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Modelling stakeholders' preferences to pinpoint conflicts in the planning of transboundary protected areas

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ABSTRACT

In this paper, we propose a sequentially participative model for planning in transboundary protected areas based on the Analytical Hierarchy Process, Goal Programming and Monte Carlo simulation. The model was developed with two scenarios: one determinist and another with simulations that provide a multi-level ranking of the most relevant goals according stakeholders' preferences to establish priorities in the planning of protected areas. Moreover, the proposed methodology is capable of identifying conflicts, providing a comparison between the most likely priorities and the most consistent group priorities associated with each planning goal. The model was tested in a Portuguese-Spanish Reserve called Meseta Ibérica and it permitted the identification of the highest conflicts in conservation, agroforestry, local development, fire prevention, wildlife conservation and certification of local products. Moreover, it found strong intercountry conflicts related to development and planning goals associated with governance at the most specific level.

1. Introduction

Conservation policies become more complex when there are administrative and political borders in the territory that rarely coincide with natural ecological boundaries (López-Hoffman et al., 2010). Transboundary conservation has been defined as a process of co-operation that seeks to achieve conservation goals across one or more international boundaries and protected areas have been central to this concept. In a context of growing importance of transboundary conservation, an updated definition of the protected area has emerged emphasizing the long-term conservation of nature with associated ecosystem services and cultural values (Dudley, 2008; Mittermeier et al., 2005). This new definition indirectly addresses the importance of ecological and social connectivity, and calls for the redefinition of Transboundary Protected Area (TBPA) as "a clearly defined geographical space that includes protected areas that are ecologically connected across one or more international boundaries and involves some form of cooperation" (Vasilijević et al., 2015).

The establishment of TBPA has emerged as a response to the need to promote effective ways to ensure biodiversity conservation that straddles national borders (Schulte et al., 2018). In its latest global inventory, the UNEP World Conservation Monitoring Centre (UNEP-WCMC) identified 227 TBPAs over the world, covering nearly 3% of the planet's land surface and representing nearly 23% of the world's network of protected areas, including at least 3043 individual protected areas (Lysenko et al., 2007). The TBPAs have grown 285% in number between the 1980s and the early 2000s (Lysenko et al., 2007).

Socio-ecological cooperation is the essence of transboundary conservation and the ultimate objective in a transboundary reserve is improving human livelihoods while safeguarding ecosystems (Brunner, 1999; Taggart-Hodge and Schoon, 2016). Transboundary conservation has the potential to bring specific ecological benefits, such as ensuring long-term maintenance of viable populations of species, securing the survival of migratory species, facilitating natural recolonisation of populations of species that currently survive in isolated patches only, building greater ecological integrity and maintaining or strengthening ecosystem resilience in the face of climate change (Vasilijević et al., 2015; Kutal et al., 2016).

However, the complexity behind the management of this type of protected area is higher than in reserves located in a single country and,

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sometimes, attaining conservation goals in protected areas can be blocked. On the one hand, there is a great diversity of stakeholders from several countries in the same area, with interests that can cause conflicts between them (Stolton et al., 2013). On the other hand, there is usually at least one decision-maker for each institution in each country with decisive power in the governance of the area. Furthermore, it is common for there to be many institutions with decision-makers in the same country. Conjoint intercountry governance becomes very complex when it is necessary to integrate all the different decisions. Moreover, it is not rare to find disagreement between scientists and managers about the management of the area (Hummel et al., 2017). In this regard, conservation management in transboundary areas requires care with three topics: collaboration, resilience and coordination between the different levels of governance. To ensure these different elements are dealt with correctly, it is necessary to correctly define management plans in the early stages, considering a conjoint approach to the goals (Vasilijević et al., 2015).

The recommended guidelines for the planning of TBPAs follows the management principles agreed between stakeholders, such as common values and vision, the participation of local people, the commitment of decision-makers and the collaboration of the staff in the park (Clamote Rodrigues and Fischborn, 2016). These principles and the planning process require a joint management structure and common funding. Arranging the planning of Biosphere Reserves using three conservation zones (core, buffer, and transition) is widespread; however, each country has its own legal, regulatory context (Trillo-Santamaria and Paül, 2016). This complex governance requires ensuring the integration of the stakeholders at all levels of governance to guarantee connectivity and maximize consensus throughout the planning process.

Participative Multi-Criteria Methods have been commonly used to plan protected areas (de Castro and Urios, 2017) and their effectiveness has been shown in some complex cases, such as the implementation of Red Natura 2000 (Cortina and Boggia, 2014; Sánchez-Lozano and Bernal-Conesa, 2017). Some studies analyse the importance of including stakeholders' preferences to improve the management of these areas. Valasiuk et al. (2018) assessed the stakeholder's planning preferences aimed at enhancing the restoration of functional networks of naturally dynamic boreal forest habitats as a public good. Holder (2016) remarks on the success of forest governance structure in a transboundary reserve located in three countries in Central America because of enhanced local participation. Opening the dialogue with governmental and non-governmental institutions to support the management of the sustainable use of natural resources within local communities is a key factor to improve the management of this biosphere reserve. Furthermore, Clamote Rodrigues and Fischborn (2016) present many transboundary conservation case studies and describe the success of these reserves related, mostly, to the improvement of participative processes that involve the stakeholders of the area and to the enhancement of transboundary cooperation.In this scenario, the involvement of local communities for the planning of transboundary reserves is very important. Nevertheless, the aggregation of individual priorities can be a difficult process that can present problems related to group consensus. Multi-Criteria Analysis can be a useful tool for the aggregation of the individual preferences with rigor to involve the stakeholders' preferences in the planning process (Ananda and Herath, 2008; Adem Esmail and Geneletti, 2018). Furthermore, these methods can provide a structured base for negotiation to achieve consensual results. In this work, a participative model is proposed to plan TBPAs that integrate the preferences of the stakeholders, based on a multi-level structure for consensual group decision-making. The model is further developed to: (1) identify a stakeholder's group consistent solution in order to establish the priorities out of all the planning goals, using a deterministic approach, and (2) model stakeholder's preferences, using a stochastic approach. The comparison of both results permits quantification of the conflicts for all the planning goals considered at three governance levels.

2. Material and methods

The proposed methodology involves four stages: i) identification of hierarchical goals, selection of stakeholders and data collection for the transboundary reserve, ii) assessment of the group consistent solution, iii) assessment of the most likely results, and iv) multi-level conflict analysis.

2.1. Identification of the hierarchical goals, the selection of stakeholders and data collection

In order to achieve success in a transboundary reserve, it is necessary to accurately define the basis that will support the conjoint planning structure. This requires taking into account all the key elements for all the countries and stakeholder groups involved in the area. In this sense, it is important to prioritize stakeholder representation of over participation. To ensure quality long-term planning, stakeholders representing all interests of all specific groups in the area should be identified and involved in the process. It is also essential that stakeholder representatives have reasonable knowledge and experience to guarantee the understanding of all the issues under consideration in conservation planning and governance. Moreover, a large number of participants can make it difficult to find group consensus, even with minor discrepancies (Brody, 2016). In fact, Mattsson et al. (2019) showed effective planning in a TBPA based on only 15 stakeholders clustered in 6 groups. Identifying the objectives to be included in the management plans must be the result of an exhaustive review of all the management documents defined for each protected area and all the management documents related to the governance of each municipality. After that, a hierarchical tree that represents all the key topics is built in a rigorous and organized manner. Therefore, all the objectives considered are organized into multilayer, work scales.

