

A Dynamic Objective–Subjective Structure for Forest Management Focusing on Environmental Issues

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ABSTRACT

In this paper a decision-making process is applied to a Chilean forestry firm that must deal with a host of environmental variables as well as profit making. At the core of this process is a ‘dynamic objective–subjective structure’ founded on the approach that decision making is about comprehending the preferences of the various parties involved and expanding the set of alternatives open to the decision makers. This is in contrast to many models that aim at finding the ‘best alternative’ and to decision analysis approaches that focus on presenting preferences via value functions. The paper describes in chronological order, following the sessions of a decision-making process, how the various components of the structure emerged. In doing so it demonstrates how the process led to an understanding of the real effects of dealing with the environment and how comprehending the preferences led to the introduction of new decision variables. Copyright © 2007 John Wiley & Sons, Ltd.

KEY WORDS: decision-making methodology; multiple criteria; natural resources

1. INTRODUCTION

In this paper a decision-making process is applied to ‘Sociedad Forestal Millalemu’, a Chilean forestry firm that must deal with a host of environmental issues as well as profit making. At the core of this process is the ‘dynamic objective–subjective structure’ suggested in Henig and Buchanan (1996) and applied in Henig and Katz (1996), which is founded on the approach that decision making is about *comprehending the preferences* of the various parties involved and *expanding the set of alternatives* open to the decision makers.

According to the Finnish researchers Kangas and Kangas (2002), ‘The objective of forest management planning is to provide support for decision making so that an efficient mix of inputs and outputs best fulfilling the objectives set for the management of the area under planning can be found’. Operations research (OR) and multi-criteria decision-making (MCDM) models have long been used to achieve this objective (e.g. Weintraub *et al.*, 1994; Martell *et al.*, 1998).

Indeed, Finland with its abundant forests and flourishing concentration of decision analysts is particularly notable for applying these methods. Thus, for example, Kangas *et al.* (2001) make the following claim: ‘Forestry actions have long-lasting effects both on economic, ecological and sociocultural considerations. Criteria other than those related to wood production have been given more and more weight in the choice of management alternatives’. In a similar vein, Caro *et al.*’s (2003) use of optimization methods to plan activities under environmental constraints is in accordance with a recent shift in forest planning to include explicit recognition of non-timber goals (Bettinger and Chung, 2004). Accordingly, the authors applied common MCDM methods in their work. For a review of research using MCDM methods, the reader is referred to Salminen *et al.* (1998), Kangas *et al.* (2001), Kangas and Kangas (2002, 2005), and Diaz-Balterio and Romero (2007).

In contrast to most of the publications that apply MCDM methods to forestry, our research has been carried out for a private firm rather than a public organization like government or a regional planner. This is the same private firm, ‘Sociedad Forestal Millalemu’, which was studied in the Caro *et al.* (2003) application. As mentioned

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above, another distinction is that our purpose is not to select or rank alternatives but to comprehend the preferences of the parties involved and to expand the set of alternatives open to the decision makers, which are not the explicit goals of MCDM methods.

Caro *et al.* (2003) apply a non-interactive MCDM method assessing the Pareto frontier. In their paper, environmental decision variables are introduced and the optimal activities for various levels of these variables are considered. More specifically, they suggest a linear programming model to calculate the trade-offs between profits and environmental variables. These trade-offs give the loss in profits for various benefits in the environmental variables. For example, with no environmental constraints annual profit is 15 996 000 US\$, while having non-harvested strips alongside public roads will decrease profit by 64 000 US\$. However, it is not explained how, based on these trade-offs, the firm selects its preferred level of activities. Is there a clear and objective selection rule or do the trade-offs reflect the firm's subjective preferences? More fundamentally, do these trade-offs provide the CEO, the board of directors or the owners with the appropriate information to make decisions that can affect the firm in years to come?

