Chapter 1
Introduction

1.1 What is Multi-Criteria Evaluation?

Let us start the discussion of multi-criteria evaluation by means of a simple everyday life example. Let us imagine staying in front of a shop and admiring a selection of jackets. What is the next step? Probably entering the shop and asking for the *price*. At this point, we have two possibilities: leaving the shop because we think the price is too high or accepting the price as reasonable. In the second case, we still need to choose the jacket we want from the original set (of, for example, ten jackets). We are therefore, probably going to try on the jackets and see which *one suits us best aesthetically*. Let us assume that we are then still undecided between four of them, although we definitely do not like the other six. How do we choose between the remaining four? Perhaps at this stage we will use the criterion of *colour*. Let us imagine we are then still undecided between two jackets. We will now look at the *quality of the fabric* and we may finally choose the one with the better quality.

This is an example of the final selection of an option by using the *lexicographic model* (see Fig. 1.1). This method refers to the procedure used to order the words in a dictionary, the first letter playing the role of the first criterion, the second letter, the second criterion, and so on. To use this method, the decision-maker must give a total strict order to the criteria:

$$1 > 2 \ldots > i > \ldots > m \tag{1.1}$$

where g_l would be the most important criterion and g_m the least important. In the lexicographic model, all actions are first ranked by means of the first criterion, then if some equivalent actions exist, these are further explored by means of the second criterion, and so on. Lexicographic orders usually lead to a straightforward selection of the preferred option; however, most of the information collected on alternatives will not play a role in the decision process.

Let us discuss this example a little further and draw some conclusions. First of all, do we have any experience of a decision-making process like this? We probably do, even if not with these criteria or in this order. Thus it seems that

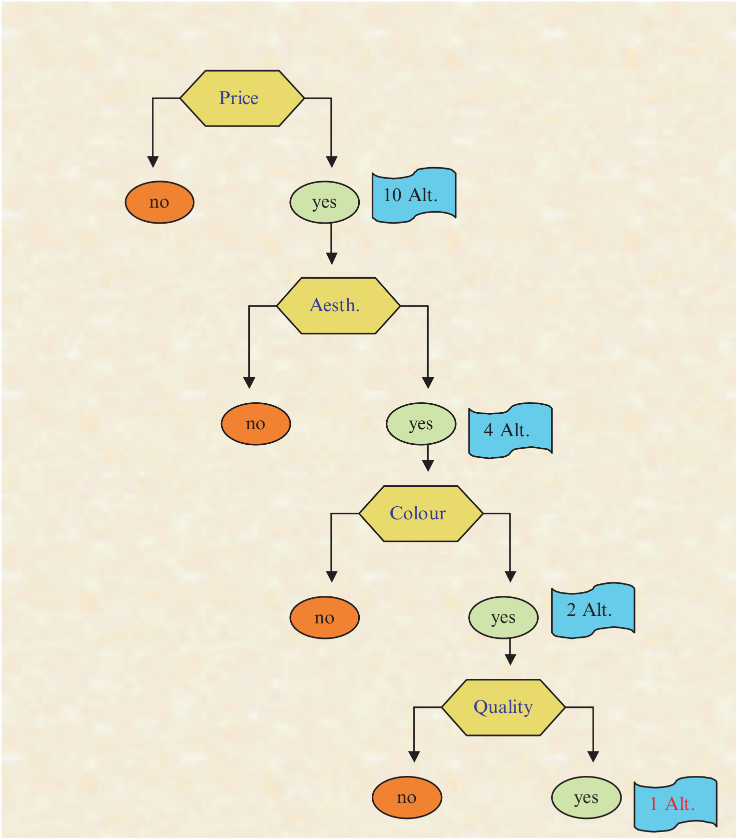

Fig. 1.1 A Lexicographic Decision Process

human beings use multi-criteria evaluation without any formal knowledge of it. We could then say that it is a behavioural assumption with a high degree of descriptive content. Secondly, does the order of criteria have any influence on the final alternative selected? Yes, of course. If we start with the criterion of quality instead of price, the jacket selected will probably be the most expensive one. This shows that when using various criteria human beings do not necessarily accord them the same weight (here I refer to the concept of weight as a coefficient of importance). In principle in the case of the lexicographic model, the first criterion alone might sometimes be enough to make the final selection (e.g. if only one jacket has the price we are willing to pay), this implies that its weight is much greater than that of any other criterion used in the selection process. This is the reason the first criterion is sometimes called the *"dictator"*.

