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Conflict resolution method for ill-defined resources management cases: application to the La Albufera natural reserve in Spain

Antonio Caselles[+], Pantaleón David Romero[†], Jean-Marie Jacques*, Eduardo Peris[‡]

[+]Departament de Matemàtica Aplicada. Universitat de València (Spain)

[†]Department of Physics, Mathematics and Computation. University Cardenal Herrera-CEU (Spain)

[‡] Department of Construction Engineering. Polytechnic University of Valencia (Spain)

*Facultés Universitaires Notre Dame de la Paix, Namur (Belgium)

Abstract

Current methods for conflict resolution present serious difficulties when applied to social conflicts arising from clashes among purposes relating to conservation, traditional uses and development in environmental management. This is because conflict can be ill-defined and some necessary data are not available at the required time. DIFUCO, a method inspired by fuzzy cognitive maps [15][11], can be applied to such situations. It is presented, applied to a specific conflictive case (a wetland natural reserve) and compared with the only usable alternative for this case: an Analytic Hierarchy Process. The results of DIFUCO and AHP differ basically because their respective assumptions vary. DIFUCO can adopt the assumptions of AHP, but not conversely, provides more information than AHP, and is more stable and flexible. DIFUCO compiles and processes conflict-related information that lies in the minds of those people involved. Moreover, it offers priorities and guidance to define possible intervention strategies for governors or arbitrators with comparatively more flexibility in less time and with fewer means and efforts.

Keywords: Conflict resolution; multiagent-multiobjective; systems thinking; fuzzy cognitive maps; resources management.

Resumen

Los métodos actuales para la resolución de conflictos presentan dificultades serias cuando se aplican a los conflictos sociales que surgen de choques entre intereses referentes la conservación, las aplicaciones tradicionales y la gerencia ambiental. Esto es debido a que el conflicto puede estar mal definido y a que ciertos datos necesarios no están disponibles en el momento requerido. DIFUCO es un método inspirado en los mapas cognitivos difusos [15][11] que se puede aplicar a tales situaciones. Este método se presenta, se aplica a un caso conflictivo específico (una reserva natural) y se compara con el único método alternativo usable para este caso: un proceso analítico jerárquico (AHP). Los resultados de DIFUCO y de AHP se diferencian básicamente porque sus asunciones respectivas son distintas. DIFUCO puede adoptar las asunciones de AHP pero no al contrario, proporciona más información que AHP, y es más estable y flexible. DIFUCO compila y procesa la información relacionada con el conflicto que reside en las mentes de las personas implicadas. Por otra parte, ofrece prioridades y orientaciones para definir las estrategias posibles de intervención para los gobernadores o los árbitros con comparativamente más flexibilidad, en menos tiempo y con menos medios y esfuerzos.

Palabras clave: Resolución de conflictos; multiagente/multiobjetivo; pensamiento sistémico; mapas cognitivos difusos; gestión de recursos.

1 Introduction

A conflict comes about through a disagreement between individuals or groups (agents) whose attitudes, values or needs differ. "Conflict is the interaction of interdependent people who perceive incompatible goals and interference from each other in achieving those goals." [10]. With socio-ecological conflicts, normally there are complex interactions among all the agents involved, including those carrying out resources management. This management implies distributing resources adequately and resolving conflicts between agents. Traditional approaches to conflict resolution, such as laws, judicial systems and similar instruments, provide solutions in which a part gains at the expense of another part.

There are several conflict resolution methods available that share out profit and loss. Each has its own assumptions (or axioms) that agents must accept in order to come to terms with the result that the method provides. Moreover, each method requires a type of different information (data) which may, or may not, be available or attainable. This involves a time factor and means that are acceptable for the given situation. Thus given a specific conflictive situation, researchers need a list of the general parameters or types of information that are usable to describe conflictive situations; for instance: list of participants, their respective objectives, utility functions, etc.

Researchers also need to prospect the specific situation in order to determine the practical possibility of giving a value to each parameter in the list compiled. Then, they proceed to assign the parameters to existing conflict resolution methods and to choose the method or methods for which the data are available. If more than one method can be used, then it might be interesting to compare its respective results to study if they are compatible and/or complementary. This is the way that authors have proceeded in a conflict involving several agents. This conflict is based in the La Albufera Natural Reserve in Valencia (East Spain), which is a wetlands site used in various ways by farmers, tourists, fishermen, hunters, industrialists, etc., with numerous frictions or conflicts among them as to the use of resources. The result of the procedure is that only one existing method can be applied (an Analytic Hierarchy Process) and that a new method is necessary to complement its results in order to satisfy decision makers. This very method has been created by the authors and is presented in this paper (from this point onward, it is referred to as the DIFUCO method).

The DIFUCO method, which is both multiagent and multiobjective, is presented in this article, and is particularly indicated for cases where:

- The conflict is not well-defined. That is, the agents, their interrelations, objectives and incompatibilities are not well known. The method helps agents to define the conflict and to identify possible solutions to reach a consensus. The method combines qualitative and quantitative social research techniques, which not only allow the assessment of the possible causes of the conflict, but also the possible measures to reach a consensus.
- There is lack of information and/or available means.
- Haste is required as far as time is concerned.
- Situations to which other more difficult methods are applied, whose results are no worse in a first instance.

For the purpose of leaving all the details of this method clear, and how the circumstances can be ill-defined, DIFUCO is applied to the case of La Albufera Nature Reserve in Valencia (Spain), and its results and procedures are compared with those of the Analytic Hierarchy Process (AHP). AHP has been considered as the only possible alternative method, given the available knowledge about the conflict and the difficulties found when applying other methods, as it is explained in section 2.

The La Albufera conflict is a social conflict that emerged from a clash among interests relating to conservation, traditional uses of natural resources, economic development and social sustainability. Such conflicts are frequent in wetlands and water management. This particular conflict presents social characteristics relating to natural

resources management, which partially come about through the imposition of protection plans that fuel strong controversy about its contents and application.

Section 2 presents the list of the general parameters that can be used in the conflict descriptions found in the literature, as well as the general description of the most relevant methods for overall conflict resolutions (OCR) using such parameters. Section 3 describes the specific conflict studied in La Albufera Natural Reserve in terms of the aforementioned parameters and justifies the use of the AHP and the need for a new method (DIFUCO). Section 4.1 describes the DIFUCO method, while Section 4.2 compares the results and procedures of both methods. Finally, Section 5 discusses the issues of this article.

