Methodological Issues on Climate Change Mitigation Studies

– Contributions from a Case Study

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Abstract:

This paper uses national greenhouse gas emission abatement costing studies as a case to discuss influential factors that determine their outcome and achievement. Costing studies are seen as part of an interconnected whole social process where actors (decision-makers, clients, facilitators, experts, etc.) interact to analyse and solve important decision problems by applying methodologies. A simple framework is used to identify several sources of contradictions that may have a significant impact on studies carried out in the single countries as well on the implementation of abatement measures. Some methodological principles are suggested to address such contradictions, structure, and change the interactions between the different dimensions of the social process framework. Two studies are mentioned, in which ideas are presented on how to deal with the central contradictions. Applying such methodologies to case studies is seen as one way of improving the chances of understanding and handling environmental problems.

1. Introduction

Mostly in this last decade, international and national responses have been established to limit the emissions of greenhouse gas (GHG) emissions and hopefully slowdown or stop the changing of the global climate. The Rio conference in 1992 produced the Framework Convention on Climate Change (FCCC) that described the first mechanisms for international commitment. The Convention entered into force in 1994. In 1997 the world's countries agreed on the first set of commitments in terms of emission targets for GHG emissions. This was formulated in the Kyoto protocol (Borges, 1999).

Within the FCCC lie commitments for single countries to incorporate international agreed emission levels into their national energy and environmental plans. Many studies and analyses have been carried out to find a 'fair' and common way of implementing goals in terms of target emissions to the many different countries of the world. Some studies have concentrated on national abatement costs in order to establish a general framework to outline cross-country comparable abatement costs for reducing GHG emission levels (UNEP, 1992, 1994).

National abatement costing studies have been met with several problems. Examples are cross-country comparisons of different energy, environmental and social structures, methodological problems, lack of comparable data, 'translation' of international emission measures into national goals and development plans, interactions between analysts/experts and representatives from governments involved in the study, and lack of experiences on implementation issues, etc.

The study presented in this paper focuses on the problems with carrying out costing studies. It was found that central difficulties were connected with either the interaction between the actors (the decision-makers and other national representatives, and analysts) and the way the study was perceived, identified and addressed methodologically. This is referred to as the social process framework for identifying, analysing and solving problems.

Looking at the national abatement costing studies through the social process framework significant contradictions can be identified between the different elements. Contradictions shall here be understood as instances or absences of agreement (existence of disagreement or even conflict), uncertainties in the perceptions or ways of dealing with the situation. Contradictions are seldom addressed or even recognised in studies but they are always present and central for the outcome.

Investigations were carried out to find ways of dealing with those contradictions. It was found that the methodologies used to guide the study here could play an important part in the process. The methodologies applied should be flexible enough to be able to support the decision-making and problem solving process by implicitly or explicitly addressing the contradictions of one specific situation.

The paper has the following outline. *Section 2* gives a short presentation of the case study and identifies a number of problems associated with costing studies. S*ection 3* presents the social process framework, which focuses on the contradictions between the four elements interacting in a problem solving process: decision-makers, analysts, the problematic situation and methodologies. *Section 4* discusses how such contradictions can be dealt with. Focus is placed here on methodologies that can support a negotiation process. Additionally, two examples are presented in which special consideration was given to the methodologies applied and the way they addressed the elements of the social process framework. Finally, the conclusions are presented in S*ection 5*.

2. National Abatement Costing Studies

In 1988, the United Nations Environmental Programme (UNEP) and the World Meteorological Organisation (WHO) established the Intergovernmental Panel on Climate Change (IPPC) which in 1990 presented its first assessment report describing the existing knowledge and scientific consensus on climate change issues.

At the Rio conference on Environment and Development in 1992 more than 150 countries signed the UN Framework Convention on Climate Change (FCCC), and gave their acknowledgement of the problem and supported intentions to cope with it. The objective of the FCCC was to achieve 'stabilisation' of greenhouse gas concentrations in the atmosphere at a level not interfering with the climate system (see United Nations, 1992, for details). Central points in the FCCC were the recognition of the need to gathering more information, and the establishment of guidelines on how to estimate comparable costs of mitigation strategies. The FCCC required parties to prepare national reports on GHG emissions and sinks, and it serves as legal basis for the international response to the climate change problem. The FCCC came into force in 1994.

