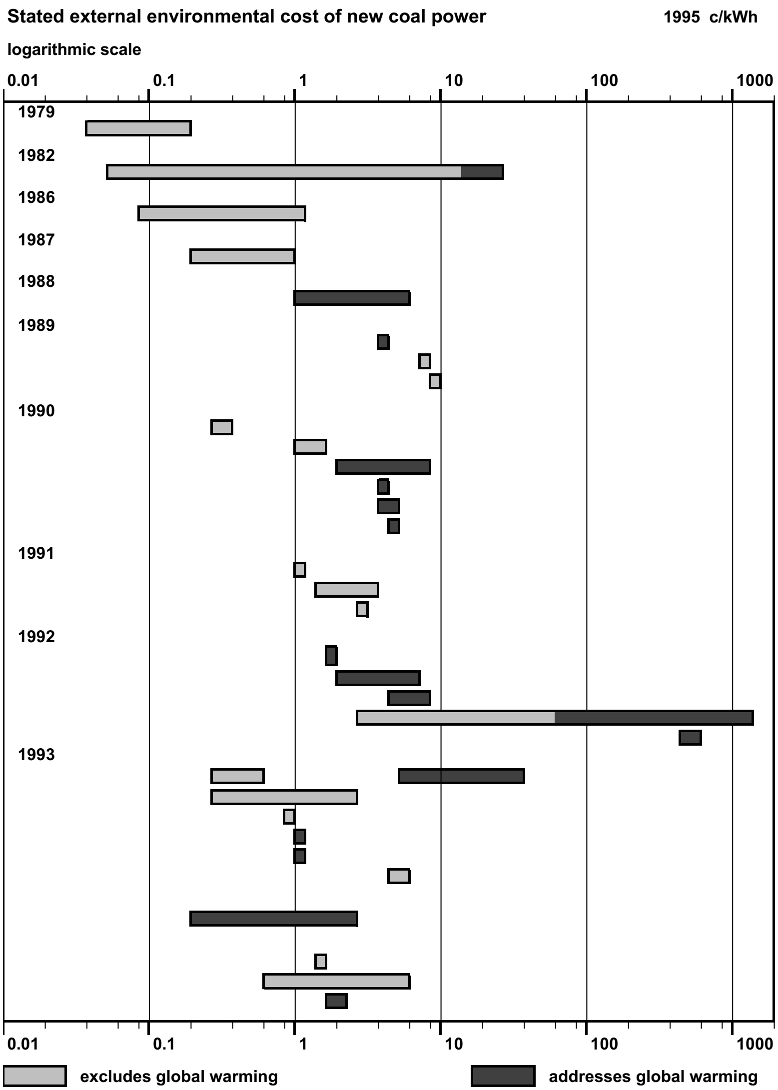


Figure 2. Variability in valuation results for energy.
Source: Stirling 1997, p. 530

This new way of looking at rationality implies a new concept of quality. What we can now evaluate is the process leading to a given decision, not the final product, i.e. the final decision. The challenge is to improve the quality of the decision process.

To summarise, non-equivalent descriptions of the same object mean that the value perspective, the values and the standards generated during the evaluation process, shift depending on the description used. Such a shift implies that reducing those values to a single measure, be it monetary or biophysical, is highly misleading. The fact that the same physical environment has a multiplicity of users and perspectives also makes a unique ordering of values impossible. The environment is a site of conflicts among competing values and interests and among different groups and communities that represent them. Thus a consensus will often be unobtainable requiring that the possibility of irreconcilable differences be recognised and catered for by promoting a plurality of approaches.

Multicriteria Processes for Evaluation

Evaluation is not a one-shot activity but a highly dynamic learning process. Judgements regarding the political relevance of alternatives or impacts may present sudden changes and hence require a process that is flexible and adaptive. The evaluation exercise should be framed in a way to allow the redesign of management alternatives and outcomes based on results from the various stages and feedback from the stakeholder participants. Key factors are to question assumptions, conduct sensitivity analyses on models and include knowledge gained from previous analyses in subsequent iterations.

The peculiar characteristic of multicriteria models is that action 'a' may be better than action 'b' according to one criterion and worse according to another. Optimising all the criteria at the same time is impossible. As a consequence, the aim is to find compromise solutions using an aggregation procedure (the so-called 'multicriteria method'). The term 'compromise solution' is used here in a technical sense, i.e. a solution as a balance among different conflicting criteria but not necessarily a compromise among different actors.

