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Twenty-five years of social multi-criteria evaluation (SMCE) in the search for sustainability: Analysis of case studies

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ABSTRACT

Social multi-criteria evaluation (SMCE) is a decision-making tool used in complex and uncertain social-ecological contexts such as those related to the management of natural resources and sustainability. It has been widely used since it was devised twenty-five years ago, but no comprehensive reviews exist for case studies specifically considering sustainability. Therefore, the aim of this study is twofold: first, to review the principles of SMCE according to sustainability; and second, to contrast the integration of sustainability within the SMCE framework by means of an analysis of case studies. Relying on an exhaustive bibliographical review, the analysis undertaken has covered the empirical evidence gap in the SMCE field by providing a systematic inventory of 41 case studies and analysing them regarding their general features, how they fulfil the SMCE process steps, and the characteristics of the results in each case. Furthermore, our general findings on the SMCE method relate to: (i) the feasibility of the operationalization of the strong sustainability principle; (ii) the incorporation of the social actors' views through participatory processes in the search for sustainability; (iii) the difficulty of reaching "compromise solutions" and the scarce real policy implementation of the outcomes in analysed cases.

1. Introduction

In a world increasingly characterized by the global environmental crisis, the gradual depletion of natural resources and the absence of an equitable provision of a minimum livelihood for the entire world population (Steffen et al., 2015; O'Neill et al., 2018), decision-making regarding the management of natural resources and sustainability is becoming more and more relevant. These decision-making processes feature: (i) outstanding uncertainty (Stirling, 2010); (ii) complexity of social-ecological systems (Audouin et al., 2013); and (iii) multi-stakeholder governance at different scales with divergent views or even opposing interests and objectives (Oteros-Rozas et al., 2015; Reed et al., 2019). Therefore, the sustainability of social-ecological systems at different scales is deeply influenced, among other factors, by both decision-making processes and public policies (Chen et al., 2018).

Among the instruments that facilitate decision-making, multi-criteria decision analysis (MCDA) has evolved since the appearance of seminal works (see e.g. Keeney & Raiffa, 1976; Roy, 1985) to gradually become a proven methodological approach involving a wide range of techniques, aggregation methods and applications (Bana e Costa, 1990; Roy, 1996; Greco et al., 2016; Doumpos et al., 2019). The growing importance of MCDA in the framework of ecological economics has also been steady. It has developed from, among other areas, the incorporation of stakeholders in social-ecological decision-making processes (Gregory and

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Keeney, 1994; Banville et al., 1998) to the consolidation of MCDA as a methodological tool within ecological economics (see e.g. Martínez Alier and Muradian, 2015; Spash, 2017), and the principle of weak comparability of values (Martínez Alier et al., 1998). Within MCDA many contributions have been made for supporting decision-making, including land planning and natural resources (Kain and Söderberg, 2008; Huang et al., 2011; Allain et al., 2017; Esmail and Geneletti, 2018), and sustainable development (see Pérez-Gladish et al., 2021). In this regard, of particular prominence has been the assessment of what is known as three-pillar sustainability (e.g. economic, social, environmental), in which the social dimension is the most overlooked dimension (Kandakoglu et al., 2019). Beyond MCDA, assessments of different sustainability paradigms (i.e., degrowth, a-growth, weak sustainability and strong sustainability) have also neglected the social approach (see Zagonari, 2020), so more attention needs to be paid to this in order to offer a better sustainability assessment approach.

Methodologies that aim to capture the social dimension are varied and diverse (see Bottero and Datola, 2020 for a review), and include social life cycle assessment (S-LCA), which is an expansion of the LCA approach that incorporates the assessment of social impacts (Moltesen et al., 2018). Within the MCDA framework, social multi-criteria evaluation (SMCE) is an instrument that has already made a major impact on decision-making by introducing the social dimension in complex social-ecological contexts.[1] SMCE is, then, characterized by introducing an integrative and participatory perspective that aims to facilitate the search for complex solutions, such as those related to the management of natural resources and sustainability (Munda, 2004, 2008). SMCE is concerned with decision-making under uncertainty, a situation that is quite usual when assessing sustainability through MCDA (Kandakoglu et al., 2019).

The conceptual and methodological framework of SMCE has been consistently defined since its inception twenty-five years ago (Munda, 1995), although it has not been free from criticism and discrepancies. Furthermore, its application on the ground has enriched its methodological and operational framework with interesting variants and innovative contributions. The application of SMCE in real-world cases is relatively extensive, and many case studies have been published, but no exhaustive review has been conducted on the subject. To our knowledge, the only piece of work that reports a review of SMCE case studies is the one conducted by Oppio and Bottero (2017), but the authors only focus on the decision problem. So, although from a theoretical perspective SMCE seems to be appropriate for addressing sustainability, from an empirical perspective the results of such assessments remain unknown. The aim of this study is therefore twofold: (i) to review the theoretical and methodological principles of SMCE in terms of its contribution to sustainability assessment; and (ii) to contrast the integration of sustainability within the SMCE framework through the analysis of real-world case studies, thus filling the gap of empirical evidence. Consequently, there are also two research questions: Firstly, why apply SMCE in the field of sustainability? What are the reasons for this? Secondly, does SMCE really serve sustainability on the ground? What is its relevance for public decision-making? As SMCE has been undertaken in practice, the analysis reports such contributions from the sustainability perspective. To this end, 41 case studies have been exhaustively analysed according to the key features of their evaluation processes and results.

[1] The literature differentiates between multi-criteria decision *analysis* (MCDA) and multi-criteria decision *aid* (MCDa). According to Roy (1996, 2016), in MCDa the *decision process* is at least as important as the final solution since the multi-criteria aggregation method is embedded in the technical, social, and political structuring process. Therefore, SMCE can be framed within MCDa since it contributes to a search for solutions during an evaluation process, including participation (Munda, 2005b). However, to facilitate reading, in this article “MCDA” (multi-criteria decision analysis) is used as a generic term, since it is the one most used in the literature.

In the next section, the methodological approach of the research is described, consisting mainly of a systematic bibliographical review and a peer-reviewed analysis of case studies. Section 3 offers the theoretical review of SMCE, emphasizing both its theoretical and methodological foundations and the reasons for its application in the sustainability arena. The fourth section includes a systematic inventory of SMCE case studies and the results of the analysis, according to the general features, evaluation process, and results of each case study. Section 5 discusses the three main arguments identified in section 3 in relation to SMCE from the sustainability perspective, i.e. operationalization of the strong sustainability principle, the role of participatory processes, and implementation of SMCE in real policy settings. Finally, the article ends with a set of conclusions.

2. Methods and materials

The methodological approach has consisted of three consecutive stages (see Table 1): (1) literature review, (2) systematic bibliographical search, and (3) analysis of case studies. This sequence mainly follows the guidelines given by Pullin and Stewart (2006) for planning and conducting a review, including search strategy, data extraction, and analysis. The analysis however does not meet the requirements for a meta-

Table 1
Methodological approach.