GHG emissions interact with national economy in complex ways through the infrastructure, structure of energy and environmental systems, and social requirements. Abatement costs were, therefore, understood differently by analysts and the first studies on cost estimation for limitation on greenhouse gas emissions arrived, accordingly, to apparently contradicting results because of different approaches and problem perceptions. To work around this difficulty, UNEP started a project on 'National Greenhouse Gases Abatement Costing Studies'[1] with the goal of producing a methodology for carrying out comparable and transparent costing studies. The studies were carried out through cooperation and interaction between national teams and international experts.

National studies intended to estimate greenhouse gas abatement costs for one or several scenarios following general assumptions specified by the UNEP guidelines (see UNEP, 1994, for details). Scenarios and costs are country specific, therefore, UNEP guidelines set emphasis on uniformity in establishing the scenarios and performing the analysis, rather than on data and modelling issues, which will vary according to the country.

National studies were met with several problems. Some problems were:

- Lack of integration of studies with national planning processes. Two extreme situations could take place involving

[1] Abatement costs are defined as the long-term costs to society of implementing a greenhouse gas emission reduction strategy compared with a hypothetical reference case where no efforts are made to reduce greenhouse gas emissions. Cost measurement include investment costs, operation and maintenance costs, and fuel costs for the individual options. Abatement options are dependent upon a country's energy, environmenal and social structure (Borges, 1999).

the collaboration between the national decision-makers and the UNEP analysts. In the first situation, the decision-makers would produce national policy documents solely based on political goals without any considerations to the technical aspects and constraints investigated on by the analysts. In the second situation, the analysts performing the country study would focus only on the technical aspects without giving regard to general national planning goals or implementation difficulties. In both situations, there was a lack of communication, interaction and recognition between decision-makers and analysts, and the results of the studies can be characterised either as a policy document or an academic exercise. In both cases, the study has little effective value nationally or internationally in terms of addressing the climate change problems.

- Difficulties in setting the general methodological framework for carrying out truly comparable country studies. Countries are different in terms of infrastructure and ways of working. A general framework must either be simple (and perhaps become too simple to address the complex problem of estimating country abatement costs) or become so complicated that most counties can not use it in practice.
- Difficulties in defining and carrying out the abatement costs estimations. Again, the countries are different and abatement options are highly different across countries. Therefore, it has to be determined which options and costs to be taken into consideration and how to compare the different economies.
- Lack of traditions in addressing this type of complex problems. Uncertainties exist in terms of the understanding of means and effects on the climate system, there is a lack of data – especially cross-country comparable data, emissions are unequally distributed and therefore there is a general lack of knowledge in how to deal with the problems. General theories and trial-and-error problem solving, discussions must be the basis for such studies.
- Lack of explicit objectives of country teams when designing mitigation strategies and assessing abatement scenarios. Often, it is found that different institutions will suggest different strategies because of inherent motivations, interests and priorities. These are not necessarily in line with political goals.

The central problems differ from study to study.

3. The Social Process Framework

Some of the central problematic areas of the study were identified to be associated with the interactions between the different actors (national decision-makers at varying levels and the different analysts/experts/facilitators), the problem situation and the methodologies used. These interactions are seen as part of a social, dynamic process with the purpose of addressing a specific problematic situation. This is referred to as the social process framework.

3.1 The Interactions

Figure 1 illustrates the social framework and the interactions between the four elements. *The decision-makers* are the group, individual or organisation with a problematic situation or decision-problem. They 'own' the problem, have their perception on it, can describe it (from their point of view) and give judgements about possible solutions. It is not always to identify the decision-maker. *The analysts* are consultants that have specialised tools to deal with the problematic situation. The analysts may be a part of the same organisation as the decision-makers but often they are not. The analysts can play different roles: facilitator, expert, advisor, analyst, etc. *The problematic situation* is any situation that needs to be solved or dealt with through a problem-solving process. Strategy development and planning in organisations are examples of processes in which problematic situations are dealt with (see Dyson, 1990, Dyson and O'Brien, 1998, or Sørensen and Vidal, 1999 for more comments on this topic). The problematic situation might also involve actors. A *methodology* is applied to solve or structure the problems. A common way of doing this is first to develop a model representing the problem and then use that model to compare different alternative solutions.