Clearly then, the order of consideration of criteria determines their relative weights.

Thirdly, what happens in our example if we do not like the overall properties of the selected jacket? Probably we will start the process again, e.g. changing the order of criteria (i.e. their weight) or accepting to pay a higher price. Again this is something which we have probably experienced and which shows that what really matters is the *learning process* and not the final decision. This latter one is *constructed* by means of the decision process and not "discovered" as the global optimum.

Finally, does the lexicographic method allow for any compensability among the various criteria considered? Intuitively, compensability refers to the possibility that some bad criterion scores can be compensated for by other very good criterion scores. For example, an overall student evaluation may be based on the principle that a very bad score in mathematics (let us say a 2 on a 0–10 scale) can be compensated for by a 10 in literature and thus the student can pass the final evaluation. This evaluation system is completely compensatory. On the contrary, a system could be based on the principle that a student has to be "enough good" in all the subjects so that a 2 in mathematics cannot be offset by any other score, however high. This second evaluation system would be a non-compensatory (or partially compensatory) one. Compensability then requires that the various criteria scores can interact among themselves; if no interaction is possible, no compensability can exist. Since in a lexicographic method the evaluation criteria are not considered simultaneously, this procedure is completely non-compensatory.

Compensability is a very important concept when multi-criteria evaluation is applied to public policies. In fact in evaluating a project, if we consider that a 2 in mathematics could represent a very bad environmental impact and a 10 in literature a very good economic impact, it is clear that allowing or not for compensability, and to what degree, is the real issue in sustainability policies. To look for compromises then implies that a dictator cannot exist. That is, all the dimensions relevant to a policy problem have to be used simultaneously and not in a lexicographic order, since otherwise some social dimensions will a priori have a much greater weight. For example, a legislative system which accepts that a financial analysis of projects should be carried out before the evaluation of their environmental impacts, is indeed prioritizing the economic dimension with respect to the environmental.

In empirical evaluations of public projects and publicly provided goods, multi-criteria decision theory seems to be an appropriate policy tool, since it makes it possible to take into account a wide range of assessment criteria (e.g. environmental impact, distributional equity, etc.), and not simply profit maximization, as a private economic agent would do (Arrow and Raynaud, 1986; Martinez-Alier et al., 1998).

From an operational point of view, the major strength of multi-criteria methods is their ability to revolve questions characterized by various conflicting evaluations, thus allowing for an integrated assessment of the problem at hand. Multi-criteria decision theory builds on the following basic concepts[1].

The dimension is the highest hierarchical level of analysis and indicates the scope of objectives, criteria and criterion scores. For example, sustainability policy problems generally include economic, social and environmental dimensions.

The objective indicates the direction of change desired. For example, within the economic dimension GDP has to be maximized; within the social dimension social exclusion has to be minimized; within the environmental dimension CO_2 emissions have to be minimized.

The evaluation criterion[2] is the basis for evaluation in relation to a given objective (any objective may imply a number of different criteria). It is a *function* that associates each alternative with a variable indicating its desirability according to expected consequences related to the same objective, e.g. GDP, saving rate and inflation rate inside the objective "growth maximization".

The criterion score[3] is a constructed measure stemming from a process that represents, at a given point in space and time, a shared perception of a real-world state of affairs consistent with a given criterion. To give an example, when comparing two countries, within the economic dimension, one objective could be "maximization of economic growth"; the criterion might be R&D performance, the criterion score could be "number of patents per million of inhabitants". Another example: an objective connected with the social dimension might be "maximization of residential attractiveness". A possible criterion could then be "residential density". The criterion score might be the ratio of persons per hectare.

