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Prioritizing Complex Issues of Hydrographic Basin Committees by Group Decision Approach

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Abstract

In Brazil, the hydrographic basin committees are the centre of decision for water resource management in their respective basins. The committee members, who represent the public sector, water users and civil society, must decide about complex issues, requesting the consideration of multiple aspects: economic, social and environmental. Given the complexity of the decision-making process, it is advantageous to have a decision support system that guarantees transparency, rapidness and, specially, a structured analysis of the problem, incorporating all aspects of the situation. This paper presents a group decision making model based on multicriteria analyses to support the members of a hydrographic basin committee to prioritize complex issues, in special activities to control the environmental degradation The proposed model works through two steps: firstly is used the PROMETHEE II method to achieve the individual rankings of alternatives, and secondly, the individual rankings of alternatives are aggregated to attain the global ranking, applying the ELECTRE IV method, reflecting the preference of the group.

Keywords: *Group decision, PROMETHEE II, ELECTRE IV, Hydrographic basin committees, Water resources management*

Introduction

Making decisions about activities of hydrographic basin committees are usually complex due to the need to consider many objectives and because they involve consequences of environmental, social and economics impacts. Also, this kind of decision requires the involvement of multiple decision makers, which makes the process more complex, since different view points must be established and discussed.

Although the complexity of decision process increases, the involvement of multiple decision makers is essential in this kind of issue, which involves public interests. The connection of opinions of each member involved becomes the decision

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process more transparent than when it is analyzed in a closed way, without the society participation. When people realize the transparency, the changes are better accepted and the credibility is guaranteed (Morais and Almeida, 2007).

Some studies regarding this subject of group decision related to environmental aspects have been drawn up in recent years which show the relevance of the theme. Among the studies presented, there are few that consider a ranking approach paying attention to the preferences of decision-makers, which very often are conflicting.

Therefore, this paper proposes a multicriteria group decision making model to aid members of a committee to rank alternatives for control the environmental degradation of its respective hydrographic basin, followed by the aggregation of individual preferences in order to obtain a solution which represents the decision of the committee.

The chosen multicriteria methods provide a ranking of alternatives, whose ordering is based on the best overall performance when all the criteria are considered, in order to avoid the choose of an alternative which performs well in one of the criteria, but performs poorly in all the other criteria. The PROMETHEE II method was used to obtain the individual rankings. The ELECTRE IV method was used to aggregate the individual results, which correspond to a new multicriteria problem, where the alternatives are the same and the criteria are the decision makers whose relative importance among them are not established.

This paper is structured as follows: Section 2 gives a presentation about hydrographic basin committees; Section 3 presents some concepts of group decision, including its main approaches, and multicriteria decision making; Section 4 presents the group decision model to aid hydrographic basin committees; Section 5 provides a model application; and Section 6 presents some conclusions.

Hydrographic Basin Committees

One of the fundamentals of the Water Resources National Politic is the decentralization and participation of all in the water resource management process - civil society, public sector and water resources users. The establishment of hydrographic basin committees is a response to this fundamental. The politic establishes the following structure to the committees: 40% of water resources users (industrial, agro-industrial, etc.); a maximum of 40% of government representation; and at least 20% of civil society representation.

It is not simple to develop activities in these committees, since their members must decide about complex problems, considering multiple criteria, some of them conflicting with each other. Moreover, the committees’ members usually execute other priorities activities, implying in a limited time to the water resources management.

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In general, the hydrographic basin committees perform a simple voting to support their decisions, so the final decision is the one chosen by the majority. This process does not help to take into account all the criteria involved in situation. Also, it is not transparent, which is an essential feature of public policy process. Moreover, it can be influenced by the debates and discussions preceding the voting, which help to promote particular interests of the most influential and/or persuasive members, preventing the decision-making in a rational way.

Given this scenario, it is necessary to implement a decision support system model to aid committees' activities, in order to consider all criteria involved in the situation, which will represent point of views and interests of committees' members, increasing the transparence and efficiency to the decision.

Used Approaches

Group decision is usually understood as the reduction of different individual preferences to a single collective preference (Jelassi et al. 1990 apud Leyva-López and Fernández-González, 2003).

