



An extended peer communities' knowledge sharing approach for environmental governance



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ABSTRACT

This paper is devoted to propose an approach to implement the idea of extended peer knowledge to environmental governance by means of engaging the «extended peer communities». Socially robust knowledge relies on transparency and citizen participation. These two underlying elements take the form of both assessment and post-assessment decision support systems. Initially, during the assessment process citizens and stakeholders are engaged in the framing, proposal of alternatives, and evaluation criteria. Then the analysts assessed the alternatives proposed by means of DSS. Then, in a second stage, the analysts inspired in the idea of transparency, gave back the assessment result to the «extended peer community» who were able to give their opinion regarding the results and suggest potential parametric changes that were used for sensitivity analyses. The authors explore the proposed extended peer communities' knowledge sharing for environmental governance assessment using a case study applied to a sustainable mobility planning process carried out in Tenerife (Canary Islands). The results gathered highlight that this approach is of use for guaranteeing the robustness of complex environmental decisions under high levels of uncertainty.

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1. Introduction

Environmental governance might be characterised as processes where, typically, facts are uncertain, values in dispute, stakes are high and decisions urgent (Funtowicz and Ravetz, 1991). These values in dispute are, furthermore, aggravated by the uncertainties related to the environmental systems (Corral-Quintana, 2004; Funtowicz and Ravetz, 1993; Funtowicz and De Marchi, 2000; Giampietro et al., 2006). All these elements complicate the traditional scientific work, where a mixture of (partial) knowledge, assumptions, and ignorance are involved. In these cases, science should look for solutions to these boundaries by means of public participation (Ravetz, 2004).

There are key dimensions of uncertainty in the knowledge base of complex environmental problems that need to be addressed, such as technical (inexactness), methodological (unreliability), epistemological (ignorance), and societal (social robustness) (Van Der Sluijs et al., 2005). In those situations where different interests prevail, dealing with technical uncertainties (like the ones related to data availability, the input data, and the model applied itself) is

not enough. In these cases, the legitimacy of planning processes are rather affected by epistemological and social uncertainties, that complicate the own process and make decision-making difficult. Therefore, assessments should be expanded to more inclusive approaches where the decision processes become more relevant than the scientific practice itself (Munda, 2005). For instance, decisions need to be taken as to who decides on the criteria to be used in a multi-criteria assessment project, or even what criteria should be used to assess a range of alternative options. In complex environmental problems, many issues are raised as to who decides the selection and weight of criteria or in the case of motorisation or mobility rates, whether they should increase or decrease. Certainty, these are all decisions that are beyond scientists and, therefore, should be collectively decided through a new social contract between the scientific community and the society (Gibbons, 1999).

In the last decades, several authors suggested that scientists should have a new contract with society when developing their scientific affairs (Funtowicz and Ravetz, 1993; Gibbons, 1999; Nowotny et al., 2006), since the increasing complexities of modern societies involve uncertainties that cannot be controlled using mainstreaming approaches, meaning those mathematical tools aimed at dealing with inexactness and unreliability, such as error bars and confidence intervals respectively (Funtowicz and Ravetz,

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1990). Higher levels of uncertainty, are produced when facts are uncertain, values in dispute, stakes are high, and decisions urgent; involving an accumulation of scientific boundaries that cannot be coped with mathematical precision (Funtowicz and Ravetz, 1991). One proposal to deal with this level of uncertainties has been the use of «extended peer communities» (Funtowicz and Ravetz, 1993). It refers to the extension of environmental governance to new participants in the policy dialogues, involving “the participation of people other than the technically qualified researchers; indeed, all the stakeholders in an issue form an ‘extended peer community’ for an effective problem-solving strategy for global environmental risks” (Funtowicz and Ravetz, 1993, p. 744). The «extended peer community» is a necessary condition to develop «socially robust knowledge». However, there are different levels of involvement, as suggested by several authors (i.e. Arnstein, 1969; Guimarães-Pereira and Corral-Quintana, 2002) evolving from non-participation to citizenship empowerment engagements. Moreover, such involvement might take place at different decision-making stages, from informing or supporting decision-making assessment to finally evaluating the results of those assessments. The objective of this article is to discuss the advantages of integrating inclusionary processes in different phases of environmental assessment processes based on citizen participation and transparency aimed at developing more robust governance processes. In this sense, it is argued that such engagement is crucial not only during governance issue assessment phases but also once these processes are concluded. Thus, inclusionary exercises should be set up to evaluate the robustness of the obtained results as well as the assessment process itself. Consequently, a methodological framework, in which society is involved during both, assessment and post-assessment processes is proposed and applied in a case study regarding the implementation of a participatory decision support process on sustainable mobility issues.

2. Methods

The proposed approach for an extended peer community creation of knowledge (Fig. 1) consists of a two-phase processes: a first one aimed at carrying out a participatory assessment followed by a social evaluation of the robustness of the decision-making procedure outcomes. It is based on the concepts of participation and transparency: (a) participation is produced in both the assessment and post-assessment processes since stakeholders and interested citizens are engaged in the environmental governance process from the very beginning of the process until the end of it; (b) meanwhile, even though transparency is also produced in both processes, it becomes more relevant in the post-assessment stage of issues, where a social validation of assessment results is considered necessary. This post-assessment process has also been called «social sensitivity analysis» (Corral-Quintana, 2004). See also Corral and Hernández (forthcoming).