It is our opinion that before any decision can be made an intensive, fundamental and dynamically evolving decision-making process has to be set in motion. To this end, as noted above, we consider here a decision-making process with Henig and Buchanan's (1996) 'dynamic objective-subjective structure' at its core. The three main components of this structure are alternatives, attributes and criteria. A *criterion* is defined as the 'raison d'être of the firm' and an *attribute* as an 'objective and measurable feature of the alternatives facing a criterion'. Appendix A presents a scheme of this structure. In Appendix B the structure captures the relevant components of the forestry firm as described in Caro *et al.* (2003), where the alternatives deal with timing and volumes harvested, road building, the type of machinery used and the amount of harvesting in the rainy winter season. Four criteria with several sub-criteria were defined in Caro *et al.* (2003). The first criterion is economic performance, with monetary values as sub-criteria, for which the corresponding attribute is net present value (NPV). Other sub-criteria like job creation or value of the forest lands have not been considered. The second criterion is environmental

values and preservation of biodiversity, with four sub-criteria: wildlife, water quality, soil quality and scenic beauty, which are measured by attributes such as units of logs, debris or sediment in the water, land density, internal drainage, profile depth, soil texture and exposed area as seen from the road. Wildlife protection was not considered. The third criterion, consideration of political climate and public awareness, was not considered, nor was the fourth, satisfying environmental standards. In the sequel we modify this structure to correspond better with the definitions of attributes and criteria.

The goals of comprehending preferences and expanding the set of alternatives are not easy to attain. In the OR literature they are handled in the modelling phase, but this is considered merely as a phase that defines the set of alternatives and the objective function using mathematical formulation and graphics in preparation for arriving at a solution. In many decision situations, however, the preferences may be too contradictory or fuzzy to be easily expressed by a unique overall objective function, a difficulty MCDM methods have tried to tackle by introducing several objective functions. This sometimes only exacerbates the difficulty as questions arise concerning how to construct such a collection of functions and how to aggregate them.

It is clear that the decision situation presented here, like many real-life situations, is far from well defined and there is no one approach that is superior to others in resolving it. Whereas decision analysis theories recommend the assessment of a value function over the attributes once they are defined, in our approach, similar to other recent approaches (e.g. Keeney, 1992), finding the right criteria and then the attributes, those related to the criteria, is the key to success. Since we do not aim to search for the optimal alternative, assessment may not be required unless it is a part of comprehending the preferences. This search for the 'best' alternative is more notable in the MCDM methodology, and Caro *et al.* (2003) is, indeed, an example of applying one of the methods practiced in the MCDM literature: varying the level of the constraints to approximate the Pareto set. On the other hand, we do adopt one of the most important features of this literature—the necessity to interact with the decision maker, although not with the aim of searching for the 'best' alternative, but to comprehend the preferences. Although we do not rule out such a search

by one of the methods proposed in the literature, this is one of the less important steps of the decision-making process, as Henig and Buchanan (1996) argue.

The paper describes, in chronological order, following the sessions of a decision-making process, how the process was handled and how the various components of the structure emerged. It demonstrates how the decision maker was helped to comprehend his preferences and to reveal alternatives for realizing them. The next section introduces the question of the environmental issues as the criteria of the firm. The main motives for actions are exposed in the third section, followed by new criteria in the fourth section. Comprehension of the preferences leads, in the fifth section, to the introduction of new decision variables. In the sixth section we discuss how attributes should be defined, and the decision process ends with a short list of recommended actions. Conclusion and comments about the process appear in the last section.

Clearly, a decision-making process cannot be performed without the decision makers, in our forestry firm, the owners, the board of directors and the CEO. In this study, which continues the application of Caro *et al.* (2003), we used a proxy to the CEO as at this stage of our research the decision-making process was still experimental. The second author of this paper, who has many years of experience in the forestry industry in general and at 'Sociedad Forestal Millalemu' in particular, and knew well the CEO, took his role as the principal decision maker.

Although the paper describes the application to a specific firm, it tries to generalize the process and the conclusions to other firms contending with multiple-criteria problems, not only forestry firms but also any entity concerned with environmental or other issues in conflict with the criterion of maximizing profits. Moreover, as the main ideas and features, and especially the objective-subjective structure, are typical of any complex decision situation, the conclusions drawn here can be used in any decision-making setting.

2. PROFITS AND ENVIRONMENTAL VALUES AS CRITERIA

According to Corner *et al.* (2001) the decision-making process can start with examining any of the three components of the structure: alternatives,

attributes or criteria. As some of these components, mainly alternatives, have already been published in Caro *et al.* (2003) we continued the process from there, trying to determine what the criteria of the firm really are. Recall that a criterion is related to the reason for the firm's existence. According to Caro *et al.* (2003), as depicted in Appendix B, 'environmental values and preservation of biodiversity' is a criterion, alongside 'economic performance'. This is quite surprising considering that private firms (and publicly owned firms) have just one criterion, customarily termed profit, economic performance or financial value. Usually, this criterion is measured by a single attribute—NPV. Although, on the face of it, this means that no criterion other than profit should affect decisions of the firm, many firms do consider other objectives, notably environmental ones, in their decision making, as reported by Bettinger and Chung (2004). How can this be justified?