Following this hierarchical structure, the stakeholders' preferences about the selected goals are collected. Selection of the stakeholders should be made carefully to ensure the representativeness of the stakeholders involved in the analysed area. The individual preferences are collected and aggregated using an Analytical Hierarchy Process.

An Analytical Hierarchy Process (AHP) allows the collection of subjective assessments and quantifies the trade-offs of pairwise comparisons (Saaty, 1980), considering individual preferences through opinions about the relative importance of criteria and alternatives using pairwise comparisons (Saaty, 1980). To obtain a hierarchical structure of the items to assess, each participant assesses the intensity of their preferences, considering a pair of attributes, in a 1–9 points scale, over a pair of attributes. If the two attributes have the same importance, the participants assign a value of 1 to this comparison, while a 9 represents the absolute importance of one criterion over the other (Saaty, 1980). AHP can aggregate individual performance indicators into one, so, when applying the AHP technique, a hierarchical decision structure is built by decomposing the decision problem into several criteria or decision elements. Paired comparison data can be analysed using a regression method or the eigenvalue technique. The use of the eigenvalue method requires the construction of reciprocal matrices of pairwise comparisons to estimate the relative weights of attributes. The right eigenvector with the largest eigenvalue in each matrix estimates the relative importance of the attributes (Ananda and Herath, 2008).

AHP is a very popular multi-criteria decision-making method (Diaz-Balteiro et al., 2017; Ezquerro et al., 2016; Ho, 2008) that works well in natural resources planning and management (Cegan et al., 2017). This method allows a qualitative assessment of the relative importance of multiple criteria that has been applied in multidisciplinary contexts. AHP has been very useful for the planning of protected areas, in particular in land-use-related zoning and conflict-solving (de Castro and Urios, 2017). AHP-GIS hybrid models have been used for zoning in protected sites taking land-use restrictions into account (de Castro and Urios, 2017; Yalew et al., 2016). Moreover, AHP has been useful in collecting stakeholder's preferences in participative planning processes in protected areas (Ortiz-Urbina et al., 2019). This technique is widely used as it is easy to apply; however, it is difficult to pinpoint consensual solutions, as it does not include uncertainty in the analysis.

The main limitations of this method are related to the high number of inconsistent primary responses and the possibility of the reversibility of the ranking, with the associated problem of the weakness of the results when the number of the criteria considered is changed (Ho and Ma, 2017). Pairwise comparison matrices must be reciprocal, homogeneous, and consistent (Saaty, 2006). Saaty (1980) fixed the acceptable consistency when the Consistency Ratio (CR) is equal to or less than 0.10 (Saaty, 2006). However, in pairwise comparisons, primary results frequently present a Consistency Ratio higher than 0.10, as the judgment calls have innate subjectivity. Related to the inconsistency limitation, the AHP is hard to use with a high number of criteria - on increasing the number of criteria analysed, the complexity of the assessment also increases, and thereby the number of inconsistent assessments is also higher. Because of this, the AHP is only used in decisional problems with a limited number of criteria, considering the fourth axiom of the AHP foundation (Saaty, 1986).

2.2. Assessment of the group consistent solution

The aggregation of individual preferences should be carried out considering the consistent preferences. To deal with the inconsistent primary results a Goal Programming Model is used. Once the inconsistencies are corrected, all the consistent matrices are aggregated using a Geometrical Average and the weights for each criterion are calculated using the eigenvalue method. This group consistent solution is formed by the weights that represent the relative importance of each attribute assessed.

Goal Programming (GP) is a linear programming technique used to resolve complex problems. GP finds compromise solutions that may not fully satisfy all the goals but do reach certain satisfaction levels set by the decision-maker. For this propose an objective function and some constraints are defined. The constraints of the model are formed by the relationship between the objectives of the achievement level for each attribute; with these attributes linking themselves through negative and positive deviations. There are some variants of GP: Weighted GP, MinMax GP and Lexicographic GP, all of which follow the general purpose of GP but each one achieves it in a different way. Weighted GP is a linear model that minimises the weighted sum of the deviations from each goal. MinMax GP seeks to minimise the maximum deviation between all possible deviations. Lexicographic GP minimises an achievement function based on a pre-emptive or non-Archimedean priorities approach. This method uses a pre-emptive weight, thus, the achievement of the goals with a defined priority is immeasurably preferred to another achievement defined for a lower priority (Romero, 2014).

Linear programming has been useful to solve conservation planning problems. Beyer et al. (2016) showed the efficiency of integer linear programming vs. a stochastic method to optimise the selection of priority areas to include in conservation planning. Specifically, GP has been widely used to model decisional problems related to forestry, usually to establish indicators to assess natural resources. Diaz-Balteiro et al. (2016) and Diaz-Balteiro et al. (2017) modelled some forestry resources with GP to quantify sustainability in forestry environments. Furthermore, GP works well combined with other multi-criteria techniques for the management and planning of natural areas (Uhde et al., 2015). Besides, in the direct application to the optimization of forestry, GP has been useful as tool for improving the consistency of paired comparisons and it has also been applied successfully in other contexts (de Castro and Urios, 2017).

Firstly, the individual stakeholder's preferences were collected using a Saaty-survey and analysed following the AHP. To improve the consistency of the primary results, it uses a weighted GP model based on González-Pachón and Romero (2004). The objective of this analysis is to obtain a matrix that is as similar as possible to the one generated by the decision-maker while meeting Saaty's conditions of similarity, reciprocity, and consistency (González-Pachón and Romero, 2004).

To correct the inconsistent matrices (CR $<$ 0.10), the Archimedean GP model was applied as laid out in Eq.s 1–5.

$$\text{Min}\sum_l (n_l^{(1)} + p_l^{(1)})^p + \sum_s (n_s^{(2)} + p_s^{(2)})^p + \sum_t (n_t^{(2)} + p_t^{(2)})^p \tag{1}$$

s.t

$$w_{ij} - m_{ij} + n_l^{(1)} - p_l^{(1)} = 0, \quad \text{l}=1, 2, \ldots, \text{n}(n-1) \tag{2}$$

$$w_{ij}w_{ji} + n_s^{(2)} - p_s^{(2)} = 1, \quad s = 1, 2, \ldots, \frac{n(n-1)}{2}, \tag{3}$$

$$w_{ij}w_{jk} - w_{ik} + n_t^{(3)} - p_t^{(3)} = 0, \;\; \text{t}=1, 2, \ldots, n(n-1)(n-2), \tag{4}$$

$$0.11 \le w_{ij} \le 9 \quad \forall \; i, j. \tag{5}$$

Let $\text{M} = (m_{ij})_{\,ij}$ a general matrix given by a participant, there is a set of positive numbers, $(w_l \ldots w_n)$, such that $m_{ij} = \frac{w_i}{w_j}$ for every $i, j = 1, \ldots, n$

After correcting the inconsistencies, the total of the consistent matrices was normalised and aggregated using a geometric average and the final weights were calculated using the *eigenvalue* method. Thus, as a result of this assessment the obtained weights represent the conjoint relative relevance for each criterion analysed.