The constraint is a limit on the values that criterion scores may assume; it may or may not be stated mathematically.

A goal (synonymous with target) is something that can be either achieved or missed (e.g. reducing nitrogen pollution in a lake by at least 10%). If a goal cannot be or is unlikely to be achieved, it may be converted to an objective.

An attribute is a measure that indicates whether goals have been met or not, given a particular decision that provides a means of evaluating the levels of various objectives.

A multi-criteria method is an aggregate of all dimensions, objectives (or goals), criteria (or attributes) and criterion scores used (in the framework of composite indicators this can be considered the definition of an *index*). This implies that what formally defines a multi-criteria method is the *set of properties underlying its aggregation convention*.

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[1]These definitions have been developed by elaborating the standard definitions in multi-criteria decision literature by means of concepts coming mainly from complex systems theory. Discussions with M. Giampietro and M. Nardo have been essential.

[2]In the framework of composite indicators a criterion is synonymous with *"individual indicator"* (see Munda and Nardo, 2007).

[3]In the framework of composite indicators, a criterion score is synonymous with *"variable"*.

Table 1.1 Example of an impact matrix

Criteria	Units	Alternatives			
		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		$g_6(a_1)$	$g_6(a_2)$	•	$g_6(a_4)$

The *discrete multi-criterion problem* can 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 *gm* *i* = 1, 2, …, *M* considered relevant in a policy problem, where the action ***a*** is evaluated to be better than action ***b*** (both belonging to the set *A*) according to the *m*-th point of view if *gm(a)* > *gm(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* × *M* matrix *P* called an *evaluation or impact matrix* whose typical element *pij (i* = 1, 2, …, *M; j* = 1, 2, …, *N)* represents the evaluation of the *j*-th alternative by means of the *i*-th criterion. The impact matrix may include quantitative, qualitative or both types of information (see Table 1.1).

In general, in a multi-criterion problem, there is no solution optimizing all the criteria at the same time (the so-called *ideal or utopia solution*) and therefore *compromise solutions* have to be found. Indeed this sad truth is very consistent with the basic principle of scarcity in economics (called the *sad science* for exactly this reason).

1.2 Social Multi-Criteria Evaluation

Various authors claim that modern economics needs to expand its empirical relevance by introducing more and more realistic (and of course more complex) assumptions to its models. The issue of "distributional coalitions" has recently been considered of key importance in determining growth factors (Olson, 1982). One of the most interesting research directions in the field of public economics is the attempt to account for political constraints, interest groups and collusion effects explicitly (see e.g. Laffont, 2000). In this context, *transparency* becomes an essential feature of public policy processes (Stiglitz, 2002). Social multi-criteria evaluation (SMCE) has been purposely designed to enhance transparency, the main idea being that the results of an evaluation exercise depends on the way a given policy problem is *represented* and thus the assumptions used, the interests and values considered have to be declared (Munda, 2004). To illustrate this issue of problem representation and transparency I will present a couple of examples.

1.2.1 A Land-Use Conflict in the Netherlands

This illustrative application concerns a study of a public choice problem in the Netherlands (the southern part of Limburg). The problem can be briefly outlined as follows (for more information see Munda et al., 1994b).

A company enjoying almost absolute dominance in the Dutch cement industry has a concession to extract marl on one of the hills in south Limburg, but this concession may expire in the near future; therefore alternative areas have to be explored. Of the possible new locations, the most appropriate is the Plateau van Margraten; this is a rather flat area used for agriculture and for some recreation. It has a unique physical structure, although it is characteristic of the landscape of the region. Zoning of this area for marl mining would fundamentally affect its social and ecological value; on the other hand, if the authorities refused to grant permission for marl mining to the company, this would lead to an almost total collapse of the national cement industry and to serious unemployment effects in an economically weak region. This situation clearly demonstrates the sharp opposition between *environmental* and *economic* interests. A first meaningful step toward an evaluation analysis for this land-use problem is to identify a set of feasible and relevant options. These are:

(1) Implementation of the original plans of the company (i.e. a concession for the total area). This would guarantee the future position of the national cement industry and also favours employment and welfare in the region. Agriculture would suffer some negative impacts, while the negative social impacts (for recreation, etc.) would be rather strong. Finally, the environmental damage would be very great.

