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Published online: 24 Sep 2018.

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ORIGINAL ARTICLE

# Participatory multi-criteria decision analysis for prioritizing impacts in environmental and social impact assessments

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**ABSTRACT**
Environmental and social impact assessment (ESIA) can be an extremely useful tool for identifying and evaluating the repercussions of a wide range of initiatives. Typically when the project and its impacts are highly complex, an ESIA can detect a large number of issues that need to be prioritized so that they can be effectively and efficiently addressed. This article presents a mixed-methodology proposal for impact prioritization in ESIA, divided into four phases: (1) creation of the stakeholders' platform; (2) identification and assessment of impacts; (3) impact categorization; and (4) impact assessment and prioritization using multi-criteria decision analysis (MCDA). This procedure was applied as an ex-post evaluation of a golf-based tourism project in the southwest of the Iberian Peninsula (Huelva, Spain), but can also potentially be used to conduct ex-ante assessments. The main contribution of the study is in the design and testing of a parsimonious procedure, which condenses a large amount of qualitative information into relatively simple operations using MCDA. The process is grounded in the constructivist social impact assessment (SIA) paradigm through stakeholder evaluation of impacts and criteria.

## 1. Introduction

Environmental and social impact assessment (ESIA) can be an extremely useful tool for identifying and evaluating the effects of a wide range of activities. These assessments normally yield extensive and exhaustive lists of impacts in numerous environmental, economic, and social areas, particularly when applied to highly complex development schemes (Vanclay 2002). The results of these studies can then be communicated to decision-makers who should then make use of the information by allocating resources to modify the project in line with the profiled impacts and/or risks. One of the problems that decision-makers encounter is the need to identify those impacts, which should be prioritized for attention in order to most effectively mitigate the project's negative effects. While the end product of an ESIA generally provides an assessment and rating of impacts based on a range of different criteria, the sheer volume of information that is produced can be difficult to manage, thereby hindering the ability of decision makers to choose priority paths of action (Ribas and da Silva 2015; Xu 2015). In light of this situation, this article provides a tool for prioritizing impacts in ESIAs to guide and support further assessment and final mitigating measures.

The logic of prioritization is habitually applied in environmental resources management and the assessment of alternatives or scenarios involving high levels of complexity and multidimensionality (i.e. the simultaneous consideration of technical, social, economic, and environmental criteria). Case studies sharing the common objective of reducing environmental and social impacts range from decision making in sediment management (in the field of environmental management itself) (Alvarez-Guerra et al. 2010) to others more oriented toward assessing the impacts of business activities to improve their sustainability (Thabrew et al. 2018). An approach close to the case that we present here is that of Riera Pérez and Rey (2013), who created differing scenarios of urban growth using multi-criterion analysis with an evaluative approach. These authors aimed to help decision-makers who are responsible for sustainable urban development. In the case study taken here as an example, the negative impacts of a previously implemented urban tourism project are prioritized, hence it is an ex-post study.

This approach is based on three of the cornerstones of ESIA: constructivism, participation, and environmental justice. First, as stated by Aledo and Domínguez-Gómez (2017), the technocratic and constructivist paradigms prevail in the ESIA field. In the technocratic paradigm, the reality is objective and its working mechanistic. Impacts can be measured from an external standpoint, applying the procedures and instruments of positivist science (Vanclay 2003, 2005). Accordingly, impact identification can be carried out by an external assessor. By contrast, the constructivist approach assumes that reality is socially constructed, and impacts are understood as experienced by the social actors involved (Jackson and Klobas 2008; Van Schooten, Vanclay, and Slootweg 2003). From this perspective, ESIA should include all of the different stakeholders in all stages— from assessment through participatory processes for identifying and understanding impacts—as well as in phases that entail putting forward alternatives.

Second, the participatory principle stresses the importance of involving affected communities in the assessment process (Becker et al. 2003; Buchan 2003; Burdge 2004; Roberts 2003; Vanclay et al. 2015). For this reason, our methodological approach is based exclusively on contributions from a platform of stakeholders, in both identifying and assessing impacts.

Finally, the process was guided by the principle of environmental justice, closely linked to that of participation. Under this principle, we acknowledge the unequal distribution of impacts among the affected groups and give this issue necessary attention and also stress prioritizing actions to minimize impacts on the most vulnerable social groups (Howitt 2011; Vanclay 2003b; Vanclay and Esteves 2011). Consistent with this principle, our project makes use of impact selection and prioritization criteria, which ensures the visibility of the most vulnerable actors, aiming to redress possible socio-environmental inequalities (Domínguez-Gómez 2016).

If, as stated by Vanclay (2002, 191), '"social impact" refers to the impacts actually experienced by humans (at individual and higher aggregation levels) in either a corporeal (physical) or cognitive (perceptual) sense,' the widening of the assessment community is an axiological requirement and especially important for those groups, which are at the same time the most affected and have the least leverage in the decision-making process (Gibbons et al. 1994; Raymond et al. 2010; Vanclay 2003a). This way of conceiving impacts is also grounded in constructivist ontology since it multiplies the realities felt and experienced by the affected parties (Burningham 1996). These axiological and ontological bases lead to an epistemological view of the object of study which departs from the approaches of normal science and conforms to the principles of 'post-normal' science (Funtowicz and Ravetz 1992) since it includes the different groups of stakeholders in impact identification and assessment. Thus the axiological, ontological, and epistemological groundings of our approach combine to give it a high level of paradigmatic consistency (Aledo and Domínguez-Gómez 2017).

Particularly, in the context where we utilize this methodology (the southwest of the Iberian Peninsula), it has been usual (and still is) for development projects to be carried out without proper assessment of environmental and social impacts. Once these projects are completed, the impacts that they cause often throw them into crisis, thereby also delegitimizing the decision-makers. The study presented here centers on negative impacts as a means of improving the socio-environmental sustainability of already implemented projects. Bearing in mind the social complexity of the context (myriad actors interacting from the standpoint of their own interests, each one with their particular view and interpretation of the project and its consequences), we opted for a mixed-methods participatory approach for feeding information into the analytical process (Johnson and Onwuegbuzie 2004). Data were contributed by the actors themselves in the application of qualitative research techniques (semi-structured interviews and focus groups). Multi-criteria decision analysis (MCDA) was used to seek a parsimonious quantitative solution in the final prioritization of impacts. Throughout the process, special attention was paid to adopting solutions which, dovetailed together, might build an advantageous methodological approach for other development projects, particularly in the case of urban tourism developments.