Both the assessment and the post-assessment processes are developed by means of the integration of formal and informal techniques, such as Decision Support Systems (DSS) and participatory techniques. Both stages will be explained in the next sections.

2.1. Assessment process

According to Guimarães-Pereira and Corral-Quintana (2002), DSS have been evolving since the early 1970 from technocratic approaches, based on experts’ knowledge, to more recent inclusive assessment frameworks, based on the community involvement in policy and decision processes. This last approach pursues the involvement of stakeholders in the decision process, as well as in

Table 1
Context framing research methods and findings.

Press review:	Legal documents:
- Framing the problem	- Framing the problem
- Identify stakeholders	- Identify stakeholders
- Identify policy options	- Recognise decisions already taken
- Identify evaluation criteria	
- Identify stakeholders’ positions	
In-depth interviews with experts:	In-depth interviews with stakeholders:
- Framing the problem	- Framing the problem
- Identify stakeholders	- Identify new stakeholders
- Identify policy options	- Identify policy options
- Identify assessment criteria	- Identify assessment criteria
- Fill the gaps	- Identify stakeholders’ positions
- Analyse policy option viability	
Focus groups:	
- Discuss the results	
- New proposals and comments	

Source: Corral-Quintana, 2004; De Marchi et al., 2000; Gamboa and Munda, 2007; Hernández-González and Corral-Quintana, 2016; Paneque-Salgado et al. 2009.

the policy proposal debate by means of progressive disclosure of information adapted to the different profiles.

The participatory evaluation procedure here proposed consists of an integrated assessment based on two steps (see Fig. 2). The first aimed at framing the problem and identifying alternatives, as well as identifying potential assessment criteria that are used in a multi-criteria analysis (MCA) at a later stage. The second step deals with validating, improving and refining the alternatives and criteria proposed in the first step. In both steps, experts and stakeholders’ opinions and knowledge are used to frame the governance issue and to define assessment alternatives and criteria. These alternatives are then evaluated using MCA.

The aim of the first stage is to detect the stakeholders involved, as well as their concerns and position. A historical review of the past 20 years of press articles and legislation, together with two rounds of interviews were carried out. The revision of legislation and local and regional press articles allows a first approximation to the social and political context in which the issue at hand is embedded and which actors have been related to the issue in the past and currently, providing a map of the relevant stakeholders and their positions.

This kind of press analysis follows previous work by Corral-Quintana (2004) and Gamboa and Munda (2007). Corral Quintana stated that this exercise is worthwhile in order to have an extensive and more balanced vision of the problem in hand: extensive because the same issue is presented by different stakeholders and therefore reflects diverse perspectives. It may also be more balanced because different press journals narrate the issue in different ways depending on both their ideology and their scale (local, regional or national).

Together, two rounds of interviews is initially carried out to experts from either the university or research centres (i.e. general overview, key characteristics, impacts and effects, and policy alternatives were collected). They are also encouraged to provide a list of involved stakeholders in the issue. A second round of interviews is directed at those actors identified during the first set of interviews. Similarly, they are asked about their concerns on the issue as well as about any other actor involved in the process. So it is assured that all relevant stakeholders and their positions are clearly elicited. These social techniques help the analysts to identify relevant information as presented in Table 1.

The second stage of the evolution process consists of the application of a multi-criteria tool. In this case the Novel Approach to Imprecise Assessment and Decision Environments (NAIADE) developed by Munda (1995) was used. NAIADE was selected because of its ability to approximate the way human mind expresses and synthesises preferences when faced with multiple contradictory

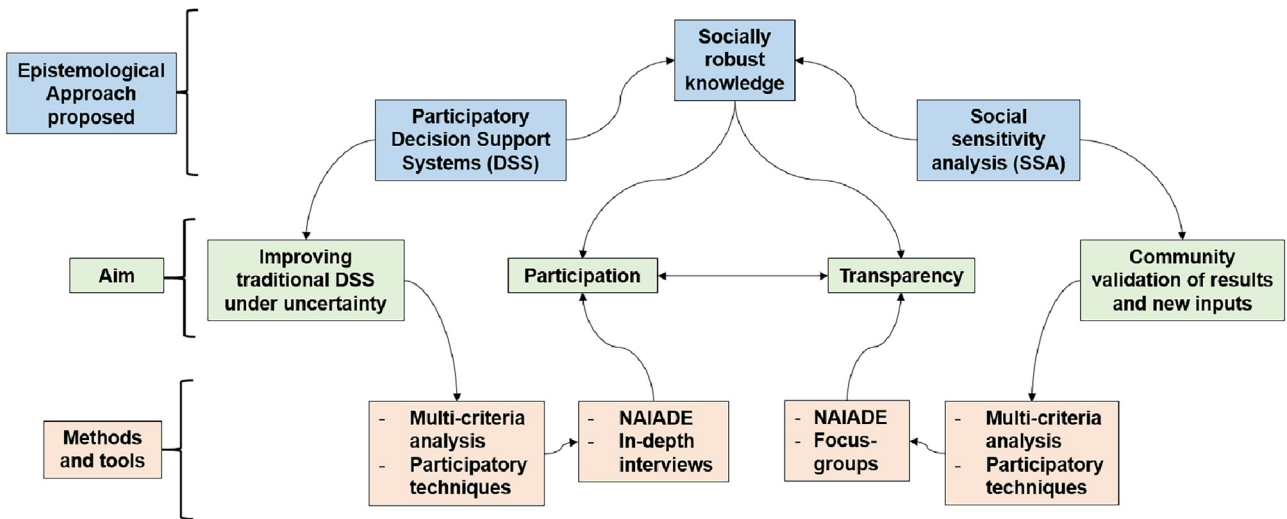


Fig. 1. Scheme of the proposed social robust knowledge approach.