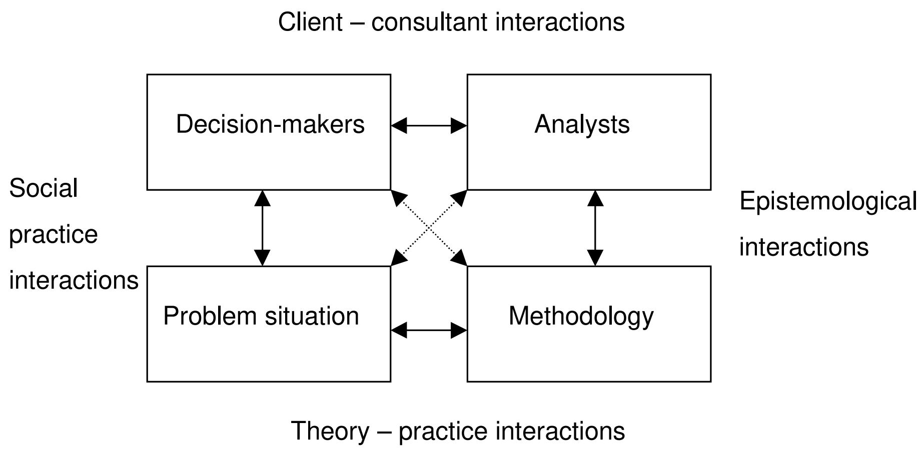

Figure 1 National studies as a social process framework

In the case of national abatement costing studies, the decision-makers' are representatives from various national authorities. The analysts' are the teams appointed to carry out the particular studies. The analyst groups consist of individuals with multidisciplinary knowledge and modelling expertise from different fields, and are often supported by international experts. The problematic situation of emission abatement is associated with estimating national abatement costs, finding evaluating strategies to deal with emissions abatement, and developing mitigation scenarios. The methodology is the system of approaches, guidelines, methods and techniques used by the actors to deal with the problem. In this case, it will encompass phases of constructing scenarios, identifying and evaluating mitigation options, etc. Many of these aspects are to be decided on by the individual countries.

Between the elements and the way they interact, contradictions can be identified determining and controlling the social process and the outcome of the study.

Contradictions are here broadly defined as controversies, unsuitability, conflicts, difference of opinions, denial, inherent uncertainties that gives contrast in perceptions and descriptions, and interactions that implicitly or explicitly are always present in a problem-solving process (Vidal, 1997).

Contradictions may be originated by objective reasons for instance associated to sell-buyer relationships. They can also be originated due to subjective reasons for instance the way a production chief and a sales chief in a company may conceptualise the problems of the organisation differently. Contradictions usually involve individuals but the term can also be used in the case that a method is not appropriate for a problematic situation.

Contradictions are always present in traditional hierarchical decision-making but are to a certain extent controlled by traditional ways of dealing with problematic situations where the problem is well known and has been solved before. In this situation, decision-makers and analysts have well-established roles, have recognised methodologies to use and ways of applying them. In complex problem situations, the roles of the actors must be established based on the premises of their interaction. The problem situation must be described and recognised as a new type of problem, and methodologies must be found to deal with the situation. Often contradictions are more visible in complex problem situations as the climate change problem.

Contradictions cannot be solved, ‘removed’ or addressed completely (as for example it would be attempted by establishing ‘consensus’ in learning organisations). They can be controlled or dealt with to certain extent. However, they may retain in a latent state and their negative potential might show again later in time and grow in importance as conditions change.