The authors distinguish two main approaches to aggregating group preferences: (i) input level aggregation; (ii) output level aggregation.

For input level aggregation, the group is asked to agree on the alternatives, criteria, weights and remaining parameters. The parameters are established in an open discussion that occurs at the beginning of the process. A multicriteria decision making method is applied using the parameters accepted by the group. This approach is most appropriate when there is little divergence amongst the group members in their choice of parameters.

For output level aggregation, a group consensus is needed only for defining the actions. Each member applies the multicriteria decision making method to his own preference structure in order to obtain his/her personal ranking. Next, the information contained in individual rankings is aggregated into a final collective ranking. During the aggregation, each member is considered as a separate criterion and each receives a weight corresponding to his/her importance in the group.

The structures of hydrographic basin committees, in which their members represent the public sector, water users and civil society, having different interest in the respective basin, indicate a strong divergence amongst them. In this case, the output level approach is most suitable to aggregate the individual preferences.

According to Srdjevic (2007), the multicriteria decision aid and the social choice theory are used to support group decision problems. The former is useful in handling structured problems and the other is useful when the available information about the problem is minimal, unconfident or predominantly qualitative. The inherent characteristics of the group decision problem determine which methodology should be used.

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The model proposed includes a stage in which a study on the hydrographic basin was performed in order to structure the problem and, consequently, use a multicriteria evaluation to support the committee. The next subsection presents some concepts of multicriteria decision making.

Multicriteria Decision Making

The problems which involve multiple criteria are named multicriteria problems. They appear in different branches of Operational Research. Also, they are present in real life problems.

Vincke (1992) defines a multicriteria decision problem as being a situation in which, having defined a set A of actions and a family F of criteria, the decision maker wishes:

- to determine a subset of actions considered to be the best with respect to F (choice problem);
- to divide A into subsets according to some norms (sorting problem);
- to rank the actions of A from the best to worst (ranking problem).

A lot of methods were developed to support the choice, sorting and ranking of alternatives in decisions involving multicriteria problems. The specialists in multicriteria divide these methods into three families: (i) multiple attribute theory; (ii) outranking methods; (iii) interactive methods. Roy (1985) classifies them as follows: (i) unique synthesis criterion approach, eliminating any incomparability; (ii) outranking synthesis approach, accepting incomparability; (iii) interactive local judgment approach, with trial-error interaction.

- Unique synthesis criterion approach: family of America inspiration, it consists in aggregate the different points of view into a unique function which will be optimized.
- Outranking synthesis approach: family of French inspiration, it consists in build a relation called outranking relation, which represents the decision maker preferences, then this relation is exploited in order to help the decision maker to solve his/her problems.
- Interactive local judgment approach: proposes methods which alternate calculation steps, giving successive compromise solutions, and dialogue steps, meaning extra source of information on the decision maker's preferences.

The outranking synthesis approach will be used in this work, since its methods provide a ranking of alternatives based on their performance considering all of the criteria, avoiding the compensation among criteria. Moreover, the method must provide a ranking of alternatives, which must be interpreted as the best sequence to implement them. The next subsections present some outranking methods.

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Promethee

PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) is a multicriteria decision making (MCDM) technique that provides a valued outranking relation (Vincke, 1992).

The PROMETHEE family methods allow that each decision maker select his/her own preference function. The preference function describes how the decision maker's preference changes with the difference in performance level for two alternatives in a specific criterion, $[g_j(a) - g_j(b)]$, where $g_j(a)$ is the performance level for alternative a in criterion j (Brans and Vincke, 1985).

These methods are also flexible for definition of preference and indifference thresholds. Moreover they allow that each decision makers assign different relative importance to criteria. All these aspect make the PROMETHEE methods very suitable to be applied for group decision.

Other advantage of PROMETHEE is related to the fact the decision makers understand easily the inherent method's concepts and parameters, which makes the preference modeling simpler and, consequently, increases the efficiency of the methods' application.

Brans *et al.*, 1986 used PROMETHEE to rank and select projects. Halouani *et al*. (2007) used them for project selection is a real problem of multicriteria group decision making. Haralambopoulos and Polatidis (2003) used the PROMETHEE to assist a group decision making with multicriteria analysis in renewable energy projects.