Stage	Objective	Method/ technique	Outcome
1. Literature review	Analyse the theoretical and methodological principles of SMCE in relation to sustainability assessment	Peer-review the most important publications relating to the SMCE framework	Theoretical framework of the research
2. Systematic bibliographical search	Collect real-world SMCE case studies	a) Selection criteria for real-world case studies: 1.- Main features of SMCE carried out in practice; 2.- Policy-oriented research. b) Case study search process: 1.- Bibliographical search: 1.1.- Main indexed databases (WoS and Scopus) 1.2.- Use of keywords and Boolean operators 1.3.-Search period: 1995–2020 2.- 'Snowball' technique	Identification of 41 case studies ensuring quality and academic standards
3. Analysis of case studies	Analyse case studies according to literature review outcome	Peer-review 41 case studies according to:a) General features of each caseb) SMCE process stepsc) Results of the SMCE application	A systematic inventory of SMCE case studies (Table A.1). Analysis and Discussion of the cases in relation to our theoretical framework

Source: own elaboration.

analysis, quite widespread for instance in monetary valuations of ecosystem services (see e.g. Quintas-Soriano et al., 2016). Instead it is of a qualitative nature, incorporating elements of taxonomic and componential analysis (Onwuegbuzie et al., 2012), which makes it possible to carry out an *ad hoc* review of the case studies.

Once the theoretical framework of the research was outlined through the literature review undertaken (stage 1), a systematic bibliographical search was carried out based upon the following guidelines (stage 2). First, two criteria were applied for selecting the real-world cases: (i) the main features of SMCE and its evaluation process had to be considered when it was applied in practice; and (ii) policy-oriented research had to be done, i.e. the outcome entails evaluation alternatives that are potentially applicable once the evaluation has been undertaken. This means the rejection of purely theoretical research and ensures the collection of case studies in which SMCE has been done in practice. So, for example, case studies in which public participation is not explicitly incorporated have been excluded (e.g., Cavallaro and Ciraolo, 2005; Tangari et al., 2008; Zabala, 2009; Browne et al., 2010).

In stage 2 the case study search process was conducted as follows. First, the main academic indexed databases (Web of Science [WoS] and Scopus) were explored by entering keywords and Boolean operators, as has been done in other studies (Dorninger et al., 2020). Three keywords were entered and combined with different Boolean operators as follows: first, "social multi-criteria evaluation" OR "social multicriteria evaluation" OR "social multi criteria evaluation"; second, "social NEAR/10 multi-criteria NEAR/10 evaluation", "social NEAR/10 multicriteria NEAR/10 evaluation", "social NEAR/10 multi criteria NEAR/10 evaluation"; then, "SMCE" and "NAIADE" were also used as keywords.[2] All these items were used for searching article titles, abstracts and keywords. Given the high number of case studies in which SMCE has been applied in the grey literature (e.g., technical reports, Master's degree theses, PhD dissertations, etc.), in this review, only papers published in impact journals were considered, thereby ensuring quality and academic review standards. The search was also limited to the period between 1995 and 2020, because 1995 was its inception year and 2020 was the last complete year. Second, the search was performed based on the 'snowball' technique (Atkinson and Flint, 2001), adopted to carry out specific searches based on bibliographical references of already analysed works.

In this stage 41 case studies were identified –Table 2 shows the numbers of papers and the years of publication of SMCE case studies in the main journals. Of the selected case studies, 22 of the 41 have been published in just six journals, with *Ecological Economics* and *Land Use Policy* comprising more than a quarter of the total number of cases.

Finally, stage 3 involved the analysis of case studies, which has resulted in a systematic inventory of SMCE case studies (see Annex, Table A.1). To contrast the integration of sustainability within the SMCE framework through the analysis of case studies, three main categories have been analysed for each case study, *oriented* to: (i) general features, to deliver the *setting* of each case study; (ii) the SMCE process steps, to find out the technical features of the *process*; and (iii) the results, to inquire about the *outcomes* of each case study. So, the analysis is framed within the SMCE process and it provides empirical evidence about case studies regarding sustainability.

Table 2
Main journals for SMCE case studies.

Journal	Number of papers	Years of publication*
Ecological Economics	6	2000, 2006, 2009, 2012, 2015(2)
Land Use Policy	5	2012, 2016, 2017(2), 2019
Sustainability	4	2017, 2018(2), 2020
Environment and Planning C: Government and Policy	3	2008(2), 2015
Environment, Development and Sustainability	2	2009, 2018
Journal of Environmental Management	2	2007, 2011
European Journal of Operational Research	1	1998
Journal of Contingencies and Crisis Management	1	2002
Energy Policy	1	2007
Progress in Planning	1	2008
Risk Analysis	1	2008
Landscape and Urban Planning	1	2010
Ocean & Coastal Management	1	2010
Environmental Management	1	2011
International Journal of Agricultural Sustainability	1	2011
Journal of Cleaner Production	1	2013
New Perspectives on Turkey	1	2013
Renewable Energy	1	2014
Forests	1	2015
Renewable and Sustainable Energy Reviews	1	2015
Agricultural Economics – Czech	1	2016
Transportation Research Part A	1	2016
Climate	1	2019
DYNA	1	2019
Landslides	1	2019

Source: own elaboration.
Note (*): in brackets the number of papers published that year.

3. SMCE framework: background and application within the sustainability arena

The literature review has made it possible to divide the theoretical framework of SMCE into two blocks. Firstly, its theoretical and methodological principles have been recalled, and then the fundamental issues of its application in the sustainability field have been addressed.

3.1. Main characteristics of SMCE

The beginning of SMCE dates from the pioneering contribution of Munda (1995), but the theoretical foundations of SMCE were formally established by that author in the paper *Social multi-criteria evaluation: Methodological foundations and operational consequences* (Munda, 2004). Munda himself, in previous works together with other researchers, had already taken some significant steps towards defining this new evaluation approach (Munda, 1995, 1996; Munda et al., 1995; Martínez Alier et al., 1998; Janssen and Munda, 1999; De Marchi et al., 2000). Similarly, later works have complemented that pioneering study from theoretical and empirical perspectives (Munda, 2005a, 2005b, 2006, 2009; Gamboa, 2006; Gamboa and Munda, 2007; Russi, 2007; Munda and Russi, 2008), forming an integral compilation of theoretical and practical studies (Munda, 2008). The foundational basis of SMCE has been established in accordance with three principal concepts that originated from the theory and philosophy of complex systems: reflexive complexity, post-normal science and incommensurability.