## 2. MCDA as a methodological framework

As a methodological framework, MCDA provides tools for dealing with complex decision-making situations involving multiple, and often conflicting objectives that stakeholder groups and/or decision makers may assess differently (Belton and Stewart 2002). The technique is a comprehensive procedure involving a rich interplay between human judgment, data analysis, and computational processes (Stewart 2005). Moreover, MCDA can be of enormous help in eliciting preferences and in enabling formulation of a model that can then be exploited to generate outcomes such as ranking of the options in play, as was necessary in the case presented here. The approach is grounded in operational research and mathematics and was originally developed to assist decision makers (Mendoza and Martins 2006).

However, recently MCDA has emerged as a widely used tool for supporting multi-stakeholder decision processes, as well as a practical method for dealing with the social dimensions of conflict since it can be combined with participatory approaches (Banville et al. 1998; Davies, Bryce, and Redpath 2013; Munda 2004; Portman, Shabtay-Yanai, and Zanzuri 2016; Proctor 2004; Stirling 2006).

The main purpose of MCDA is to evaluate the performance of alternatives according to criteria representing the key dimensions of the issue(s) to be decided on and that involve human judgment and preferences. There are five basic steps in MCDA: (1) identifying the alternatives; (2) establishing assessment criteria; (3) scoring the alternatives against each criterion; 4) weighing the criteria; and (5) aggregating all of this information (Belton and Stewart 2002). The first four steps can be combined with and/or integrated into participatory approaches, allowing stakeholders to express their preferences and thereby to contribute actively to the decision-making process. This makes the main characteristics of MCDA suitable for the objective of this study, namely to obtain an ordered classification for prioritizing negative impacts, completely based on information provided by the stakeholders and with the aim of identifying the effects that require urgent action or assisting the allocation of resources for mitigation. Thus, prioritization was grounded in the transversal knowledge that different social actors brought to the project, steering clear of any bias stemming from the particular interests or limited knowledge of any single social actor.

There are, in brief, several reasons for applying MCDA: (1) to support multi-stakeholder priority-setting decisions; (2) to generate a structured ranking or scoring of options (project impacts); and (3) to guarantee a participative and transparent decision-making process while simultaneously facilitating the learning process and the dialogue among stakeholders on the relative merits of different options (Fish et al. 2011; Rammel, Stagl, and Wilfing 2007).

Various forms of MCDA has been used for research on environmental assessment for a number of decades (Bojórquez-Tapia, Sánchez-Colon, and Florez 2005; Huang, Keisler, and Linkov 2011; Kiker et al. 2005). It has proven itself particularly useful in contexts where decision-making is complex due to the diversity of data sources to take into account or when the decision is particularly important or a potential source of conflict (Badera 2010; Levy 2005). The approach affords a parsimonious solution when considering not only purely environmental factors, but also political, cultural, social, and economic issues (Azarnivand and Chitsaz 2015;

Vilcekova and Burdova 2015; Wanderer and Herle 2015). Studies based primarily on MCDA for specific solutions are abundant (Aragonés-Bletran, García-Melón, and Montesinos-Valera 2017; Malloy et al. 2013; Mota, de Almeida, and Alencar 2009; Rossi, Cancelliere, and Giuliano 2005; von Doderer and Kleynhans 2014). Further, the use of MCDA as a complement to wider methodological approaches occupies a notable place in scientific production in the field of sustainable management and social and environmental life cycle assessment of different economic activities (De Luca et al. 2015; Cowell, Begg, and Clift 2006; Karjalainen et al. 2013).

Studies centered on social impacts are particularly interesting for current purposes. The work of Ana Maria Esteves (2008a, 2008b), and Esteves and Vanclay (2009) is a key reference in the use of MCDA as a way of integrating qualitative and quantitative approaches, as is that of Stolp et al (2002), which utilizes this approach in incorporating citizens' values into EIA. Also, Estévez, Walshe, and Burgman (2013) identify a total of 119 studies where social processes and impacts are analyzed using multi-criteria methods. The most frequent procedure in these studies is that stakeholders score impacts (previously defined by the research team) on ordinal scales. In our approach, it was the stakeholders who defined the project impacts and our team coded and categorized these impacts to assess and evaluate them. Qualitative techniques (interviews and a subsequent focus group) were used to gather information on impacts. Atlas.ti software was used for coding, categorizing, and producing the data matrix, which then formed the input for the MCDA. Xenarios and Tziritis (2007) combine (as in our case) grounded theory and content analysis as a theoretical framework for producing quantitative data based on qualitative information (Xenarios and Tziritis 2007).

In recent decades, several MCDA methods have been developed. Among them is PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations), which belongs to the family of outranking methods and their applications and has attracted increasing attention from scholars and practitioners due to its ability to rank finite sets of alternative actions based on conflicting criteria (Behzadian et al. 2010). This group of outranking methods was first introduced by Brans (1982) in the form of a partial ranking of alternatives (PROMETHEE I) and was then expanded by Brans and Vincke (1985) to a full ranking approach (PROMETHEE II). Several versions of the PROMETHEE methods were developed and adapted to complex decision-making situations (Brans and De Smet 2016) and specifically PROMETHEE GDSS

(Group Decision Support System) was implemented (Macharis, Brans, and Mareschal 1998) to solve a variety of multi-factor multi-person decision-making problems and to take into account inputs from a group of stakeholders and decision makers.

We selected PROMETHEE for this study for four reasons. First, it can deal with uncertain and fuzzy information. Second, it allows for the selection of criteria that are usually difficult to quantify (because qualitative judgments can be integrated into the model). Third, it provides an easy means of precisely evaluating stakeholders' priorities and managing degrees of compensation among criteria by assessing thresholds of indifference and strict preference. Finally, its structured process, sound mathematical foundation, and varied analytical and graphics tools enable the user to make a thorough analysis of the problem and create a systematic audit trail for assessment options (a feature that is particularly important in a participatory context that entails facilitated debate and consensus building).