2.3. Assessment of the most likely solution

The assessment of the most likely solution is based on a stochastic analysis using the Monte Carlo simulation method.

Monte Carlo simulation (MCS) is a statistical sampling approach to analyse uncertainty in Multi-Criteria models (Baudry et al., 2018). This computational method uses an algorithm which uses repeated random sampling to obtain results. MCS permits characterization and quantification of the uncertainty associated with the attribute values and the weights to define their probability function (Feizizadeh and Kienberger, 2017). Furthermore, several studies show the efficiency of MCS in complex systems with multi-variable contexts to check the effect of the iterations from their probability functions (Baudry et al., 2018; González et al., 2018). Some studies have applied or analysed simulation models of interdependent systems (Ouyang, 2014). Specifically, Zimmerman (2001) and Zhang and Peeta (2011) applied simulation models to solve problems with functional interdependency. Zimmerman (2001) analysed functional interdependency when the operation of one infrastructure system is necessary for the operation of another infrastructure system. Zhang and Peeta (2011) analysed interdependencies between infrastructure systems in a multilayer network and found functional interdependencies when the functioning of one system requires inputs from another system or can be substituted by the other system.

MCS has been widely used for the planning of natural resources (Klausmeyer and Shaw, 2009; Soares-Filho et al., 2010; Pérez-Rodríguez and Rojo-Alboreca, 2017). Many studies combined simulation methods with GIS analysis, above all to manage the control of fire (Kanga and Singh, 2017), erosion (Vieira et al., 2018), water management (Dimitriou et al., 2017) and to predict the effects of changes in land use (Terra et al., 2014). Nevertheless, the simulations are usually made with isolated criteria using scenarios (de Castro and Urios, 2017). Until now, MCS has not been applied to the strategic management of natural areas, and specifically in the planning of protected areas, in a sequential way considering interdependence between the analysed criteria.

2.4. Multi-level conflict analysis

Conflict analysis compares the result of the assessment described in step (ii) and the most likely results obtained using a sequentially Monte Carlo simulation model.

In the proposed model, simulations permit introducing uncertainty in the AHP analysis, using a sensibility analysis based on the variability per cluster of pairwise matrices. As a result of a higher number of simulations, it obtains probability functions associated with each criteria that permit identification of the most likely weights for each level and criteria.

The assessment developed in step (ii) provides the most consistent group results, while this simulation-based assessment provides the most likely results. The comparison of both results represents the potential distance of the consensus about the priority of each management objective. These results permit the identification of divergences between specific weights of each attribute at each level of the hierarchical tree. Also, it is possible to identify the conflicts between managers from different countries. This in-depth conflict analysis is quantified using an analysis of the distance. The Euclidean distance between the consistent conjoint result and the most likely result for each attribute at each level is calculated using Eq. 6. Once this is done, the distances are normalised and the percentage representative of the conflict captured by each criterion is calculated following Eq. 7.

$$d_i^L = \sqrt{(w_c^{Li} - w_l^{Li})^2} \tag{6}$$

where d_i^L represents the distance between the consensual and the most likely weights for level L and criteria i, w_c^{Li} represents the weight obtained by the group consistent result and w_l^{Li} represents the most likely weight for level L and criteria i.

$$D_i^L = \frac{d_i^L}{\sum_{i=1}^{n} d_i^L} 100 \tag{7}$$

where D_i^L represents the normalised distance in percentage for the ith of the n criteria of level L.

This analysis can be useful to assess discrepancies between the consistent results and the most likely results, and similarly, to identify conflicts in the group consistent results of the countries involved in the governance of the protected area.

In a similar way, intercountry conflict is calculated using Eq.s (8) and (9).

$$Id_i^L = \sqrt{(w_{cA}^{Li} - w_{cB}^{Li})^2} \tag{8}$$

where Id_i^L represents the intercountry distance for level L and criteria I, w_{cA}^{Li} represents the weight obtained by the group consistent result for stakeholders of country A, and w_{cB}^{Li} represents the weight obtained by the group consistent result for stakeholders of country B, by each level and criteria.

$$ID_i^L = \frac{d_i^L}{\sum_{i=1}^{n} d_i^L} 100 \tag{9}$$

where ID_i^L represents the normalised intercountry distance as a percentage for the ith of the n criteria of level L.

2.5. The Meseta Ibérica case study

The model was tested in a Portuguese-Spanish TBPA: the Meseta Ibérica Transboundary Biosphere Reserve. Meseta Ibérica was classified as a Transboundary Biosphere Reserve by UNESCO (Man and the Biosphere Programme: MAB) in 2015 and comprises two natural parks in Portugal (*Parque Natural de Montesinho* and *Parque Natural do Douro International*) and two natural parks in Spain (*Lago de Sanabria y sierras Segundera y de Porto* and *Parque Natural Arribes del Duero)*. This area comprises 12 Portuguese municipalities and 59 municipalities in Spain (47 in Zamora and 12 in Salamanca). The Transboundary Biosphere Reserve Meseta Ibérica has a surface area of 1.132.607 ha. and a population density of 14 habitants per km^2. The area is located in the transition of the Mediterranean and the Eurosiberian biogeographic zones, close to the Atlantic coast. Overall, the climate is temperate oceanic sub-Mediterranean (Castro et al., 2010). The area is representative of mountain and plateau landscapes in the north-western Iberian Peninsula. Historically, its main economic activities were related to agriculture (Nunes et al., 2008). Rural exodus, starting in the mid XX century, national and EC policies related to agriculture and forestry, nature conservation, and fire suppression in Portugal and Spain have contributed to restructuring these landscapes and their functioning. The progressive abandonment of the territory and the corresponding increase of fire hazard call for a careful definition of landscape management plans, so that the most relevant conservation goals fall in line with the stakeholders' preferences (Castro et al., 2010; Sil et al., 2019).Local communities in the Meseta Ibérica are still dominated by farmers, some of whom are dedicated to animal and forest production. Industry, particularly related to farming, has, however, grown in the past decades thanks to the benefits originated from innovation and research initiatives led by higher education institutions and research centres located on both sides of the Portuguese-Spanish border. In the tertiary sector, tourism has grown significantly in the same period, often associated with the establishment of protected areas. This includes housing but also outdoors activities such as birdwatching, trekking and climbing. Nature conservation, often connected to traditional cultural heritage, has also attracted newcomers to the region. These, working usually in local NGOs are usually qualified experts in fields such as biology, forestry, veterinary, agriculture, environmental sciences and arts. Together with the thousands of students and researchers who come to Bragança and Zamora every year, they contribute to the establishment of a large community of young, trained and dynamic entrepreneurs with a special interest in nature and its conservation. Finally, government officers at either local, regional or national level with responsibilities in land planning and management of natural resources and protected areas, are also an important part of the society in the region.