2 Description of conflicts and methodological background

The following list of the parameters that can be used for the descriptions of specific conflicts have been obtained from the overall conflict resolutions (OCR) literature, particularly Wolf [21] and Shields et al. [18]. Given a specific conflict, the following information has to be obtained as a starting point insofar as this is possible:

1. List of the *participants*, *agents*, *actors*, or other equivalent names [18] [2] [16] [10] [11] [14] [17].
2. *Management alternatives* with measurable attributes, *control variables* and their possible values, *ways out of the conflict*, or equivalent expressions [18] [2] [16] [11].
3. *Utility functions* (functions that calculate each participant's utility or satisfaction) [18] [1].
4. List of participants' *objectives*, *aspects* of the conflict, *causes* of the conflict, or similar expressions [2] [16]) [11] [20].
5. The target variable to be maximized or minimized, the compromise solution, participants' average satisfaction, or equivalent expressions.
6. The degree of satisfaction or utility of each participant in case of disagreement.
7. A list of the participants' possible action strategies and their respective motivating circumstances.
8. Each participant's order of preference of all the management alternatives.
9. Each participant's preferred ordered pair of management alternatives.
10. A list of the possible *coalitions* (subsets of participants that can compensate their respective utilities) [10] [11].
11. *Each participant's* relative *power* to impose their solution [2] [16].
12. The importance or *strength of each objective* for each participant [2] [16].
13. Influence or *impact of each management alternative* on each participant's or coalition's objective [2] [16] [10].
14. Influence or impact of each participant's satisfaction on each other in relation to each objective.
15. Importance of each objective for overall satisfaction.

In the literature on overall conflict resolutions (OCR), one article that studies various methods and applies them to ecosystems is that by Shields et al., [18], which suggests that OCR must use one method or another according to the available data, as well as the axioms that agents are willing to take on; we completely agree with this opinion. At any rate, these authors understand OCR as an assessment of intervention or management alternatives, and the consequent selection of commitment solutions. Likewise, these authors consider the following to be relevant elements of the conflictive situation employed in one or more of the methods they present: *participants*, *management alternatives with measurable attributes* (actors' preferences or aversions as regards alternatives), and *utility functions* or participants' benefits; they also assume that all these elements are well-defined before starting the method. Nevertheless, some conflicts may exist where these assumptions cannot be accepted.

Another important background to the matter is the work of Keemey and Kaiffa, (1976), in which multiobjective optimization is used. That is, each actor *i* and measurable attribute x_r is associated with an objective or

utility function $J_i(x_r)$, which quantifies each actor's preferences. The multiobjective function of an intervention or a management alternative is $J(x_1,\ldots,x_r)=\sum_i J_i(x_r)\cdot k_i$ with $\sum_i k_i = 1$, where $k_i \geq 0$ is the weights of the different actors. In this sense, therefore, the sought solution, which is the selected alternative, is that which corresponds to the multiobjective optimization, meaning that $\max \sum J_i(x_r)\cdot k_i$. It is worth pointing out that neither Shields et al. [18] nor Keemey and Kaiffa (1976) explain how to create utility functions since they only state that they are based on the actor's preferences as far as the measurable attributes are concerned.

Multicriteria decision-making (MCDM) problems may involve many factors, some of which are not measurable; consequently, more than one analysis method may be needed.

MCDM can be classified into two types: multiobjective (MODM) and multiattribute. MODM methods are based on programming techniques, while multiattribute methods combine programming techniques and qualitative measurements.

MACBETH [3][4][5] is a method to help decision making and is based on the utility theory developed by Kaiffa (1976), but it includes certain particularities as regards the original formulation of Kaiffa. The main particularity is the way to generate scores for options and to assign weights to the criteria: MACBETH only requires qualitative judgments about the difference between the attractiveness of criteria, and it automatically verifies its consistency at the time the decision maker introduces them. The works of Salo [17] and Cho [9] present some decision-making techniques based on MCDM which study the preferences of several group members representing the actors implied in the conflict.

When we attempted to apply MACBETH to the La Albufera case, we found two kinds of difficulties:

- *We need a general table;* that is, a table allowing Public Administrations to determine the actors and aspects of the problem in which to intervene. This is not possible in the MACBETH environment.
- *We need to work with large matrices;* MACBETH works very slowly (as it analyzes consistency) with judgment matrices when their size increases.

Other methods that have proved useful for conflict resolution are the multicriteria methods based on the *outranking* methodology, mainly ELECTRE, GAIA and PROMETHEE [6][7]. This methodology cannot be applied to the La Albufera case because our aim is not an attempt to determine which criterion is optimum to solve the conflict, but to establish which agents have to intervene to solve the conflict.

The article of Kangas and Kangas [13] presents several methods based on MCD and AHP to study forest management conflicts. In particular, this work studies several previously mentioned methods, such as ELECTRE, MACBETH, PROMETHEE and AHP. The conclusion that the authors draw is that the choice of one depends not only on the type of conflict, but also on the type of solution or preferences to prioritize, and that the majority of the methods are too rigid as far as their way of dealing with the necessary data is concerned, which can lead to incoherent results in certain situations. MACBETH is very rigid because of its criteria to weigh the input matrix, the consistency analysis, etc. Moreover, the way that ELECTRE and similar methods determine the ranking of criteria and impacts is also rigid.

Regarding other works on conflicts resolutions in the bibliography, in general we found that: Alexander [2] applies the Saaty [16] method about the AHP; this method is analyzed more generally by Srdjevic [19] and begins by identifying those *actors* involved (parameter 1 of the above list of parameters, p1 in brackets in the following), their *objectives* (p4), and the *possible ways out* of the conflict (p2) to resolve the Ulster conflict. He continues by pondering the *power of each actor* (p11) to determine the way out of the conflict by pondering *the strength of each objective* (p12) within each actor, and by also pondering the *capacity of all the ways out* (p13) of the conflict to fulfill each objective of each actor. Once the last step has been achieved, he finishes by giving priority or relative importance to each way out of the conflict to fulfill the actors' objectives.

As regards the studies about the conflicts in the particular case we are dealing with, the La Albufera of Valencia, we highlight the study by García and La-Roca [10] on *the assessment of the conflicts of values in the organization of the hydrographic basin, La Albufera of Valencia.* It is the only study that deals with the La Albufera conflict formally using a clear method. The method used in this case is based on the selection of certain criteria or values, and on the cluster analysis to form (p10) *coalitions* with the (p1) *actors* who prioritize values similarly; it uses an (p13) *impact matrix* for the management alternatives on coalitions, and it determines which management alternative benefits more coalitions.

We also highlight the study by Jacques et al. [12] as being relevant among the studies on La Albufera of Valencia. This study suggests a similar method to that we presently propose (DIFUCO), although there are some notable differences because these authors' model is less developed and has not been put into practice.