One possibility is that the owners of the firm or their representatives are personally concerned with the environment and use the firm as a tool to take care of these concerns. But then they are not being loyal to the 'raison d'être' of the firm, which is to maximize profit, and even actually decrease the profit, as is evident from Caro *et al.* (2003). Actions related to personal values (value being a synonym for criterion as defined by Keeney (1992)) of the environment should be funnelled through personal channels. Indeed, our CEO confirmed that, although he personally loves to roam the forests and is in favour of preserving nature, he believes that no personal motives should be allowed to shape the firm's actions.

Another possibility is that environmental issues do constitute one of the firm's criteria, as assumed implicitly in Caro *et al.* (2003) and explicitly expressed in Pukkala (2002a): 'ecological goals are just additional objective variables making the planning more multi-objective than earlier and, unfortunately, more complicated'. In other words, environmental issues are part of the 'raison d'être' of the firm. However, this is implausible unless the firm was established to protect the environment and this is not the case for our firm and, probably, not for any private forestry firm. We asked the CEO bluntly why he should consider giving up any part of his profit to have non-harvested strips alongside public roads. The response was that he has to consider such actions as being in the best interests of the firm, even though the firm is not

directly responsible for the scenery along the highways. In fact, the firm's objectives are in conflict with the public and the government that represents it, and that worries him.

Thus, if indeed the only criterion of the firm is profit then the only reason for environmental issues to be considered is that they actually affect the firm's profits but are not criteria *per se*. Profit can be affected in two ways:

- Directly, when protecting the environment changes the economic value of the firm in terms of quantity and quality of timber. For example, reducing soil erosion improves soil conditions in the long run, which may increase the timber production.
- Indirectly, by influencing legislation and the demand for the firm's products. For example, reducing contamination of water reduces negative effects on neighbours, which may decrease local pressures to reduce harvesting.

Both of these effects are mentioned in Caro *et al.* (2003): 'The need to preserve forest soils grew both as an awareness of the benefit for the forestry companies of increasing the value of their holdings, by having better quality lands for future harvests, as well as the realization that the political climate was increasingly pointing towards more active environmental protection. ...Firms became interested in determining the trade-offs between measures to preserve and protect the environment both for considerations of value of their own holdings, and to prepare themselves for the expected political discussions on measures and regulations that the government is likely to impose in the future.' So what remains to be done is to understand the environmental variables and relate them to various attributes that measure these direct and indirect changes, and to understand how they affect profits. None of this was done in Caro *et al.* (2003). Only direct costs of preservation were considered, while the long-term benefits to the firm were not addressed. This can be justified by the difficulty of assessing these benefits. But can a rational decision be taken by ignoring the impact of these variables?

The CEO took part in this discussion concerning the criteria of the firm and acknowledged that his preferences, especially those concerning protection of the environment, were now in the right perspective, and he was pleased not to have been

forced to determine trade-offs, for which he felt unready. On the other hand, he argued that he was not completely happy with profit being the sole criterion of the firm and more sessions were needed to get the preferences straightened out.

3. EXPOSING SUB-CRITERIA

During the previous session it was made clear that the main source of the CEO's anxiety was the possible intervention of governments and other organizations in regulating forest management for the sake of preserving the environment. Indeed, the CEO was very well acquainted with recent developments on the subject.

In general, the environmental situation, in political terms, is complex, and has changed significantly in the last few years in the direction of making compliance with rigorous environmental issues far more important. There are several non-government organizations (NGOs) that are concerned with the environment. Actually they are organizations with lists of criteria that include integrity of ecosystems and preservation of biodiversity (Charter of the Global Greens, Canberra, 2001). Some are motivated by ideology, varying from relatively moderate to extreme conservatism, and they are mostly based outside Chile. Their resources come from members, who may have significant influence. Then there are local conservation groups, which are not very powerful but have made alliances with the international NGOs.

Analysis of the Chilean government's motives reveals that they are influenced by several organizations: foreign governments (especially the US) and the NGOs for the protection of the environment mentioned above. Other motives are the wish of the government to protect communities near the forests from contamination of their resources and preserve the environment for the benefit of Chilean citizens and visitors. On the other hand, the government is well aware of the importance of the forest industry to the economic and social life of Chile and so, contrary to the NGOs, it does not automatically support in protection, as was evident in the last global recession when the government relaxed the pressure on the timber industry.