First, understanding that the real world is a complex system in which one sole perspective is incapable of capturing the relevant aspects of a problem at hand. In addition, the systems that include human participation are *reflexively complex,* as they include two distinctive characteristics: consciousness and purpose. Besides, reflexivity implies the existence of structural uncertainty, as this is produced by the diversity of ethical values and their societal randomness, and these cannot be resolved by means of more measurements but rather by integrating diverse dimensions and sources of knowledge (Bernal and Zografos,

[2] NAIADE (Novel Approach to Imprecise Assessment and Decision Environments) is a particular aggregation method for MCDA (JCR, 1996). According to Munda (2008), it complies with almost all of the desirable properties for SMCE, so it was assumed that the use of such a keyword would make it easier to find SMCE cases.

2012). There is therefore a clear need to improve the quality of the social process in the decision-making procedure, using for this an 'extended peer community', including scientists, decision-makers and society at large (Munda, 2004). Second, to handle these characteristics *post-normal* science (Funtowicz and Ravetz, 1991, 1994) proposes an increased interaction among politics, science and society within the framework of public policies, as well as in the transparent management of uncertainty (Gamboa, 2006). In fact, post-normal science is distinct from traditional sciences, given that its organizing principle is not 'truth' but rather 'quality'. Accordingly, it suggests that science must combine two crucial aspects of scientific work to serve public policies: uncertainty and values in conflict. Finally, the third conceptual pillar of SMCE is *incommensurability*, i.e. "the absence of a common unit of measurement between plural values" (Martínez Alier et al., 1998: 280), which entails rejecting reductionism. Within the context of MCDA, this means that when deciding on the common comparative term to use to achieve a ranking of alternatives, a value is in conflict, which is irreducible. Munda (2004) goes further and proposes a distinction between *social incommensurability* and *technical incommensurability*. The former is attached to the concept of democracy because it refers to the "existence of a multiplicity of legitimate values of a society" (Munda, 2004: 664), and technical incommensurability refers to the issue of "representation of multiple identities in descriptive models" (Ibid.) and comes from the multidimensional nature of complex systems.

As for the evaluation process, SMCE is developed in a set of four steps (Table 3). In this process, two elements stand out: (i) the continuous feedback between the different steps as well as among the diverse social actors that are involved; and (ii) the combination of scientific and social knowledge. The established steps are not rigid, but flexible; and the evaluation process should not end with the mere results reached in a technical ranking, but rather, these results should be discussed with the social actors involved.

So relying on the essential works of Munda (2004, 2008), and supported by the contribution of Garmendia et al. (2010), the methodological foundations of SMCE can be summarized as follows:

a. The inclusion of the social dimension upon incorporating multiple legitimate values existing in society (*social incommensurability*).
b. The use of distinct types of knowledge: knowledge of technical experts, of public managers and of social actors.
c. The participation of social actors as input for the analysis. The incorporation of social participation mechanisms responds to various needs: (i) to incorporate the best of all possible knowledge regarding the problem at hand; (ii) to ensure transparency in both the selection of criteria and the creation and evaluation of alternatives; (iii) to generate a mutual learning process between all participants involved; and (iv) to establish an ongoing 'quality control' mechanism that enables a redefinition of those aspects that are susceptible to improvement during the evaluation process.
d. Transparent development. Transparency in the evaluation process is an essential element given that the assumptions made should be clearly specified and known by all participants involved.
e. Transdisciplinarity. SMCE is appropriate for taking on *technical incommensurability,* as it prevents reductionism in the construction of descriptive models through assumptions regarding: (i) the purpose of the model; (ii) the scale of analysis; and (iii) the establishment of dimensions, objectives and criteria used in the evaluation process.
f. Integration of distinct types of available information. SMCE permits the use of both quantitative and qualitative information (e.g., in the multi-criteria impact matrix fostering an informed discussion among social actors).
g. Aggregation method. This plays an important role because the ranking of the alternatives evaluated by applying the multi-criteria algorithm should be consistent with the information and assumptions used.

3.2. Why and how to apply SMCE within the sustainability arena

SMCE has been defined as a pertinent methodological framework for approaching a "sustainable economy" (Munda, 2008), and in our view three main reasons should be highlighted in terms of why SMCE is considered to be relevant for application to the sustainability arena:

3.2.1. The strong sustainability principle: Its operationalization in the decision-making process

Strong and weak sustainability principles are defined in terms of the level of substitution between natural and human-made capital (see Neumayer, 2010 for an in-depth review). Strong sustainability implies the limited substitution of natural capital for human-made capital, e.g. the loss of certain biological species cannot be replaced by an increase in the utility derived from the use of one particular infrastructure. Something

Table 3
SMCE process by steps.

Participative process	Step	Objective(s)	Methods	Feedback looping
	Problem definition	-Identification of relevant social actors -Definition of the conflict	-Institutional analysis -In-depth interviews -Historical analysis -Workshops -…	
	Structure the problem	Selection of evaluation criteria Creation of alternatives	-In-depth interviews -Focus-groups -Questionnaires -Surveys -…	
	Evaluation	Complete the multi-criteria impact matrix	-Multi/inter-disciplinary technical methods	
	Analysis	Rank the alternatives	-Aggregation method -Trade-off analysis	

Source: own elaboration based on Munda (2008) and Garmendia et al. (2010).

implicit in strong sustainability is the existence of a threshold of critical natural capital (CNC) whose exploitation should not be exceeded, as this may lead to irreversible environmental impacts. Therefore, the strong sustainability principle establishes that certain elements are 'critical' due to their unique contribution to human well-being (Ekins et al., 2003). In contrast, weak sustainability implies a high degree of substitution between the two types of capital. So, SMCE permits the operationalization of the strong sustainability principle in several ways by: using a partial or non-compensatory aggregation method; including a veto threshold through the MCDA model; and defining alternatives by excluding those options exceeding CNC thresholds.

The reasons to apply the strong sustainability principle are as follows (Pelenc and Ballet, 2015): (i) natural capital is characterized by irreversibility; (ii) natural capital is multifunctional, i.e. in certain situations it can provide several services simultaneously; (iii) there is uncertainty concerning the effects that destroying natural capital will have on human well-being; and (iv) intergenerational justice may be undermined, as an increase in future consumption is not an appropriate substitute for the loss of natural capital. In addition, as SMCE may be carried out within a complex social-ecological systems framework (Berkes et al., 2003), its objective would be to capture the inherent diversity in complex situations instead of attempting to homogenize them (Martínez Alier et al., 1998). Therefore, with regard to the *technical incommensurability*, SMCE includes extensive information from distinct disciplines and takes a trans-disciplinary approach, thereby avoiding reductionism and incorporating an essential element of social-ecological sustainability.