The GDSS module allows for the easy and direct integration of different stakeholders into the analysis, thus supporting group-level decision-making. Indeed, PROMETHEE-GDSS is considered a highly transparent process that can be used with a limited amount of interference by the supporting team. It provides a clear view of each stakeholder preference and for the group as a whole, offering strong support for deliberation and negotiation within a common space (Macharis et al. 2015).

## 3. The case study

The case for this study is an urban tourism development project that has already been completed. The temporal relationship of this investigation is thus consequential because the decisions taken in the past are not subject to modification. The findings outlined here will be included in reports commissioned by the public administration responsible for urban and tourism development with the aim, first, of demonstrating a relatively simple method for identifying and prioritizing both the negative and positive impacts caused by future projects. Second, the literature bears witness to the fact that the actors who are the weakest, the least influential, and the most marginalized by the design and implementation of projects are those who tend to be the most affected by their negative outcomes. This initiative then trials the implementation of this method to alleviate the most serious impacts, in line with the principles of sustainability and socio-environmental justice on which it is grounded.

Located in southwestern Spain, in the municipality of Cartaya (Province of Huelva) and in the coastal town of El Rompido, the project is named 'El Rompido Golf' and it comprises a 36-hole, 50-hectare golf area made up of two 18-hole courses. The project borders a dense pine forest to the southwest (part of the Río Piedras y Flecha de El Rompido Natural Site, an officially protected preserve) and orange groves to the north. It is also linked to a hotel development comprising a four-star aparthotel with 305 apartments and 844 beds and a five-star hotel with 184 bedrooms and 12 suites (394 beds), both of which are connected to the golf courses.

The project also features a considerable amount of residential property. On its southeastern border, there is a housing development of 165 luxury dwellings on individual plots and arranged around an artificial lake adjacent to the golf facilities. Also, adjoining this development to the east is a further partially built estate (construction was halted in 2008 due to lack of sales, but resumed in 2016) comprising 200 projected dwellings with shared sports and leisure activities (tennis and paddle-tennis courts, football pitch, swimming pools). Both developments enjoy private security, controlled access, and fences around their entire perimeters. The project also includes a shopping mall and marina for leisure boats.

Cartaya, the municipality where the project is based, adopted a tourism-development strategy with a strong emphasis on golf-based projects in the early 1990s. Its geophysical environment is characterized by undulating terrain, the mouth of the River Piedras, and a wide expanse of pinewoods, scrub brush, and wetlands. The area is characterized by a Mediterranean climate with mild winters and hot summers and an average annual temperature of around 23 °C. In the last two decades, Cartaya has increased its sociopolitical and economic weight in the province of Huelva (part of the region of Andalusia) due to growth in agro-industry and associated activities. As of 2014, Cartaya had a population of 19,168 registered inhabitants, a 29.8% increase over the past 10 years mainly due to the increase in agriculture, which has attracted workers from the north and sub-Saharan Africa and Eastern Europe (IECA 2014). Until the mid 1990s, tourist facilities were virtually nonexistent. In El Rompido, a small fishing village on the coast, there was some residential sun-and-sand tourism, but this was seasonal, low-intensity, and basically local. During the second half of the decade, the town council boosted tourist initiatives by encouraging mixed- and golf-based projects.

As shown in Figures 1 and 2, the main golf-based projects in the area are generally low-density developments (as few as five homes per hectare on some

1. El Rompido (urban area)
2. Forestry reserve (pine woods)
3. Paraje natural protegido
4. Agricultural area
5. Cartaya (urban area)
6. Hotels and golf course

Scale: 0 ⊢———⊣ 1km
Source: Google Earth, November 2016.
Created by authors

**Figure 1.** General aerial images of the case study area.



1. El Rompido (historic town centre)
2. Residential development 1995-2000
3. Residential development 2000-2008
4. Future development
5. Hotel (post-2000)
6. Golf course
7. Agricultural area
8. Marina (post-2005)
9. Nature reserve

Scale:
0 ⊢——————⊣ 1km

Source: Google Earth, November 2016.
Created by authors

**Figure 2.** Specific aerial images of the case study area.

plots). This scale, together with the idyllic setting, the landscaping of built-up areas, and the presence of the golf courses and their associated facilities, has earned the projects special designations for 'high quality' and 'sustainability' in the town's General Urban Ordinance Plan (GUOP). These designations imply a certain kind of local 'branding' to reach more affluent clients that have been a common strategy of numerous coastal municipalities in southern Europe where the traditional residential tourism model was perceived as being exhausted (Domínguez-Gómez and Aledo 2005).

This article outlines only part of the methodology that was applied to this ESIA study funded by the Spanish national and Andalusian regional governments. From 1997 to 2007, Spain went through a property boom in which the star product was the golf course-based residential and hotel complex. Numerous towns and cities on the Spanish coast opted for this tourism model as a basis for development and it was implemented without any form of planning to address the environmental and socioeconomic risks. The real estate and financial crisis that erupted in 2008 called into serious question the efficacy of this approach. During the crisis, the negative impacts on the environment, the economic dependence created by exclusive reliance on the property market, the corrosive implications of urban corruption, and the deterioration of local cultures became evident (Aledo 2008; Aledo, Jacobsen,

and Selstad 2012; Domínguez-Gómez and Aledo 2005).

A decade later, with the worst years of the crisis apparently now in the past, a new cycle of property-based growth is getting underway in the same areas. In the current context, it thus seems essential to carry out assessments such as that presented in this article to strengthen development policies and land-use decisions and to include environmental and social risk analyses in their design. It is a timely moment to reorient development in the area toward environmentally and socially sustainable forms that are more able to ensure the well-being of local populations.

## 4. Methodology

The procedure adopted for impact prioritization was divided into four main phases: (1) creating the stakeholders' platform; (2) making a preliminary identification and assessment of impacts; (3) categorizing impacts; and (4) assessing and prioritizing negative impacts using MCDA. Figure 3 summarizes the general procedure that is explained in the following pages. Phases 2 and 4 are essentially participative. In Phase 2, impacts are defined by stakeholders (244 in total, later grouped in 103 categories). In phase 4, the stakeholders again assess those categories in a focus-group session.

### Phase 1: creating the stakeholders' platform

Creating the stakeholders' platform was the first step in ensuring the participatory nature of the process.