Since the establishment in the 1970s of protected areas in the area that is now part of the Meseta Ibérica Biosphere Reserve, conflicts between local stakeholders and governmental bodies, as in many other inhabited protected areas in the world, have been usual, a few times strong, in particular at the time of their establishment. The perception of belonging to the protected area and misinformation but also restrictions related to land use and land cover, game and fishing, forest harvesting, and other activities are usually the source of conflicts. In several occasions, conflicts arise from the practically inexistent involvement of local communities in decision-making processes. The establishment of a TBPA in the region has made governance and decision-making processes more complex by introducing new actors and by involving authorities that traditionally did not have a leading role in nature conservation in the region such as municipalities, which might move decision-making processes further away from local communities and individuals.

Decision-making in the Meseta Ibérica relies on ZASNET, a European Grouping of Territorial Cooperation (EGTCs) with headquarters in Bragança, Portugal, created in 2010, "to facilitate cross-border, transnational and interregional cooperation between Member States or their regional and local authorities" (European Union, 2017). This institution is comprised by Diputación de Zamora, Diputación de Salamanca, and Ayuntamiento de Zamora, in Spain, and by Associação de Municípios da Terra Fria do Nordeste Transmontano, Associação de Municípios da Terra Quente Transmontana and Câmara Municipal de Bragança, in Portugal. ZASNET promoted the candidature of the Meseta Ibérica to the MAB program and has been coordinating this TBPA since its creation.

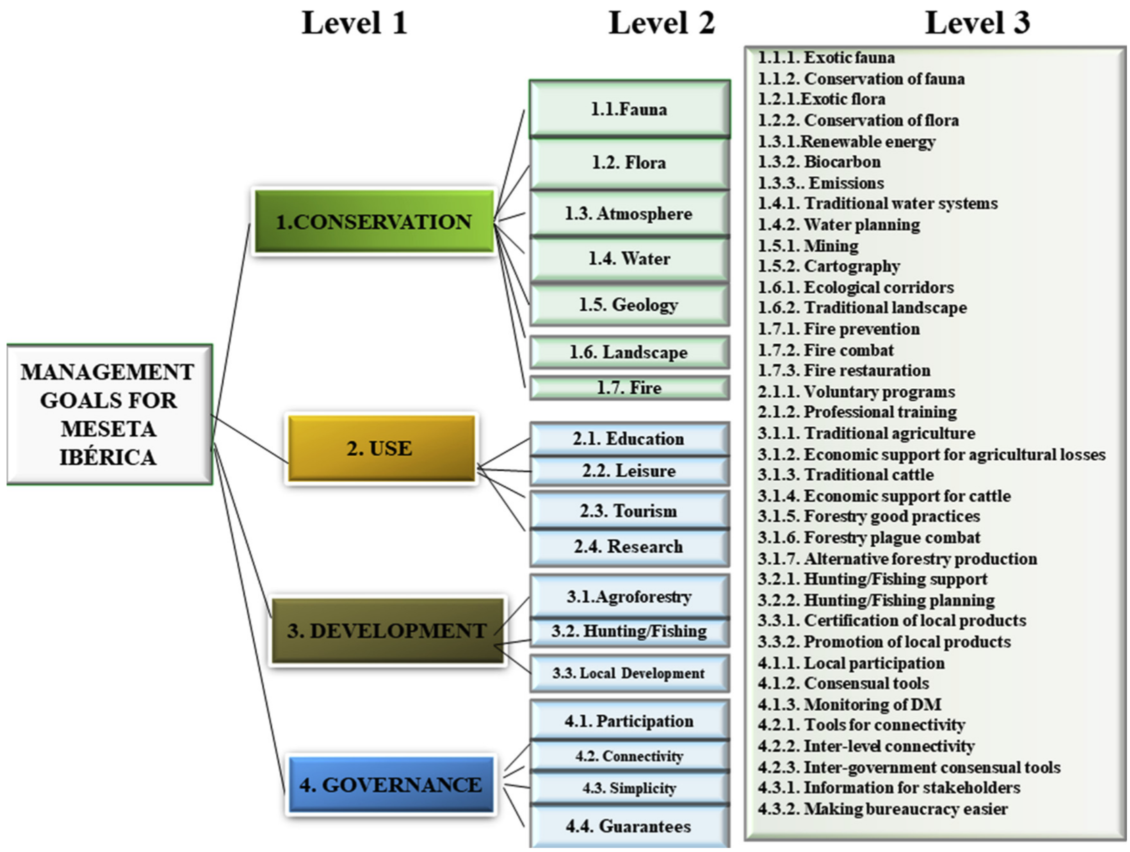

Fig. 1. Hierarchical structure for the planning of the Meseta Ibérica Biosphere Reserve.

3. Results

The results of the application of the model are shown below.

3.1. Establishment of multi-level goals, selection of stakeholders and data collection

Firstly, the objectives for the planning of the natural area were defined in a three level hierarchical structure (Fig. 1). The first level involved 4 main goals, the second 18 criteria and the third included 37 criteria. The explanation of each topic is available in the Supplementary material 1.

The objectives of the first level were based on three main global objectives of the Biosphere Reserves: Nature Conservation, Logistic support and Development. Moreover, these objectives comprise all nine objectives defined by The International Union for Conservation of Nature (IUCN) for protected areas with international category V (Natural Park). Furthermore, a fourth objective that is particularly important in transboundary areas related with governance was incorporated.

The second and third criteria involve the main topics to consider in the management plan. These criteria were established integrating key elements included in the land planning documents of each of the four natural parks in the Meseta Ibérica and the strategic plan for the Meseta Ibérica Biosphere Reserve: *Plano de Ordenamento do Parque Natural do Montesinho*, *Plano de Ordenamento do Parque Natural do Douro Internacional*, *Plan de Ordenación de los Recursos Naturales del Parque Natural Arribes del Duero* and *Plan de Ordenación de los Recursos Naturales del Lago de Sanabria y alrededores*.

Four key stakeholder groups were identified: government, farmers, businesses and scientists. Government represents the technicians, the natural park directors, and the representatives of local governments. Farmers comprise associations and key actors that represent the interests of the owners of land, agriculture and cattle breeders, in the reserve. The businesses group is formed by representatives of owners of small businesses located in the territory of the reserve. Scientists are experts with a high level of knowledge about the reserve.

To collect the data, a “Saaty-type” survey was carried out online (24% of the total number of surveys) and through personal interviews (76% of the total number of surveys), between July 2017 and June 2018. A sample formed by the assessments of the 50 most representative stakeholders in the Meseta Ibérica was collected. Specifically, the sample was a highly representative group formed by 18 government officers, 12 farmers, 12 businesspersons, and 8 scientists. This sample comprised members of stakeholder groups in the four natural parks considered in this study.

3.2. Results of group consistent assessment and most likely result

The data from the surveys were analysed using the AHP method described in the methods section. As a result of this assessment, 1100 matrices were obtained and inconsistencies in 221 matrices were corrected using a Goal Programming model (Eq. 1), recovering 207 consistent matrices. Finally, a total of 1086 valid matrices were analysed (Table 1).