Clearly, this would be the best option for *interest groups supporting the cement company*.

(2) The use of an alternative area (the Rasberg area, in the same region) for marl mining. But this area is much smaller and the physical condition of the soil would hamper a profitable cement production at current prices. On the other hand, the ecological damage would be less serious.

This option could be interpreted as a *compromise between the authorities and the company* (in fact a concession is given, but the location is decided by the political authorities and not by the company).

(3) The provision of a concession for one half of the area (Plateau van Margraten). This would lead to fewer agricultural losses, while the environmental damage

would also be less severe. The economic impacts would be less favourable than those of the first option.

This is a possible basis for compromise. However, it *could be very dangerous for the political authorities*, since it might maximize the conflict precisely by making nobody happy.

(4) A concession from political authorities for marl mining in the present area. This would be only a short-term solution (since it is not possible from a technical point of view, to continue the extraction of marl for an indefinite period), which is a less attractive option from an economic perspective.

Clearly, this option is not consistent with the others with respect to the time horizon. It reflects a *typical attitude of politicians* all over the world, i.e. the inclination to pass the problem on to somebody else (the succeeding government).

(5) Importing marl from the Plateau van Vroenhoven, an area in Belgium.

This solution might be attractive from *a national standpoint*. But if we take into account the global environmental consequences (the environmental impact of extraction in Belgium and transport of marl) it is clearly the worst option from an environmental point of view. This option also shows the importance of the *hierarchical level* we use to describe a problem (region, country, European Union, etc.).

(6) A restructuring of the company so that it becomes a trade and research organization for cement instead of a production unit. This would lead to a certain loss of employment, while the future need for such an organization is unclear.

This option might be attractive for *anyone without an economic interest* in the company.

(7) A closedown of all productive activities of the company.

This might be *favourable from the viewpoint of environmentalists* and people who use the area for recreation, but would lead to serious economic problems for the region. These options are to be judged on the basis of various evaluation criteria. Three main groups of criteria can be distinguished, viz. economic, social and environmental. These three classes can be subdivided into various components.

(A) *Economic criteria*

1. Employment in agriculture
2. Employment in the cement industry (including marl mining)
3. Agricultural production
4. National production of marl
5. Value added in the cement industry

(B) *Social criteria*

6. Residential attractiveness
7. Recreational attractiveness (daily)

8. Tourism attractiveness
9. Congestion created in transportation infrastructure

(C) *Environmental criteria*

10. Quality of geo-physical structure
11. Diversity and scarcity of eco- and bio-components
12. Consistency with existing landscape components
13. Consistency with existing cultural–historical components.

Of course, the options and criteria described belong to only one of the possible approaches to the problem. They are the result of a decision process developed on that particular occasion. However, one should note that the degree of *transparency is really very high*. It is easy to identify the interests represented by each option.

One could decide to measure the environmental impact of the various policy options in the Netherlands alone, or in both the Netherlands and Belgium: according to the choice made, the "constructed solutions" would be different. In any case, it is clear that such a choice implies a *value judgement*, i.e. the implementation of a weak or strong sustainability philosophy.

1.2.2 Assessing Urban Sustainability

Let us consider an example involving four cities, two belonging to highly industrialized countries (Amsterdam and New York) and two belonging to transitional economies (Budapest and Moscow). The indicators used are typical of the literature on urban sustainability (see e.g. Barbiroli, 1993 or the Urban Indicator Programme). The profiles (i.e. the score of each city according to each indicator) of these four cities are described in Table 1.2.