Giordano et al. [11] present an OCR method to be used by communities where actors can negotiate, which enables the accomplishment of sustainable conflict management. This method assumes that each individual in the community is accessible to be interviewed. The list of *actors* (p1) is obtained as a list of *communities of interest* through cognitive maps, and originates from all the individuals representing their interests in each *aspect of the conflict* (p4). The actors propose the list of *management alternatives* (p2). The time to form *coalitions* (p10) is when management alternatives are set up. Coalitions are formed using the communities' opinions, expressed in linguistic terms, which are transformed into fuzzy distances between fuzzy sets. This method cannot be applied to the La Albufera case because: (a) affected individuals cannot be implicated in this process in practice; (b) we assume that negotiation is impossible because most of the stakeholders are collectives without any kind of easily obtainable representation; therefore, Public Administrations have to decide management alternatives and, (c) management alternatives have to be found by Public Administrations, which need help with this target.

Finally, in relation to managing the natural resources of wetlands and the resolution of conflicts from various viewpoints, such as law, economy, engineering, anthropology, geography and, especially, from the systems theory, the work of Wolf [21] is of much interest.

3 Presentation of the La Albufera conflict

3.1 Presentation of the La Albufera site

The La Albufera Nature Reserve of Valencia (Spain) is the most emblematic wetland site in the Valencian Community, and all the wetland site environments are represented within it. La Albufera belongs to the *lagoons, coastal marshlands and associated environments group*, and it covers 21000 hectares (the exclusion of urban ground and enclaves has not been accounted for). The municipal areas making up the area are Valencia, Catarroja, Albal, Silla, Sueca, Sollana, Cullera, Albalat de la Ribera, Algemesí, Massanassa, Alfafar and Sedaví. The predominant use of grounds in this reserve is of a wetland environmental kind: physically, the lagoon itself, marshlands and rice fields. It is composed of surface water, ground water, irrigation returns and sewage. It receives water through natural discharges and underground springs. It is directly regulated by gorges, and indirectly so through aquifer pumping in the southern Valencian plain.

The quality of its water is apt for farming uses. The factors affecting its natural pattern are: regulation of irrigation returns from the Royal Irrigation System and from the underground feeding area through pumping; artificial drainage by means of canals, gorges and artificial drainage pumping. Its predominant urban feature is *protected non building land* and its specific protection type is *Nature Reserve.*

The La Albufera Nature Reserve is presented as a conflictive protected natural space case where problems between the local population and Public Administrations have led to a situation in which adequate regulation plans have not been established for lengthy periods.

3.2 The La Albufera conflict

A social and ecological conflict emerges when groups, organizations or other social agents consider that a given economic activity entails the excessive exploitation of natural resources. This kind of conflicts has three reference participant types:

- Central (National) Public Administrations which, through local delegates, decide management contents.
- Private promoters of development actions (within the economic sector, which are usually alien to the affected area), local conservationist groups, and other interested groups (farmers, traders, fishers, etc.).
- Local Public Administrations.

The conflict originated in the 1960's given the industrialization, urban development and agriculture modernization processes which drastically altered the relative stability of the lagoon and its environment. An increase in contamination of urban, industrial and agricultural origins, the rapid urban development of the nearby coast, increasing presence of new infrastructures and substitution of rice fields for other land uses, have all contributed to its alteration. Not only wildlife, but also agricultural and fishing activities, are all affected by the environment contamination caused by industrial development. Contamination to agriculture affects the health of workers and consumers, whereas it effects on fishing affect the quantity (it can kill fish directly and can make reproduction difficult) and quality of captured fish. Nevertheless, fishing is nowadays a part-time activity for traditional fishing families (approximately one hundred), whose main activity is related to tourism by attempting to profit from the landscapes that the lagoon offers.

There are four causes behind the conflict between environmental conservation and agriculture: (1) use of herbicides, pesticides and fertilizers; (2) land owners' rights; (3) waste regulation types; and (4) animal protection.

Shooting is a sustainable activity. Ecologists wish to completely forbid it because of the large number of poachers it involves. Actually, there is a permanent ongoing dispute involving shooters, ecologists and local and regional Public Administrations as to shooting schedules. On the other hand, an agreement has been reached between shooters and farmers because the latter flood rice fields, which attracts avifauna.

New urban development and construction near the beach in recent decades have been the cause of numerous conflicts in this area. The main pressure group (developers) pressurizes the Local Administration. In fact, the building industry is the most incompatible activity with nature conservation. Further aggression, such as industrial and urban contamination, can be reduced with adequate depuration facilities promoted by the Public Administrations (at the local, regional and state levels). Finally, new facilities for tourists (holiday homes, roads, restaurants, etc.) have damaged the quality of the landscapes around the lake and in its environment.

The next section determines the agents in conflict, as well as their respective parameters and objectives. Nevertheless, the overall objective for the Public Administrations is to adopt adequate laws and to promote suitable infrastructures to maximize aid and to minimize damage as regards the pressure groups involved.

3.3 Agents and their objectives and conflict parameters

Here we specify the 15 general conflict parameters (see Section 2.) in the present case.

1. **The conflicting groups** are the following:

   a) *Farmers*, who traditionally grow rice and whose number tends to diminish. It is important that there are enough farmers to feed the avifauna and for adequate water management. Public Administrations have to favor the presence of the avifauna and control the use of contaminating chemicals. Currently, Public Administrations subsidize farmers to help them continue with their activity and to maintain the hydraulic infrastructure. Another alternative is to consider buying rice farms to reduce contamination.

b) *Hunters.* Although hunting is a regulated activity, there are illegal hunters who can wipe out protected species. Another problem is lead which contaminates water and affects the avifauna and ichthyofauna. Public Administrations are in constant dialog with hunters to help reach a consensus.

c) *Builders and estate investors*. When the La Albufera Reserve was declared a protected area, no more building licenses were granted, including those of previous residents who wished to modernize their houses.

d) *Fishermen*. Their activity is affected by agriculture (chemicals and crop invasion affecting the lagoon).

e) *Tourists.* Their presence leads to birds abandoning their nests.

f) *Hotel and catering owners.* Their activity is related with tourists.

g) *Industrialists.* Their activity affects water quality and air quality, which is detrimental to fishermen, hunters and farmers.

h) *Public Administrations (Local, Regional and State)* prepare legal dispositions and manage the Nature Reserve.

i) *Land owners.* They expect to have freedom of use and transformation of land uses, and tax benefits.

j) *Residents.* They should like to have unlimited use of the Reserve, conveniences and quality public services.

k) *Ecologists.* They pursue maximum environmental conservation.

The above mentioned activities and aims of the actors are the main causes of the La Albufera conflict; it consists in the attainment of an agent's goal could hamper the achievement of the other agents' objectives.

2. **Management alternatives.** Public Administrations can grant *subsidies* to some conflicting groups, make decisions about building some roads or other kinds of *infrastructure*, and about publishing legal dispositions which could benefit some groups, but could be detrimental to others. The problems for Public Administrations include the long-term repercussions of benefitting some groups and harming others. Thus, with respect to management alternatives, the information that Public Administrations desire to obtain consist in the identification of the agents to be benefitted and the agents to be hampered in the different aspects of the conflict (quality of water, avifauna, urban land, etc.).