In analysing the power of foreign governments and the NGOs it became clear that they not only can advocate legislation but also may alter the

demand for the firm's products and, in the extreme case, may even initiate a consumers' boycott. The driving force behind these organizations is public opinion, both foreign and local, which is more and more concerned with the effects of industrialization on nature. This led us to recognize the importance of the image, both domestic and foreign, of the firm and the timber industry.

What emerged here was a major shift in the process: the firm is only one of the players in this game of preservation and they interact and influence each other reciprocally. Indeed, as it turns out, the main reason for the process being initiated in the first place was that there are other players, like the government and the NGOs, in the forest. The firm has to first understand the strategies of these players before taking any major action. Furthermore, as all these organizations are sensitive to public opinion, it is clear that the firm's image as a preserver of the environment is important.

Formally, we identified two sub-criteria that are related to profit: reactions of organizations and the firm's image. Trying to understand how these factors affect the firm's economic performance we realized that we were heading for an obstacle that other approaches have tried to circumvent. It is clear that the firm's image and organizations' reactions are feeding each other but it is hard to understand the dynamics of the interaction. They may both cause fluctuations in demand, decrease the value of the forest areas and increase costs due to regulations, but, again, it is not easy to map the relations.

It became clear that a new dimension of decision variables was created after revealing these sub-criteria. Although the issue was postponed for a later stage of the process, it became clear that decision variables relating to the influence of public image, both in Chile and abroad, and to learning and understanding the intentions of the organizations, are only part of these new decision variables.

Above all, the process introduced a new factor, surprisingly not considered so far, that of the uncertainty concerning the behaviour of the public and the organizations in response to the actions of the firm. We should also note here that there is a level of uncertainty about the nature of the environmental standards several years from now. The CEO acknowledged that this was what he had in the back of his mind all the time, and that some of the actions he considered were, indeed, in

response to uncertainty about the future. It became clear that an effort had to be made to come to terms with uncertainty.

4. EXPOSING NEW CRITERIA

The potential intervention of the organizations, discussed in the last section, became the turning point of the decision process. The CEO expressed his opinion that this intervention was not only related to economic performance but to the very existence of the firm. Trying to understand the possible impact of an intervention and regulation he realized that in the long run the firm could even be forced to close, either by law as a polluter, or due to economic bankruptcy, as demand halted and costs rose.

It seems that environmental variables may affect the firm in a much broader sense than has been thought till now. Indeed, it depends on how broad the criterion of profit is. In fact, different executives and stakeholders may understand 'profit' in different ways. There are two major elements that are responsible for such differences: uncertainty and timing of profits. Terms like 'stability' and 'survival' are among those used by firms to explain decisions that are not in accord with maximizing NPV. These terms are intuitive and not well defined, which, being criteria, are not unusual. Generally speaking, stability is related to a steady stream of income over time, which eases the running of the firm, and survival refers to the possibility of events like high losses or environmental catastrophes that may lead to the demise of the firm. NPV, being an expected aggregated value, does not capture these criteria, and other attributes have to be found to assess them. It is worth mentioning that a firm can be compared with a human being who not only wishes for a high level of income but also dislikes sharp fluctuations that may place his existence at risk. The similarity is apparent because, after all, the preferences of the firm reflect those of its owners and managers. Like people, firms are commonly risk averse.

In order to include these notions in the list of the firm criteria we define 'welfare' as the overall criterion of the firm, following Pukkala (2002a): 'The task of forest planning is to show the way to use forest resources in such a way that the welfare, or utility, of the forest owner is maximized'. So, profit, stability and survival are possible criteria underneath the overall criterion of welfare,

although different stakeholders may aggregate them differently to attain maximum welfare of the firm in accordance with their subjective preferences.

The sessions with the CEO became a kind of 'strategic therapy' as he started to expose his fears concerning the dangers the firm faced in the long run if it confronted the organizations. Elaborating on stability and survival he also expressed his concerns about the firm's operational management capabilities. Introducing new regulations can affect the moral of the workers and managers. Worse still, they can feel they are detested by the public and in the worst case they can even be attacked physically. In the CEO's words: 'I can visualize the tomatoes being thrown at me as I enter our offices'. As public opinion becomes negative, executives and professionals in particular may be reluctant to continue working for the firm, which will surely have repercussions on the firm's production. This discussion endowed us with another sub-criterion, one that is related to 'staff satisfaction'.