Table 1.2 Impact matrix for the four chosen cities according to the selected indicators

Alternatives / Criteria	Budapest	Moscow	Amsterdam	New York
Houses owned (%)	50.5	40.2	2.2	10.3
Residential density (pers./hectare)	123.3	225.2	152.1	72
Use of private car(%)	31.1	10	60	32.5
Mean travel time to work (minutes)	40	62	22	36.5
Solid waste generated per capita (t/year)	0.2	0.29	0.4	0.61
City product per person (Uss/year)	4750	5100	28251	30952
Income disparity (Q5/Q!)	9.19	7.61	5.25	14.81
Households below poverity line (%)	36.6	15	20.5	16.3
Crime rate per 1000 (theft)	39.4	4.3	144.05	56.7

A standard approach is to rank these cities by constructing a composite indicator. A typical composite indicator, *I*, is built as follows (OECD, 2003, p. 5):

$$I = \sum_{i=1}^{N} w_i x_i \tag{1.2}$$

where x_i is a normalised variable and a weight attached to x_i, with $\sum_{i=1}^{N} w_i = 1$ and $0 \le w_i \le 1$, $i = 1, 2, \ldots, N$.

It is clear that from a mathematical point of view a composite indicator entails a weighted linear aggregation rule applied to a set of variables. The main technical steps needed for its construction are the following:

1. Standardization of the variables to allow comparison without scale effect.
2. Weighted summation of these variables.

The standardization step is a very delicate one. The main sources of uncertainty and imprecise assessment are:

- *The normalization technique* used for the different measurement units involved.
- *The scale adjustment* used, for example population or GDP of each country considered.
- *The common measurement unit* used (money, energy, space, etc.).

Several techniques can be used to standardize variables (Saisana and Tarantola, 2002; OECD, 2003). However, although each normalisation technique entails different absolute values, the ranking produced remains constant. In our example, the "*distance from the best and worst performers*" technique is applied, where positioning is in relation to the global maximum and minimum and the index takes values between 0 (laggard) and 100 (leader):

$$100\left(\frac{\text{actual value - minimum value}}{\text{maximum value - minimum value}}\right) \tag{1.3}$$

By applying (1.3) to the values contained in Table 1.2, the results presented in Table 1.3 are obtained. The indicators "houses owned" and "city product per person" have to be maximized. All others have to be minimized. To apply (1.2) it is thus necessary to transform the indicator scores of these indicators by using the simple equation (100 – normalized indicator score).

By applying this transformation to the values contained in Table 1.3, the results presented in Table 1.4 are obtained.

By applying (1.2) to the values contained in Table 1.4, the following results are obtained:

Budapest = 512.986
Moscow = 533.373
Amsterdam = 463.169
New York = 492.052

Table 1.3 Normalized impact matrix

100	78.674	0	16.770
33.485	100	52.28	0
42.2	0	100	45
45	100	0	36.25
0	21.95	48.78	100
0	1.335	89.691	100
41.213	24.686	0	100
100	0	25.462	6.018
25.116	0	100	37.495

Table 1.4 Normalized impact matrix accounting for minimization objectives

100	78.674	0	16.770
66.515	0	47.72	100
57.8	100	0	55
55	0	100	63.75
100	78.05	51.22	0
0	1.335	89.691	100
58.787	75.314	100	0
0	100	74.538	93.982
74.884	100	0	62.505

Thus the final ranking puts Amsterdam into bottom position (worst than all other cities considered); Moscow is in top position, Budapest ranks second and New York third.

At this point two questions need to be answered: *Where are these (somewhat surprising) results coming from and what do they mean?*

Let us start with the first question. The results obtained depend on:

1. *Quality of the information available* (In our case, for example, the data values for Amsterdam on the use of private cars and on criminality are suspiciously high, while criminality in Moscow and residential density in New York are suspiciously low).
2. *Indicators chosen* (i.e. which representation of reality we are using, and therefore whose interests are taken into account).
3. *Direction of each indicator* (i.e. the bigger the better or vice versa, in our example, the principle is that house ownership should be maximized, but this could be quite debatable and culturally dependent).
4. *Relative importance of these indicators* (in our case all the indicators are considered to have the same importance, i.e. no weighting coefficient is used).
5. *Ranking method used* (in this case the linear aggregation rule).