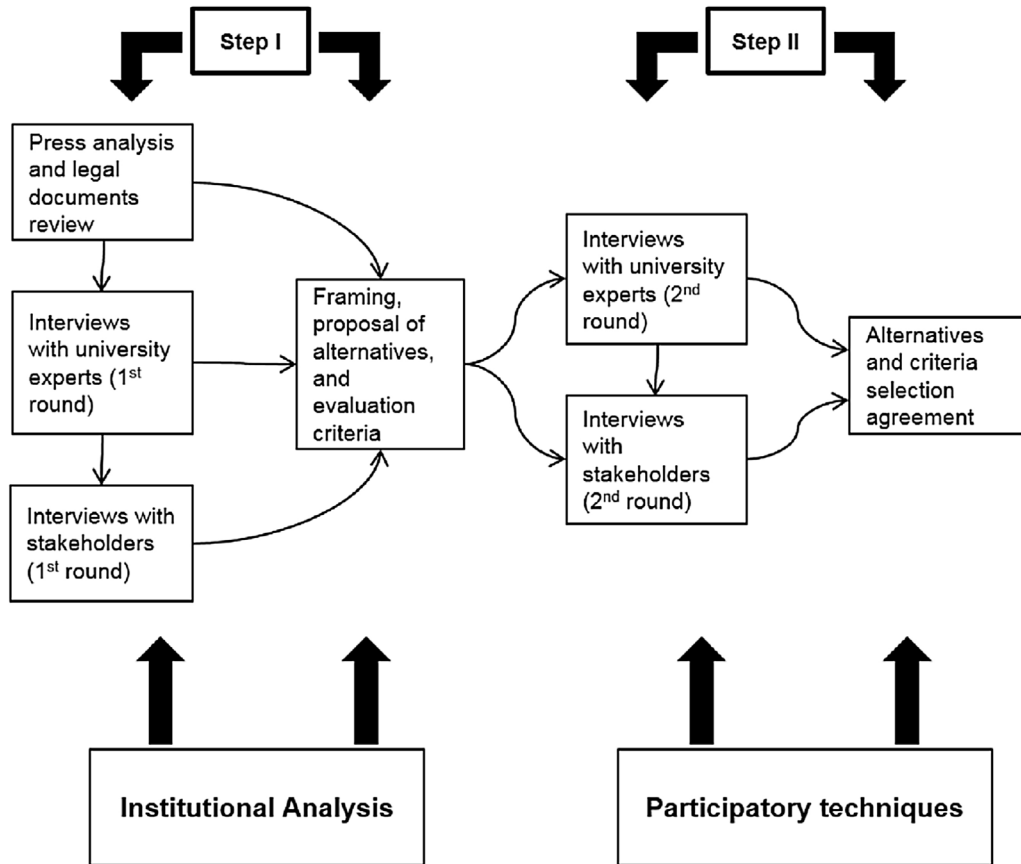


Fig. 2. Scheme of the evaluation process.

Source: adapted from Hernández-González and Corral-Quintana (2016).

decision perspectives (Munda, 2004; Corral-Quintana et al., 2016). NIAIIDE belongs to the wider family of outranking methods and details are discussed in Munda (1995, 2004). This method can incorporate fuzzy numbers in its calculations to deal with inexact information.

During the last 20 years NIAIIDE has been applied from different perspectives in different studies related to environmental issues. Thus, in several cases, such as the analysis carried out by Brand et al. (2002) and Espelta et al. (2003) NIAIIDE has been implemented

from a more technocratic perspective, being the researchers those in charge of defining alternatives and criteria, and developing and assessing the impact matrix. While, in some cases such as Corral-Quintana (2004), and Paneque-Salgado et al. (2009) NIAIIDE was also applied within participatory frameworks in which stakeholders were involved in the assessment process, either validating results in the first article or involving the actors in the definition of criteria and alternatives and the development of the assessment as Paneque-Salgado et al. (2009) proposed.

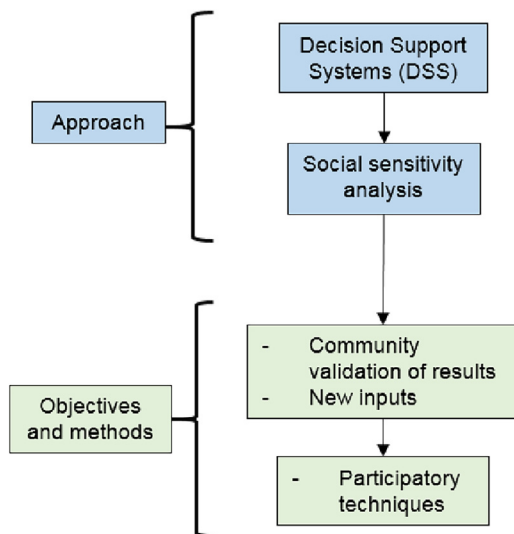


Fig. 3. Scheme of the proposed post-evaluation process.