At this point, we decided to end the sessions on comprehension of the preferences and turn to the objective components of the structure: attributes and alternatives. The results of the last sessions are described in Appendix C as the subjective part of the structure. As can be seen in Appendix C, at this stage the firm was explicitly considering new criteria, including stability and survival of the firm, with corresponding sub-criteria directly related to the reactions of the different agents to the firm's actions: government, environmental NGOs, neighbouring communities and customers, in particular those in developed countries that place a high value on environmental preservation.

5. ALTERNATIVES

New decision variables had by now emerged naturally while preferences had been exposed and comprehended. Needless to say, the decision variables that were considered in Caro *et al.* (2003) seemed less important at this stage. Those variables can be regarded as tactical, whereas some of the new ones can be labelled as strategic. Hence, one of the achievements of the process was the switch from tactical planning to strategic management. Actually, environmental issues disappeared from the list of criteria of the firm, though they may be on the list of criteria of the government

and other organizations. Environmental issues are expressed only on the list of the decision variables. We should remark that other decision variables could be employed to adhere to the firm's preferences: financial, manufacturing, marketing, etc. However, our decision process deals with those related to environmental issues only.

The reality of the existence of other players introduced a new dimension of decision variables that are related to the following groups: organizations involved in protecting the environment, the public in Chile and abroad, customers and workers. Furthermore, part of the decision-making process is to reveal the decision variables that can be employed by these groups, namely the actions that the government and the NGOs can apply as a response to the firm's actions, in response to public demand or just as a part of their agenda.

The main organizations concerned with protecting the environment are the Chilean government and the NGOs, but others, like foreign governments, may be involved too. An effort has to be made to identify these entities, learn their motives and strategies, and establish relations with them while trying to predict their responses to the possible actions of the firm and hence deriving further decisions. The involvement of other organizations and understanding their motives brought up an interesting idea: seeking their assistance in preserving the environment and in learning the subject, and even asking for financial support, especially from the Chilean government. Another idea is the establishment of a permanent institute common to the forestry industry and the government that will examine the issue of forestry and the environment.

Although the public is not directly involved, it is the driving force behind the organizations. Learning the public needs and assessing trends in public opinion concerning preservation of the environment can give the firm a head start in responding to the organizations' demands, and this brings us to the firm's image, an issue with which it had never been concerned previously. A public survey to assess its image must be conducted, followed by a study on how the firm's actions might affect its image and the means to improve public perceptions of the firm.

Similar but more specific surveys and studies should be conducted among the firm's customers in order to assess demand as a function of the firm's actions. Finally, the impact of the

environment's actions and image on the workers must be examined, bearing in mind their needs and their environmental values.

6. ATTRIBUTES AND SHORT-TERM DECISIONS

It is evident that most of the decision variables suggested at this stage aim to collect information, indicating the lack of knowledge and the high uncertainty that the firm is facing. There is no group within the firm, or working for the firm, which collects information and advises the firm on environmental issues. In particular, the firm has no measures to assess its actions in terms of the criteria. That is, except for the natural attributes mentioned in Caro *et al.* (2003) the firm had not used or developed any attributes. Hence, the need for it to gather knowledge on environmental attributes: how they are affected by the various decision variables and how they affect the criteria of the firm: costs, profits, image and the reaction of other players.

This paper does not suggest any new attributes, leaving this for a later stage in the process. In any case, attributes that measure the effects of environmental decision variables are discussed at length in the literature (see Pukkala, 2002b, for references) and deserve a paper of their own. But let us return to describing the role of attributes in our structure.

In a recent paper that summarizes previous studies, Keeney and Gregory (2005) wrote as follows: 'The selection of an attribute should be viewed as a decision'. The impression conveyed by the paper is that creating appropriate attributes is an art that requires knowledge, experience and ingenuity, and this requires effort and resources. Altogether, it is one of the most difficult steps in the decision process. The difficulty is not only technical, in that the technology does not yet exist, but also conceptual. For example, how does one measure scenic beauty ravaged by timber harvesting? Conceptually, beauty is in the eye of the beholder. Caro *et al.* (2003) suggested measuring the 'exposed area as seen from the road'. It is doubtful that this indeed measures damage to scenic beauty. From a technical point of view, questions of timing, location, equipment and more arise. Even, a relatively simple criterion like quality of water is not simple to measure, not to

mention attributes that measure protection of wildlife.