3. **Participants' utility functions.** These functions cannot be specified a priori because they depend on the method chosen to solve the conflict.

4. **Participants' objectives (goals, aims, attainments, targets).** The following ones are those one or more of the participants pursue, but they cannot be more precisely determined a priori:
   a) Extending urban land.
   b) Quality of water.
   c) Quantity of water.
   d) Quality of air.
   e) Healthy Avifauna.
   f) Healthy Ichthyofauna.

5. **The compromise solution or variable to be optimized.** It is impossible to establish it a priori. The obvious one is the non concreted overall fulfillment.

6. **Utility or degree of satisfaction of each participant should no solution be found.** It is impossible to establish it a priori.

7. **Each participant's strategies.** It is impossible to establish it a priori because it is assumed that most of them have no representation to be consulted, others are not willing to reveal it and, most of the members of a given collective are not going to use the same strategy.

8. **Each participant's preferred order for each management alternative.** It is impossible to establish it a priori because no specific management alternatives have been established.

9. **Each participant's preferred ordered pair of management alternatives.** It is impossible to establish it a priori

because no specific management alternatives have been established.

10. **List of possible coalitions.** It is impossible to establish it a priori.
11. **Each participant's relative power to impose their solution.** This information can be estimated from a series of interviews made with some members of the different conflictive groups; it is represented in Table 2.
12. **Importance or strength of each objective for each participant.** It can be estimated as Item 11 indicates; it is represented in Table 4.
13. **Influence or impact of each management alternative on each objective of each participant or coalition**. It can be estimated as Item 11 indicates; it is represented in Table 5.
14. **Influence or impact of each participant's satisfaction in relation to each objective**. It can be estimated as Item 11 indicates and is available upon request.
15. **Importance of each objective for overall satisfaction**. It can be estimated as Item 11 indicates and is available upon request.

4 Adequate Methods for the La Albufera Conflict

Given the aforementioned data availability, among the tested methods (ELECTRE I, II, III, GAIA, AHP and others) only AHP can be applied in an attempt to fulfill the objectives set out in this work. The most relevant OCR methods found in the literature and their respective parameters (numbered as in Sections 2 and 3.2) are provided in Table 1:

4.1 The DIFUCO method

The DIFUCO method is inspired by fuzzy cognitive maps [11][15] and the system concept underlies it (a system is a collection of interrelated elements). Thus, system elements may be actors, political structures and variables. Variables may be input variables (control variables if they can be controlled, or scenario variables otherwise). Consequently, we can introduce an objective variable for the overall system (a kind of general fulfillment) into the system, along with the necessary control and scenario variables, in order to find optimal strategies to maximize general fulfillment through simulation.

Possible Method	Required parameters	Data not available for parameters:
Multiobjective optimization	1, 2, 3, 4, 5	2 as required, 3, 5
Games (simple bargaining)	1, 3, 6, 7	3, 6, 7
Voting	1, 2, 8 or 9	8, 9
Cooperative games	1, 2, 3, 10	3, 10
Analytic Hierarchy Process	1, 2, 4, 11, 12, 13	-
DIFUCO	1, 2, 14, 15	-

Table 1. Relevant OCR methods (first column), their respective required parameters according to Section 2 (second column) and availability of the data for the La Albufera conflict (third column).

Instead of comparing powers, DIFUCO is based on assessing the direct plus indirect repercussions (positive and negative) of the fulfillments of an actor and political structure activity, and the effect of an input variable on the fulfillment of the other actors and the output variables in relation to each objective.

DIFUCO produces results that guide Public Administrations (*political structures*) to adopt laws, to grant subsidies and to build infrastructures that benefit or harm the adequate actors in the adequate amount in order to maximize general fulfillment. Furthermore, DIFUCO helps the user identify "conflictive aspects"; that is, the actor-actor or variable-actor pairs where a benefit or increment in the former harms the latter.

We now go on to introduce the method. First, we specify the implicit conditions and assumptions in the method. Second, we describe the steps of the algorithm. Finally, we obtain the corresponding results for the La Albufera conflict.

4.1.1 Assumptions of the DIFUCO method

The assumptions relating to conflicts in general are:

1. All actors pursue their own benefits and, at the same time, actors' benefits may be either beneficial or detrimental to the other actors.
2. In general, Public Administrations or governors may either favor or hamper the achievement of the objectives of some actors though legal regulations.
3. In general, Public Administrations or governors may promote works to build infrastructures, give subsidies so that actors take initiatives, or take other types of action to control the system.
4. Each actor's fulfillment, benefit or utility is of relative importance to society, and is determined by a survey or by any other adequate method.
5. Conflicts have one aspect (which are objective for any actor) or more. If it has more than one aspect, the relevant importance of each aspect for society is determined by a survey or by any other suitable method.
6. The influence or impact that an actor's benefit or public control action has on the benefit of other actors is materialized in a short period of time in relation to the overall conflict horizon.
7. The impacts that some actors' benefits have on others, just as we referred to before with relative importance, are determined by a reliable survey.
8. The people who use the conclusions resulting from a study like this one are arbitrators, governors, Public Administrations or entities that have the power to control the system (we shall use the word *society* to name them from now onward). What these people wish to know is which actors are best to favor or to hamper the achievement of their objectives, and which control variables are more important to achieve the highest possible overall fulfillment rate.
9. Those entities in conflict are willing to accept the arbitrators or the government's decision implicitly or explicitly, and to also adapt to it.
10. Actors may aspire to receive benefits of the following types: a) direct; that is, economic, power, increased business perspectives, etc.; b) indirect; that is, social consideration for actors or their group, personal prestige and image, increased self-esteem, etc.

Assumptions related to the method:

1. Indirect influences through different channels are additive.
2. Indirect influences within the same channel are multiplicative.
3. Direct influences are assessed between -1 and +1.

4.1.2 Formalizing the DIFUCO method

DIFUCO is formalized as follows.