As for the aggregation method, there are many mathematical algorithms and methods for solving problems within MCDA, mainly divided (Guitoni and Martel, 1998) into elementary methods, the single synthesising criterion and outranking methods. For the same case study different methods may yield different results, so the outcome may depend on the method selected (Mysiak, 2006), making the choice of method decisive. In the sustainability arena, the properties that multi-criteria methods should comply with have been compared in diverse works (e.g. in terms of compensation, uncertainty and equity), and scholars have concluded that some methods are more suitable than others (Janssen, 2001; Munda, 2005b, 2008; Polatidis et al., 2006; Ananda and Herath, 2009; Grima et al., 2017). We consider that some properties are particularly relevant for their application in the SMCE framework:

i. Non-compensatory. This is probably the most remarkable property for sustainability assessment, which depends on the aggregation method selected. For example, the fuzzy weighted sum or TOPSIS method are totally compensatory, whereas NAIADE, REGIME and ELECTRE are completely or partially non-compensatory (Guitoni and Martel, 1998), i.e. these methods prevent compensations between high and low valuations, therefore they are suitable for introducing the strong sustainability principle into the assessment.
ii. Capturing uncertainty. The inherent uncertainty that characterizes decision-making on sustainability must be transferred to the multi-criteria model. This can be done e.g. by using fuzzy set theory in the aggregation procedure or by sensitivity or scenario analysis (Stagl, 2007).
iii. Use of weights. This is particularly related to integrating social preferences into the model as social actors should be able to reflect their view on sustainability (e.g. three-pillar sustainability, degrowth, etc.) through defining and weighting criteria. Depending on the selected aggregation method, weights can be considered in the criteria (e.g. REGIME) or not (e.g. NAIADE).
iv. Transparent. The multi-criteria model itself can help transparency through some properties, such as simplicity or ease of use. However, what is most important is the transparency of the evaluation process as a whole, for which the specifics of the aggregation model (weights, preference thresholds, etc.) must be made explicit.

3.2.2. The role of participatory processes

In the MCDA framework, any representation of a complex system is only one potential representation of it (Giampietro et al., 2006). Therefore, an operational 'value' definition should be chosen, given that social actors with distinct interests, identities, cultures and objectives will offer different definitions for the 'value' concept (O'Neill, 1993). In fact, the diversity of 'valuation languages' used by the social actors should condition the choice of the assessment method in the decision-making processes, more so in situations where a social-ecological conflict exists (Rodríguez-Labajos and Martínez Alier, 2012). Especially in these situations, the incorporation of the social actors' perspective may contribute to the sustainability.

It is useful to create spaces that facilitate the development of adaptive learning processes and that include a greater spectrum of types of knowledge and experiences of the different social actors in order to assess sustainability (Kasemir et al., 2003). Participative processes include this *social incommensurability* in SMCE. As noted, in SMCE participation is used as input for the analysis, but the criteria and weights are not necessarily extracted directly from the participation, unlike in the cases of participatory multi-criteria analysis (Stagl, 2006) or deliberative multi-criteria evaluation (Proctor and Drechsler, 2006). According to Munda (2004, 2008), participation is a necessary condition but not a sufficient one, and the determination of the criteria weights lies in the 'plurality of ethical principles' existing in society. Therefore, the evaluation criteria and their weights should not be directly extracted from participative processes, as this is technically very difficult, pragmatically undesirable, and ethically unacceptable. However, this does not explain how to address the choice of those principles; alternatives have been proposed to consider this issue. On the one hand, in discursive participative processes participation can be used as a way to reach agreement (not necessarily consensus) among social actors (van den Hove, 2006). On the other hand, Garmendia and Gamboa (2012) introduce criteria weights into the analysis via social preferences, by means of clustering the individual preferences of social actors.

According to some authors, definition and evaluation criteria in SMCE is mainly a technical task consisting of measuring the degree to which social actors' objectives are met by the different alternatives (see e.g. Gamboa and Munda, 2007; Garmendia et al., 2010). This requires some technical knowledge to be implemented correctly as the set of criteria should meet some requisites, such as legibility and operationality (Bouyssou, 1990). However, as this technical approach is largely based on the experts' view, it may undermine the participation of social actors in the determination of the problem at hand and in the definition of the relevant criteria (Kallis et al., 2006). This way of proceeding may favour subjectivity since the analyst has the opportunity to introduce his/her own value opinions, i.e., when selecting and weighing the criteria (van Pelt et al., 1990; Ciani et al., 1993). This criticism is however inherent to any valuation methodology (e.g. cost-benefit analysis, life cycle assessment), and in any case this bias is minimized when the analysis process is as transparent and consistent as possible. Any outcome of the technical tasks should be communicated to social actors for their validation and quality control.

However, SMCE also faces other difficulties regarding the framing of participatory processes within the evaluation process, such as representation (Soma, 2010), or information quality, legitimacy, and social dynamics (Díez et al., 2015). For example, the mere choice of social actors and the power that some of these may exercise within any participative process favours informative bias in MCDA (Gamper & Turcanu, 2007). According to Fürst (2008), the issue of social actors' power has not been sufficiently addressed in SMCE, and additionally the evaluation process within SMCE should be rethought by emphasizing the evolution that social actors experience through social learning in terms of the formation, transformation, resolution, and acceptation of their preferences.

3.2.3. Implementation of SMCE: Looking for a compromise solution

As has been pointed out, SMCE is a methodological framework to support decision-making, in particular regarding natural resource management and sustainability. Its vocation therefore places it, not exclusively but mainly, in the domain of public affairs policymaking. Compared to other participatory and deliberative multi-criteria methods, SMCE has less capacity to open up the issues of the problem at hand but, by contrast, is more suitable for supporting closing down and arriving at recommendations (Stagl, 2007). It has even been proposed for the evaluation and implementation of policy measures in certain areas such as forest planning (Vargas, 2005). However, as with other methodologies, the application of SMCE has more to do with the practitioners than with the methodology itself. Moreover, the impact on policymaking is closely related to the existing legal framework, which undoubtedly conditions its application (e.g. environmental impact assessment is foreseen in many Western countries). In fact, the limited use of MCDA in public decision-making can be overcome through an explicit legal requirement, thus contributing to its expansion in the field of sustainability (Gamper & Turcanu, 2007).

On the other hand, the evaluation process itself may also condition the implementation of the results of the analysis. The existence of diverse groups of social actors and interests usually involves divergence among them, and the result for such a decision-making problem is determined by the degree of divergence and bargaining; "normally, such a result is a compromise solution" (Nijkamp, 1979: 70). Munda (2004: 665) goes a step further, defining compromise solutions as "the balance between incommensurable values and dimensions", and differentiating between social ones (i.e. coming from value conflicts) and technical ones (i.e. coming from conflicting non-equivalent representations of the same policy options).

However, in the search for compromise solutions the very process may highlight issues that should necessarily be taken into account in favour of sustainability. So *procedural rationality* (Simon, 1976) has demonstrated the importance of the decision-making process in itself (structure, procedure, involved participants, etc.) over the final results. This feature in MCDA has been emphasized by Roy (2016) as *problematic*, i.e. in the way in which decision aid may be envisaged. So the search for compromise solutions among the relevant social actors may contribute to a better outcome in terms of sustainability, as this alternative may produce longer-term results than one in which there is no compromise among social actors. However, it cannot be ignored that compromise solutions do not per se favour 'sustainable' alternative choices, as the selected alternative may be 'unsustainable'.