The steps of a participative multicriteria evaluation process, based on the so-called NAIADE method (Munda 1995), are schematised in Figure 4 on page 14. The NAIADE method (**N**ovel **A**pproach to **I**mprecise **A**ssessment and **D**ecision **E**nvironments) is a discrete multicriteria method. NAIADE uses a fuzzy conflict analysis procedure. A matrix is used showing the impacts of different courses of action on each different interest/income group and a fuzzy clustering procedure indicates the groups whose interests are closer in comparison with the others. The impact or evaluation matrix (see Box 4) may include crisp, stochastic or fuzzy measurements of the performance alternatives with respect to evaluation criteria. Thus it is very flexible for real-world applications.

BOX 4: Multicriteria Representation

A typical multicriteria problem with a discrete number of alternatives may be described in the following way: **A** is a finite set of **n** feasible actions (or alternatives); **m** is the number of different points of view or evaluation criteria g_i **i=1, 2, ... m** considered relevant in a decision problem, where the action 'a' is evaluated to be better than action 'b' (both belonging to the set **A**) according to the i-th point of view if $g_i(a)>g_i(b)$. In this way a decision problem may be represented in a tabular or matrix form. Given the sets **A** (of alternatives) and **G** (of evaluation criteria) and assuming the existence of **n** alternatives and **m** criteria, it is possible to build an **n x m** matrix **P** called evaluation or impact matrix whose typical element p_{ij} (i=1, 2, ..., m; j=1, 2, ..., n) represents the evaluation of the j-th alternative by means of the i-th criterion.

Example of an Impact Matrix

	Alternatives (A)				
Criteria	Units	a_1	a_2	a_3	a_4
g_1		$g_1(a_1)$	$g_1(a_2)$	.	$g_1(a_4)$
g_2		.	.	.	.
g_3		.	.	.	.
g_4		.	.	.	.
g_5		.	.	.	.
g_6		$g_6(a_1)$	$g_6(a_2)$	.	$g_6(a_4)$

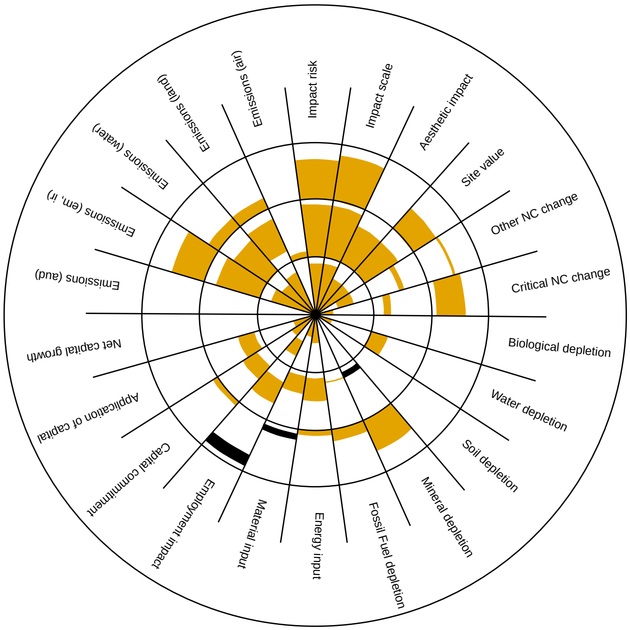


Figure 3. Example of a multicriteria assessment map showing the comparison between building a nuclear power station and a major energy conservation programme. Orange bars show criteria upon which the energy conservation scheme has a more favourable rating, and black bars show the converse.
Source: Spash and Clayton (1997) 'The maintenance of natural capital: Motivations and methods'. Philosophy and Geography I: 143–174.

Sometimes, the multicriteria ranking and the equity ranking may be divergent, mainly because the information provided by these rankings is different in nature. The **multicriteria ranking** can be considered more 'technical'. That is, alternative options are evaluated according to a set of socio-economic and environmental criteria that were chosen by decision-makers or affected actors themselves to reflect actors' values (or preferences or interests). However, the determination of the criterion *scores* is independent of their preferences. For example, an interest group can accept the use of a criterion measuring the effects of various alternatives on employment, but the determination of the result cannot be (at least completely) controlled by them (the same applies, for example, to environmental impact indicators). Moreover, the ranking is a consequence of all the criteria considered simultaneously. The **impact score** of each alternative should be determined by the affected groups themselves (or at least represent the direct consequences for the groups). Value judgements have to be made which will affect the policy analysis. For example: Should all actors have the same importance/weight? Should the ranking be obtained by majority principle? Should some veto power be conceded to minorities? Are income distribution effects important?