Once inconsistencies were corrected, all the consistent matrices

Table 1
Total, corrected, null and valid matrices.

Matrix	Total	Corrected	Null	Valid
2 × 2	551	0	0	551
3 × 3	349	161	5	344
4 × 4	150	46	7	143
5 × 5	50	14	2	48
Total	1100	221	14	1086

Table 2
Consistent conjoint weights, the rank for the consistent weights, the most likely weights and the rank for the most likely weights for each attribute in level 1.

Level 1	Consistent	Consistent Rank	Likely	Likely Rank
Conservation	0.4491	1	0.3900	1
Use	0.1660	3	0.1830	3
Development	0.2382	2	0.2774	2
Governance	0.1466	4	0.1779	4

Table 3
Consistent conjoint weights, the rank for the consistent weights, the most likely weights and the rank for the most likely weights for each attribute in level 2.

Level 2	Consistent	Consistent Rank	Likely	Likely Rank
Fauna	0.1146	2	0.1138	4
Flora	0.1099	3	0.1202	3
Atmosphere	0.0309	14	0.0221	14
Water	0.0549	7	0.0322	11
Geology	0.0280	17	0.0182	15
Landscape	0.0375	11	0.0227	12.5
Fire	0.0731	5	0.0399	10
Education	0.0689	6	0.0277	12.5
Leisure	0.0195	18	0.0099	18
Tourism	0.0361	12	0.0174	17
Scientific Research	0.0414	9	0.0168	16
Agroforestry	0.1263	1	0.2386	1
Hunting/Fishing	0.0357	13	0.0854	6
Local development	0.0762	4	0.1680	2
Participation	0.0480	8	0.0946	5
Connectivity	0.0303	15	0.0650	8
Simplification	0.0398	10	0.0777	7
Guarantees	0.0285	16	0.0601	9

were aggregated providing a group solution. These results represent the most consistent conjoint solution and the "ideal aggregate solution". Likely results have been provided by the probability function defined using the MCS method. Both results, group consistent weights and likely results, for levels 1, 2 and 3, are presented in Tables 2–4, respectively.

Results for level 1 show that Conservation and Development were the most valued topics with 44.91% and 23.82%. In the second level, the most valued criterion was Agroforestry (12.63%), followed by Fauna (11.46%) and Flora (10.99%), Local development (7.63%) and Fire (7.31%).

The third level highlights the conservation of high-value species of fauna (7.94%) and flora (7.44%), the certification of local products (4.19%) and fire prevention (4.09%) as the most relevant topics for stakeholders.

3.3. The most likely result vs. The group consistent solution. Pinpointing conflicts

As a result of 1000 iterations using a multi-level MCS on the originally paired comparisons obtained from the Saaty-survey, the distribution of the stakeholders' preferences was characterized. This distribution permitted the identification of the most likely weights associated with the 59 criteria analysed sequentially. In addition, the percentage of conflict was calculated using Eq.s (6) and (7) and the results for each level are presented in Tables 5–7. These values represent the variability related to each planning goal.

The comparison between the most likely result and the group consistent result identified Conservation as the criteria with most potential degree of conflict as it presents the highest variability, despite have obtained the best score. The results show the greatest distance between the conjoint weight and the most likely value, with a percentage of conflict of 40.31% (Table 5). This means the objectives related to conservation represent a high variability and could be conflictive in decision-making processes. The probability of better evaluating the

Table 4
Consistent conjoint weights, the rank for the consistent weights, the most likely weights and the rank for the most likely weights for each attribute in level 3.

Level 3	Consistent	Consistent Rank	Likely	Likely Rank
Exotic fauna	0.0352	6	0.0231	11
Conservation of fauna	0.0794	1	0.0442	4
Exotic flora	0.0356	7	0.0222	13
Conservation of flora	0.0744	2	0.0461	3
Renewable energy	0.0139	26	0.0129	20
Biocarbon	0.0078	37	0.0084	25
Emissions	0.0092	35	0.0093	23
Traditional water systems	0.0258	11	0.0051	31
Water planning	0.0291	10	0.0057	30
Mining	0.0168	24	0.0070	28
Cartography	0.0112	31	0.0050	32
Ecological corridors	0.0173	23	0.0071	27
Traditional landscape	0.0203	18	0.0079	26
Fire prevention	0.0409	4	0.0038	35
Fire combat	0.0210	15	0.0018	36
Fire restoration	0.0112	30	0.0012	37
Voluntary programs	0.0365	5	0.0096	22
Professional training	0.0325	9	0.0088	24
Traditional agriculture	0.0241	13	0.0311	8
Economic support for agricultural losses	0.0178	22	0.0262	9
Traditional cattle	0.0235	14	0.0313	7
Economic support for cattle	0.0186	21	0.0256	10
Forestry good practices	0.0195	19	0.0222	14
Forestry plague combat	0.0107	33	0.0163	17
Alternative forestry production	0.0124	28	0.0191	15
Hunting/Fishing Support	0.0111	32	0.0129	19
Hunting/Fishing Planning	0.0247	12	0.0224	12
Certification of local products	0.0419	3	0.0716	1
Promotion of local products	0.0343	8	0.0512	2
Local participation	0.0207	17	0.0063	29
Consensual improvements	0.0134	36	0.0042	34
Monitoring of DM processes	0.0139	25	0.0043	33
Tools for connectivity	0.0117	29	0.0170	16
Inter-level connectivity	0.0103	34	0.0133	18
Inter-government consensual tools	0.0083	27	0.0109	21
Information for stakeholders	0.0191	20	0.0358	6
Making bureaucracy easier	0.0207	16	0.0417	5

Table 5
Percentage of conflict in level 1.

LEVEL 1	Conflict Percentage
Conservation	40.31
Use	11.60
Development	26.74
Governance	21.35

Table 6
Percentage of conflicts in level 2.

Level 2	Conflict Percentage	Level 2	Conflict Percentage
Fauna	00.13	Agroforestry	18.75
Flora	01.71	Leisure	01.60
Atmosphere	01.47	Tourism	03.12
Water	03.79	Hunting/Fishing	08.29
Geology	01.64	Local development	15.33
Landscape	02.47	Participation	07.79
Fire	05.55	Connectivity	05.79
Education	06.88	Simplification	06.32
Scientific Research	04.10	Guarantees	05.28

Table 7
Percentage of conflict in level 3.