From a social perspective, SMCE may contribute to the search for compromise solutions in case of explicit social-ecological conflicts. First, the SMCE process is designed to address potential conflicts. Second, distributive aspects in conflict analysis may also be interpreted in terms of sustainability, i.e. the costs/benefits that are assumed by the different social actors from an ecological-environmental perspective. In addition, SMCE has also been characterized with respect to environmental justice. Zografos et al. (2014) argue that it is easy to include actual or potential 'environmental liabilities' as evaluation criteria since environmental damage can be expressed as different types of biophysical or qualitative indicators. In fact, criteria such as 'enforcement of laws' and 'distribution of environmental harms' have actually been employed in SMCE from an environmental justice perspective (Zepharovic et al., 2021).

4. Analysis and results

This section explains the two outcomes derived from the analysis undertaken. First, the systematic inventory of case studies is presented, and then the results of the analysis are commented on.

The systematic inventory of case studies (see Annex, Table A.1) was elaborated in accordance with the three categories defined in section 2: (i) general features of each case study, according to variables for delivering the *setting*: number, year, author(s), place, subject, funding; (ii) the SMCE process steps (see Table 3), according to the steps of the evaluation *process* for providing technical features: Problem definition (social-ecological problem, public participation method), Structure the problem (number of criteria and of alternatives), Evaluation (technical method), Analysis (aggregation method, sensitivity analysis, social evaluation); (iii) results of each case study, according to key features for inquiring about *outcomes*: best ranked alternative, compromise solution, implementation.

Next, the results of the analysis are commented on according to the three categories mentioned above and defined in the inventory (Annex, Table A.1).

4.1. General features of each case study

The number of cases has increased over the years, showing a notable rise since 2015, with 19 of the 41 cases analysed, that is, 46% of cases, published in the last six years of the analysed period. The places where they have been carried out are highly diverse, but mostly comprising countries in Europe and Latin America. SMCE has been used in a range of contexts that respond to different objectives, but most of these objectives were related to planning and natural resources. Table 4 groups together the 41 case studies according to the subject of analysis, in which most evaluations focus on rural planning, farming and food, water resources, and urban planning.

The funding of the cases is predominantly public; 22 of the 41 cases analysed (about 54%) have been the outcome of publicly funded research, and another two of public administration contracts (5%). Five cases have been funded by universities (12%), and only one case (C24) has received funding from a private company.

4.2. The SMCE process steps

Here the main technical features of each step within the SMCE process are analysed.

Table 4
Case studies by subject.

Number of cases	Subject of analysis	References
6	Rural planning	Pearson et al. (2010); Siciliano (2012); Acosta and Corral (2015); Grima et al. (2017); Martínez-Sastre et al. (2017), Etxano et al. (2018).
5	Farming and food	Tarrasón et al. (2007); Siciliano (2009); Bernal and Zografos (2012); Aydin et al. (2013); Lutz et al. (2017).
5	Water resources	De Marchi et al. (2000); Paneque et al. (2009); Antunes et al. (2011); Domènech et al. (2013); Kolinjivadi et al. (2015).
5	Urban planning	Özkaynak (2008); Sturiale and Scuderi (2018); Bottero et al. (2019); Sturiale and Scuderi (2019); Bottero and Datola (2020).
4	Contingency and disaster risk reduction	Torrieri et al. (2002); Scolobig et al. (2008); Scuderi and Sturiale (2016); Maes et al. (2019).
4	Energy resources and planning	Gamboa and Munda (2007); Munda and Russi (2008); Borzoni et al. (2014); Corral et al. (2015).
3	Extractive activities	Vallejo et al. (2015); Walter et al. (2016); Corzo and Gamboa (2018).
2	Coastal uses and activities	Roca et al. (2008); Garmendia et al. (2010).
2	Protected areas	Oikonomou et al. (2011); Etxano et al. (2015).
2	Waste management	Haastrup et al. (1998); Benitez-Campo and Peña-Salamanca (2019).
1	Regional development	Gamboa (2006)
1	Species invasion	Monterroso et al. (2011)
1	Transport	Hernández and Corral (2016)

Source: own elaboration.

4.2.1. Problem definition step

Two main types of social-ecological problem have been identified; first, the explicit existence of two opposing views at stake (signalled with "vs." in Table A.1) in 18 cases (C2, C4, C5, C7, C9, C12, C14, C17, C21, C22, C23, C25, C26, C27, C30, C31, C33, C37), and second, for the rest of the cases a number of different set options in opposition/conflict. So it is confirmed that SMCE is used to address situations involving disputed values and opposing views, and such situations may lead to social-ecological conflicts when proposing and deciding about options to deal with the problem at hand. However, the real-world cases also show that public participation is an indispensable element in the evaluation process. The most used method is the interview (34 cases), followed by focus groups or workshops (24 cases), all of them elements embedded in the SMCE "ideal process" (Munda, 2008). Additionally, most cases use a combination of participative methods (32 cases), showing that SMCE is able to integrate diverse methodologies as a means of shaping in the best possible way the problem at hand.

4.2.2. Structuring the problem step

According to Yoon and Hwang (1995) the number of criteria used should range between 7 and 12, which has been met in 24 of the 41 cases analysed. Among the cases that do not meet this premise, in 10 of them the set of evaluation criteria exceed the upper limit of 12, reaching in some cases even 20 or more (C23, C28, C31, C36, C39). A high number of criteria should not jeopardize the technical requirements set out by Bouyssou (1990), such as eligibility and operability, but it may do so when the criteria-setting process largely depends on social actors, due to difficulties for them derived from processing the information (Díez et al., 2015).

4.2.3. Evaluation step

The methodological flexibility of SMCE during the evaluation is also confirmed, in that SMCE is an open decision-making framework that can integrate varied methods in different steps. The explicitly integrated technical methods are as follows: Scenario Evaluation Methods (C1), SWTO Analysis (C3), Historical and Institutional Analysis (C8), Narrative Analysis (C10), Ecosystem Services/Function Analysis (C14, C17), EMSU (C18), Societal metabolism (C19), Mapping through GIS (C24, C33), Discrete Choice Experiment (C25), Landscape and Biogeographical Valuation (C25, C35), Fuzzy Cognitive Mapping (C31), Atomic Absorption Analysis (C34), Water Quality Analysis (C34), Delphi Method (C40), Discourse Analysis (C40), and Stakeholder Circle Methodology (C41). However, in most cases a non-specific method has been used for the case study's *ad hoc* quantitative or qualitative evaluations (C2, C4, C5, C6, C7, C9, C11, C12, C13, C15, C16, C20, C21, C22, C23, C26, C27, C28, C29, C30, C32, C36, C37, C38, C39).