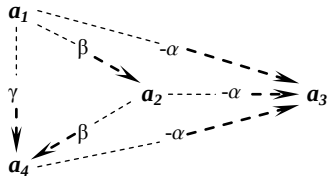
1. Identification of agents, participants, actors (which we consider synonyms):
   $$\boldsymbol{P} = \{P_1, \ldots, P_n\}$$
2. Identification of the objectives of actors, aspects, perspectives or points of view (which we consider synonyms) from which the conflict may focus on:
   $$\boldsymbol{A} = \{A_1, \ldots, A_m\}$$
3. Identification of the "control variables", which can receive a value from the promoters of the study (all or a part of the actors) and, the "scenario variables" or exogenous incontrollable ones (when existing), which can receive only hypothetical values:
   $$\boldsymbol{C} = \{C_1, \ldots, C_p\}$$
4. Identification of the objective variable which we name the general fulfillment level: $\boldsymbol{S} = \{S\}$
5. Identification of the direct impacts matrices among actors' fulfillments, overall fulfillment and control variables; one for each conflict aspect. We represent them as a three-dimensional matrix: $\boldsymbol{I} = [I_{ijk}]$
   where: $i = 1, \ldots, n+p$; $j = 1, \ldots, n+1$
   $k = 1, \ldots, m$
   That is, the first subscript i represents both the agents and control variables (elements that have an impact), the second subscript j represents the agents and overall fulfillment (elements that receive impacts), and the third subscript k represents the conflict aspects.
   Let $\boldsymbol{Q} = \boldsymbol{P} \cup \boldsymbol{C} \cup \boldsymbol{S}$.

From now onward, we will call any ***Q*** component either a *conflict element* or a *conflictive element*.

6. Identification of the weights vector that society assigns to the different conflict aspects: $\boldsymbol{W} = (w_1, \ldots, w_m)$
where: $w_k \geq 0$; $w_k \leq 1$; $\sum_{k=1,\ldots m} w_k = 1$
7. Calculation of both the direct and indirect impacts matrices among the actors' fulfillments, overall fulfillment and the control variables (among conflict elements or *conflictive elements*); one for each conflict aspect. We represent them as a three-dimensional matrix: $\boldsymbol{Y} = [Y_{ijk}]$
where: $i = 1, \ldots, n+p$ $j = 1, \ldots, n+1$
$t = 1,\ldots,n+p, n+p+1,\ldots,n+p+n+1$
That is, $t \in TC$, $TC=\{$*ordinal numbers between 1 and 2n+p+1*$\}$, implying that we have placed the *conflictive elements* in order with the agents coming first, followed next by the control variables and finally by the objective variable so that:

$$Y_{ijk} = \sum_{CH_{ijk}} \prod_{r,s \in CH_{ijk}} I_{rsk}$$

where: CH_{ijk} is the set of all the loopless chains between *conflictive element i* and *conflictive element j* in the *k* aspect. A chain is understood to be an ordered subset of *TC* elements so that those with *r, s* ordinals that correspond to the $I_{rs} \neq 0$ values are contiguous. For instance, let us consider that $[\boldsymbol{I_{ij1}}]$ is represented by the impacts (Greek letters) in the following graph:



where the total impact of a_1 on a_3 must consider the direct impact (–α) plus the indirect impacts. To obtain the last ones, first construct the causal chains between a_1 and a_3, which are: $a_1 \rightarrow a_3$; $a_1 \rightarrow a_2 \rightarrow a_3$; $a_1 \rightarrow a_2 \rightarrow a_4 \rightarrow a_3$; $a_1 \rightarrow a_4 \rightarrow a_3$; second, assess the total impact of a_1 on a_3 in each chain; that is: $(-\alpha) \cdot 1 = -\alpha$; $(\beta) \cdot (-\alpha) = \xi_1$; $(\beta) \cdot (\beta) \cdot (-\alpha) = \xi_2$; $(\gamma) \cdot (-\alpha) = \xi_3$; finally, calculate the total impact of a_1 on a_3 as: $\boldsymbol{Y_{131}} = -\alpha + \xi_1 + \xi_2 + \xi_3$.

8. Calculation of the direct plus indirect impacts matrices: $\boldsymbol{Z} = [Z_{ij}]$,
where: $i = 1, \ldots, n+p$; $j = 1, \ldots, n+1$ and in such a way that:
$$Z_{ij} = \sum_{k=1,\ldots m} Y_{ijk} \cdot w_k$$
9. Location of the conflictive zones in the total impacts matrix of each aspect; that is, in ***Y***, and in overall matrix ***Z.*** This is achieved by highlighting the negative impacts (which imply that the greater an actor's benefit or utility, the loss of another actor's utility).
10. Deduction of the optimum strategies to control the conflict. This is achieved by selecting the control variables whose total impact on overall fulfillment is greater (to prioritize them) by selecting the actors whose fulfillment has a more positive impact on overall fulfillment (to design the measures that favor them), and by selecting the actors whose fulfillment has a negative impact on overall fulfillment (to design the measures that do not favor them). That is, given that $\alpha \geq 0$ and $\beta \geq 0$, then select:
$$t_{\acute{o}ptimum\_positive} = \max_{t \in TC} \left(Z_{t,2n+p+1}\right) \quad ;$$
$$t_{\acute{o}ptimum\_negative} = \min_{t \in TC} \left(Z_{t,2n+p+1}\right)$$
or,
$$t_{suboptimum\_positive} \Leftrightarrow \left(Z_{t,2n+p+1}\right) \geq \alpha \quad ;$$
$$t_{suboptimum\_negative} \Leftrightarrow \left(Z_{t,2n+p+1}\right) \leq -\beta$$

Most alternative methods are limited to assessing management alternatives designed a priori. A management alternative for the DIFUCO method would be the one we have named *strategy*. A strategy does not need to be previously defined; for this reason, the list of strategies or management alternatives is not featured in the formalized method description. The optimum and suboptimum strategies are deduced as a result of the priorities given to the

control variables and as supports to the actors, which supply the global impacts matrix ***Z***. Obviously, the decision-making team has to choose among its action possibilities (not necessarily determined before applying the method): (a) how to improve the control variables that the method has selected as having the most influencing power on overall fulfillment; (b) how to benefit the actors that the method has chosen as those whose fulfillment is more positive for overall fulfillment; (c) how not to benefit the actors that the method has selected as those whose fulfillment is more negative for overall fulfillment. This has the advantage of offering greater flexibility and range in terms of designing the intervention strategies within the conflict.

4.1.3 Applying the DIFUCO method to the La Albufera conflict

Now, we attempt to provide criteria to Public Administrations to both legislate and adopt control actions to increase overall fulfillment (the combination of all the actors' fulfillments) of the people and entities related with La Albufera Nature Reserve of Valencia through a systemic analysis. This analysis studies the interrelations between the relevant elements relating to both the problem and the DIFUCO method. Public Administrations are being informed of the results obtained in this paper; however, there will probably be no feedback.

Given the complexity of the considered conflict and the consequent difficulty in reaching an agreement, DIFUCO is especially adequate because it helps define and structure the actors involved, the most significant aspects of the conflict, and the actors who have to give to reach the best agreement.