To summarise, NAIADE can give the following information:

- ranking of the alternatives according to the set of evaluation criteria, i.e. compromise solution(s);
- indications of the distance of the positions of the various interest groups (i.e. possibilities of convergence of interests or coalition formations);
- rankings of the alternatives according to actors' impacts or preferences.

NAIADE can be used to combine conflict analysis procedures with multicriteria evaluation results. This can assist policy-makers to identify policies that help reach a certain degree of consensus or that is more equitable for affected groups. In general, while formal evaluation tools cannot *solve* the conflicts, they can help provide more insight into the nature of conflicts and ways of arriving at policy compromises, thereby increasing the transparency of the evaluation process. They can also be considered as learning tools helping the actors to become aware of their own assumptions and preferences as well as those of the other actors.

Participatory Processes for Environmental Valuation

In order to form environmental policy under conditions of complexity 'extended peer communities' could be particularly appropriate; an 'extended peer community' consisting not only of persons with some form or other of institutional accreditation, but also of all those with a desire to participate in the resolution of the issue. They are already being created, in increasing numbers, either when the authorities cannot see a way forward, or know that without a broad base of consensus no policies can succeed. Methods include citizens' juries, focus groups and consensus conferences. While the forms and powers of such methods are varied, all have one important element in common: they assess the quality of policy proposals, including a scientific element, on the basis of whatever science can be mastered during the preparation period. Verdicts arising from such methods have some degree of moral force and hence political influence. Here the quality is not merely in the verification, but also in the creation; as local people can imagine solutions and reformulate problems in ways that the accredited experts, with the best will in the world, find difficult (see Policy Research Brief 10).

This implies a move from substantive rationality to procedural rationality. In procedural rationality, the process is evaluated. Since an optimal solution is nonexistent, the important factor is the quality of the process leading to the decision. Optimal solutions are hence replaced by satisfactory solutions (Simon 1983).

Box 5: Setting Environmental Standards

The UK Royal Commission on Environmental Pollution in its 21st Report, on Setting Environmental Standards, makes several observations and recommendations reflecting this new understanding.

On uncertainty:

9.49: *No satisfactory way has been devised of measuring risk to the natural environment, even in principle, let alone defining what scale of risk should be regarded as tolerable;*

on values:

9.74: *When environmental standards are set or other judgements made about environmental issues, decisions must be informed by an understanding of peoples' values ...;*

on extended peer communities:

9.74 (continued): *Traditional forms of consultation, while they have provided useful insights, are not an adequate method of articulating values;*

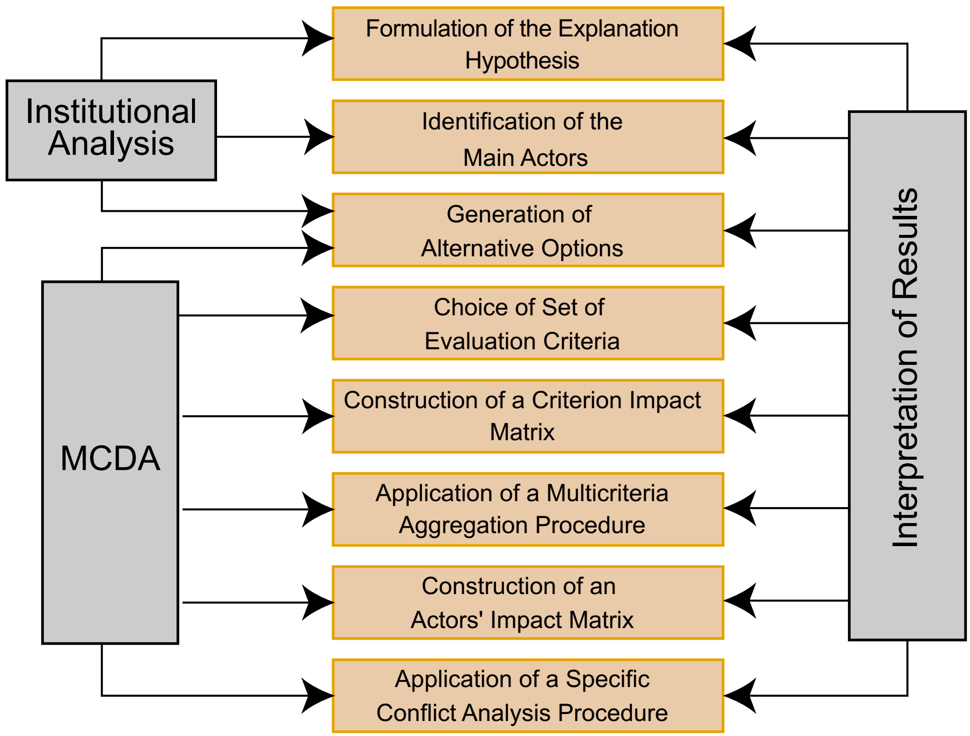
on a plurality of legitimate perspectives:

9.76: *A more rigorous and wide-ranging exploration of people's values requires discussion and debate to allow a range of viewpoints and perspectives to be considered, and individual values developed.*

Source: Royal Commission for Environmental Pollution (1998), pp. 133–136.

The steps of an overall participative multicriteria evaluation process might be characterised as in Figure 4. The relationship between MCA and participatory processes is further elaborated in Policy Research Brief 10.

Figure 4. Scheme of the evaluation process.
Source: O'Connor *et al.* 1998, chapter 5, p. 12



To summarise, good processes for environmental valuation should be able to address and deal with:

- different requirements and interests with regard to environmental systems and their quality;
- social and biophysical irreversibility;
- scientific uncertainties and conflicting interests over changes in environmental quality; and
- issues of fairness in distributions socially and relating to geographical and time scales.

Policy Recommendations

Considering complexity from an operational point of view, any environmental policy process should be able to:

- recognise and acknowledge the inherent subjectivity of fundamental framing assumptions of any scientific method;
- ensure analytical rigour *and* political legitimacy of the evaluation tools used;
- provide a set of non-equivalent descriptions of the change in environmental quality considered. This set of non-equivalent descriptions should be able to reflect on each of the relevant space-time scales involved and the relevant viewpoints/concerns of major interest groups;
- discuss possible scenarios by establishing links between changes occurring on different scales reflecting how the consequences of the hypothesised change will be perceived by different interest groups (e.g. farmers, consumers, local communities, other social groups) and affect outcomes (e.g. for future generations, individual species, local ecosystems, biosphere as a whole);

see also Policy Research Briefs 4, 6 and 7

- weigh trade-offs when dealing with non-equivalent methods of description (multicriteria analyses) by involving affected groups both in the process of building up a useful set of indicators and then in the process of discussing scenarios (deliberative participatory techniques).

see also Policy Research Brief 10

Analysis on environmental problems cannot be left to experts alone.

Since multicriteria evaluation techniques can be based on a constructive rationality and have the potential to take into account conflictual, multidimensional, incommensurable and uncertain effects of decisions, they are a promising assessment framework for micro and macro policy analysis.

Formal evaluation tools can provide insight into the nature of and into ways of arriving at policy compromises, thereby increasing the *transparency* of the evaluation process.

Key Points

Complexity

Complexity arises when something is difficult to understand and impossible to analyse with simple frameworks. There is no optimal solution to the management of complex systems.

Limitations

Evaluations are structured and bounded by assumptions that can have profound implications for the different options under valuation. The choice of analytical conventions determines the rank ordering and yet the choice of one convention is no more reasonable than others. This raises the concern that there can be a whole suite of models and scientific studies that can provide technical justifications for any political decision, effectively shrouding the decision in false legitimacy.

Multiplicity of Perspectives

see also Policy Research Brief 4

Valuations are always performed under some description and set of assumptions. The very fact that there are non-equivalent descriptions of the same object means that the value perspective, the values and the standards generated during the evaluation process shift depending on the description used. Such a shift implies that reducing those values to a single measure, be it monetary or biophysical, is misleading and biased. The fact that the same physical environment has a multiplicity of users and perspectives also makes a unique ordering of values impossible. This implies that analysts should include interested parties from the outset as a matter of rigour and an essential component.

Participatory Decision Processes

see also Policy Research Brief 10

Those affected by decisions are the source of ideas about how to design the management alternatives and evaluation criteria. Management objectives vary according to interests. The valuation preferences vary with different agendas depending on whether those included in the process are local users or national or international agencies. Furthermore, the view that the outside 'expert' adviser knows best is misleading. Local people can imagine solutions and reformulate problems in ways that the accredited experts do not find natural.