Level 3	Conflict Percentage	Level 3	Conflict Percentage
Exotic fauna	02.59	Economic support for agricultural losses	01.80
Conservation of fauna	07.52	Traditional cattle	01.66
Exotic flora	02.85	Economic support for cattle	01.51
Conservation of flora	06.03	Forestry good practices	00.58
Renewable energy	00.22	Forestry plague combat	01.20
Biocarbon	00.13	Alternative forestry production	01.44
Emissions	00.02	Hunting/Fishing Support	00.38
Traditional Water Systems	04.43	Hunting/Fishing Planning	00.48
Water planning	04.99	Certification of local products	06.34
Mining	02.10	Promotion of local products	03.60
Cartography	01.32	Local participation	03.08
Ecological corridors	02.17	Consensual tools	01.97
Traditional landscape	02.65	Monitoring of DM processes	02.05
Fire prevention	07.93	Tools for connectivity	01.14
Fire combat	04.11	Inter-level connectivity	00.64
Fire restoration	02.14	Inter-government consensual tools	00.56
Voluntary programs	05.74	Information for stakeholders	03.57
Professional Training	05.06	Making bureaucracy easier	04.49
Traditional agriculture	01.49		

other three criteria, above all Development, is above the consistent result. Obtaining an individual higher priority over Development, Governance and Use criteria is more likely than the group priorities over them.

Figs. 2 and 3 show a visual presentation of the planning goals analysed with a conflict percentage higher than 3% in levels 2 and 3, respectively.

In level 2, the most conflictive criterion was Agroforestry, which accounted for 18.75% of the total conflict for each level. Local development is the second topic in terms of high variability, with 15.33%. The distance analysis showed that in both planning goals, obtaining higher priorities is more likely than the conjoint priorities (Table 6).

The criteria with the highest distances with the consensual solution at the most specific level, level 3, were fire prevention (3.71%) and conservation of high value animal species (3.52%). In both cases, the most likely results were lower than the group results (Table 7).

The conflict analysis between Spain and Portugal was analysed via a

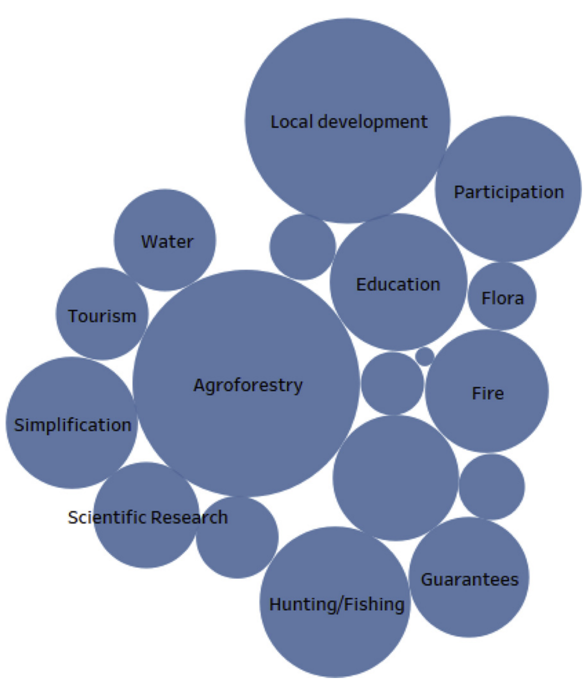

Fig. 2. Visual conflicts higher than 3% in level 2, where the size of each bubble represents the relative importance of each attribute in each level.

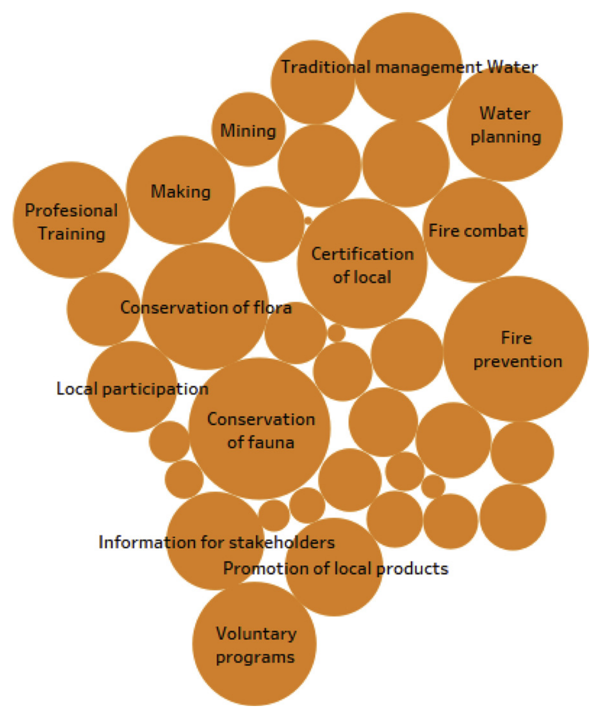

Fig. 3. Visual conflicts higher than 3% in level 3, where the size of each bubble represents the relative importance of each attribute in each level.

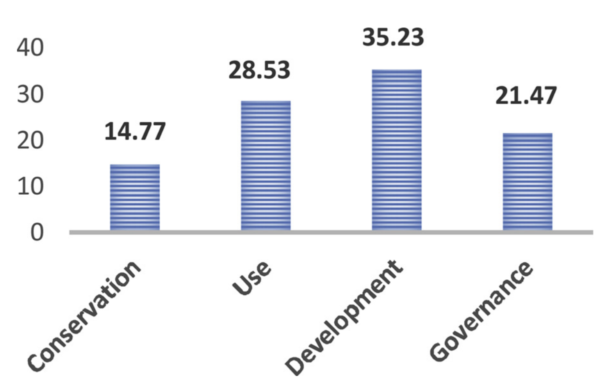

Fig. 4. Intercountry percentage conflict identified in level 1.

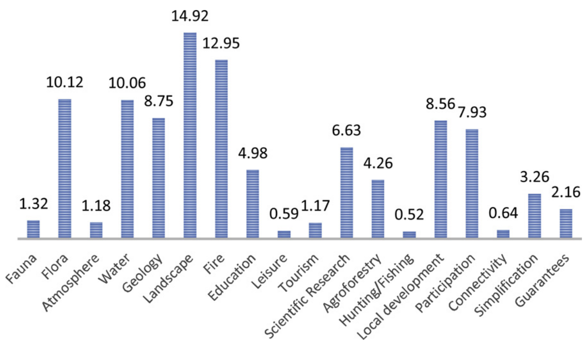

Fig. 5. Intercountry percentage conflict identified in level 2.

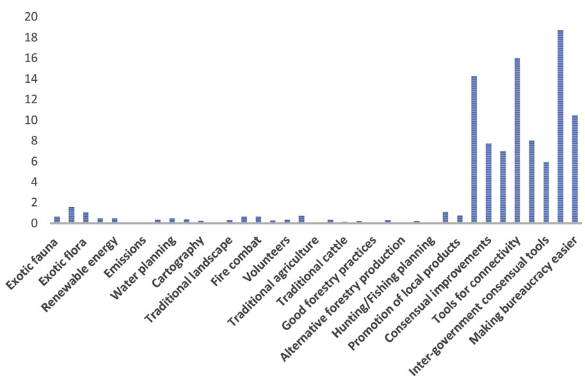

Fig. 6. Intercountry percentage conflict identified in level 3.

comparison between the consensual solution obtained by Spanish and Portuguese stakeholders separately. The percentage conflict was calculated using Eq.s (8) and (9) and it is presented in Figs. 4–6.