Actor	***Particular objective***
Real estate investor (INVE).	Lack of building restrictions
Farmer (AGRI)	Maximum crops
Fisherman (PESC)	Maximum catches
Hunter (CAZA)	Abundant hunting results
Resident (RESI)	Unlimited use of the Reserve, conveniences and quality public services
Industrialist (INDU)	Unlimited use of the Reserve's resources to increase production
Hotel and Catering owners (HOST)	Plenty of customers
Tourist (TURI)	Quality and well-priced services
Land owner (PROP)	Freedom of use and transformation of land uses; tax benefits
Ecologist (ECOL)	Maximum environmental conservation
Local Administration (Valencia City Council) (ADML)	Transparent management of the Reserve; defend municipal patrimony and voters
Autonomous Administration (Valencian Regional Government) (ADMA)	(Idem)
State Administration (Spanish Ministry of the Environment) (ADME)	Defend the State's interests

Table 2. List of the actors we have considered and their particular objectives.

1. The procedure followed to put the proposed method into practice in this particular case is as follows:
2. Interview a group of people who, in their minds, are related to the Nature Reserve. These were informal interviews conducted with an outline script, which were taped and subsequently transcribed to a text form. We should make it clear that interviewees were not submitted to a formal questionnaire as it was considered impossible to obtain one should the limited means available be fully fulfilled. The ideal procedure to follow would have been a Delphi process with specially selected people who were willing to devote as much time to the matter as necessary. Therefore, the procedure we used to compile basic information does not form part of the DIFUCO method.
3. Identification of the actors ***P*** from the interviews and from the study by Jacques et al. [12].
4. Identification of the ***A*** aspects (the objectives of any actor) after these interviews.
5. The list of aspects that we considered, in which the attainment of an agent's goal could hamper the achievement of the other agents' objectives, is the following:
   - Extending urban land
   - Quality of the water
   - Quantity of water
   - Quality of the air
   - Avifauna
   - Ichthyofauna
6. Identification of the possible control variables ***C*** after these interviews.
   We introduced two control variables: *the subsidies* given to certain actors (and external aid); construction of *infrastructures* that affect the Nature Reserve.
7. Identification of the relative importance of each aspect ***W*** after these interviews.

In order to study the conflict in general, which includes all the aspects, we need to see the *global matrix.* This is obtained by calculating the weighted average of the impacts matrix that corresponds to all the conflict aspects. A weight needs to be assigned to each aspect to accomplish this. The weights we assigned (in %) are featured in Table 3.

Conflict aspect	***Weight***
Extending urban land	0
Quality of the Water	15
Quantity of Water	30
Quality of the Air	15
Avifauna	20
Ichthyofauna	20
The sum of the weights	**100**

Table 3. Weights assigned by experts to the conflict aspects.

8. Identification of the direct impacts ***I*** obtained based on the interviewees' opinions, which have been translated into numerical values by the authors after applying the following criterion:
9. Positive, negative or null influence: + sign, - sign or zero.
10. Should the influence be either positive or negative, then:
11. Very slightly (1), slightly (2), regular (3), very much (4), extremely (5).
12. These impacts, which were initially assessed between -5 and +5, were subsequently normalized to the interval [-1, +1] of real numbers. The definitive value assigned to each impact is the average of the values assigned to it by the interviewees.
13. Calculation of the indirect plus the direct impacts matrices ***Y.*** We used the DIFU program [8] to do this (available at http://www.uv.es/caselles).
14. Location of the conflictive zones in the total impacts matrices. These zones stand out for their bolder or lighter gray tones or for their black

tones (as required), depending on the degree of the conflicts (negative total impact) among the actors, or among the actors and the control variables.

15. Recommendations for arbitrators or governors.

Let us now look at the Global Matrix (1).

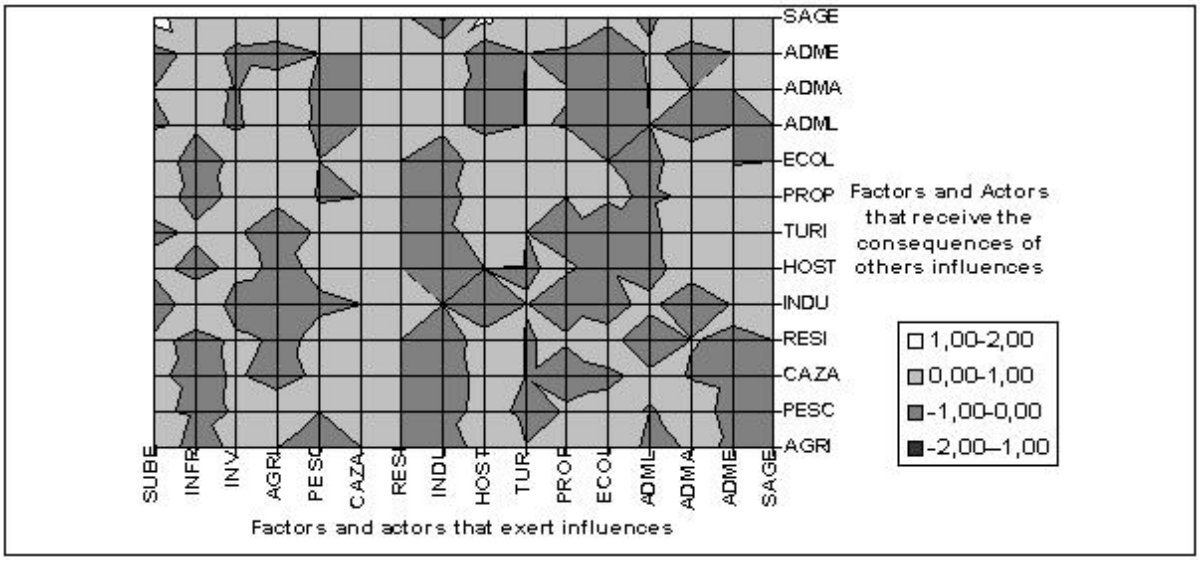


Figure 1. Direct + indirect influences between -5 and 5, among the various people involved in the La Albufera conflict (Actors) and among the other factors involved in relation to the Global Matrix.

According to these results, which account for both the direct and indirect impacts, and which take all the conflict aspects into account, what is more detrimental to overall fulfillment (SAGE) is the activity undertaken by industrialists (INDU) and by the Local Administration (ADML) (these are the only two negative impacts in the matrix). What most favors overall fulfillment are subsidies (SUBE) and the hotel and catering activity (HOST). Consequently, the defined intervention strategies must be adjusted by the results of the analysis. The rest of the values in the column of Figure1, headed SAGE, provide us an idea of the relative value or repercussion that the possible favorable interventions have for some actors.

4.2 Comparing AHP and DIFUCO

AHP is a structured technique to help complex decision making based on mathematics and psychology, was developed by Thomas L. Saaty in the 1970's and has been studied and refined since then. AHP permits the user to structure decision problems to represent and quantify its elements, to relate general objectives and to assess alternative solutions. Its application fields are decision making in the government, industry, business, health and education domains. We have adapted the method presented by Saaty [16] to solve the La Albufera conflict by following the same steps that Saaty followed for the Ulster conflict.