4.2.4. Analysis step

The technical features are addressed as follows: (i) aggregation methods used; (ii) type of sensitivity analysis, depending on parameters used; and (iii) social evaluation undertaken. First, the majority of the analysed cases use NAIADE, i.e. 26 of 41, either individually (C1, C2, C4, C9, C10, C11, C12, C13, C14, C16, C17, C23, C24, C25, C26, C27, C28, C29, C33, C35, C36, C39, C41) or combined with another aggregation method (C3, C6, C38). So in general SMCE and NAIADE are collectively applied. Among the cases in which NAIADE is not employed, there are two groups of differentiated cases. First, in some cases no aggregation method is used (C8, C18, C19, C30, C34), which means SMCE is used as a *process* and not so much as an *instrument* in the search for a particular outcome. Second, in some other cases a variety of aggregation methods are applied: four of them use the Analytical Hierarchy Process (AHP) method (C15, C31, C32, C40), one uses Multi-Attribute Value Theory (MAVT) (C38), and five use the Condorcet rule (C5, C7, C21, C22, C37).

Second, more than half of the cases (i.e., 22 of 41) carry out sensitivity analysis, through which it is possible to evaluate the robustness of the model. Variations are introduced in the initial conditions or parameters of the model, and the effects of such variations on the final ranking of alternatives are observed. If the result changes significantly, then the outcomes are sensitive to uncertainty, which has been modelled in the analysed case studies by varying parameters related to the following three areas: compensation, weights, and thresholds. (i) *Compensation* is dealt with by NAIADE by means of varying the degree of compensation among criteria: the variation of the compensation index (parameter γ) is applied in a few cases (C4, C13, C16, C17, C26) in which the behaviour of the model as compared to different levels of compensation in aggregation is observed. The compensation suggests that positive valuations obtained in certain criteria may be compensated with negative valuations obtained in other criteria, and therefore the model leads to weak or strong sustainability. (ii) Variations of the relative *weight* of criteria are used in two ways. On the one hand, as NAIADE considers equally weighted criteria, sensitivity analysis has been done by means of comparing results derived from NAIADE with results derived from REGIME (C3, C6, C9). In contrast to NAIADE, REGIME is an aggregation method that assigns importance weights to the criteria but when only ordinal criterion scores are used (Hinloopen et al., 1983). As argued by Mysiak (2006) comparing different methods may prevent inconsistency in results obtained. On the other hand, a variation of the relative weight of criteria is carried out using Condorcet rule (C7, C22, C37), AHP (C15, C40), and MAVT (C38) methods. (iii) The use of preference and indifference *thresholds* for undertaking the NAIADE sensitivity analysis is less common (C17, C22, C26), and consists of reducing or increasing the thresholds to observe the effect of such variations on the results. For example, Kolinjivadi et al. (2015) vary the value of the thresholds by 50% to check model robustness.

Finally, social evaluation is undertaken in 27 of the 41 cases (C1, C2, C3, C4, C5, C6, C8, C10, C11, C13, C14, C15, C16, C17, C21, C23, C25, C26, C28, C29, C31, C33, C35, C36, C38, C39, C41), and in almost all of them this is carried out by means of NAIADE. In a further step, two of those cases (C11, C28) also compare the results of the social assessment with the results of the technical assessment. However, in four cases in which NAIADE is used no social evaluation is undertaken (C9, C12, C24, C27). This can be seen as an *underemployment* of NAIADE, which provides the opportunity to use an equity matrix to carry out social evaluation. By contrast, four cases use NAIADE just for social evaluation but not as an aggregation method (C3, C8, C15, C21). Two other cases use either a different impact matrix (C6) or a validation focus group (C31) for social evaluation.

4.3. Results of each case study

A few of the analysed cases do not technically evaluate the alternatives (C14, C30, C34) so they do not obtain any particular outcome, and other cases obtain unclear results (C8, C12, C40). As for evaluation alternatives, in the majority of the analysed cases the *business as usual* (BAU) alternative is considered, but in only one case is it the most suitable technically (C4). This reveals that in most cases SMCE serves to propose a best ranked alternative different to the *status quo*. Additionally, if the general characteristics of the best ranked alternatives are reviewed they tend to be *integrative* alternatives, i.e. holistic alternatives which combine some sort of mix in terms of social and ecological perspectives (e.g. C31, C36). This is shown in the majority of cases, in which the most suitable alternative is not identified with an *extremist* option, i.e. an alternative in which a particular dimension prevails over the rest (economic, territorial, social, institutional, ecological, etc.) (e.g. C27).

As for the so-called *compromise solution*, 12 of the 41 cases do not specify whether one has been reached (C3, C6, C7, C8, C9, C14, C18, C19, C22, C32, C37, C40), another 10 cases state that one has not been reached (C2, C4, C10, C11, C15, C21, C24, C26, C27, C28), in a few cases such an alternative is conditioned by circumstances (C23, C30, C33, C34), and just 15 of the cases rely on the compromise solution (C1, C5, C12, C13, C16, C17, C20, C25, C29, C30, C35, C36, C38, C39, C41). So around 65% of the cases do not explicitly consider this solution or tend to note the difficulty in achieving a compromise solution due to the opposing positions of the social actors. This clearly reveals the difficulties in achieving consensual solutions to social-ecological problems in which the opposing views involved are often irreconcilable.

Additionally, relevant to the analysis undertaken is the evidence of whether the best alternative has been implemented or not, regardless of whether it is a compromise solution. In this regard, in only one case has the SMCE served to implement the outcome (C14) and in another this was yet to be decided (C35), while in the vast majority of the 41 cases analysed it has not been implemented (in 28, or 68%) or this is not specified (in 11, or 27%). This result, together with the mainly public funding received in the majority of the cases, highlights the research and methodological focus of the use of SMCE. In fact, the objective of a 'methodological' proposal is recurrent in the cases (e.g. C4), together with references to a 'research' setting (e.g. C11).

5. Discussion

The findings of the analysis are discussed in terms of the reasons given for SMCE's suitability for application to the field of sustainability (strong sustainability, participatory process, and real implementation). Within each of these reasons, the main themes around which the discussion revolves have been addressed in sub-sections (aggregation method, sensitivity analysis; geographical scale, social evaluation and social actors' role; compromise solutions, policymaking and public decision-making).

5.1. Operationalization of the strong sustainability principle

5.1.1. Aggregation method

As noted in cases in which an aggregation method is not applied (C8, C18, C19, C30, C34) SMCE has been used as a *process* rather than as an *instrument* in the search for a particular outcome. This reveals the usefulness of SMCE as *problematic* within MCDA (Roy, 2016), sometimes even more than an instrument geared towards finding a particular solution. By contrast, given the cases in which alternatives are not technically evaluated (C14, C30, C34) or unclear results are obtained (C8, C12, C40) the objective of delivering policy recommendations pursued by SMCE may be undermined. In addition, the selected aggregation method may substantially modify the final result. For example, Afsordegan et al. (2015), employing TOPSIS, obtain similar but different results from Gamboa and Munda (2007), who employ NAIADE for the same real-world case study in regard to wind energy. So the final result, and therefore compromise solutions, depend on both the evaluation process followed and the aggregation method selected.