The research project adopted a broad definition and stakeholders were considered to be any individual, group, or organization that might be affected by, or have an interest in the project or that might hold information or experience relevant to its implementation and/or assessment. To build the stakeholders' platform, we identified the social groups fulfilling these conditions and sought two representatives per group to cooperate in our research. The drawing up of the list of stakeholders was based on literature and document reviews, the experience acquired by the study's coordinating team in previous research, and a number of consultations with social and academic experts in various areas. In selecting the group of academic experts, we raised the number of participants to five to be able to include colleagues from a range

**Table 1.** Members of the stakeholders' platform.

| Categories of stakeholders |
| --- |
| (1) Regional administration |
| (2) Town council |
| (3) Entrepreneurs' associations |
| (4) Large hotel entrepreneurs |
| (5) Small businesses, restaurants, bars (owners and staff) |
| (6) Tourism services and golf providers |
| (7) Builders and estate agents involved in project |
| (8) Agricultural entrepreneurs |
| (9) Staff from golf courses and large hotels |
| (10) Building and estate agent staff |
| (11) Golf tourists |
| (12) Non-golf tourists |
| (13) Residents' association (Spanish and foreign residents) |
| (14) Hunters, sportspeople, sailors, etc. |
| (15) Ecologists |
| (16) Golf sports federation |
| (17) Population – local community in general |
| (18) Seasonal population (summer) |
| (19) Academic experts in the fields of geography, economy and development strategy, sociology, company management and ecology |
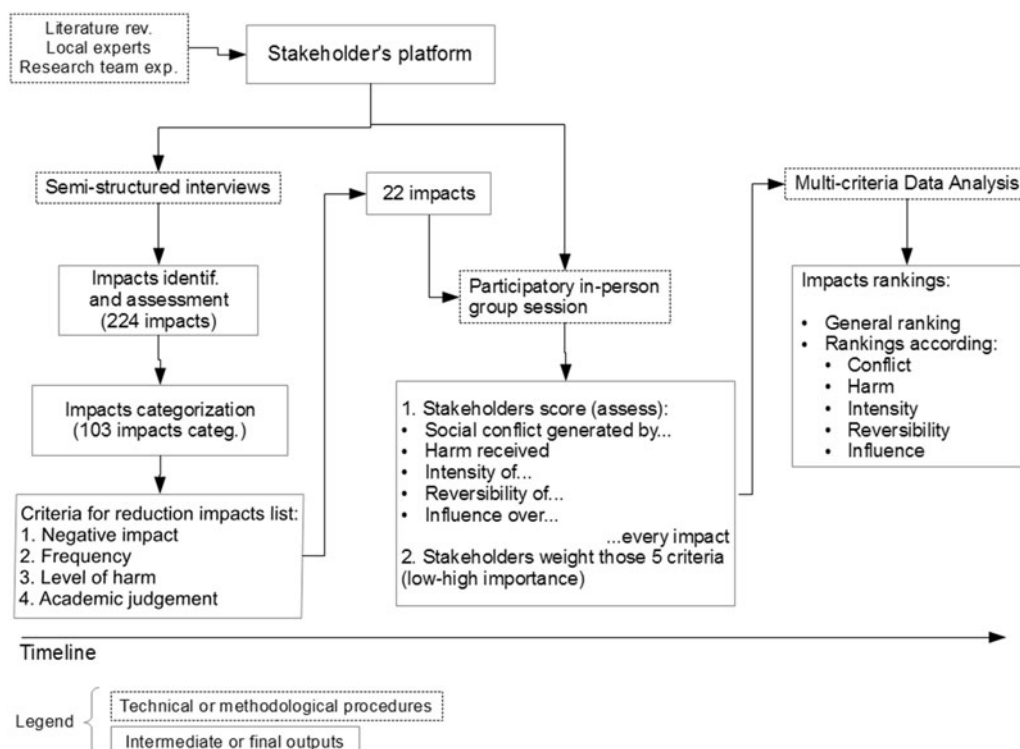


**Figure 3.** Process layout.

of different disciplines. In total, the platform comprised 41 participants. Table 1 below provides a comprehensive list of the stakeholders who took part.

## Phase 2: preliminary identification and assessment of impacts

To identify the impacts and make a preliminary assessment of them, we conducted semi-structured interviews with two representatives from each stakeholder group (five representatives in the case of the academic experts) who had identified the project's impacts according to their own experience, knowledge, and perceptions. Thus, as a first step, the interviewer asked an open-ended, generic question designed to trigger a brainstorm about impacts, the results of which were noted down by the interviewer. On completing this identification task, participants were then asked to evaluate:

- Positive/negative character of the impact on the project-affected area: the participant was asked to rate the positive potential (to benefit the project-affected area) or negative potential (to harm the project-affected area) of each of the impacts identified in the interview on a scale of 0 ('very negative') to 10 ('very positive').
- Level of harm/benefit for the stakeholder: the participant was asked to rate the degree to which each impact harmed or benefited the social group which s/he represented on a scale of 0 ('severely harmed') to 10 ('strongly benefited'). Participants that had been chosen for their academic specialization—and not for being affected by the project—were not asked to rate this item.

The objective of this phase of the project was to formulate an extensive set of possible impacts and to elicit feedback on the frequency of each of them as well as data on its direction (positive vs. negative) and level of harm. We explained the aim of this first step and the meaning of the scales to the representatives of each stakeholder group at the start of the interview.

## Phase 3: categorizing impacts

By the end of the interview with members of the stakeholders' platform, we had initially identified a total of 224 impacts. Given the extensive number of consequences, we then sorted them into categories to reach a final list that was free of redundancies. Below we refer to this stage as the *categorization phase* of the process because each of the impacts was assigned to a category grouping that included other elements with similar semantic content. In total, we identified 103 impact categories.

While this exhaustive breakdown of positive and negative impacts was instructive in helping to create a useful decision-making tool, it was clear that we could significantly increase its utility by including another stage in which impacts were ranked according to diverse criteria. In the light of the arguments presented above, and since the ultimate aim of prioritizing impacts is to identify those which should be addressed first, seemed logical, when ranking such impacts, to focus initial attention on the negative ones. Thus, using information from Phase 2 on the 'positive/negative character of impact on the project-affected area,' 36 of the 103 impact categories were classified as negative (i.e. the participant assigned a score between 0 and 4), and this selection of negative impacts was then further analyzed and ranked.