All these uncertainties have to be taken into account when we claim that any given city is "better" than another. At this stage, it also seems clear why it is claimed in multi-criteria evaluation that what is really important is the "*decision process*" and not the final solution, since this solution has a value only as a product of the decision process and is not an "ultimate Truth" (in Herbert Simon's words, we could say that we should move from "*substantive to procedural rationality*").

Historically the first stage of the development of multi-criteria decision theory was characterized by the so-called methodological principle of *multi-criteria decision making* (MCDM), the main aim of which is to elicit clear subjective preferences from a mythical decision-maker (DM) and then try to solve a well-structured mathematical decision problem by means of a more or less sophisticated algorithm. In this way a multi-criterion problem can still be presented in the form of a classical optimization problem (Keeney and Raiffa, 1976). The limitations of the classical concept of an optimum solution and the consequential importance of the decision process was emphasized in the context of decision sciences by authors such as H. Simon and B. Roy.

According to Simon (1976), a distinction must be made between the general notion of rationality as an adaptation of available means to ends, and the various theories and models based on a rationality which is either substantive or procedural. This terminology can be used to distinguish between the rationality of a decision considered independently of the manner in which it is made (in the case of substantive rationality, the rationality of evaluation refers exclusively to the results of the choice) and the rationality of a decision in terms of the manner in which it is made (in the case of procedural rationality, the rationality of evaluation refers to the decision-making process itself). "A body of theory for procedural rationality is consistent with a world in which human beings continue to think and continue to invent: a theory of substantive rationality is not."

Roy (1985) states that in general it is impossible to say that a decision is a good or bad one by referring only to a mathematical model: all aspects of a decision process which leads to a given decision also contribute to its quality and success. Thus, it becomes impossible to establish the validity of a procedure either on a notion of *approximation* (i.e. discovering pre-existing truths) or on a mathematical property of *convergence* (i.e. does the decision automatically lead, in a finite number of steps, to the optimum a^*?). The final solution is more like a *"creation"* than a discovery. In *Multiple-Criteria Decision Aid* (MCDA) (Roy, 1985), the principal aim is not to discover a solution, but to construct or create something which is viewed as liable to help "an actor taking part in a decision process either to shape, and/or to argue, and/or to transform his preferences, or to make a decision in conformity with his goals" (Roy, 1990) (*constructive or creative approach*).

The need for public participation has been increasingly recognized in a multi-criteria decision-aid framework. Two recent proposals have been participatory multi-criteria evaluation (Banville et al., 1998) and social-multi-criteria evaluation (Munda, 2004). Social multi-criteria evaluation accords with the need to extend MCDA by incorporating the notion of the stakeholder; for this reason a social multi-criteria process must be as *participative* and as *transparent* as possible; although, it is further argued that participation is a *necessary* but not a *sufficient* condition. This is the main reason why the concept of "Social Multi-criteria Evaluation" (SMCE) is proposed in place of "Participative Multi-criteria Evaluation" (PMCE) or "Stakeholder Multi-criteria Decision Aid" (SMCDA).

In my opinion, one should not forget that even a participatory policy process could always be influenced by strong value judgements. Do all the social actors have the same importance (i.e. weight)? Should a socially desirable ranking be obtained on the grounds of the majority principle? Should some veto power be allowed to minorities? Are income distribution effects important? In the light of these questions, the objective of the present book is to discuss in depth the methodological foundations, the mathematical axiomatization and the operational consequences of SMCE in the context of public choice in sustainability issues.