However, without appropriate attributes that link alternatives and criteria a proper and rational decision process cannot take place. The attributes are the bridge between the subjective world of the preferences and the objective world of the decision variables and according to Keisler (2002) they are the factor that differentiates one alternative from another. The importance of the attributes is that they embody the criteria and sharpen their meaning. In Keeney and Gregory's (2005) words: 'The thoughtful choice of attributes clarifies the meaning of each objective, provides for a useful description of the consequences of each alternative, and facilitates an insightful evaluation of alternatives'.

It should be emphasized that introducing the attributes later may change the structure as it now appears in Appendix C. Moreover, contrary to many MCDM methods, we do not think that the sole purpose of attributes is to extract trade-offs. It is our opinion that the attributes are necessary to give some substance to the criteria as one of the three main components of the structure.

One of the main problems in forming attributes, as observed by Keeney and Gregory (2005), is that they are not purely objective. Usually, there is no one attribute that exactly measures the criterion, as the criterion is by nature intuitive and abstract. Even the notion of profit is much more than any one attribute, including the NPV. Several attributes may reflect a criterion, but the aggregation is subjective. There is an unbridgeable gap between a criterion and its attributes. As Keeney and Gregory (2005) note, even an objective attribute is selected subjectively. Clearly, environmental experts have to be recruited to assist in creating, selecting and constructing the attributes.

Our recommendations for the sequel are to form more attributes to measure the effects of protection on the environment. We cannot exaggerate the importance of meaningful natural attributes that the organizations and the public understand and accept. Then, attributes that measure the value of the firm's forest and uncertainty and fluctuations of the stream of income should be defined. These attributes are common in decision analysis and may include terms like standard deviation, probabilities of various events, utility function, etc., apart from NPV. These common attributes must be drawn up in cooperation with the decision makers to that they are capable of

interpreting them in a meaningful way vis-a-vis the criteria. Other attributes should measure the firm's image and the opinions of the workers. Then the impact of the decision variables, those of the firm and others, on the attributes will be assessed as described in Appendix D.

This stage of the decision process ends with some recommendations for short-term actions:

- Establish a department for the environment headed by a vice president who will take charge of the decision process.
- Appoint a public relations person to take care of the firm's image.
- Establish a guidance centre for environmental issues that will help and guide staff and managers.
- Enable professionals and workers to proactively participate in decision making and production processes in relation to the environment.
- Hire experts on environment issues.

Ideas about actions that were expressed in this and previous sections will be taken care of by the vice president and are not repeated here as they are still embryonic in form.

7. CONCLUSION

Is our decision process, with the objective–subjective dynamic structure at its core, a good process? Is this process an easy task for the firm to carry out?

The answer to the first question is straightforward. Building the structure set a real decision-making process in motion. The CEO began to understand the real effects of dealing with the environment, and this understanding led him to take the right steps to promote its welfare. It is our opinion that comprehending preferences is not only about assessing trade-offs, but mainly about understanding and bringing to light the criteria of the firm. Indeed, it took very little time for the full subjective structure of the criteria to be revealed and to put the decision situation on the right track, and, as seen in the previous sections, this led to the emergence of the right decision variables and to a start in formulating the right attributes.

The process was also educational. It exposed the owners and the managers to environmental issues, which until then had been a source of fear. The

process put the issues in the right perspective for them.

Moreover, the process allowed the CEO to express his concerns and preferences freely, without being forced to make binding decisions. It can be asked whether 'survival' and 'stability' are genuine criteria. Criterion is an elusive term, reflecting the vague nature of preferences and values. In this context, it was the belief that preferences and values are not pre-determined that led Roy (1996) to a new approach, which he termed multi-criteria decision aid (MCDA). Like many other researchers we share this view and as such see the criteria 'survival' and 'stability' as merely reflecting the thoughts of the CEO. More importantly, our approach led to new decision variables, i.e. expanding the set of alternatives.

The transparency of the process is important for convincing the government of the seriousness of the firm in taking environmental considerations into account. As Pukkala (2002a) notes: 'Another element of social sustainability is the fairness and transparency of the process in which forest plans are produced and management alternatives evaluated'. In other words, it is important to let everybody know that the firm is aware of the environment.

The answer to the second question is not simple. The process involves much more effort than just posing trade-offs to the firm. However, as the CEO felt that the process would lead the firm to the right decisions he was keen to cooperate in making it happen. Making long-term decisions about the environment necessitates a thorough understanding of the issues and that is precisely what the process is about.