## Phase 4: assessing and prioritizing negative impacts with MCDA

Classifying and ordering the selection of negative impacts is a useful way to increase efficiency in decision-making. When determining actions to eliminate or mitigate negative impacts of a project, and particularly when the resources available for such measures are limited, decision-makers need to focus attention on the most urgent and/or detrimental impacts. It was for this reason that we designed an MCDA procedure with the objective of carrying out this prioritizing task. For this study, we combined the use of PROMETHEE II with PROMETHEE GDSS to integrate individual stakeholder evaluations and rankings into a group decision. This procedure was implemented using Visual PROMETHEE Version 1.3, developed by Mareschal (2012).

We first identified the alternatives that were to be evaluated. In this case study, using data collected in Phases 2 and 3, an initial total number of 36 categories of negative impacts were selected. However, the methodological literature advises that when scoring alternatives against criteria is done exclusively by stakeholders, it is useful to set a maximum number of items to be assessed. This helps to avoid confusion and fatigue among the participants and ensures that everyone is able to complete the task. However, the guidance does not reach definitive conclusions on what this number should be. The range of alternatives should be large enough to represent a realistic selection for the decision maker while not being so numerous as to make analysis unnecessarily complex (Proctor and Drechsler 2006). In technical terms, the procedure is similar to the application of an 'attitude scale' where the impacts are considered

**Table 2.** Selection of impacts by criterion.

| Negative Impacts | Frequency | Selection criterion |
| --- | --- | --- |
| Increased/ diminished consumption of water resources | 7 | Frequency |
| Alteration of ecosystem | 4 | |
| Seasonality | 4 | |
| Urban growth | 4 | |
| Water pollution | 3 | |
| Increased property speculation/prices | 3 | |
| Increased tourist demand | 3 | |
| Changes in types of tourist services | 3 | |
| Loss of green areas | 2 | |
| Dependency on external economic factors | 2 | |
| Changes in activities/Loss of traditional businesses | 2 | |
| Tourist ghetto | 2 | |
| Loss of cultural identity/features | 3 | |
| Changes in types of services | 2 | |
| Changes in the landscape | 1 | Severe harm |
| Lack of cooperation by complexes with local businesses | 1 | |
| Closed tourist packages | 1 | |
| Low increase in local population's wealth | 1 | |
| Alteration of soil quality | 1 | Experts |
| Lack of connection with local culture | 1 | |
| Creation of a tourist brand | 1 | |
| Lack of employment/investment returns | 1 | |

as stimuli in relation to which the participants have to position themselves. Also, in such scales, we start from the hypothesis that subjects respond according to their sociological and psychological characteristics.

While it is difficult to find solid arguments in the literature for establishing a maximum number of items in a list of independent elements, a widely used argument calls for including 'only the necessary ones.' A high number of items is generally acknowledged to be a means of improving reliability. However, if the list is too extensive, it is assumed to have a negative effect (although this has yet to be demonstrated), since the informant tires of the number of items (Alwin 1992; Alwin and Krosnick 1991; Böhme and Stöhr 2014; Cannell, Miller, and Oksenberg 1981; Gummer and Roßmann 2015). After reviewing this guidance, and in light of the circumstances and objectives of our study, we decided that an interval between 20 and 25 impacts was appropriate (from the technical point of view) and realistic (from the point of view of the circumstances and needs of ESIA and the participatory application of MCDA).

However, since our methodology aimed to achieve a high level of applicability to a range of projects and contexts, we tried to keep in mind that the number of impacts identified in the previous phase could vary according to the case study, and thus could well exceed the recommended maximum. If we add a large number of stakeholders usually involved in projects being pursued at any one time—resulting in the identification of a higher number of impacts—this necessity becomes, if anything, more pressing. To address this issue, we devised a number of criteria enabling us to scale back the number of principles on which information was obtained in Phase 2. This allowed us to reduce

the number of negative impacts if, after the categorization step (Phase 3), we still exceeded the recommended maximum. These principles were applied in the order set out below, until we reached the established limit (20–25 impacts; finally 22 impacts in total):

1. *Frequency*: As our first filter we took the frequency of each impact for each category of stakeholders; in other words, when the same impact was cited by two members of the same group of stakeholders, we counted it only once. On the basis of this principle (citation frequency), we included in the impact selection for the MCDA all negative impacts cited by a minimum of two different categories of stakeholders (i.e. all negative impacts with a minimum frequency of two). Applying this criterion yielded 14 negative impacts with frequencies varying from two to seven (as shown in Table 2).

2. *Severely damaging impacts*: The next filter was based on the level of harm suffered by the stakeholders. Impacts not yet included in the list, but rated from 0 to 2 for the 'level of harm/benefit received by the stakeholder' in Phase 2 were selected. Thus the principle of environmental justice was included in this filtering process, making visible the contributions of the most seriously harmed actors in the case study's social context. Based on this principle, four impacts were added to the reduced selection, arriving at a figure of 18 impacts.

3. *Negative score given by academic experts*: After applying the two previous filters we had not yet reached the maximum number of impacts to be evaluated. We therefore factored into the reduced selection those impacts which the academic experts had assigned highly negative

scores for the project-affected area (0–2). The reason for using this academic filter is the possibility that other participants may have overlooked some particularly important impacts due to the high level of academic or technical specialization needed to anticipate them. Application of this principle—which added four more impacts to the list—resulted in a final selection of 22 impacts, thus reaching the threshold established for the application of a participatory MCDA. Table 2 provides the final breakdown of the impacts to be prioritized using MCDA.

Second, we developed definitions and weights for the criteria. While in previous phases, each member of the stakeholders' platform had the opportunity to make contributions and preliminary assessments of their own impact selection, as we began this step they had not yet seen or assessed the impacts that had been identified by the other participants. It is important that the final classification of impacts be constructed by the whole group of participants and that everyone is fully aware of the entire set of impacts that were identified. In this way, participants are able to evaluate the impacts identified by the other members of the platform rather than only the ones that they had indicated themselves in their individual interviews. Accordingly, this phase was designed so that stakeholders could assess each item from the filtered selection of negative impacts derived during the previous phase and express their preferences by giving a weighting to each criterion used to classify impacts. This assessment yielded the final prioritization of impacts to be communicated to the project developers.