De Marchi et al. (2000) explored the possibilities of NAIADE to deal with natural resource management, specifically to water related issues, due to its potential to use qualitative information as well as to develop conflict analyses between stakeholders (De Marchi et al., 2000; Corral et al., 2015). Several authors have also applied this method to handle natural resources management issues, highlighting NAIADE's capacity to cope with uncertain data and to provide a framework for communication among stakeholders (Paneque-Salgado et al., 2009; Guimarães-Pereira et al., 2005; Kallis et al., 2007; Videira et al., 2007). Corral-Quintana (2004) have pointed out that NAIADE is a flexible and robust tool to explore air pollution issues, since the information and the results can be presented in a transparent way to be fully understood by those stakeholders involved. The ability of using uncertain information, as well as dealing with the complexity of the options that decision-makers may be interested in, have also been mentioned when dealing with energy and environmental performance of different transport technologies (Brand et al., 2002) and forest reforestation (Espelta et al., 2003).

Based on the knowledge provided by both the reviewed scientific literature and the experts' opinions, an impact matrix was built (see Table 4). The horizontal axis shows the alternatives, while on the vertical axis the evaluation criteria are presented. Meanwhile, each cell reflects how the alternative is influenced qualitatively by the selected criterion. The NAIADE assessment of alternatives is carried out by means of pairwise comparison with respect to each evaluation criterion generating a ranking of alternatives (JRC, 1996).

This participatory-integrated-assessment-based evaluation process might bring potential benefits of including the extended peer community in the environmental governance (Giering, 2011): (a) ownership of policies, (b) better decisions in terms of sustainability and the inclusion of community values, (c) public agencies credibility, and (d) faster planning implementation. This is what Susskind and Elliott (1983) described more than thirty years ago as «coproduction».

2.2. Post-assessment process

The post-assessment process is aimed at knowing the robustness of the previous assessment process. In order to do so, an approach based on the combination of technical and social methodologies is proposed (see Fig. 3). Sensitivity analysis (SA) is widely used to quantify how input variables define the output of a model

by means of either global or local techniques (Turányi, 1990). However, the existence of high levels of uncertainties requires the use of social techniques in order to compensate the lack of scientific knowledge.

As mentioned in Section 1, these higher levels of uncertainty have associated a series of scientific boundaries and social complexities that can only be managed by the engagement of citizens and stakeholders in the decision process. Therefore, the second part of the assessment process requires the so-called Social Sensitivity Analysis (SSA) proposed by Corral-Quintana (2004) and further developed in Corral and Hernández (forthcoming), which is based on stakeholders' control of results. The idea of SSA is, then, bringing back the assessment results to the stakeholders to deal with complex issues in which stakeholders defend different/strong positions – on occasions irreconcilable ones. Such, SSA should not be seen as a mere process of informing or consulting citizens, two of the lowest rungs on Arnstein's ladder of citizen participation (Arnstein, 1969). It is also as a means to climb further up the ladder to levels of citizen power or at least to assess the degree of social acceptance of the analysis carried out and in some cases to use the initial assessment as an excuse to drive a reflexive dialogue among the stakeholders about the *problematique* at hand.

SSA reduces the technocratic characteristic of the assessment processes in decision-making, since SSA not only allows the stakeholders to follow-up the decision process from the very beginning (framing of the issue at hand, proposal of alternatives and criteria assessment, and quality control of the information used), but also give the stakeholders the opportunity to provide inputs and feedbacks at the end of the decision process. This approach, when applied, produces closeness between analysts, decision-makers, and stakeholders, as well as provides transparency to the decision process. Thus, the assessment might become more reliable to the eyes of the community.

Thus, Guimarães-Pereira et al. (2005) suggest that the scientific tools applied should be understood as conceptual tools that allow the development of debate, dialogue, and deliberations between stakeholders. By means of these debates and dialogues, new knowledge is produced and can be used within the own decision process. Jones (2011) focused on these processes eliciting identifying potential solutions to the issues at hand, through the implementation of stimulus materials and focus groups. Morgan (1996, p. 130) defines focus groups “as a research technique that collects data through group interaction on a topic determined by the researcher”. It has also been defined as a social event (Bloor et al., 2001) or a form of group interviewing (Gibbs, 1997) that pursues the collection of qualitative information intended to answer research questions (Morgan and Krueger, 1993). Focus groups help the researchers to detect attitudes, feelings, beliefs, experiences, and reactions that would not be collected by other social research method (Gibbs, 1997; Kitzinger, 1994).

Focus groups have then been considered useful tools to learn more about the degree of consensus of a certain topic, as well as the opinion of the stakeholders involved, and their reasons to answer certain research questions (Morgan and Krueger, 1993). Focus groups are also useful to collect information on tensions between opposing parties (Kitzinger, 1994; Morgan and Krueger, 1993). However, when those parties are too polarised, the focus group might not work adequately (Hernández-González, 2014). Similarly, focus groups might be appropriated to shed light on uncertainties and ambiguities related to the issue at hand (Bloor et al., 2001), being an effective and economical way to collect relevant information in a short period of time (Gibbs, 1997).