It was observed that the effects on the firm's welfare are uncertain due to developments in technology, trends in public opinion and political influence, in Chile and abroad. Hence, as well as being asked about trade-offs the firm will be asked about forecasts concerning future developments. The motivation will then be to collect data and to consult with experts about these developments, and, importantly, this will lead to the expansion of the set of alternatives. New alternatives concerning technology, public opinion and politics will be considered in addition to the standard decision variables of timing and quantities of harvesting. They will include alternatives for developing technologies that do not harm the environment, facilities for purifying water, constructing a positive image, contributing to the NGOs, and

participating in preservation in other parts of the country. It is possible that the main shift of the analysis will be not to MCDM or MCDA procedures but rather to analyse the uncertainty that the firm faces.

We argue that many MCDM or decision theory methods may not be appropriate to our situation in this stage. These approaches focus on tactical planning, which cannot be done without first considering making strategic plans. Furthermore, the decision-making process cannot be separated from the implementation process as can be seen from the short-term recommendations. The decision process must continue from within the firm with external consulting on decision making, the environment and public relations. This is a long and perhaps endless process, which must be flexible, informative, connected to the realities of the changing world and attentive to the decision makers' preferences.

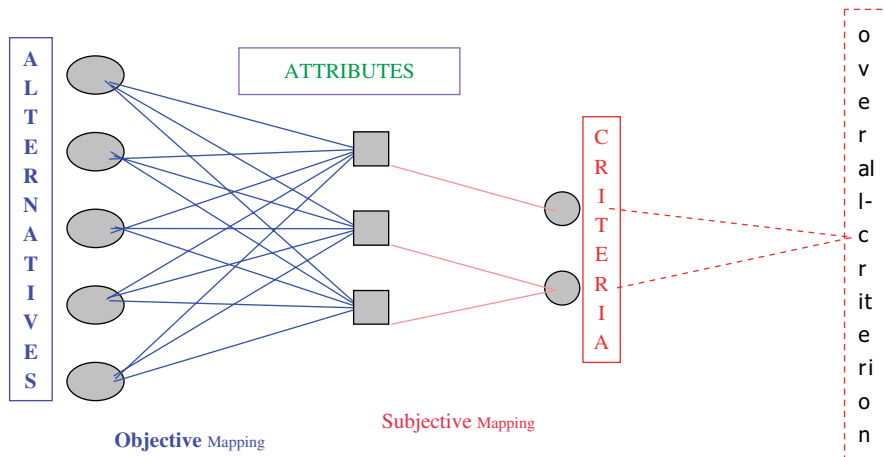
There is a considerable difference between the process set in motion here and many other MCDM approaches. As already noted many methods concentrate on trade-offs between profits

and environmental variables, whereas our process is an inquiry into the relationships between these issues and profit in its broadest sense, welfare. Moreover, decisions on trade-offs between profits and the various environmental attributes use subjective preferences prematurely, whereas our process tries to push the boundary between objective knowledge and subjective preferences to where it belongs. As to assessment of the trade-offs between profit and other criteria like stability and survival, we leave that for a later stage, if it is deemed necessary.

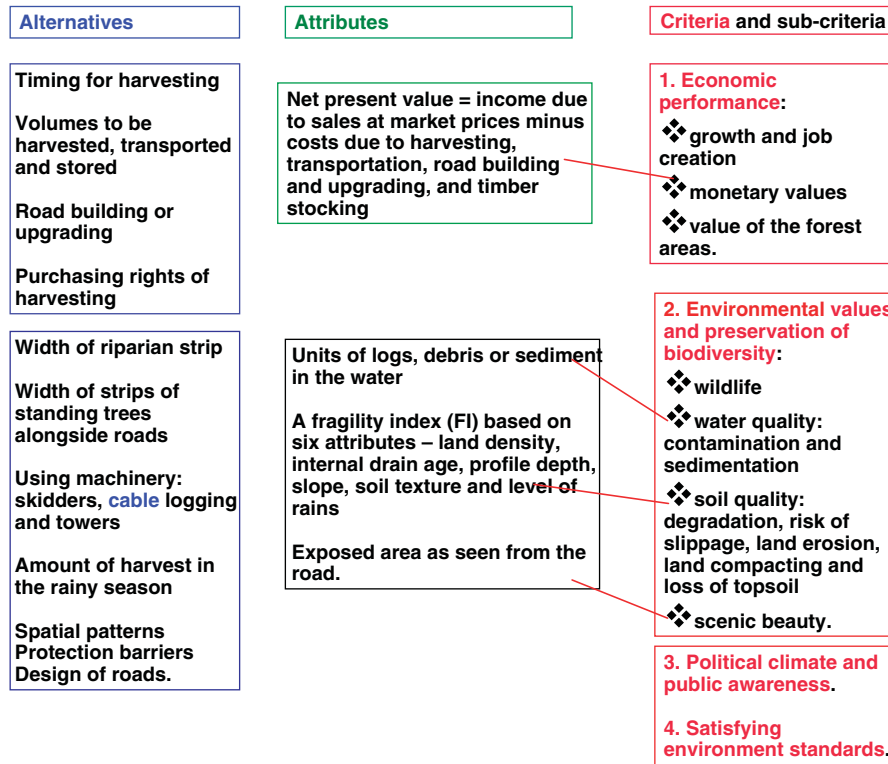
It is our opinion that the problem of decision making is collecting information of two kinds: about the objective world and relating to the decision makers' preferences. The first phase of the process begun here was mainly concerned with the subjective preferences of the decision makers. The next phase will be about the external world.