Figure 1 outlines various sources for contradictions. These shall be commented on. The interaction between the analysts and the methodology is ruled by contradictions linked to *epistemological stipulations*. The analysts will normally choose and use methodologies of their epistemological traditions and experiences. Epistemological contradictions exist, both in *the analyst – methodology interaction* and *the analyst – problem situation interaction*. The analyst can only perceive and work with the problem situation and the methodologies in terms, he knows of. Every scientific field and school of thought have their own perceptions, traditions, ways of describing problems and dealing with these. Assumptions, ways of limiting the problem description and applying the methodology may all be in conflict with the real world (and perhaps the perception of the decision-makers). Contradictions (conflicts, uncertainty) arise because of different perceptions, limitations in the way analysts epistemologically can see the problem, limitations in the methodology itself, conflicting assumptions and interests, lack of directing the problem as it is without using methodologies that always are used, etc. Also an analyst may view the problem from his own point of view and political interests and in that way add to the contradictions of the epistemological interactions. The analysts are in many situations also responsible for presenting and 'translating' the results of the methodological application for the decision-makers. In this presentation epistemological limitations also lie in how they can make reflections and present the results from objective and neutral perspectives.

The contradictions between *the problem situation and methodology* and the *decision-makers and the methodology* interactions are associated with the *theory – practice interactions.* These contradictions have to do with successful problem solving and implementation of methodologies. There are two sides to the contradictions of the theory – practice interactions; how well or appropriate the methodology captures the problem situation, and how well decision-makers understand and identify themselves with the methodology used. In terms of the decision-maker and the problem situation, this interaction is often ruled by traditional ways of looking upon problematic situations using a strategic and political view on them. In this way of looking at the problem, there may also be some limitations to the detail or broadness of the problem. Having a perception of a problematic situation, decision-makers often also have a perception of what the results of an analysis should be. This means that decision-makers have an idea of how solutions should be investigated and represented. Often this again is based on traditions and experience. Using a methodology, which perhaps directs the problem situation better but not has been introduced to the decision-makers before, there is a risk that the decision-makers will have reluctance towards the methodology and its results. This means that the methodology has a central role in the description and translation of the problem situation and the way it is solved, perceived, understood and accepted by the decision-makers.

When two groups interact to support each other, there is always a risk of conflicts at the social–psychological level that must be managed in some way. These risks will differ according to the nature of the relationship and contradictions may arise as a consequence of the so-called *client–analyst interaction*. The two groups might belong to different organisations with different traditions, culture, sometimes from different countries, and might also reflect other contradictions in society. Even if both decision-makers and analysts recognise that climate change is a problem, they do not necessarily perceive the problem in the same way. For governments, climate change is just a part of the development problem and plans that includes many other economic, social and environmental issues. If the study relies on the political side only, it might disregard technical considerations and constraints and runs the risk of being only an example of policy planning. On the other hand, if analysts isolate themselves form decision-makers and socio-political contradictions, the study will not rise interest by decision-makers, who see it as an academic exercise.

The social – practice interface has to do with the contradictions that are present between *the decision-makers and the problem situation.* In practice, the decision-makers own the problem and must act upon it. The decision-makers are also the ones who in reality determine or set the frames for how the problem situation shall be looked upon and solved by the analysts. The social and political function of the decision-makers as well as public and inter-organisational opinion may be determining for how the decision-makers respond to the problem situation. When referring to the national abatement costing study, it is clear that the social – practice contradictions are important. Different countries prioritise the problem situation according to national interests, development stage, etc. This means that decision-makers' interest in the problem situation may be highly different from the analysts' point of view that creates a gap between these three dimensions.

Finally, it shall be mentioned that other contradictions often are present. These have to do with internal conflicts among the individuals in the groups of actors – between decision-makers and analysts. Important sources of conflict are the power relations related to who co-ordinates and finances the studies, the view on the problem situation, and inter-personal, human relations.