For all these reasons, focus groups have become attractive techniques for citizen participation, since they are flexible tools that can be used at any step of a decision-making process (Bloor et al., 2001). Moreover, they have also been considered flexible tools since

groups can be sorted, for example, by age or profiles (Guimarães-Pereira and Funtowicz, 2013). Just to mention some examples, focus groups has been applied to improve governance of water resources (Guimarães-Pereira et al., 2005; Paneque-Salgado et al., 2009), to assess windfarm location (Gamboa and Munda, 2007), and sustainable mobility policies (Hernández-González and Corral-Quintana 2016). However, it has to be noted that focus groups are not representative of what the community think about a certain issue (Gamboa and Munda, 2007); it is rather a social research method (Bloor et al., 2001; Morgan and Krueger, 1993).

3. Case study

The island of Tenerife due to its characteristics of isolation, high external dependency and a tourism-based economy consumes natural resources at a high rate. Ayuso-Álvarez et al. (2009) consider that these consumption levels could reach the equivalent of seven times the Island's surface area. According to the Regional Government, the Island's road transport system is a clear example of unsustainable development (Gobierno de Canarias, 2003) that has led to different environmental, social and economic impacts, such as congestion, road accidents, air pollution and noise among others (Hernández-González, 2014). Furthermore, this land-transport model has encouraged the local authorities to further expand the transport system (Ramos-Pérez, 2005) such that the land-based transport public administration expenses are currently surpassing the revenues produced by the own transport system (Hernández-González, 2016).

This continuous infrastructure expansion has led to a range of easily noticeable transport impacts in Tenerife. Thus, its capital city has been estimated to produce €11 million annually of congestion costs (Muñoz de Escalona, 2004), meanwhile the metropolitan area is believed to produce €109 million of congestion costs annually (Hernández-González, 2014). In terms of road accidents, at least 8600 accidents have been registered in 2012, the last year available (ISTAC, 2016). Air pollution is also an issue in the Island. Air monitoring stations registered excesses of either European Union's legal limits or World Health Organization's recommendations for PM₁₀, PM_{2.5}, and SO₂ in 2015 (EA, 2016). Lastly, around 36 000 people are exposed to unhealthy road traffic noise (SIMAC, 2010).

These land-transport impacts usually assume different types of scientific and social uncertainties that requires deep attention. These will be briefly discussed in the next section.

3.1. Uncertainties

Three different types of uncertainties related to policy-making might be characterised: technical (referring to inexactness), methodological (referring to unreliability), and epistemological (referring to the border with ignorance). This last kind of uncertainty is the one that cannot be dealt with by standard mathematical or computational techniques; instead it faces irremediable uncertainty and insoluble questions (Funtowicz and Ravetz, 1990).

Hernández-González (2014) has identified these three sorts of uncertainties in sustainable transport issues. Thus, inexactness appears for example when calculating congestion costs. As a consequence of imprecise speed-flow functions, different value of time for transport users, and other imprecise traffic data, congestion costs might be sensitive to input variables. Unreliability turns up when the application of different methodologies can lead to different results. For example Hernández-González (2014) discussed how the same policy option can be ranked differently depending on the methodology applied. Lastly, epistemological uncertainties can, however, be detected either for accidents (how to consider patient pain and relatives grief as non-quantifiable negative trans-

port impacts), or air pollution (especially related to dose-response functions that cannot fully reflect all the complexities of real world situations, such as mixed air pollutants).

These uncertainties make difficult to tackle certain problems and decisions. In this context, Funtowicz and Ravetz (1993) highlight that when science is applied to policy issues, it cannot provide certainty for policy recommendations; and the conflicting values in any decision process cannot be ignored. As a result, the complexity of these systems require the use of new tools of analysis, in which the decision-making process is, as far as possible, democratic, involving other decision-aid tools (Guimarães-Pereira and Corral-Quintana, 2002) as well as involve all social actors (Funtowicz et al., 1999). However, the involvement of all social actors in environmental governance is not free from controversies (Van Der Sluijs et al., 2008; Pereira and Quintana, 2009). This will be dealt with in the next section.

3.2. Controversies

Road transport in Tenerife is an extremely sensitive social, environmental and economic issue: different stakeholders are either directly or indirectly affected by the policies and actions taken by public authorities. Human health and quality of life are at stake. In the case of Tenerife, various stakeholders have expressed their opinions about road transport on the Island over the last decades; promoting or holding back political decisions, according to their interests and their power to influence the policy arena.

Several groups of stakeholders of the island have expressed their point of views publically regarding transport in the last decades, from decision-makers and political parties, business groups, trade unions, public transport companies, to disparate NGOs and citizens associations. A summary of their visions and stakes is presented in Table 2. For more information on the controversies, refer to Hernández-González and Corral-Quintana (2016).