This method considers three hierarchical levels inside the conflict elements:

- First level: participants (actors). Each actor's absolute strength, power or weight to determine the solution is obtained from a matrix representing each actor's relative strength action in relation to each other (a kind of comparing matrix). AHP assumes that the effect of an actor's fulfillment is independent of the fulfillment of others.
- Second level: the actors' objectives. The absolute importance or weight of each objective is calculated from a series of matrices that represent the relative weight of each objective in relation to each other for each actor, and from the results of the first level (each actor's absolute strength).
- Third level: the political structures (for instance, Public Administrations) that can help satisfy actors' objectives. The

absolute strength, power or weight of each political structure is calculated from a series of matrices that represent the weight of each political structure to help each actor reach each objective.

Recommendations to help determine the most adequate political structure with a view to assist each actor to reach each objective derive from the previous analysis. The procedure to obtain this kind of vectors for the weights is based on obtaining the eigenvector associated with the maximum eigenvalue of the comparing matrix. Saaty's method was applied to the La Albufera case; the corresponding results are summarized in Table 4.

As regards interpreting the results presented herein a, backward process has to be followed. Observe that the political structure in Table 4 with a greater weight is *Autonomous Administration* (0.3549), which would act firstly on *farmers* (0.0815) by making laws principally about *land use* (0.012) and *quality of water* (0.035). The second form of action would address *industrialists* (0.0482 in Table 4), principally in terms of *quality of water* (wastewater) (0.0122) and *quality of air* (contamination emissions) (0.0098). The third form of action would address *builders and estate investors* (0.0348 in Table 4) in relation to *infrastructures* (0.0058), etc. These values were obtained with the hierarchical analysis (the results of the respective simulations are available upon request).

	Adme	Adma	Adml
ESPE	0.0261	0.0348	0.0241
AGRI	0.0699	0.0815	0.0965
PESC	0.0300	0.0346	0.0401
CAZA	0.0212	0.0295	0.0177
RESI	0.0249	0.0348	0.0256
INDU	0.0480	0.0482	0.0475
HOST	0.0192	0.0275	0.0226
TURI	0.0194	0.0229	0.0208
PROP	0.0224	0.0210	0.0226
ECOL	0.0191	0.0202	0.0276
Total	**0.3002**	**0.3549**	**0.3451**

Table 4. Weight of each political structure in relation to each actor (AHP)

Therefore, the AHP results prioritize political structures, actors and the actors' objectives. AHP is based on comparing the power, strength or weight of political structures, actors and objectives.

The AHP method prioritizes *political structures, actors* and *aspects* from the relative powers among them (for details, see 4.1). Thus, the most influential political structure would be Autonomous Administration, which would act firstly on *farmers* (firstly, soil, then quality of water, etc.), secondly on *industrialists* (firstly, quality of water; secondly, quality of air, etc.), thirdly on *builders and estate investors* (firstly, soil, etc.), etc.

	AGRI	PESC	CAZA	RESI	INDU	HOST	TURI	PROP	ECOL	ADML	ADMA	ADME	SAGE
SUBE	1.073	0.235	0.075	0.159	-0.506	0.206	-0.148	0.31	0.492	-0.061	0.017	-0.418	1.5
INFR	-0.642	-0.187	-0.109	-0.164	0.402	-0.208	0.103	-0.205	-0.369	0.098	0.071	0.314	0.134
INVE	0.289	0.046	0.031	0.06	-0.161	0.121	0.098	0.097	0.16	-0.037	-0.021	-0.136	0.343
AGRI	0.0	0.171	-0.103	-0.041	-0.198	-0.077	-0.5	0.228	0.247	0.118	0.245	-0.21	0.42
PESC	-0.138	0.0	0.047	0.04	-0.022	0.042	0.103	-0.024	0.001	-0.045	-0.073	-0.001	0.392
CAZA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
RESI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.37
INDU	-0.987	-0.407	-0.438	-0.518	0.0	-0.461	-0.113	-0.354	-0.82	0.37	0.403	0.697	-1.191
HOST	0.878	0.316	0.289	0.433	-0.853	0.0	0.163	0.427	0.816	-0.372	-0.396	-0.694	1.203
TURI	0.028	-0.2	-0.009	-0.008	0.004	-0.008	0.0	0.005	0.0	0.009	0.015	0.0	0.33
PROP	0.178	0.044	-0.101	0.026	-0.083	0.017	-0.053	0.0	0.078	-0.007	0.006	-0.066	0.427
ECOL	0.418	0.062	-0.037	0.155	-0.191	-0.044	-0.339	0.096	0.0	-0.733	-0.692	-0.85	0.232
ADML	-0.16	-0.019	0.07	-0.335	0.147	-0.214	-0.202	-0.084	-0.145	0.0	0.065	0.123	-0.142
ADMA	0.043	0.071	-0.012	0.006	-0.395	0.286	0.514	0.078	0.3	-0.24	0.0	-0.255	0.537
ADME	-0.025	-0.057	-0.035	-0.022	0.04	0.081	0.181	0.008	-0.001	-0.002	0.0	0.0	0.244
SAGE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 5. Global matrix produced by DIFUCO.

The DIFUCO method (see 4.1.2 for details) prioritizes political structures (the last three items in the SAGE column in Table 5) given the direct repercussion of their activities on actors (as perceived by them in the past). The actors' priorities are calculated in a similar fashion (the first items in the SAGE column in Table 5), whereas the priorities of the aspects are directly obtained as data (see Table 3). Thus the most influential political structure on general fulfillment is also Autonomous Administration (0.537); however, its greatest positive influence is on tourists (0.514) (+0.923, extending land, +0.896, quality of water, etc.). Next it positively influences hotel and catering owners (0.286) and ecologists (0.3), and its greatest negative influence is on industrialists (-0.395) and hunters (-0.012). It is noteworthy that, unlike DIFUCO, AHP does not consider the effect of the fulfillment of some actors on that of other actors because it assumes they are independent.

Another difference between AHP and DIFUCO lies in the interpretation of priorities. In AHP, priorities derive from relative powers with a view to reaching the objectives. In DIFUCO, however, priorities derive from the effect of the activity of actors and political structures on general fulfillment, as perceived in the past. Thus, Local Administration activity (the City Council as the owner of the Nature Reserve) has a positive effect only on hunters and industrialists (in spite of having high power) (Table 4).

Besides priorities (the only result of AHP), DIFUCO calculates the effect of some input variables (subsidies and infrastructures in the La Albufera case) on each actor's fulfillment and on general fulfillment, as well as the effect (positive or negative) of each actor's fulfillment on the fulfillment of other actors both globally and per aspects.