4. Addressing Contradictions

In the study, it was found that some central contradictions affiliated with the social process framework could be addressed through applying methodologies guiding and structuring such processes. Within this lie considerations to the type of methodology applied and how it can/will be implemented. It is clear that not all methodologies give equal support in handling or addressing contradictions. In some cases, methodologies are needed to carry out calculations in a systematic and trustworthy way (focusing on the contradictions of the theory – practice interactions) without much consideration to other interactions. In other situations, the diverging interests between actors are the fundamental contradictions, which need to be addressed with methodologies focusing on supporting negotiations and solving conflicts. Each situation must be analysed and methodologies selected to address the particular situation.

In the study, it was found that some features are more important than others when selecting and applying methodologies for such case studies. Important features are:

- Transparency – that allows for most actors to understand the principles of the methodology.
- Interactiveness and participation – that allows for actors to be involved in the process of both defining and solving the problem situation usually finding consensus to conflicting situations.

- Flexibility – that gives the involved actors room for their interpretation and use of the methodology to fit into their situation.
- Problem structuring – which directs the problem situation and shows the directions to which more detailed analyses are needed.
- Simplicity – which gives the actors a possibility to use the methodologies themselves and in that way gain an understanding and trust of the problem and solutions.

Of course, methodologies cannot address all contradictions. In some situations there must be given special focus to reorganising the way the actors traditionally interact or to the institutional set-up. In case of for example conflict or disagreement between different decision-makers, it may be necessary to take action in terms of handling the way they interact themselves before methodologies can be applied to address other contradictions.

The following two cases illustrate how methodologies have been proposed and used to address central contradictions in association with the national abatement costing studies. The first example takes up the problem of formulating national energy and environmental strategies. It addresses mostly the client – analyst interface and help closing the theory – practice gap. The example is not based on any specific country but is based on experience of working with developing countries. The second example contributes to alleviate a number of contradictions linked to the social practice interactions, the theory – practice interactions and the epistemological interactions. In a national study of Peru, those concerns were addressed using various methodologies within a group of national stakeholders.

4.1 Strategic Approaches to Climate Change at Country Level

The construction of national mitigation scenarios often suffers from fragmentation of responsibilities that are spread over several government agencies and ministries. Coordination of policies and strategies is influences by a complex system of rules and regulations by which competencies, tasks and responsibilities are divided among ministries, directorates, and departments. Experience shows that that studies that involve technical and financial assistance are likely to antagonise the participating agencies rather than enhancing cooperation. Often institutions lack the experience and expertise for conducting or coordinating a nationwide study. Contradictions are commonly influencing this situation especially within the client – analyst interaction and the theory – practice interaction.

In Borges *et al.* (1998) suggestions are made on how a new institutional set-up can be made for enhancing cooperation. A complementary or alternative way is to address the contradictions by application a methodology, which forces analysts and decision-makers to combine their knowledge, experience and problem views to achieve consensus. In the first example, the so-called SWOT analysis was applied.

4.1.1 Improving interactions

The SWOT analysis is a rather simple and flexible methodology that can be used by a group or by individuals to focus on an organisation's strategies (in this case the organisation is the nation in focus). SWOT is an acronym of internal Strengths and Weaknesses, and external Options and Threats. Focusing on these points and combining these into a matrix, strategies can be formulated that minimises weaknesses and threats and maximise strengths and options. The matrix is then used to formulate four different types of strategies by combining minimisation of threats and weaknesses and maximisation of strengths and opportunities. Normally, a country should consider all types of strategies and from that find the most relevant strategies to implement as their country strategy. The SWOT analysis has been used in many private and public organisations and has showed itself as a fruitful approach to support a group of persons in the first stages in strategy development through dialogue and participation. The analysis favours dialogue in a planning process by including a model that is shared by the participants. More detail on the SWOT analysis can be found in for example Dyson (1992) or Dyson and O'Brien (1998).

The SWOT analysis was applied to the national abatement costing studies in two ways: a classical way and a mixed way.

In the classical approach, the SWOT analysis was used to propose general strategies for mitigation. Decision-makers were here to outline their goals and visions while the technical/analytical details were directed at a later stage – after the formulation of the different strategies. Applying the SWOT analysis in this way, the analysts will have to be supportive in the process and act as facilitators. Results of the application are given in form of general policy strategies (identified in the SWOT matrix) incorporating the strengths, weaknesses, threats and opportunities of the country. Details on the results can be found in Borges *et al.* (1998).