We asked the stakeholders to score the performance of each project impact according to the following criteria, on a scale of 0 to 10:

- Degree of social conflict created by the impact: the impact's potential to give rise to social movements against the project, with $0 =$ no active struggle/$10 =$ mass and/or violent anti-project movements.
- Degree of harm suffered by the respondent's stakeholder category: the degree to which each impact would negatively affect the respondent's social group in the present or future, with $0 =$ no negative effects/$10 =$ extremely negative effects.
- Degree of intensity of the impact: the strength of the impact in the project-affected area, with $0 =$ very low or zero intensity/$10 =$ very high or maximum intensity.
- Degree of reversibility of the impact: whether conditions prior to the impact could be recovered or not, with $0 =$ impossible to recover

original conditions/$10 =$ possible to completely recover original conditions.
- Degree of influence (of the participant's stakeholder group) over the impact: level of stakeholders' capacity to reduce or eliminate each impact, with $0 =$ my group has no influence on the impact/$10 =$ my group can eliminate the impact. The inclusion of this criterion aimed to incorporate, once again, the principle of environmental justice. With the incorporation of the power dimension, we sought to highlight negative impacts on which the stakeholders seemed to have less influence or power.

An expert panel selected the five criteria in accordance with the axiological, ontological, and epistemological principles of an ESIA based on the constructivist paradigm (Aledo and Domínguez-Gómez 2017). In essence, this procedure involves the commitment of special attention to the most vulnerable groups, the identification of impacts on the basis of how the stakeholders experience or perceive them, the broadening of the community of assessors through participatory techniques, and the deployment of the territorial development model as a process of conflict among opposing parties. Thus, impacts, on one hand, with high social conflict, harm, and intensity and, on the other hand, those with low stakeholder influence are prioritized.

When applying this methodological approach to other cases, the criterion 'degree of reversibility' would change according to the project status. When, as in this case, a project has already been carried out, its irreversible impacts cannot be addressed so impacts with high reversibility—those that may still be mitigated—should be prioritized. When the project has not yet been realized, the lower the reversibility of the impacts, the higher priority they should be assigned. In this case study, given that a large part of the project had already been implemented, we selected the former option.

The weighting of criteria was performed by the stakeholders. PROMETHEE is based on the assumption that the decision maker or stakeholder is able to weigh the criteria appropriately, at least when the number of criteria is not too large (Macharis et al. 2004). This method also allows for weighting techniques that are relatively easy to understand, an important point when working with stakeholders. The stakeholders were asked to assign a weight to each of the five criteria, representing both the criterion's importance and the stakeholder's preferences. A rating technique (direct ranking) was used (Bottomley, Doyle, and Green 2000) and each stakeholder gave a value from 1 to 5 (very low importance – high importance) to each criterion. Subsequently, the software (Visual PROMETHEE)

**Table 3.** Range of variation of the weights for each criterion.

| Criterion | Mean weight | Standard error | Maximum weight | Minimum weight | Standard deviation |
|---|---|---|---|---|---|
| Conflict | 0.22 | 0.015 | 0.13 | 0.33 | 0.06 |
| Harm | 0.19 | 0.012 | 0.10 | 0.26 | 0.05 |
| Intensity | 0.20 | 0.014 | 0.08 | 0.25 | 0.05 |
| Reversibility | 0.20 | 0.012 | 0.15 | 0.30 | 0.05 |
| Influence | 0.20 | 0.009 | 0.14 | 0.27 | 0.03 |

automatically normalized weights so that their sum was equal to one (100%).

The members of the stakeholders' platform were invited to a face-to-face meeting (focus group) where they were first informed fully on the selection of negative impacts that had been derived from the previous phases. Also, we explained how the impact selection had been made and defined and clarified each impact in detail. We then initiated a collective discussion of impacts. This group procedure had a two-fold aim. First, it permitted the sharing of knowledge among all members of the platform and between the research team and the stakeholders; thus the meeting enabled participants to see the contributions of the rest of the platform. Second, the process ensured that all participants were aware of and understood equally both the meaning and implications of the various impacts that they were assessing as well as the assessment criteria (this being one of the methodological requirements of MCDA) (Proctor and Drechsler 2006; Dodgson et al. 2009). Therefore, starting from the initial work of presentation and discussion, participants had the opportunity to think about the selected impacts, to put them into context, and to consider positions and interests other than their own. This task laid the basis for common ground in the subsequent rating activity.

Finally, we used the data collected during the focus group to generate an initial decision matrix for each stakeholder in the software Visual PROMETEE. For this purpose, a preference function, parameters, and thresholds for each criterion were also set in relation to the case study specificity. In this case, the 'social conflict,' 'harm,' 'intensity,' and 'reversibility' criteria were maximized, while the 'influence' criterion was minimized, according to decisions by the expert panel regarding the criteria values for impact prioritization. We utilized the simplest preference function type (type 1, usual preference function), which corresponds to optimization and has no threshold.

We subsequently ran PROMETHEE II to calculate the preference flows and rank all the impacts. Positive (Phi+), negative (Phi-), and net flow (Phi) were calculated by the software according to the equation established by Brans and Mareschal (Brans and Vincke 1985). Positive flow indicates the intensity with which an impact is chosen over others; it is a global measurement of the strengths of an impact, and the higher the Phi+, the higher the impact priority. Negative flow represents the intensity with which an impact is exceeded by others. It is a global measurement of the weaknesses of an impact and the lower the Phi-, the higher the impact priority. The balance between them is the net flow (Phi). The program thus encompasses and aggregates both the strengths and weaknesses of the impacts into a single score, which can be positive or negative. Phi is used to obtain an impact ranking based on the principle that the higher the net flow value, the higher the priority of the impacts (for more details, see Brans and Vincke 1985; Brans and De Smet 2016).

This process enabled us to obtain the individual rankings of the project impacts (one for each stakeholder participating in the session). The individual rankings were then combined using the PROMETHEE GDSS procedure. The net flows obtained for each stakeholder were used to build a matrix, which would calculate the final net flows of each project impact, resulting in the final group assessment (Brans and De Smet 2016; Macharis, Brans, and Mareschal 1998). We subsequently repeated the same procedure, but taking into account only one criterion per analysis (Unicriteria Analysis), first individually and then aggregating the results at the group level. The outcomes of both the global ranking process and the single-criterion analysis are outlined below.