1.3 Social Multi-Criteria Evaluation and Sustainability Issues

In the eighties, the awareness of actual and potential conflicts between economic growth and the environment led to the concept of "*sustainable development*". Since then, all governments have declared, and continuously proclaim, their willingness to pursue economic growth under the flag of sustainable development although often development and sustainability are contradictory terms. In the last decade, there have been various attempts to develop theoretical definitions and systems for the assessment of sustainability, but so far no consensus emerged on pros and cons of any definition and its implementation (see e.g. Barbier and Markandya, 1990; Horwarth and Norgaard, 1990, 1992; Chichilnisky, 1996; Musu and Siniscalco, 1996; Pearce et al., 1996 Munda, 1997a; Faucheux and O'Connor, 1998).

The concept of sustainable development has a wide appeal, partly because, in contrast with the "zero growth" idea by Daly (1977), it does not set economic growth and environmental preservation in sharp opposition. Rather, sustainable development carries the ideal, of a harmonization or simultaneous realization of economic growth and environmental concerns. For example, Barbier (1987, p. 103) writes that sustainable development implies: "*to maximize simultaneously*[4] the biological system goals (genetic diversity, resilience, biological productivity), economic system goals (satisfaction of basic needs, enhancement of equity, increasing useful goods and services), and social system goals (cultural diversity, institutional sustainability, social justice, participation)". This definition correctly points out that sustainable development is a *multidimensional* concept, but as everyday life teaches us, it is generally impossible to maximize different objectives at the same time, therefore as formalized by multi-criteria decision theory, compromise solutions must be found.

Let us try to clarify some fundamental points of the concept of "sustainable development". In economics by "development" is meant "the *set of changes* in the economic, social, institutional and political structure needed to implement the transition from a pre-capitalistic economy based on agriculture, to an industrial *capitalistic* economy" (Bresso, 1993). Such a definition of development has two main implications:

[4]Emphasis added.

1. The changes needed are not only quantitative (like growth in gross domestic product), but also qualitative (social, institutional and political).
2. There is only one possible model of development, i.e. that of western industrialized countries. This implies that the concept of development is viewed as a process of cultural fusion towards the *best* knowledge, the *best* set of values, the *best* organization and the *best* set of technologies (and that these are all western …).

Adding the term "sustainable" to the "set of changes" (the first point) means adding an ethical dimension to development. The issue of *distributional equity*, both within the same generation (intra-generational equity, e.g. the North-South conflict) and between different generations (inter-generational equity) becomes crucial (Munda, 1997a). Going further, a legitimate question could be raised: sustainable development *of what and for whom*? (Allen et al., 2002). Norgaard (1994, p. 11) writes: consumers want consumption sustained, workers want jobs sustained. Capitalists and socialists have their "isms", while aristocrats and technocrats have their "cracies".

Martinez-Alier and O'Connor (1996) have proposed the concept of ecological distribution to synthesize sustainability conflicts. The concept of *ecological distribution* refers to the social, spatial, and temporal asymmetries or inequalities in the use by humans of environmental resources and services. Thus, the territorial asymmetries between SO_2 emissions and the burdens of acid rain are an example of *spatial ecological distribution*. The inter-generational inequalities between the benefits of nuclear energy and the burdens of radioactive waste are an example of *temporal ecological distribution*. In the USA, "environmental racism", meaning locating polluting industries or toxic waste disposal sites in areas where poor people live, is an example of *social ecological distribution*. We can then conclude that sustainability management and planning is essentially a question of *conflict analysis*. As a tool for conflict management, multi-criteria evaluation has demonstrated its usefulness in many environmental policy and management problems (see e.g. Romero and Rehman, 1989; Nijkamp et al., 1990; Janssen, 1992; Munda, 1995; Beinat and Nijkamp, 1998; Munda et al., 1998; Ringius et al., 1998; Janssen and Munda, 1999; Hayashi, 2000; Bell et al., 2001). As a consequence the use of multi-criteria decision theory seems very relevant for tackling sustainability conflicts.