In the mixed approach, it was the intention to work both at the strategic level and the technical/operational level of planning. Using this approach both decision-makers and analysts were brought together to discuss mitigation issues, and specific aspects of the climate change problem. First, technical details cannot be discussed. The discussion must be based on a ground all participants can understand, follow and have interests in. Disagreements of effects of relevant measures might give leads to aspects that need further investigation. The idea is that participants outline their points of view on mitigation issues, options etc., and from those the planning process initiates. For each mitigation option identified, the group discusses requisites of that option and identify strengths and weaknesses. In a similar manner, opportunities and threats can be identified through the expected consequences. Here comes the more analytical and technical side into the analysis. Results of this application are more principles, directives, important relations that later must be elaborated on to form strategies. Again, results of such an application can be found in Borges *et al.* (1998).

What was central for the study was the relatively easy way to methodologically address the problem situation. It was concluded that the SWOT analysis would secure a higher integration of international regulations and national goals and plans, higher participation of decision-makers, and totally a higher likelihood for implementation and addressing the climate change issues. The classical application would primarily direct contradictions between the social – practice interactions. The mixed approach would address contradictions associated with the client – analysts interaction and would contribute to enhancing the theory – practice interaction because the decision-maker and the analysis would share more information on the problems and ways of working around it.

It shall be mentioned that others have found the introduction of a special methodology to be of value in establishing national climate policies. In Wilenius and Tirkkonen (1997), the Delphi technique has been applied.

4.2 Incorporating Multicriteria Analysis in Abatement Costing Studies

It was concluded that the UNEP formal analysis structure has some limitations in its way of addressing the problematic situation. Many inaccuracies were build into the analyses and results of the studies, which raised conflicts between the client – methodology interface. From other studies, it was concluded that contradictions between decision-makers and the methodological approach used would be so severe that it would almost block the whole process.

The aim of this second example was, therefore, to produce more realistic scenarios using other methodological approaches and making sure that national decision-makers were involved in the study. It was important to apply methodologies that both directed the problem situation of the decision-makers and were accepted and recognised as analysing tools.

4.2.1 The Workshop

In order to deal with the contradictions, a workshop was established. A national study team was created. The idea of the workshop was bringing together opinions of all people in team into the analysis as well as some relevant stakeholders.

At first, the study team was introduced to the methodologies to be used – by themselves. It was decided that multicriteria decision aid should be applied since it were the omission of the existence of multiple criteria that was criticised in the original UNEP guidelines.

The multiple decision aid is a group of methodologies that gives support to a group of people in how they shall prioritise or choose among several alternatives or options under the existence of multiple criteria. Choosing among alternatives can be more or less difficult and demand different levels of analysis and formalism. The best choice is often very complicated and conflict-filled due to the consideration of multiple criteria. Often the methodologies will not find the optimal solution to a decision problem but show the advantages and disadvantages of different alternatives for the decision-makers to decide upon.

In the last decades the developments in the area of multiple criteria aid has produced a large number of methodologies to support decision-making. These methods differ in the way the mechanisms for incorporating decision-makers' preferences into the decision-making process. One characteristic of the methods is that the decision-makers have a lot of control over the process, which gives legitimacy to the results and often provides a justification and explanation to the choice, made. A good introduction to multicriteria theory can be found in Zeleny (1982).

The study group was introduced to the principles of various multiple criteria aid methodologies and models.

Secondly, the study team should establish and develop scenarios using the methodologies and knowledge on the central areas of energy, transport and agriculture which all are associated with emission scenarios. A group of experts were formed for each sector. The task of the groups was to agree on a common ground for carrying out the analysis (criteria and options to be evaluated) and to develop the emission scenarios. It was up to the groups themselves to decide on which of the multicriteria decision aid methodologies they would use. More detail about the study can be found in Borges (1999).

From the study, it was seen that each group used a different method that they felt were more adequate for their case. This shows that the participants achieved 'appropriation' of the methods and felt comfortable with the methodology.