# 5. Results

We designed individual decision matrices using the scores and weights collected during the face-to-face session. Table 3 shows the weights assigned to the five criteria by the stakeholders. There is little difference among the mean punctuations obtained for the selected criteria. All of them appear in a range of 0.19 (Harm)–0.22 (Conflict). The criteria of 'intensity,' 'reversibility,' and 'influence' all obtained a score of 0.20.

The next step was for us to aggregate the stakeholders' net flow vectors into a group decision matrix and to compute a global PROMETHEE using Visual PROMETHEE GDSS (Macharis, Brans, and Mareschal 1998). Table 4 shows the

**Table 4.** Global ranking of the 22 project impacts, obtained using Promethee GDSS.

| Project impacts | Promethee GDSS priority rank* | Phi | Lowest priority rank | Highest priority rank |
|---|---|---|---|---|
| Closed tourist packages | 1 | 0.2830 | 2 | 20 |
| Tourist ghetto | 2 | 0.2547 | 2 | 11 |
| Lack of golf complex cooperation with local businesses | 3 | 0.2423 | 1 | 16 |
| Seasonality | 4 | 0.2070 | 1 | 18 |
| Dependency on external economic factors | 5 | 0.1601 | 1 | 21 |
| Lack of connection with local culture | 6 | 0.1084 | 3 | 22 |
| Low increase in local population's wealth | 7 | 0.0665 | 1 | 18 |
| Increased property speculation/prices | 8 | 0.0196 | 1 | 21 |
| Lack of employment/investment returns | 9 | 0.0188 | 1 | 22 |
| Water pollution | 10 | 0.0021 | 1 | 21 |
| Loss of cultural identity/features | 11 | −0.0070 | 5 | 21 |
| Urban growth | 12 | −0.0129 | 3 | 22 |
| Changes in activities/loss of traditional businesses | 13 | −0.0495 | 3 | 21 |
| Changes in the landscape | 14 | −0.0773 | 2 | 21 |
| Loss of green areas | 15 | −0.0910 | 2 | 22 |
| Increased tourist demand | 16 | −0.0974 | 1 | 19 |
| Creation of a tourist brand | 17 | −0.1106 | 2 | 20 |
| Alteration of ecosystem | 18 | −0.1310 | 5 | 22 |
| Changes in types of services | 19 | −0.1645 | 8 | 22 |
| Changes in types of tourist services | 20 | −0.1800 | 7 | 22 |
| Increased consumption of water resources/ diminished water resources | 21 | −0.1932 | 4 | 21 |
| Alteration of soil quality | 22 | −0.2480 | 9 | 22 |

*Lower rank indicates higher priority.

overall ranking of the project impacts according to the framework used in this study. In our case, according to the scores given by the stakeholders, the project impacts to be prioritized were the existence of 'closed tourist packages,' the creation of a 'tourist ghetto,' and 'lack of golf-complex cooperation with local businesses,' with a net flow of 0.285, 0.255, and 0.242, respectively. In the lowest positions of the ranking, we found 'alteration of soil quality,' with a Phi of -0.248, and 'increased consumption of water resources/diminished water resources' with a Phi of -0.193. This is particularly interesting, given that this last impact was the most frequently selected in the preliminary impact identification and assessment phase, as shown in Table 2.

The participants considered different opinions and judgments when evaluating the project impacts, thereby yielding a dissimilar ranking. The range from highest to lowest priority was considerable for most project impacts. As displayed in Table 4, several impacts were rated both last (#22) and first (#1) by different stakeholders. The impacts with least difference between the highest and lowest priority rank were 'tourist ghetto' (9) followed by 'alteration of soil quality' (13).

Although the main outcome of the MCDA was the general ranking of impacts based on a combination of the five criteria, consideration of the independent rankings for each criterion can also be a useful decision-support tool. Attention to a specific criterion can be necessary at different times during the decision-making process and the scores obtained by each impact for the various criteria can afford

different insights from those offered by the general analysis.

Table 5 shows the project-impact ranking obtained when we computed the net flows for each criterion separately. The five rankings were different. According to the net flow calculated using the 'social conflict' criterion, the most conflict-creating impact was 'lack of golf-complex cooperation with local businesses,' while 'creation of a tourist brand' had the lowest potential for conflict. Regarding the 'degree of harm' criterion, 'seasonality' was the most damaging impact and 'increased consumption of water' the least. As shown in Table 2, 'increased consumption of water' was the most frequent impact during the identification phase of the study. This result may be interpreted as a sign of priority or importance for the stakeholders, but when qualifying impacts according to the five selection criteria the same impact did not reach such a high level of priority (as shown in Table 4 and in the uni-criterion rankings in Table 5).

For the 'degree of intensity' criterion, 'closed tourist packages' was the strongest impact and 'alteration of soil quality' the weakest, according to the view of the participants. The scores for 'degree of reversibility' resulted in a tie between 'loss of cultural identity/features' and 'lack of connection with local culture' as the most irreversible impacts and 'increased property speculation/prices' as the most reversible. Finally, with regard to the 'degree of influence criterion,' 'alteration of soil quality' was identified as the impact over which the stakeholders had the least influence while 'seasonality' was seen as the most easily influenced.

**Table 5.** Uni-criterion ranking of the 22 project impacts.

| Criteria | Conflict | Harm | Intensity | Reversibility | Influence |
|---|---|---|---|---|---|
| Project impacts | Priority rank | Priority rank | Priority rank | Priority rank | Priority rank |
| Increased consumption of water resources/diminished water resources | 21 | **22** | 20 | 14 | 7 |
| Alteration of ecosystem | 10 | 14 | 21 | 15 | 19 |
| Water pollution | 8 | 9 | 15 | 16 | 3 |
| Loss of green areas | 16 | 12 | 18 | 11 | 12 |
| Alteration of soil quality | 19 | 21 | **22** | 20 | **1** |
| Changes in the landscape | 14 | 10 | 6 | 19 | 17 |
| Seasonality | 4 | **1** | 3 | 10 | **22** |
| Dependency on external economic factors | 7 | 2 | 10 | 7 | 15 |
| Changes in activities/loss of traditional businesses | 15 | 16 | 17 | 6 | 14 |
| Low increase in local population's wealth | 5 | 8 | 12 | 9 | 18 |
| Lack of cooperation by complexes with local businesses | **1** | 4 | 4 | 3 | 20 |
| Lack of employment/investment returns | 9 | 5 | 7 | 13 | 10 |
| Increased property speculation/prices | 12 | 17 | 8 | **22** | 2 |
| Urban growth | 11 | 18 | 2 | 21 | 9 |
| Increased tourist demand | 17 | 13 | 11 | 18 | 8 |
| Changes in types of tourist services | 20 | 19 | 16 | 17 | 6 |
| Tourist ghetto | 3 | 7 | 13 | 4 | 5 |
| Changes in types of services | 18 | 15 | 14 | 12 | 16 |
| Creation of a tourist brand | **22** | 20 | 9 | 5 | 13 |
| Closed tourist packages | 2 | 3 | **1** | 8 | 4 |
| Loss of cultural identity/features | 13 | 10 | 19 | **1** | 11 |
| Lack of connection with local culture | 6 | 6 | 5 | 2 | 21 |