However, the key lies in to what extent the strong sustainability principle can be applied under SMCE, which largely depends on the aggregation method used. In cases in which a compensatory aggregation method is used, weak sustainability is consequently pursued, so the strong sustainability principle is not achieved. The clearest cases are those in which AHP (C15, C31, C32, C40) and MAVT (C38) are applied, as both aggregation methods are highly compensatory. So aggregation methods as such should be avoided in order to enforce the strong sustainability principle.

5.1.2. Sensitivity analysis

In the analysis, a majority use of NAIADE within the SMCE was found. In fact, this aggregation method is of special interest, given that it not only includes uncertainty through fuzzy sets but also allows the parameters to be modulated to align according to weak or strong sustainability, which can be verified by sensitivity analysis. In the cases in which the sensitivity analysis was undertaken via variation of the compensation index, results linked to strong sustainability may have been achieved, since an alternative achieved through a low compensation parameter is robust (i.e., application of strong sustainability). Some studies also carry out their analyses in accordance with the minimum operator (minimum compensation possible) (C16, C33) or a low compensation degree (C12, C26), and therefore in these cases the strong sustainability principle is also pursued. Therefore, many evaluation alternatives in the analysed cases can be categorized under strong sustainability.

The variation of the credibility index (parameter α) in NAIADE for the sensitivity analysis, however, has also been made in some cases (C12, C23, C25, C33, C35), leading to a weak/strong sustainability debate. The interpretation of some authors is that the greater the α, the lower the level of compensation among criteria, thereby being in line with strong sustainability, and *vice versa* (Shmelev and Rodríguez-Labajos, 2009; Shmelev, 2012; Seidl, 2017). However, Barinaga-Rementeria and Etxano (2020) state that variations of the preference thresholds of each criterion allow a more concise analysis of sustainability over the variations of α, underlining the fact that those variations act on all criteria simultaneously without knowing exactly their effect on each.

As has been shown, in general SMCE and NAIADE have been applied together, as has been done in about 65% of the cases. However NAIADE has also been criticized because (i) it exhibits a lack of transparency (Kain and Söderberg, 2008), (ii) qualitative information may only be used as a linguistic variable (Buchholz et al., 2009), and (iii) the operability to differentiate between weak and strong sustainability is not sufficiently adequate, although it has been explicitly designed for this purpose (Shmelev, 2017). With regard to the latter, as has already been mentioned, several cases show the operability of the strong sustainability principle (e.g. C12, C16, C26, C33) and should therefore not raise doubts in this respect. On the other hand, the OPTamos software (Singh et al., 2016; Grima et al., 2018) fulfils some interesting requirements, such as transparency and the use of weights. It is also easy to use with a user-friendly interface, so, compared to NAIADE, this makes up for some of its shortcomings. However, since its aggregation method is based on AHP it is compensatory, so it does not comply with the strong sustainability principle.

In moving beyond the weak/strong sustainability debate a panorama may be glimpsed that integrates a more dynamic and systemic vision of sustainability in accordance with social-ecological systems. But MCDA aggregation methods in general are conceived under the (non-) compensatory paradigm. So in a decision-making context in which such a limitation arises, we believe that this is the most appropriate way to proceed: first, use partially non-compensatory methods, and second, a non-compensatory application of such methods. In such a way, pursuing the strong sustainability principle, the sustainability of social-ecological systems would be favoured over the application of a weak sustainability principle. In fact, the maintenance of a certain level of natural capital (according to the CNC) makes it possible to have a reservoir that would facilitate the durability of these systems.

5.2. The role of the participatory processes

5.2.1. Geographical scale

In terms of the mechanisms of participation, as noted above, the majority of the analysed cases use interviews and focus groups. These participatory methods are well adapted to the local scale, the most common scale to approach social-ecological problems like the ones reviewed through the analysis of case studies. Since divergent policy options and irreconcilable opposing visions arise, such problems may result in conflicts. In fact, real-world cases reveal that SMCE is mainly linked to the local level, but some of the potential conflicts are at the same time global, such as water scarcity (C11), biofuel production (C24), oil extraction (C27) and mineral extraction (C30). So in these cases *glocal* social-ecological conflicts are faced (Urkidi, 2010). The paradigmatic case in this regard may be Yasuní National Park (Ecuador); it is an explicit conflict of local scale but at the same time clearly reflects global environmental burdens (Vallejo et al., 2015). All these cases reflect explicit social-ecological conflicts strongly tied to the local scale, but with unavoidable global implications such as resource depletion or climate change. So SMCE is applied locally but the issues are, eventually, global environmental ones.

With regard to geographical scope, therefore, the key is whether participatory processes really contribute to sustainability, among other issues, by channelling such multi-level social-ecological conflicts. It is not only a matter of the technical difficulties of carrying out participatory processes beyond the local scale, in which the actors involved are better represented with respect to the conflict addressed, as it has been shown that these difficulties can be overcome by means of literature reviews or population surveys (C11). Instead, a diverse narrative is necessary, moving away from a merely local perspective and emphasizing the global environmental implications, in order to tackle such social-ecological conflicts in all their magnitude. In this respect, emphasizing the role of ecological distribution conflicts (Scheidel et al., 2018) and the rise of environmental justice (Zepharovic et al., 2021) as forces for sustainability may be promising ways.

5.2.2. Social evaluation and social actors' role

Traditionally, equity matters have been introduced in MCDA through the weights of the different criteria or through the ethical criteria of evaluation, but NAIADE introduces a third possibility, the use of an equity matrix by means of social evaluation (Haastrup et al., 1998). This analysis contributes to explaining distributive aspects in the decision-making process, because it makes it possible to know the position of the different participants with respect to each of the evaluation alternatives and the identification of those groups that shall benefit or lose the most. Therefore, a conflict analysis by means of the equity matrix contributes to the search for *compromise solutions* from a social perspective (De Marchi et al., 2000; Russi, 2007; Munda, 2008), which offers an advantage compared to other aggregation methods. In fact, 25 of the 41 analysed cases use NAIADE for social evaluation. In addition, two of the cases analysed (C23, C28) show the possibility of carrying out a 'social sensitivity analysis' by means of NAIADE (Corral and Acosta, 2017; Corral and Hernandez, 2017), thus broadening the scope of the social evaluation.

The influence of social actors on both criteria and threshold setting within the participatory process is another important issue with regard to sustainability. First, when sensitivity analysis is undertaken by means of variations of the relative weight of criteria, apart from technical aspects, the role of social actors in defining such weights is underlined. In this regard, further research is necessary, as the difficulty shown by the social actors in addressing the different interpretations of the criteria has been shown to be a challenge (Scolobig et al., 2008). However, progress has also occurred: the limitation linked to the weights of the criteria has been overcome by Garmendia and Gamboa (2012), and this theoretical contribution has been contrasted by means of a case study using the Condorcet rule and the subsequent Condorcet-Kemeny-Young-Levenglick (C-K-Y-L) method (C21). Because this method complies with the requirements to address distributional issues in sustainability policy (Munda, 2009), a consistent alternative has been provided to those methods that consider equally weighted criteria in the assessment of sustainability.