The greatest conflicts between countries appeared in the topic Development (Fig. 4). Portuguese stakeholders valued this topic less than Spanish stakeholders, prioritizing use and governance (Table 8). In level 2, the largest differences in prioritizations between Spanish and Portuguese participants were found in Landscape, Fire, Water, and Flora (Table 9). The three former topics were more important for Portuguese participants than Spanish ones, while Flora obtained a better position in the rank of Spanish stakeholders (Fig. 5).

Level 3 show very large differences in the valuation of governance planning goals between Spanish and Portuguese participants. All these topics were considered much more important by Portuguese than Spanish decision-makers (Table 10). Specifically, the highest divergences were found in the improvement of the information for local people, tools for connectivity and ensuring the participation of local stakeholders (Fig. 6).

4. Discussion

4.1. Establishment of multi-level goals, selection of stakeholders and data collection

Building a multi-level hierarchy is essential to reduce the number of

Table 8
Consensual weights for Spanish stakeholders and consensual weights for Portuguese stakeholders identified in level 1.

Level 1	Spain	Portugal
Conservation	0.4195	0.3800
Use	0.1354	0.2117
Development	0.2634	0.1692
Governance	0.1816	0.2390

Table 9
Consensual weights for Spanish stakeholders and consensual weights for Portuguese stakeholders identified in level 2.

Level 2	Spain	Portugal	Level 2	Spain	Portugal
Fauna	0.1255	0.1346	Tourism	0.0426	0.0345
Flora	0.1255	0.0554	Scientific Research	0.0274	0.0733
Atmosphere	0.0227	0.0309	Agroforestry	0.1415	0.112
Water	0.0367	0.1064	Hunting/Fishing	0.0292	0.0256
Geology	0.0153	0.0759	Local development	0.0926	0.0334
Landscape	0.0298	0.1331	Participation	0.0515	0.1064
Fire	0.064	0.1536	Connectivity	0.0411	0.0455
Education	0.0515	0.0859	Simplification	0.0628	0.0403
Leisure	0.0139	0.018	Guarantees	0.0317	0.0467

pairwise comparisons (Pérez-Rodríguez and Rojo-Alboreca, 2017). For this reason, it is necessary to define the hierarchical structure in the most homogeneous manner, considering all the relevant objectives for the transboundary area. The hierarchical structure can partially solve this problem, but it does not dismiss it entirely.

The AHP is the most used method in qualitative assessment. AHP provides qualitative opinion data and translates it into numeric data. This is very useful to carry out statistical analysis. However, it is important to take the natural subjectivity of human opinion into consideration. In fact, human preferences sometimes present inconsistencies, overall when the complexity of the process is high. Thereby AHP is difficult to apply when the number of pairwise comparisons is high, as the grade of inconsistencies that usually appear in the primary results.

Hierarchical methods, such as AHP, are the most used multi-criteria methods to develop participative models in protected areas (de Castro and Urios, 2017) and their popularity has grown in the two last decades (Diaz-Balteiro et al., 2017). That is due to their simplicity and easiness of understanding by non-expert stakeholders whose participation is essential in decision-making processes. It is especially important to ensure participation of all agents in the planning and management of TBPAs where there are several authorities involved so that the decision processes flow between all the institutional and non-institutional stakeholders involved uninterruptedly (Mattsson et al., 2019; Vacik et al., 2014).

The first point to discuss is the people on whom the data collection was focused. The stakeholders of each park comprising the transboundary area are representative stakeholders with good knowledge about the protected area. Despite the hierarchical structure permitting a reduction in the number of the pairwise comparisons, maintenance of some matrices with relative complexity, such as 4×4 matrices and 5×5 matrices was needed. In this line, the primary results collected about the stakeholders' preferences obtained a high consistency, considering the complexity of the pairwise comparison. It is very common to obtain high inconsistency ratios in these cases (Zandebasiri and Pourhashemi, 2016). However, the results were relatively consistent, i.e., 68% of the 5×5 matrices were consistent, and the 66.67% of the 4×4 matrices were consistent too. These data show the great knowledge of the participants and provides reliability to the analysis. Furthermore, these results show a good understanding of the issues analysed by all the participants in the process.

4.2. The most consistent solution

The most consistent solution is formed by the group solution gained from the aggregation of the individual consistent solutions. Considering the conceptual definition of inconsistency as "the number that expresses how homogeneous a matrix of opinions is" (Ho and Ma, 2017), this solution could be the "ideal" one as a mathematical approach, as it represents the most homogeneous consensual solution. A linear programming method was applied to obtain the most consistent solution in

Table 10
Consensual weights for Spanish stakeholders and consensual weights for Portuguese stakeholders identified in level 3.

Level 3	Spain	Portugal	Level 3	Spain	Portugal
Exotic fauna	0.0627	0.0414	Economic support for agricultural losses	0.0224	0.0118
Conservation of fauna	0.0422	0.0932	Traditional cattle	0.0285	0.0241
Exotic flora	0.0524	0.0179	Economic support for castle	0.0187	0.0127
Conservation of flora	0.0524	0.0374	Good forestry practices	0.0228	0.0193
Renewable energy	0.0166	0.0017	Forestry plague combat	0.0136	0.0037
Biocarbon	0.0048	0.0059	Alternative forestry production	0.0108	0.0137
Emissions	0.0068	0.0042	Hunting/Fishing support	0.0099	0.0036
Traditional water systems	0.0174	0.0067	Hunting/Fishing planning	0.0194	0.022
Water planning	0.0283	0.0136	Certification of local products	0.0516	0.0167
Mining	0.0148	0.0028	Promotion of local products	0.0411	0.0167
Cartography	0.0043	0.0116	Local participation	0.0309	0.4924
Ecological corridors	0.0155	0.014	Consensual improvements	0.0168	0.267
Traditional landscape	0.0217	0.0113	Monitoring of DM processes	0.0151	0.2405
Fire prevention	0.0425	0.0214	Tools for connectivity	0.017	0.535
Fire combat	0.0251	0.0043	Inter-level connectivity	0.0085	0.267
Fire restoration	0.012	0.0034	Inter-government consensual tools	0.0063	0.198
Volunteers	0.0345	0.0454	Information for stakeholders	0.0361	0.6413
Professional training	0.017	0.0405	Making bureaucracy easier	0.0202	0.3587
Traditional agriculture	0.0247	0.0249			

each matrix of the decision tree, providing the most consistent solution. This permitted recovery of 94.04% of the lost information.

Although some studies propose interactivity as a guarantee for consensuses (Sarkki et al., 2015; Williams, 2011), excessively long decision-making processes can be tedious, tiring and sometimes, inefficient (Eyvindson et al., 2012). As a result, the number of participants can decrease and the remaining participants can lose interest, which would lead to their responses lacking reliability. The proposed model is an effective alternative to reduce time and resources involved in decision-making processes while avoiding iterations and achieving consensual solutions.

The most important consensual topics in the Meseta Ibérica were Conservation in level 1, Agroforestry, Fauna and Flora in level 2, and Conservation of fauna, Conservation of flora, Certification of local products and Fire prevention for the goals identified in level 3. These should be the priorities for the planning of the Meseta Ibérica protected area, considering the most homogeneous preferences of the group of stakeholders.