PROMETHEE II is an implementation of PROMETHEE technique, in which a complete pre-order of alternatives is obtained from a parameter named net flow, which is calculated for each alternative, representing a score received by them according to their performance (Brans and Vincke, 1985).

An alternative a outranks an alternative b if the net flow of a is bigger than the net flow of b, $Q(a) > Q(b)$, and a is indifferent to b if its net flows are equal, $Q(a)=Q(b)$ (Brans and Vincke, 1985). Based on the net flow information, the rankings of each decision maker are obtained, and the alternatives are ordered in decreasing order of their net flows.

Due to its inherent characteristics, PROMETHEE II method seems to be the most suitable method to support decisions taken by hydrographic basin committees.

Electre

The ELECTRE (Elimination Et Choix Tranduisant la Réalité) is a family of methods. These methods provide a subset of alternatives which outrank other alternatives that are out off this subset. These methods use the concept of concordance and discordance to measure the relative advantage and disadvantage between pair or

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alternatives, respectively (Vincke, 1992).

Although ELECTRE IV is a method of ELECTRE family, it uses the concept of indifference (q) and preference threshold (p) instead of using the concept of concordance and discordance, which makes its implementation easier than the other ELECTRE family's methods.

In ELECTRE IV, the outranking relations are defined by the alternative's performance level, through the following outranking ratios: Strong Outranking (aS^Fb) and Weak Outranking (aS_fb). The concept of qualification is used based on the ratios of strong and weak outranking, in order to define the two modes of ranking. The initial qualification of the alternatives is determined by the ratio of strong outranking. The weak ratio is used to distinguish, if possible, among those alternatives which have the same value of initial qualification (Belton and Stewart, 2002).

During the aggregation of the individual preference, each decision maker of committee is considered as criterion, having no specification of weights, since the relative importance among decision makers is not being judged. The ELECTRE IV method is especially useful in this case due to the fact that it does not request a weighting among criteria.

Proposed Group Decision Model

In this section we describe a group decision model to aid the prioritization of alternatives to control the degradation problem of a hydrographic basin. The group which will receive the support is the entity responsible for the hydrographic basin management, which is usually performed by its respective committee.

The model uses the multicriteria method PROMETHEE II to create a ranking of alternatives for each decision makers. These ranking will express the decision makers' individual preferences in relation to a set of criteria. Firstly, PROMETHEE II method was chosen because of the following requirement of the problem: a non compensatory method which provides a ranking of alternatives. Secondly, it is a relatively simple application method. Finally, it allows the decision makers to choose the type of preference function, preference and indifference thresholds, thus ensuring better modeling that fits the decision makers' preferences.

The individual rankings are aggregated using the ELECTRE IV method. This stage corresponds to a new resolution for the multicriteria problem where the alternatives are the same and the criteria are the decision makers. ELECTRE IV was chosen because it does not request a weighting among criteria, which in this case are represented by the decision makers, whose relative importance are considered the same in the decision process.

The model is divided into three stages: 1) problem characterization stage, obtained from a study on the hydrographic basin, with the definition of decision-makers, criteria and alternatives to reduce environmental degradation; 2) individual evaluation stage, where a multicriteria decision aid method is used to obtains

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individual rankings; 3) group evaluation stage, where the individual results are aggregated (Figure 1).

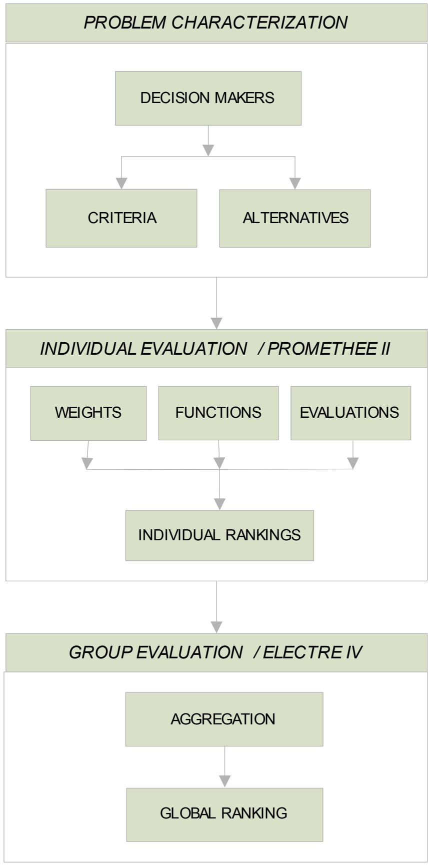

Figure 1 - Overview of the proposed method

Problem Characterization Stage

In this stage, a study about the hydrographic basin is performed in order to characterize its actual situation, in relation to its degradation condition, and to verify which entities are responsible for the hydrographic basin's management.