The idea of applying the multiple criteria aid was that the study team should combine scenarios with different choices of options. This methodology forces people to work together and share viewpoints about the problem thus improving the decision-maker – analyst interactions. It forces the members of the workshop to learn and understand the methodologies in order to act upon them, and through this also the interaction between the decision-maker and the methodology is improved.

The most important contribution of the workshop was providing a structured interactive process by which the definition of scenarios and choice/prioritisation of mitigation options could evolve according to the points of view of different stakeholders. It was the opinion of both the study team and the analysts that this way of working together was beneficial for all parts involved.

5. Conclusions

National abatement costing studies are influenced by many factors. In a case study, it was found that most difficulties are associated with the social process framework constituted by the four elements: decision-makers, analysts, problem situation and methodologies. Problematic situations are referred to in terms of the contradictions that are always present but which can be addressed by applying methodologies with the purpose of dissolving them or achieving consensus. Two examples showed how contradictions can be addressed in national abatement costing studies by applying methodologies that address the central contradictions of the social process framework.

The social framework presented is not limited to the issue of climate change. In most problematic situations that need to be addressed, the interactions and contradictions exist and influence the situation. Often they are implicitly dealt with through the well-established frames of problem solving and decision-making that traditionally have been carried out and have established the roles of the actors. In other situations – which are often associated with complex problematic situations that have no traditions being solved – the contradictions are nevertheless present and must be addressed somehow.

However, it should be mentioned that the social process framework only considers the problematic situation as it is presently. It does not direct the problems that may evolve in time. Also, many situations will inherently be influenced by contradictions associated with the details of human interactions, power relations, the development of the political process, etc., between the decision-maker and the analysts groups. The social process framework is only a simple model of a more connected whole of social processes taking place in organisations and societies.

Looking at environmental problems in such a structural, methodological way we find there is a higher probability for understanding problems in case studies and therefore a higher chance that we find the way to address environmental problems and implement solutions. By addressing the dimensions of the social framework through the application of structuring, planning and methodological perspectives, we can improve the setting for environmental problem solving and hope to solve the environmental problems of today and of the future.

6. References

Alcamo, J., Shaw, R., and Hordijk, L. (eds.) (1990): *The Rains Model of Acidification – Science and Strategies in Europe*. Kluwer Academic Press, Dordrecht.

Borges, P.C (1999): *Multicriteria Planning and Optimisation. Heuristic Approaches.* To be published as Ph.D. Thesis at Institute for Mathematical Modelling, Technical University of Denmark, Lyngby.

Borges, P., Sørensen, L., Villavicencio, A., and Vidal, R.V.V. (1998): Strategic Approaches to Climate Change at Country Level – Focusing on Greenhouse Gas Abatement. *Investigação Operacional,* vol. **18**, pp. 183-205.

Dyson, R. (ed.) (1990): *Strategic Planning: Models and Analytical Techniques*. John Wiley & Sons, Chichester.

Dyson, R. and O’Brien, F.A. (eds.) (1998): *Strategic Development. Methods and Models*. John Wiley & Sons, Chichester.

Sørensen, L. and Vidal, R.V.V. (1999): *Strategy and Planning as a Learning Process* (In Danish). Handelshøjskolens Forlag, Copenhagen.

UNEP (1992): *UNEP Greenhouse Gas Abatement Costing Studies – Phase One*. UNEP collaborating Centre, Risø National Laboratory, Roskilde.

UNEP (1994): *UNEP Greenhouse Gas Abatement Costing Studies – Phase Two*. UNEP collaborating Centre, Risø National Laboratory, Roskilde.

Vidal, R.V.V. (1997): *The Contradictions of Planning*. Notes for Public Planning and Operational Research. Institute for Mathematical Modelling, Technical University of Copenhagen, Lyngby.

Willenius, M. and Tirkkonen, J. (1997): Climate in the Making. *Futures*, vol. **29**, no. 9, pp. 845-862.

Zeleny, M. (1982): *Multiple Criteria Decision Making*. McGraw Hill series in Quantitative Methods for Management, USA.