4. Results and discussion

As seen, sustainable transport impact assessment implies managing high uncertainty levels. Democratizing environmental governance by means stakeholders and citizen engagement has been considered appropriate to manage this kind of uncertainties. However, their involvement is not free from complications and difficulties, since each social actor hold different stakes. From all this process, a series of advantages of applying participation and transparency to the whole decision-making process will be highlighted in the next sections. As presented in Fig. 1, the results will be given in separate stages, i.e. an assessment process and a post-assessment process.

4.1. Assessment process

The inclusion of the extended peer community have brought different advantages to the assessment process: (a) framing the issue at hand, including the existing conflicts among the stakeholders, (b) definition of alternative policy options apart from the one provided by the local authorities, (c) definition of the criteria that should be used in the MCA, and (d) the vision of the stakeholders to manage uncertain information, such as the qualitative criteria used in the impact matrix.

First of all, the extended peer community helped the analysts to frame the issue properly. This framing step allowed the social and political context of transport issues in Tenerife to be drawn up. This facilitated an evolutionary analysis of the role and positions of each stakeholder (see for example Table 2). Furthermore, the framing was of use to confirm that the issue of sustainable transport is not only an academic issue but also a daily-life issue for the local

Table 2
Stakeholders interests.

Stakeholder	Role	Stake
Regional Government	Regional transportation planning	Undefined position concerning transport policy. It consisted of a sum of incoherent transport infrastructure promotion
Island Council	Insular transportation planning	In the last 15 years, a transport policy has been proposed. It consists of the promotion of rail transport as well as interurban road transport. They have also considered several discourage measures for urban road transport
Nationalist party	Nationalist coalition	See above. They are part of the Regional Government and the Island Council along with the Labour party
Labour Party	Labour party	Undefined position concerning transport policy. Contradictions can be easily found among different party leaders with respect to transport policies. They are part of both the Regional Government and the Island Council
Conservative Party	Conservative party	All transport policy should attend transport user interests for all modes of transport indistinctly. Contradictions can also be found among their leaders when discuss about railway infrastructure
Left Party	Left party	Land-based transport should be adjusted to Island's natural resources, as well as should attend social needs. Railway infrastructure could be appropriate if discourage measures for cars are implemented
Green Party	Green party	Land-based transport should be adjusted to Island's natural resources, as well as should attend social need. Railway infrastructure is not appropriate for small islands
Construction sector	Business group	Infrastructure should be promoted all around the Island, since it brings growth, wealth and employment
Automotive dealers	Business group	Private transport should have preference as it is the preferred mode of transport by islanders. Public transport should also be promoted, but it should not compete with cars
National Trade Union I	Trade union	Rail transport should be promoted in order to provide workers with better means of transport when commuting
Local and National Trade Union II	Trade union	Rail transport promotion can harm bus company employees. The bus company may grow and improve the service if the company is subsidised as much as railway infrastructure
Bus company	Insular transportation service	They have been asking for bus lanes in the metropolitan area and bus transport promotion for the last 15 years. They see the bus company as being unable to attend Island's transport demand
Taxi drivers' union	Regional transportation service	They see their sector as a potential complement of the bus company, especially for remote locations in the Island. Their promotion could reduce transport costs and increase public transport service efficiency
Tram company	Insular transportation service	They defend the promotion of rail transport as well as the introduction of discourage measures for road transport. This company would operate railway infrastructure
Environmentalists	NGO	Land-based transport should be adjusted to Island's natural resources. Land-based transport demand should shrink
Mobility-reduced people	NGO	They defend the promotion of accessibility to transport services. They see the bus company unable to meet their needs. Rail transport is much more accessible
Public transport users	NGO	They defend the promotion of rail transport, as well as the introduction of measures to discourage road transport
Citizen organisation	NGO	They reject the Council transport policy, specifically the expected northern train infrastructure. Their properties might be affected by the infrastructure
Transport experts	Council transport advisers	They do not believe in the Council transport policy, although they must defend it in public as declared in in-depth interviews and focus-groups
University experts	Academics	The current bus service should be promoted as well as discouraging road transport for a more efficient transport policy

Source: own elaboration based on press review, in-depth interviews and focus group sessions.

population. Therefore, the involvement of stakeholders provided the analysts with valuable information regarding the positions each stakeholder had with respect to the issue at hand, as well as their preferences when proposing policy options.

The second advantage identified has been the proposal of alternative policy options for sustainable transport apart from the one provided by the Council of Tenerife. Since the official transport policy is a mere collection of disperse and existing transport policies (such as roads, tram, and train policies), the stakeholders were able to put plausible alternative options on the table (see Table 3). Thus, by means of two rounds of in-depth interviews to the stakeholders, a new range of alternative were proposed.

The third advantage identified concerns the social identification of potential assessment criteria. Thus, as seen in Table 4, the interaction between researchers and stakeholders came up with a set of assessment criteria covering different environmental, social and economic-institutional dimensions. Furthermore, both criteria goals (maximise or minimise) and nature (quantitative or qualitative) were collectively clarified.

Table 3
Transport policy options.

Acronym	Description
Alternative A	Business as usual: neither new policies nor measures are implemented
Alternative B	Focuses on car-centre planning: new roads are built and the current bus transport system might be improved
Alternative C	Implement the Council's policy: new roads are built, along with a railway system; several dissuasive measure for car use might be adopted
Alternative D	Focuses on train transport policy: a railway system is introduced along with dissuasive measures for car use
Alternative E	Improve current public transport system, as well as the introduction of dissuasive measures for car use

Source: Hernández-González and Corral-Quintana (2016).