Also is necessary an analysis of the main degradation sources and critical areas must be performed. It is also important to perform a research about alternatives developed in other basins, which are controlling the degradation problems caused by the same kind of degradation source.

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Alternatives

Using the information about the status and main degradation sources of the hydrographic basin, a technical study must be performed in order to formulate a set of alternatives to control the degradation effects which was identified. Each alternative should have a description including technical information in order to be possible evaluate them in relation to the criteria considered.

Criteria

The family of criteria should evaluate the economical, social and environmental benefits of alternatives. Also, it should evaluate the financial investment requested by each alternative, such as the monetary value for action implementation and for maintain its operation.

The criteria description should provide the understanding about what each criterion will evaluate. Some of them request a subjective evaluation, in which is used a verbal scale, subsequently converted in a numerical one. A verbal scale, whose levels are very high, high, medium, low and very low, is useful in this kind of evaluation, in which alternatives to control an environmental degradation are evaluated considering economical, social and environmental criteria.

The scale's level (very high, high, medium, low and very low) should be well defined and described, since decision makers' evaluation will be done according to these levels. It is essential to guarantee a coherent evaluation.

Table 1 presents a verbal scale and its respective numerical scale. If the highest level (very high) corresponds to the best evaluation expected for a criterion, so its numerical value must be the highest; in this case, the criterion is called maximum criterion. If the highest level correspond to the worst evaluation expected for a criterion, so its numerical value must be the lowest; in this case, the criterion is called minimum criterion.

Table 1 - Conversion of verbal scale to numerical scale

	Maximum	**Minimum**
Verbal	**Numerical**	**Numerical**
Very high	1,00	0,00
High	0,75	0,25
Medium	0,50	0,50
Low	0,25	0,75
Very low	0,00	1,00

If possible, the criteria should be evaluated using physical measures. The criteria related with investment value and maintenance costs must be evaluated according to the monetary value requested by each alternative for its implementation and operation, respectively.

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Decision makers

It must be verified which entities are responsible for the hydrographic basin management. Then, the decision makers are defined in accordance with the Water Resources National Politic, which suggests the decentralization and participation of all in the water resource management process.

The decision makers should represent the public sector, civil society and water resources users (industries, agro-industries, water treatment and supply company, etc.). In order to avoid making the group too large, it should be considered only one member from each sector/entity that has an interest in the hydrographic basin.

Individual Evaluation

The goal of this stage is to identify the decision makers' preference and obtain their individual evaluation of alternatives. It is important to emphasize that each evaluation represents the preference of the person who performed the evaluation, and not the preference of the sector/entity which is being represented by the decision maker, although the decision maker's preference is directly influenced by the preference of his/her sector/entity.

Weights of the Criteria

To perform individual evaluation, each decision maker should assign a value between 0 and 100 for each criterion which represents the weight of the criterion. The decision makers need to understand what each criterion means and how the criteria will be evaluated in its respective scale. It should be clear that the weight of the criterion is related to the relative importance of the criterion within the criteria family. If a decision maker considers that some criteria are not relevant to him/her, he/she will assign a weight equal to zero to these criteria.

Preference Functions

A preference function, $P_j(a,b)$, should be assigned to each criterion. It describes how the decision maker's preference changes with the difference in performance level for two alternatives within a specific criterion. $P_j(a,b)$ takes a value between 0 and 1. The better the performance of alternative a is compared to the performance of alternative b, the bigger is the $P_j(a,b)$ value; on the other hand, if the performance of a is less than that of b, then $P_j(a,b)$ takes the value 0 (Brans *et al*., 1986).