The second characteristic of the term "development" refers to the western industrialized production system as a symbol of a successful development process. However, serious environmental problems may proceed from this vision. For example, according to actual social values in western countries, to have a car per two/three persons could be considered a reasonable objective in less developed countries. This would imply a number of cars ten times greater than the existent one, with possible consequences for global warming, reserves of petroleum, loss of agricultural land and noise. The contradiction between the terms "development" and "sustainable" may not be reconcilable unless alternative models of development are considered.

One such model is offered by the so-called *co-evolutionary paradigm*. According to this view of social evolution, borrowed from biology (Ehrlich and Raven, 1964),

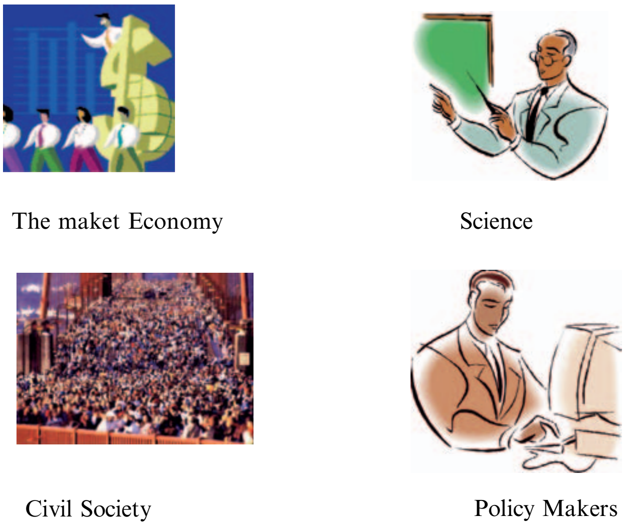

Fig. 1.2 Main actors of a sustainability policy process

there is a constant and active *interaction* between organisms and their environment. Organisms are not simply the results but they are also the causes of their own environments (Gowdy, 1994; Norgaard, 1994). Economic development can be viewed as a process of adaptation to a changing environment while being itself a source of environmental change. In real societies, “people survive to a large extent as members of groups. Group success depends on culture: the system of values, beliefs, artefacts, and art forms which sustain social organization and rationalize action. Values and beliefs which fit the ecosystem survive and multiply; less fit ones eventually disappear. And thus cultural traits are selected much like genetic traits. At the same time, cultural values and beliefs influence how people interact with their ecosystem and apply selective pressure on species. Not only have people and their environment coevolved, but social systems and environmental systems have coevolved” (Norgaard, 1994, p. 41). From the co-evolutionary paradigm the following lessons can be learned:

(1) A priori, different models of co-evolution are possible, and then no unique optimal development path exists. *The spatial dimension* is a key feature of sustainable development.
(2) Respect for cultural diversity is of fundamental importance. In environmental management local knowledge and expertise (being the result of a long co-evolutionary process) are sometimes more useful than experts opinions. *Social participation* is then essential for successful sustainability policies.

From this brief discussion the following conclusions can be drawn (see Fig. 1.2):

1. A proper evaluation of sustainability options needs to deal with a plurality of legitimate values and interests found in a society. From a societal point of view,

economic optimization cannot be the only evaluation criterion. As is well known, not all goods have a market price, or this price is often too low (*market failures*). Environmental and distributional consequences (intra/inter-generational and for non-humans) must also be taken into account. In this framework multi-criteria evaluation is a very consistent approach.

2. If from a sustainability point of view, it is accepted that society as a whole has an indefinite lifespan, a much longer time horizon than is normally used on the market is required. A contradiction then arises: politicians usually have a very short time horizon (often four–five years depending on the electoral system) and this has the effect that sustainability is rarely among their priorities (thereby causing a *government failure* (for an overview of different perspectives on the role of governments in the economic sphere see e.g. Buchanan and Musgrave, 1999). For this reason I think that evaluation of public projects should take into account the entire "*civil society*" (including ethical concerns about *future generations*) and not only mythical benevolent policy-makers. This is why I am developing the concept of "social" multi-criteria evaluation, the main objective of which is to integrate scientific knowledge with social participation in the framework of sustainability public choice.