*In "**bold**" the most important (rank 1) and least important (rank 22) impact for each criterion.

## 6. Conclusion

This study aligns itself with those ESIA studies which, on the basis of participatory and qualitative research techniques, distill a large amount of complex information utilizing multi-criteria analytical models, thus facilitating decision-making for the design and implementation of projects and subsequent mitigation of impacts. The methodology presented in this article shows strong potential as a support tool for decision-making in environmental and social impact assessments. It combines in the same solution a range of theoretical and methodological frameworks, which form part of the daily work of both ESIA practitioners and academics. On one hand, the theoretical-epistemological basis of the constructivist paradigm is respected, using qualitative research techniques with each and all of the stakeholders involved or interested in the development project. The totality of their views and criteria are included, not only in the initial data collection but also in the successive phases of data elaboration. In addition, the methodology effectively integrates some of the more traditional EIA criteria, such as intensity or reversibility, with more socially oriented criteria, such as social conflict, harm, and influence, while attempting to balance power relations within decision-making processes at the same time as giving prominence to the most vulnerable social groups. We can affirm that the results condense the information gathered throughout the process in such a way that decision-makers are reliably and validly informed on a sound basis of socio-environmental inclusivity.

In addition, from a technical-methodological point of view, qualitative data is combined with a typical quantitative elaboration using mathematical tools. This mixed-methods focus tends to be the base argument, or even the methodological ideal, in all environmental analysis literature, which seeks explanations and solutions for complexity through the adoption of multi- and transdisciplinary approaches (Johnson and Onwuegbuzie 2004; Sale, Lohfeld, and Brazil 2002). Although we have illustrated this methodology with an example of a project that has already been carried out, the availability of a prioritized list of impacts can also be of great assistance to decision makers when designing mitigation actions, making modifications to a planned project, and implementing measures for resource allocation or conflict prevention.

In this study, we also demonstrate that these prioritization methods in socio-environmental impact assessment can be useful for dealing with social, cultural, and political issues (in addition to those mainly cited in environmental management itself). From the practical point of view, social impact analysis (SIA) identifies lengthy chains of impacts of varying kinds. Prioritization using MCDA can encompass these different assessment criteria to construct the different levels of impact magnitude. In other words, they are useful methods for all the fields of knowledge relating to these different criteria. Specifically, the inclusion of social vulnerability as a criterion in impact prioritization responds to the principles of environmental management with an ethical-political emphasis. As can be observed in our case study, the social construction of impacts (that is, how stakeholders understand and experience them) is key for defining the degree to which stakeholders will be affected and the extent to which they will suffer. The analytical system prioritizes the consideration of those impacts, which have the

greatest effect on vulnerable actors and can, therefore, be used as a tool for improving social balance in the affected territory.

Whatever the specific case, the method we have used here involves certain limitations, which should be taken into account in future applications. First, while the final sample of participants can be seen as exhaustive and ensured the participation of all the social groups that we identified, its final size made internal stratification of groups by age, gender, or life-course status impossible. Such differentiation, however, may be interesting in more complex social contexts requiring larger samples. In any case, it should be kept in mind that the qualitative nature of data gathering in this study did not seek statistical but social representativeness; we aimed to ensure the inclusion of the interests and perceptions of all the relevant social groups. Second, the need to hold a face-to-face group session may cause scheduling problems for the participation of all actors, although in our case, none were absent. Finally, due to the need to establish criteria for prioritization, we decided to select only negative impacts. The exclusion of positive impacts inevitably resulted in a limited final assessment, making it impossible to discuss trade-offs. Including positive impacts in the study would have required us to design specific criteria for them, but an MCDA could have also been applied in this case.

This account of the work carried out so far reflects similar problems encountered in the field by other social researchers in ESIA. We mainly sought to contribute to expanding the possibilities for social research studies in the design and operation of development projects with potential for environmental and social impacts. Efforts to integrate both social and environmental impact assessments usually lead to the formulation and implementation of bespoke methodologies. This tends to be seen as a handicap to the procedural efficiency required by developers or, more generally, decision-makers, the typical clients of these studies.

The different phases of an ESIA should, therefore, develop in the direction of methodological efficiency, seeking maximum parsimony and standardization, as far as possible, of research methods and techniques, in order to integrate them into pre-project and ex-post studies, and particularly in the case of EISs. Initiatives such as the one presented here encounter a range of problems relating to differences in scientific cultures (engineering vs. social sciences) and management approaches (executive efficiency vs. caution and/or appropriate forecasting and comprehensive risk management).

In addition, this mode of activity faces a scientific-academic challenge in terms of the extrapolation of knowledge and technology. The chief problem is how to make data-gathering and analysis processes more efficient and their outcomes more functional. Some analysts have developed specific principles to this end (Reed et al. 2014). In the area of translational knowledge, the line of work arguing for the need and usefulness of sharing languages and methodological approaches among different areas of knowledge is increasingly productive. 'Knowledge for development' (Langthaler, Witjes, and Slezak 2012) and 'knowledge interaction' (Davies, Nutley, and Walter 2008) are concepts founded on the need for communication between science and society to restore meaning and real productivity to science as a social institution. These are issues and challenges that merit the further effort. Clearly, the advantages of this methodological approach are many, particularly regarding the enhanced understanding of the social dimension of the environment on the part of the applied natural sciences and engineering.

## Disclosure statement

No potential conflict of interest was reported by the authors

## Funding

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