Determining the preference function is an important step and it is essential that decision makers understand what the criteria mean. Some functions require the definition of some parameters. In this case, the decision maker should assign a value to parameter p, the preference threshold, above which the decision maker considers an alternative preferable to another one and/or he/she should assign a value to parameter q, the indifference threshold, below which the decision maker is indifferent between

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two alternatives.

The decision makers should select one of the six basic types of function for each criterion. The selection of preference function can be made globally.

Evaluation of Alternatives

Each decision maker must evaluate each alternative in relation to each criterion. The analyst will ask to the decision maker (d_k) how he evaluates the alternative (a_i) in relation to the criterion (c_j).

If the criterion is subjective, the verbal scale (Table 2) will be used. In this case, the analyst must verify if the decision maker understood the meaning of the criterion and its respective scale levels.

Initially, this procedure must be performed for all criteria, secondly, for all alternatives and then for all decision makers.

Regarding the criteria related to investment value and maintenance costs, the alternatives are evaluated based on estimates of the competent organizations. This is justified by the fact that the evaluation of alternatives regarding these criteria is a highly complex activity, requiring specific studies, usually very expensive and lengthy ones, which would be impracticable in the decision process, as they would involve decision makers from multiple sectors and with multidisciplinary skills. Therefore, the decision makers cannot evaluate the alternatives, and consequently the values assigned provided by the competent organizations will be considered.

With the individual evaluation and the ones performed by competent organizations, the analyst will perform his own analysis as follows.

For each criterion and for each alternative, the intensity of preference for one alternative over another, the $P_j(a,b)$, is calculated for each criterion and for each pair of alternatives. In other words, the level of preference for alternative *a* over alternative *b* considering only the criteria *j*. $P_j(a,b)$ should be calculated according to the kind of preference function that was associated with criteria *j*. As $P_j(a,b)$ approaches 1, the preference for alternative *a* increases.

Then, the preference index is calculated for each pair of alternatives. Moreover, the positive and negative flows are calculated

The alternatives' preference indexes are stored in a matrix of alternative versus alternative. Each cell has the preference index for each pair of alternatives, $P(a,b)$. The sum of the preference indexes in a line of the matrix represents the positive flow of the alternative which is placed in that line. The sum of the preference indexes in a column of the matrix represents the negative flow of the alternative which is placed in that column. A similar matrix must be built for each decision maker.

Individual Ranking

The net flow for each alternative must be calculated for all decision

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makers applying the PROMETHEE II method. Based on the net flow information, the rankings of each decision maker are obtained, and the alternatives are ordered in decreasing order of their net flows.

Global Result

This stage corresponds to a new resolution for the multicriteria problem through ELECTRE IV method. The set of alternatives are the same and the criteria correspond to the decision makers, having no information about relative importance among them. The net flows calculated for each alternative according to the evaluation of each decision makers represent the evaluation of the alternatives according to the criteria, which are represented by the decision makers.

Firstly, for each pair of alternatives, (*a, b*), the difference between its respective net flows is calculated, which corresponds to the level of performance of the alternative *a*. In this case, any difference between the net flows corresponds to a strict preference relation. Therefore, it is not necessary to define the indifference and preference threshold parameters (Alencar and Almeida, 2008).

Then, based on this level of performance, the outranking relations (strong and weak) are constructed. Finally the ranking is obtained, using the concept of qualification, which is based on the strong and weak outranking relations.

Case Study

The model was applied to the Committee of the hydrographic basin of the Rio Jaboatão in Pernambuco, Brazil. A study about the basin was performed to establish the problem characterization by defining the decision makers who participates of the decision process, identifying the alternatives and the criteria, being introduced the measurement scales of the criteria.

Problem Characterization

The hydrographic basin of the Rio Jaboatão (Pernambuco, Brazil) has a drainage area of 426.70 km2 covering part of the townships of Cabo de Santo Agostinho, Jaboatão dos Guararapes, Moreno, Recife, São Lourenço da Mata and Vitória de Santo Antão. In this hydrographic basin, the soil is used for urban occupation, diverse industrial activities, agricultural activities, especially the cultivation of sugar-cane, and occupied by areas of Atlantic forest and mangroves (CPRH, 2007).