Lastly, another advantage was distinguished. Due to the fact that several criteria could not be considered in quantitative terms, qualitative qualifiers were used instead. The views of the stakeholders were used to fill in these cells in the impact matrix (see criteria in

italics in Table 4). Both press review and in-depth interviews were managed to assign qualitative assessment to these criteria.

4.2. Post-assessment process

Three relevant advantages of involving stakeholders in the post-assessment stage have been identified: (a) the reinforcement of the assessment results, (b) the acknowledgement that stakeholders suggestions in post-assessment processes should never be refused beforehand, and (c) the acknowledgement that underlying assumptions of assessment processes should never be taken for granted.

This stage was carried out by means of two focus group sessions (Hernández-González and Corral-Quintana, 2016), in which stakeholders proposed corrections and suggestions to improve the assessment. The idea of the post-assessment process is, therefore, determining the robustness of the evaluation processes when high levels of uncertainties and conflicts between stakeholders are involved. An approach based on a combination of technical and social methodologies is proposed (Corral and Hernández, forthcoming). On the one hand, a «classical» sensitivity analysis is applied in order to validate the technical results by changing the model's parameters. On the other hand, an «extended sensitivity analysis» is also used based on the feedback produced from different social discussions using focus groups, i.e. the community is involved in the decision-making process and give opinions on the assessment results, including the sensitivity analysis outcome.

First of all, the SA applied confirmed that the results given in the assessment processes are robust in parametric terms. Different MCA parameters were change in order to explore the possibilities having different results as a consequence of changes in input data. This technical exercise have shown that the alternatives encouraging public transport and establishing dissuasive measures for car use were the best policy options and were, therefore, robust. More details can be seen in Corral and Hernández (forthcoming).

Regarding the SSA, the stakeholders made two relevant suggestions in both focus group sessions. Those were taken into account for further exploration: one came from the car industry and the other from experts in transport economics. First, the automotive

industry highlighted that qualitative criteria should not reflect stakeholders' standpoints (as seen in the assessment process). Instead, qualitative criteria should be removed from the analysis, and therefore, from the impact matrix. Secondly, experts in transport economics suggested that considering fatal, severe and slight transport accidents should not be treated as separate criteria (in bold in Table 4). As a consequence, accident data was considered as a unique criterion. These fundamental changes in the assessment process were considered highly useful to guarantee the robustness of the assessment results. The application of MCA to these suggestion produced non-relevant changes regarding the Council's policy option, compared to the assessment process. Thus, the Council's policy option was again considered poor in terms of MCA performance, as the assessment process had already shown. This indicated that improvised land-transport planning should not be practised. Thus, the assessment process has pointed it out, meanwhile a post-assessment process, based on sensitivity and social sensitivity analyses, have reinforce the results.

However, one additional and unexpected outcome was obtained from this post-assessment interaction. This result came up when the car industry suggested that qualitative criteria should be removed from the analysis, as indicated above. This suggestion led the authors to change fundamental parameters in the MCA that ended in the business as usual alternative rising to the top of the ranking. This result troubled the analysts and led them to look further at the underlying assumptions of the model: the expected 20% increase in mobility demand according to the local transport agency (Cabildo de Tenerife, 2012).

The consequences of this increase are, inevitably, the provision of transport infrastructure for either private or public transport, implying land-take, environmental impacts and substantial economic investments, among others. Therefore, the option of doing-nothing became relevant in the analysis, indicating that increasing mobility demand cannot be an option for sustainable mobility planning, even though this extra demand is to be dealt with by supposed sustainable means. This result led the authors to question the underlying assumptions of the assessment process in order to explain how a bad situation (the business as usual

Table 4
Impact matrix.