4.3. The most likely solution

Though decision trees can be useful to reduce the number of pairwise comparisons, these sequential methods present the problem of variability propagation between branches. For example, when one criterion has enormous variability (different opinion between decision-makers) the derived cluster (set of criteria), inherit this variability, independently of the variability of criteria in the cluster. For this reason, it’s recommendable to add a complementary analysis to identify possible conflicts in these criteria. In this study we developed a stochastic analysis to compare the most consistent solution with the most likely solution.

Using the variability between criteria could be important when there is multi-level scheme, because of the propagation of its variability. The MCS method provides one solution about the distribution of the weight of each criterion in each simulation, and could be different in another one, so is important to repeat this process *n* times. Although traditionally uncertainty has not been considered to explicitly model the priorities of stakeholders or to be able to identify conflicts between them, recent research has showed that it can be useful to support decision-making processes and to obtain aggregated solutions for each stakeholder or group of stakeholders (Baudry et al., 2018; Eyvindson et al., 2018). In addition, it improves the transparency of the processes and identifies conflicts at several levels.

As we show in the results, this was repeated 1000 times, and the final results were assessed statistically for comparison with the most consistent solution.Thus, the application of the MCS provided information about the variability of each objective and thereby provided the most likely solution. As shown in the results, the most likely results could be different to the consistent solution (Tables 2,3 and 4). In fact, the ranks of the most relevant objectives in the analysed area are different in levels 2 and 3. Moreover, the distances are greater throughout the tree at higher levels. In the case study, the rank is the same in level 1, for the consistent results and the most likely results (Table 2). However, in level two, both ranks are different. Although Agroforestry gained the first position in two ranks, Fauna gained the second position in the most consistent solution but it obtained the fourth position for the most likely position. Thus, the criteria Local Development gained the second best position for the most likely solution and the fourth for the consistent solution. This means that given a consensual decision, Fauna would be considered the second most important objective for the planning of the Meseta Ibérica, but this objective gained extreme valuations by stakeholders, and therefore it could be a conflictive topic. Moreover, it means that there are individual valuations beyond this consensual solution.

In addition, another relevant discrepancy was found between both ranks in the goals related to Hunting/Fishing, which obtained the 6^{th} position for the most likely solution but the 13^{th} for the consistent solution. Scientific research and all the topics related to governance also showed high discrepancies in the position of both ranks. Nevertheless, some topics match both ranks, such as Agroforestry (1 st), Flora (3th), Atmosphere (14th) and Leisure (18th) (Table 3). In the third level, the discrepancies between both ranks are higher and there were no matches for any criteria (Table 4).

4.4. Implications of the variability, pinpointing conflicts

As the results show, there are differences between the most consistent and the most likely solutions, which could be interpreted as a possible seed of conflicts or differences between stakeholders’ opinions. Axiom 4 of the Saaty method says that *“the idea that an outcome can only reflect expectations when the latter are well represented in the hierarchy*” (Saaty, 1986), and probably this axiom is satisfied with the most likely solution using multi-level decision trees considering the variability in opinion. These differences between most consistent and likely solution shows which criteria are sensitive to open group debate to minimise the differences or look for consensus.

In the presence of strong land use conflicts, as is often the case in protected areas, the early identification of conflicts is key to ensure the success of planning (Nordström et al., 2010). In transboundary conservation areas, it is essential to approach conflicts in an integrated manner (Petursson et al., 2011). When policies involving a natural space are not well coordinated or connected with the problems of the local population and the territory, such policies might not only be ineffective but also, the might jeopardize the conservation of the territory (Pinto-Correia and Azeda, 2017). To ensure good interconnection between all agents involved in decision-making, the model we proposed allows for the identification of conflicts in an integrated manner, including the interests of all the stakeholders and authorities operating at several levels, i.e., local, regional, national or supranational, that are involved in the planning of the reserve. Furthermore, the sequential structure of the process ensures that consensuses will be reached already from its first stages; therefore, avoiding decisions to be blocked in more advanced stages. This confers agility and efficiency to the process, avoiding the fatigue of participants and a waste of time and monetary resources.

In The Meseta Ibérica Biosphere Reserve, the Conservation goal was the most conflictive in the first level (Table 5). Agroforestry, Local development, Hunting/Fishing and Participation were the goals with more potential conflicts, in the second level (Table 6). In the third level, Conservation of Fauna, Fire prevention, Certification of local products, Conservation of Flora, Water prevention and Making bureaucracy easier were the most conflictive topics analysed (Table 7).

Finally, the intercountry analysis permitted identifying the planning goals needed for a more in-depth analysis and negotiation in the final decision-making processes. In the analysed TBPA, the comparisons between the stakeholders in the two countries showed the high potential for conflicts related to some topics related to development, such as landscape and fire, and conservation of flora. Portuguese stakeholders give less importance to development than to the other analysed topics in the first level. This can become one source of conflicts that may hinder the definition of policies in the Meseta Ibérica. At the second level, landscape and fire were the most conflictive topics. In both cases, the Portuguese considered them more important than Spanish stakeholders. Finally, at the most specific level, all the topics related to governance presented the highest potential conflicts between both countries. This could be problematic in final decision-making steps, and therefore, it is advisable to start negotiation processes at early steps to avoid the decision-making processes being blocked.

5. Conclusion

In this paper, we developed and applied a model based on AHP, GP and MCS methods to support integrated planning in the Meseta Ibérica TBPA based on a multi-level governance approach.

The Multi-level structure of the model has allowed the disaggregation of a large cluster into smaller clusters that makes understanding the assessed topics easier. This structure and the treatment of the inconsistencies monitored have significantly improved the quantity of the useful data. Moreover, the sequentiality of the methodology permitted pinpointing conflicts given different specification grades in an integrated manner.

In general, participants understood well the process and identified an integrated ranking of the management goals for the Meseta Ibérica based on their preferences. This ranking prioritized objectives related to conservation and development in a first level, agroforestry, fauna and flora in a second level, and conservation of fauna, conservation of flora, certification of local products and fire prevention, at the most specific level. Nevertheless, it is advisable to start dialoguing with stakeholders groups to define carefully these objectives, since most of them presented high conflict percentages. Accordingly, it is important to identify conflicts clearly enough so as to focus the required negotiations on solving them.

Moreover, the model permitted the identification of intercountry conflicts in the early steps of the decisional process to guide and establish negotiations between the countries involved in the planning of the TBPA. In the case study of the Meseta Ibérica, strong intercountry conflicts related to governance were found. It is therefore advisable to start negotiations focused on these especially sensitive topics to prevent potential blocks in decision-making processes in the future.

The proposed model contributes to the development of methods that support the planning of TBPAs based on consensual stakeholder solutions. The main added-value of this model is the capacity to identify conflicts in a sequential and integrated manner while avoiding iterative processes, and improving efficiency compared to previously developed models. Moreover, the versatility of the model makes it possible to apply it to identify conflicts between governance levels, stakeholder groups, and countries.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2019.104233.

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