The committee responsible to decide about its issues is named COBH-Jaboatão (Rio Jaboatão Hydrographic Basin Committee). It is composed by twelve public sector's representatives, six civil society's representatives and twelve water users' representatives.

In order to avoid making the group too large, only one member from each sector/entity was considered to compose the decision group. In this way, the decision makers are members of that committee who represent the public sector, civil society,

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industries, agro-industries and water treatment and supply company. The Table 2 shows the group composition.

Table 2 – Decision makers

Representation	Sector/Entity	Quantity
	Industries	01
Water Resources Users	Agro-industries	01
	Water treatment and supply company	01
Public Sector	Union, State or City	01
Civil Society	Universities or social organization	01

Through the study about the basin, the decision-makers proposed a set of six alternatives in order to control its environmental degradation. The Table 3 presents the alternatives and its respective description.

Table 3 - Alternatives

Code	Description
A1	Secondary sewage treatment in Jaboatão dos Guararapes, requiring that industrial waste be pre-treated according to the established standards.
A2	Educational campaign in the townships within the hydrographic basin (with the exception of Recife).
A3	Campaign with industry to minimize the quantity of water used in production processes by offering monetary incentives for those industries that show positive results.
A4	Development of a plan of sustainable agriculture specific to the rural producers of Vitória de Santo Antão which focuses on soil and water conservation for the hydrographic basin of the Rio Jaboatão.
A5	Recovery of native vegetation along the banks of the river Jaboatão.
A6	Improving the collection of waste material along the river, such as providing periodic trash removal.

Also, seven criteria were considered to evaluate the alternatives in relation to economical, financial, social and environmental aspects. These criteria and its respective descriptions are presented in Table 4.

Individual Evaluation

A face-to-face meeting was held with each decision maker, individually, to present the alternatives, criteria and the evaluation scale. Then, the weight of criteria and its respective preference functions were defined. Finally the alternatives were evaluated in relation to each criterion by the decision makers individually.

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Table 4 – Criteria

Code	Criteria	Description
C1	Investment value	This is the monetary value for action implementation. The monetary unit is given in Brazilian currency (Reais). A smaller value is preferable to a higher value.
C2	Maintenance Costs	This is the monetary value to maintain the action in annual operation. The monetary unit is given in Brazilian currency (Reais). A smaller value is preferable to a higher value.
C3	Response time	This is the minimum time necessary to achieve the action benefits. The units are given in months. A smaller value is preferable to a higher value.
C4	Efficiency	Corresponds to the territorial scope of the action benefits in the area of the hydrographic basin within the township of Jaboatão dos Guararapes (specifically) and in the area of the hydrographic basin included in neighboring townships. The measure is an ordinal scale (very low, low, regular, high, very high). A higher value is preferable to a smaller value.
C5	Dependence on third-parties	This is the action dependency, which does not consider the involvement and participation of others (society). The measure is an ordinal scale (very low, low, regular, high, very high). A lower value is preferable to a smaller value.
C6	Industrial impacts	Corresponds to the negative impacts that the action will cause on industrial activities from the operational, economic or legal points of view. The measure is an ordinal scale (very low, low, regular, high, very high). A lower value is preferable to a smaller value.
C7	Agricultural impacts	Corresponds to the negative impacts that the action will cause on agricultural activities. The measure is an ordinal scale (very low, low, regular, high, very high). A lower value is preferable to a smaller value.

Each decision maker evaluated the relative importance of the criteria and then attributed corresponding weights to each criterion, which were normalized by the analyst. Table 5 presents the criteria's weights.

Table 5 – Criteria's weights

Decision makers	Criteria						
	C1	C2	C3	C4	C5	C6	C7
DM1	0.40	0.30	0.06	0.06	0.06	0.06	0.06
DM2	0.26	0.26	0.09	0.13	0.09	0.17	0.02
DM3	0.19	0.14	0.14	0.19	0.14	0.10	0.10
DM4	0.19	0.22	0.04	0.22	0.15	0.11	0.07
DM5	0.15	0.05	0.05	0.15	0.10	0.30	0.20

For criteria C1, C2, C3 and C4, the decision maker's preference for one alternative in relation to another was considered to increase linearly with the difference in performance among them. Based on a determined preference threshold,

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one alternative was found to be preferable to the others. For the other criteria (C5, C6, and C7) it was considered that if the performance of one alternative is slightly higher than the performance of another, then the former is entirely preferable. The Table 6 presents the preference functions and its respective parameters. They were defined by the analyst, who considered that they are equal for the whole group.