In short, AHP assumes that political structures and actors are independent, and it calculates the absolute strengths (always positive) of political structures, actors and objectives from the relative ones. However, DIFUCO assumes that input variables, output variables, political structures and actors can be dependent, and it calculates both the direct and the indirect influence (positive or negative) of each one on all the others.

Moreover, when the number of comparing criteria (for instance, actors) is $n>10$ in AHP, consistency in matrices cannot be guaranteed. Furthermore, the calculation process of eigenvalues and eigenvectors implies stability problems in the results.

5 Conclusions and comments

The DIFUCO method, apart from being applicable when *participants*, *management alternatives with measurable attributes* (actors' preferences or aversions as regards alternatives), and *utility functions* or participants' benefits are well defined, helps define management and intervention alternatives (legal regulations by governmental organizations, promotion of infrastructures or works, subsidies, etc.) when these are not well-defined (see Section 4.1.3 last paragraph). That is, when: (a) affected individuals cannot be implicated in this process in practice; (b) negotiation is impossible because most of the stakeholders are collectives without any kind of easily obtainable representation; therefore, Public Administrations have to decide management alternatives; (c) management alternatives have to be found by Public Administrations, which need help with this target. The DIFUCO method helps to determine utility functions, even when no measurable attributes are available, and explains how to assign adequate weights (through the impacts: see Section 4.1.2 step 7). Furthermore, it permits users to simulate different scenarios with incontrollable variables and different strategies for decision makers (Step 3 of Section 4.1.2).

This paper applies AHP method and Section 4.2 compares it with the DIFUCO method described in Section 4.1, revealing its relative strengths and weaknesses. For its comparison with MACBETH see Section 2.

DIFUCO proves more flexible than other methods to manage data and the regulations to determine impacts (see Section 4.1.2 step 7 and Section 4.1.3). The methods that DIFUCO includes require less parameters than the other methods described in the literature (see Table 1), which enables non experts to adequately

analyze its results and makes decision making easier and clearer.

DIFUCO offers stakeholders some flexibility and/or help to: (a) define the conflict; (b) identify the actors involved; (c) identify the factors involved; (d) determine the priority actors to be fulfilled; (e) determine the priority actors to not be fulfilled; (f) establish the priority factors to improve; and all this to reach the best agreement or overall fulfillment. As an instance, for (a), (b) and (c) see Section 4.1.3 steps 1 to 4; for (d), (e) and (f) see Section 4.1.3 step 9.

When we compare theoretically the DIFUCO method with other more generalized methods to resolve conflicts, we can draw the following comments:

1. Other methods, such as *multiobjective optimization*, consider *measurable attributes x*, and *utility functions J(x)* for each actor, which are used to assess each management alternative *A*. In the DIFUCO method, conflict *aspects* are comparable to *attributes* to a certain extent. Nonetheless, *aspects* are not necessarily measurable. Bear in mind that the impacts between actors, plus the control variables and the objective variables, are pondered to obtain the global impacts matrix. Moreover, the *W weights* in the DIFUCO method refer to the importance that the different aspects have for "society" and not for each actor. Consequently, the *utility functions*, which are comparable to the global impacts matrix ***Z*** calculation to an extent, refer to "society" and not to the actors. Furthermore, they are not applied to *measurable attributes x*, but to impacts *I*. The *commitment solution*, which is obtained by pondering the actors' utilities in the multiobjective optimization, is demonstrated in the DIFUCO method through the impacts on the *objective variable*, or through the different actors' "overall fulfillment" plus the control variables. These differences confer a greater degree of flexibility and adaptability to the DIFUCO method for the following cases: (a) when it is not possible to find the aforementioned measurable attributes; (b) when it is not possible to clearly define the importance that its specific values have for each actor.
2. Regarding the so-called *game with n people for simple bargaining*, its requirement of having determined the solution a priori is known, and this is measured in terms of the participants' utility should there be no agreement (the so-called *conflict aspect*). This requirement, along with those of having defined the actors' strategies and their utilities, imply that this method is comparatively very restricted. As for *cooperative games*, other than requiring alternatives and utility functions defined a priori, they include the condition that coalitions may be formed among participants by assuming that utilities are transferable (compensative) among the members of each coalition.
3. Methods that include *votes* assume management alternatives that are well-defined and studied by the participants, that participants are perfectly identified, and a laborious process to both gather and scrutinize the votes.
4. The AGORA method [10] describes the determination aspect of the actors' utilities in great detail (a large tree diagram of values, the relative importance of each value for each actor, the proximity analysis among the actors' opinions, and forming coalitions with this information), determines an impacts matrix of management alternatives (defined a priori) with the values, and deduces the alternative, or alternatives, that are not unacceptable by any coalition. This method was applied to the La Albufera case (Valencia, E. Spain) to the aspect *determining the limits of this Nature Reserve*. It is obviously a very difficult method which demands the perfect determination and identification of both alternatives and actors, and it requires lots of questionnaires that address the actors.
5. Limitations and comments about DIFUCO. These may be derived from its static nature. In other words, recommendations to arbitrators are assumed valid for a given time period, after which the method has to be restarted. This limitation may not necessarily be an inconvenience because

the actors may differ (some have disappeared, others have formed coalitions, etc.) after this period of time, and the direct impacts among them may also vary. Given the flexible nature of DIFUCO, when plenty of data are available, probably a method using these data would be preferable. Let us recall that DIFUCO only needs parameters 1, 2, 14, and 15, described in Section 2, are well defined and, parameters 4 and 5 may be ill defined (as in La Albufera problem). The remaining parameters are not needed. Parameter 2 (management alternatives) is introduced through "control variables" (see Section 4.1.2) which value may be determined by Public Administrations (case of La Albufera) or be the result of a negotiation process (case where each group of participants has a representative). In any case, participation of stakeholders is guaranteed, at least by choosing the persons to be interviewed or to fill questionnaires (Delphi, for instance) to obtain the needed information to determine the required parameters (see Section 4.1.3).

In short, the DIFUCO method may be considered a method that compiles and processes conflict information in the minds of those people who are involved in it, and one that provides priorities and guidance to define possible intervention strategies on the governors' or arbitrators' part with comparatively more flexibility, in less time and with fewer means and efforts.

6 Future Research

We believe that improving the DIFUCO model must aim to provide it a dynamic character (as it is in its present state), as well as the capacity to perform simulations that determine the future consequences of different intervention strategies on the governors' or arbitrators' part in the conflict. Thus, we are working on the *cross-impact* method in its *multiperiod* version *with events and trends.*

Another possible future research line may be the integration of MACBETH and DIFUCO in such a way that the weights used in DIFUCO to construct the global conflict matrix can be obtained as they are in MACBETH.

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