In commenting on the experience that he underwent the CEO said that all in all the process is what he calls plain 'common sense'. We believe that that is exactly what is needed in a decision-making process.

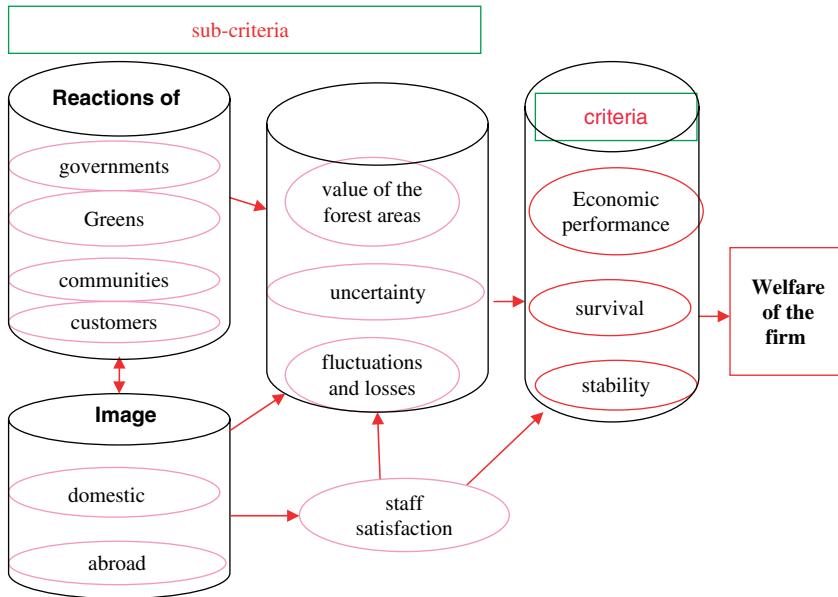
APPENDIX A: A SCHEME OF THE OBJECTIVE-SUBJECTIVE STRUCTURE



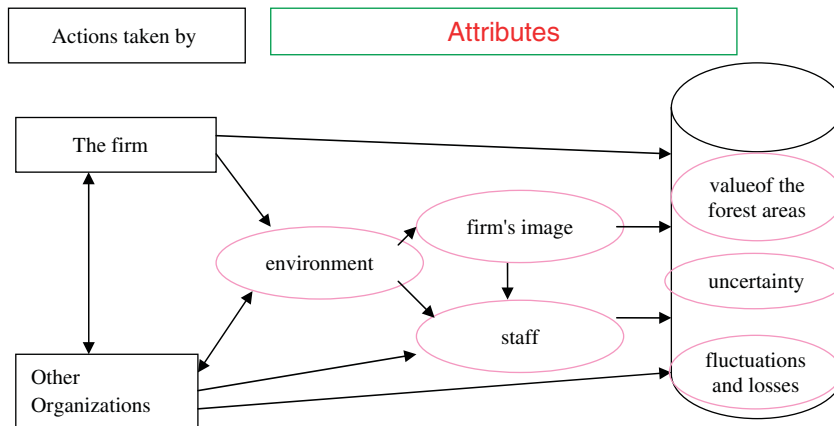
APPENDIX B: THE STRUCTURE ACCORDING TO CARO *ET AL.* (2003)



APPENDIX C: THE STRUCTURE AFTER THREE SESSIONS



APPENDIX D: IMPACT OF DECISION VARIABLES ON THE ATTRIBUTES



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