Table 6 – Preference functions and its respective parameters

Criteria	Function	Parameter p
C1	V-shape criterion	100 000
C2	V-shape criterion	50 000
C3	V-shape criterion	6
C4	V-shape criterion	0.5
C5	Usual criterion	-
C6	Usual criterion	-
C7	Usual criterion	-

Regarding the criteria C1, C2 and C3, the alternatives are evaluated based on estimates of the competent organizations. These values assigned by these organizations will be considered for all decision makers, representing their own evaluations. The other criteria are subjective in nature, which enables decision makers to evaluate each of the alternatives on a verbal scale, which is converted into a numerical scale, as shown in Table 1.

The PROMETHEE II was used to construe the individual rankings based on information above. These rankings are presented in Table 7.

Table 7 – Individual rankings

Rank	DM1	DM2	DM3	DM4	DM5
1	A2	A2	A2	A5	A5
2	A3	A3	A4	A2	A3
3	A4	A5	A3	A1	A1
4	A5	A4	A1	A3	A2
5	A6	A1	A5	A4	A4
6	A1	A6	A6	A6	A6

Sensitivity Analysis

The decision maker DM1 assigned 70% of relative importance to the criteria related to the financial aspect (C1 and C2), whilst the other decision makers assigned 50%, at maximum, to this aspect.

For this decision maker, a redistribution of the weights was performed in order to verify the behavior of the results in case of financial aspect's importance limited up 50% in relation to the others aspects. Analyzing the Gaia plane, it was verified that, even with a significant reduction in weights of C1 and C2, the decision stick remains in the same direction.

For the other decision makers, it was verified the behavior of the results

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when submitted to small variation in the weights of criteria. No variation was verified in decision stick direction, confirming the robustness of the result.

Global Ranking

The ELECTRE IV method was used to aggregate the individual results, which corresponds to a resolution of a new multicriteria problem. In this case, the alternatives are the same, the criteria are the decision makers and the evaluation of alternatives is represented by its respective net flow calculated by PROMETHEE II method. As far as criteria's weights are concerned, the method does not request its specification. The Table 8 shows the global ranking.

Table 8 – Global ranking

Rank	Alternative
1	A2
2	A3 and A5 (tie)
3	A1 and A4 (tie)
4	A6

The alternative ranked in the global ranking top, A2, is also in the top of three individual rankings and well positioned in the other ones. Moreover, the alternative ranked in the global ranking bottom, A6, occupied the worst position in four of the five individual results. This brief analysis reveals that the aggregation is coherent with the individual results and satisfactory for the majority of decision makers.

The ties in the second and third position should not be interpreted as indifference among the alternatives. This is justified by the fact that the implementation of such alternatives demands high investments originated, usually, from Public Sector. Consequently, the implementation of the remaining alternatives (assuming that the highest ranked one was implemented just after the decision process supported by this model) in the ranking will always generates a new decision problem related with the quantity of resource available to implement the next alternative at the moment. Therefore, the ties can be interpreted as alternatives for a new decision process, in which only the resources available are being considered.

Conclusions

This study presents a model of a group decision support system which aims hydrographic basins committees in the selection of an alternative for environmental degradation controlling of their respective hydrographic basins.

For each decision maker a set of alternatives is ranked through the use of the outranking method PROMETHEE II, considering a family of criteria. Then, these individual results are aggregated using ELECTRE IV method. The final result represents the preference of the committees, considering the preferences and point of view of all decision makers, whose importance in decision process is the same.

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The use of the multicriteria approach as the basis for the recommendations determined by a hydrographic basin allows a structured analysis of all possibilities, in accordance with different aspects of the situation (economical, financial, social and environmental). This structuring is essential in this kind of decision problem, since the set of alternatives usually has a complex nature; there are multiple aspects involved; and multiple decision makers (public sector, users, and civil society).

The model provides transparence to the decision process, which is essential, since it refers to public questions. Moreover, it provides rapidness, being useful due to the limited time dedicated to the committees' activities by their members.

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