Evaluation as a Learning Process

see also Policy Research Brief 11

From a practical point of view, one has to note that evaluation is not a one-shot activity; on the contrary, it takes place as a learning process. The evaluation process is usually highly dynamic, so that judgements regarding the political relevance of items, alternatives or impacts may present sudden changes, hence requiring a policy process which is flexible and adaptive in nature. This is the reason why evaluation processes have a cyclic nature where there is adaptation of elements of the evaluation process due to continuous feed-back loops among the various steps and consultations among the actors involved. The valuation exercise should be framed in such a manner as to allow for redesign of management alternatives and outcomes as more information is gained and included in the evaluations.

Sensitivity Analysis

Key factors of valuation exercises are to question assumptions, conduct sensitivity analyses on models, and include knowledge gained from previous analyses in subsequent iterations. Sensitivity analyses have to be recommended to elucidate conflicts among alternatives and objectives and to test the robustness of the model. Expressing results in terms of sensitivities, both to uncertainties in the model as well as divergent values, reveals model biases as rank orders of alternatives potentially change. Management recommendations should be drawn from the varying rank orders, and not just from numbers given to two or more significant figures.

Multidimensional Approaches

Once explicit recognition is given to the fact that economy–environment interactions are also characterised by significant institutional, political, cultural and social factors through which action is carried out, the use of a multidimensional approach becomes essential. Since multicriteria evaluation techniques are based on a 'constructive' rationality and allow one to take into account conflictual, multidimensional, incommensurable and uncertain effects of decisions, they may be a promising assessment framework for policy analysis under conditions of complexity.

Environmental Policy Process

see also Policy Research Brief 4

From an operational point of view, any environmental policy process should be able to:

(i) provide a set of non-equivalent descriptions of the change considered. This set of non-equivalent descriptions should be able to reflect on each of the relevant space-time scales and involve the relevant viewpoints/concerns of major interest groups;

(ii) discuss possible scenarios by establishing links between changes occurring on different scales reflecting how the consequences of the hypothesised change will be perceived by different interest groups;

(iii) carry out evaluations by involving the interest groups both in the process of building up a useful set of indicators and then in the process of discussing scenarios.

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EVE Concerted Action **ADDRESS**

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Concerted Action on Environmental Valuation in Europe (EVE)

This policy briefing series communicates the findings from nine workshops and three plenary meetings under the EVE programme. These showed the diversity of research currently being undertaken in the area of environmental values and their policy expression. The type of information relevant to the decision process extends from ecological functioning to moral values. Thus a range of approaches to environmental valuation, from ecology to economics to philosophy were presented.

EVE was a 30 month project which started in June 1998 funded by the European Commission, Directorate General XII within Area 4, Human Dimensions, of the Environment and Climate RTD programme, Contract No. ENV4–CT97–0558.

The project was co-ordinated by Clive L. Spash and managed by Claudia Carter, Cambridge Research for the Environment (CRE) in the Department of Land Economy, University of Cambridge. The following research institutes were partners in the concerted action:

- Bureau d'Economie Théorique et Appliquée (BETA), University Louis Pasteur, Strasbourg, France
- Cambridge Research for the Environment, Department of Land Economy, University of Cambridge, UK
- Centre for Human Ecology and Environmental Sciences, University of Geneva, Switzerland
- Centre d'Economie et d'Ethique pour l'Environnement et le Développement (C3ED), University of Versailles Saint-Quentin-en-Yvelines, France
- Centre for Social and Economic Research on the Global Environment (CSERGE), University of East Anglia, Norwich, UK
- Department of Economics and Economic History, Autonomous University of Barcelona, Spain
- Department of Economics and Social Sciences, Agricultural University of Norway, Åas, Norway
- Department of Environmental Economics and Management, University of York, UK
- Department of Philosophy, Lancaster University, UK
- Department of Rural Development Studies, Swedish University of Agricultural Sciences, Uppsala, Sweden
- Department of Applied Economics, University of Laguna, Tenerife, Canary Islands, Spain
- Environmental Economic Accounting Section, Federal Statistical Office, Wiesbaden, Germany
- Ethics Centre, University of Zurich, Switzerland
- Fondazione Eni Enrico Mattei (FEEM), Milan, Italy
- Istituto di Sociologia Internazionale di Gorizia (ISIG), Gorizia, Italy

The purpose of this concerted action was to analyse effective methods for expressing the values associated with environmental goods and services, ecosystem functions and natural capital, with a view to the achievement of the goals summarised in the concept of sustainability. The appropriate role of decision-makers and citizens in environmental policy-forming became a central focus in the debate over how different values should be expressed.

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