Criteria \ Alternatives	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Air pollution	Approx. 38	Approx. 43	Approx. 31	Approx. 31	Approx. 43
Noise	Approx. 1848	Approx. 1780	Approx. 1839	Approx. 1830	Approx. 1772
GHG emissions	Approx. 313	Approx. 299	Approx. 308	Approx. 307	Approx. 298
Land-use change	0	Approx. 441	Approx. 519	Approx. 191	Approx. 116
Visual quality	<i>Bad</i>	<i>Bad</i>	<i>More or less bad</i>	<i>More or less good</i>	<i>Good</i>
Urban concentration	<i>Bad</i>	<i>Bad</i>	<i>Bad</i>	<i>More or less good</i>	<i>Good</i>
Ecosystem conservation	<i>Bad</i>	<i>Bad</i>	<i>Bad</i>	<i>More or less good</i>	<i>More or less good</i>
Slight injury	Approx. 458	Approx. 428	Approx. 451	Approx. 449	Approx. 426
Serious injury	Approx. 36	Approx. 33	Approx. 35	Approx. 35	Approx. 33
Fatal accidents	Approx. 8	Approx. 8	Approx. 8	Approx. 8	Approx. 8
Cycle lanes	0	0	6.5	6.5	6.5
Bicycle use	Approx. 921	Approx. 921	Approx. 1842	Approx. 1842	Approx. 1842
Road safety	<i>Bad</i>	<i>More or less bad</i>	<i>Moderate</i>	<i>More or less good</i>	<i>Good</i>
Affected buildings	0	Approx. 513	Approx. 620	Approx. 316	Approx. 212
Fairness	<i>Bad</i>	<i>Moderate</i>	<i>Moderate</i>	<i>More or less good</i>	<i>More or less good</i>
Energy consumed	Approx. 127	Approx. 120	Approx. 125	Approx. 125	Approx. 120
Self-funding	<i>Bad</i>	<i>Very bad</i>	<i>Extremely bad</i>	<i>Very bad</i>	<i>Bad</i>
Viability	<i>Bad</i>	<i>Moderate</i>	<i>Moderate</i>	<i>Moderate</i>	<i>More or less good</i>
Urban public space availability	<i>Bad</i>	<i>Bad</i>	<i>Moderate</i>	<i>More or less good</i>	<i>Good</i>
Congestion	More or less good	More or less bad	More or less bad	Good	More or less good
Economic activity	<i>Bad</i>	<i>Moderate</i>	<i>Moderate</i>	<i>More or less good</i>	<i>Good</i>
Time lost by pedestrians	Approx. 156	Approx. 144	Approx. 24	Approx. 24	Approx. 144
Investment costs	184.9	1982.8	4917.6	3814.6	962.0
Maintenance costs	Approx. 1.1	Approx. 1180	Approx. 1057	Approx. 1047	Approx. 1170
Employment	Approx. 19100	Approx. 18100	Approx. 18900	Approx. 18800	Approx. 18000
Household rent	<i>Bad</i>	<i>Moderate</i>	<i>Moderate</i>	<i>More or less good</i>	<i>Good</i>

Source: Hernández-González and Corral-Quintana (2016).

alternative) could be ranked first in the MCA. As a consequence of this reasoning, it could be argued that (a) the feedback from any stakeholder or citizen should never be refused beforehand, since it might lead to finding out that (b) underlying assumptions of a model should never be taken for granted.

5. Concluding remarks

In this paper we have proposed an approach integrating formal and informal methods, which is based on the concept of “extended peer communities” (Funtowicz and Ravetz, 1993) and “socially robust knowledge” (Gibbons, 1999). Following their ideas on participation and transparency, we have proposed a structured methodological process to validate the results of environmental governance. The outcomes of an assessment as well as the corresponding sensitivity analysis should be provided to the «extended peer community», in order to fulfil the requisite of transparency. With extended peer community we mean the involvement of key stakeholders and citizens in a certain issue, so as to either validate the results or receive additional feedbacks from them.

Environmental governance issues cannot be fully understood by only considering technical aspects. Therefore, the assessment process has needed the development of an integrated assessment with the involvement of the stakeholders. An involvement based on the implementation of the «socially robust knowledge» idea is therefore based on two-phase participatory assessments that notably enriches the decision-making process, since it allows a clearer idea of (a) the issue at hand, (b) stakeholders' concerns and positions and, (c) robustness of the results. The combination of their knowledge with the information provided by the legal and press review is critical to frame the issue at hand, to define the different assessment criteria and the policy alternatives. In a second stage, the results of the alternatives are discussed and modified during a focus group session attended by the stakeholders.

The idea behind this approach was to integrate both characteristics of socially robust knowledge which are citizen participation and transparency from the beginning of the process until the end of it. Public authorities and private institutions' representatives participated in both the assessment and post-assessment processes, i.e. in-depth interviews and focus group sessions. In the case under study, it was a rewarding experience for the researchers as a source of valuable knowledge, but also for the participants themselves. As mentioned, the interaction among stakeholders led to sharing of opinions and an understanding of the positions and concerns of others.

The results of the assessment process indicate that the most feasible alternative, under current conditions, to reduce road transport impacts might be the improvement of public transport systems followed by the implementation of dissuasive measures for car use. The sensitivity analysis developed in the post-assessment process has also reinforced the results obtained in the assessment stage. Therefore, we could say that these two alternatives were robust.

The second part of the post-assessment process carried out questioned the previous conclusions, since all the alternatives assessed were based on the assumption that mobility patterns will increase a 20% from 2008 to 2016, according to the local transport agency estimation (Cabildo de Tenerife, 2012). Clearly, as seen, if an increase in mobility rates is assumed, actions on land-use planning becomes inevitable, either to provide road or public transport infrastructure, both having impacts (at different scale) in terms land-take, and infrastructure costs. Then, if a *business as usual* alternative (based on doing-nothing) might be either indifferent or equal to alternatives that improves public transport, this could be indicating that indefinitely mobility growth might not be an option if sustainability is considered seriously.

Summing up, in contexts of scientific uncertainty and social controversy, environmental governance cannot be fully understood by only considering technical aspects. In fact, we believe that in those situations where stakes are high, scientific uncertainties are unavoidable, environmental planning strategies are unclear, and stakes are high, there is a need for inclusiveness during all assessment phases, such as the framing, the design and assessment of the policy alternatives, as well as the social control of the results. Thus, the implementation of extended peer communities knowledge sharing approaches, such as the proposed in this paper, facilitate a better understanding of environmental governance due to its ability to deal with multiple dimensions and to incorporate indispensable social values.

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