Secondly, the issue of transparency in the participative process is highlighted by means of threshold setting, specifically regarding NAIADE. This task may be undermined by the subjectivity of the analyst when the social actors' views are translated and expressed through technical work (Russi, 2007). To overcome this weakness, thresholds can be defined either based on the maximum and minimum valuations of the alternatives for each criterion (C27) or on making their values explicit (C35), ensuring transparency in the participative process. So we do believe that NAIADE is a suitable aggregation method from a transparency perspective, as it provides the preference and indifference thresholds as well as the values of the compensation and credibility indexes.

5.3. Real implementation of SMCE

5.3.1. Compromise solutions

The analysis undertaken shows that achieving compromise solutions is not an easy task, because just a third of the cases (i.e. 15 of 41) manage this, about a quarter of them (i.e. 10 of 41) do not, and approximately 40% do not specify whether the compromise solution has been achieved, or it is conditioned by circumstances. So although the literature on SMCE establishes its ability to reach compromise solutions (De Marchi et al., 2000; Munda, 2004, 2008; Russi, 2007), the case studies show the complexity of application on the ground; that is, participative processes reveal a complex real world in which social-ecological conflicts and social incommensurability, in the form of opposing viewpoints, may arise. So sustainability may be at risk in cases in which opposing views are irreconcilable and no compromise solution is reached, because the solutions that are found are not necessarily durable over time.

As for the compromise solutions reached in the case studies, the key issue to be highlighted is whether such alternatives are 'truly' sustainable. The analysis reveals that in some cases social-ecological conflicts are of such a scale that their development may undermine sustainability (e.g., extractive activities). In one case, for example, the best ranked alternative advocates not exploiting the resources (Vallejo et al., 2015), thus favouring strong sustainability. But what happens when an evaluation alternative suggests the transformation of natural capital into reproducible capital, such as the construction of road infrastructure in a natural area, and is this alternative technically the most suitable? This would be the case of the so-called integrative alternatives, in which pursuing a holistic perspective seems to undermine the strong sustainability principle. By contrast, in so-called extremist alternatives, apparently strong sustainability may be pursued more easily because a particular 'sustainable' dimension (e.g., ecological) prevails over the rest. With this view, the analysis suggests that (strong) sustainability may be at risk, as the majority of the best ranked alternatives may be considered integrative ones. However, a more in-depth analysis of the features of each evaluation alternative in each case study would be needed; this goes beyond the scope of our analysis, as the case studies do not sufficiently specify such features.

5.3.2. Policymaking and public decision-making

We agree with Roy (2016) that the contribution of MCDA is essentially derived from a *constructivist* path (i.e. a search for a working hypothesis for recommendation) and an *axiomatic* path (i.e. a search for norms for prescribing), rather than a *realist* path (i.e. producing descriptions). In fact, we believe that MCDA in a public policymaking context should be linked with those two paths because it should serve either for recommending or prescribing policy measures. However, this would open the debate about the placement of MCDA in public policymaking in terms of, among other issues, agency, pertinence or efficiency. The analysis carried out, based on cases in which policy-oriented alternatives have been sought to deal with specific social-ecological problems in practice, calls into question the effectiveness of SMCE for public policy. So is the use of SMCE relevant for sustainability policymaking? The answer is no, in the light of the analysis carried out; only one case has shown the application of the result in a real setting. In line with Gamper and Turcanu (2007), this casts serious doubt on its use in terms of public policymaking. However, the analysis also reveals that the best ranked alternatives are actually *new* policy-oriented alternatives, as just one of the best ranked alternatives is BAU (C4). Therefore, SMCE serves to *recommend* changes in sustainability policy options, as most best ranked alternatives are different from BAU.

Methods, in general, are not neutral insofar as they condition the narratives for sustainability (Saltelli et al., 2020), and this is also the case with SMCE. But if the goal is really to promote decision-making for sustainability, policymakers should be aware that there are several aspects to consider when selecting methods: (i) integrating the complexity and holistic vision that social-ecological systems require at different scales (Berkes et al., 2003; Folke et al., 2005); (ii) taking into account incommensurability to promote sustainability (Lejano et al., 2019); and (iii) considering uncertainty in evaluation (Prato, 2007). However, decisions about the methods selected for decision-making processes probably have more to do with randomness (e.g., accessibility, availability of resources, deadlines, etc.) than with suitability. For example, cost–benefit analysis has a good reputation in the public policy arena despite the fact that it also is criticized regarding its contribution to sustainability and well-being (Wegner and Pascual, 2011). So a *new* narrative for sustainability from public bodies would be required, incorporating features that methodological frameworks such as SMCE share. In any case, such a narrative should serve to make the use of SMCE, and MCDA generally speaking, part of the legal requirements for evaluation in public decision-making processes. The incorporation of MCDA, and in particular of SMCE, as a legal requirement is essential for these methods to have a greater presence in public decision-making processes.

The analysis also shows that the search for alternatives is feasible under the strong sustainability principle, when selecting the aggregation method and adjusting the required parameters. Therefore, this may be a normative requirement to start the public decision-making process as it has already been considered within SMCE (Pelenc and Etxano, 2021). However, in a context of unavoidable uncertainty, if the strong sustainability principle is to be deployed, the *precautionary principle* should be considered, as it may prevent irreversibility (see Howarth, 2017; Seidl, 2017). For example, evaluation undertaken by Bernal and Zografos (2012) can be inspiring in this regard, as it combines both the strong sustainability and precautionary principles, so the best ranked alternative already contains the precautionary principle. In the case in which there is caution in terms of the ecological-environmental impacts generated by specific alternatives, it would be reasonable to discuss this principle and whether or not to undertake the evaluation process. The issue at stake would be the relationship between the precautionary principle and the veto power in the decision-making process, i.e. whether veto power can be exercised over ‘unsustainable’ alternatives. If so, it should be exercised prior to the formulation of these alternatives, because irreversibility could jeopardize the well-being of both current and future generations. But what is the veto power capacity of the different social actors in a decision-making process? Beyond the distribution of power, what is at stake is whether social actors are willing to consider a decrease in natural capital, and if they are, to what extent—that is, where the CNC threshold is situated. Therefore, CNC may also be defined socially, in the case that the social actors advocating no substitution of natural capital with reproducible capital have the opportunity to actively participate in the decision-making process.

6. Conclusions

This study has reviewed the theoretical and methodological principles of SMCE in terms of its contribution to sustainability assessment, and then it has contrasted the integration of sustainability within the SMCE framework through the analysis of real-world case studies. Based on an exhaustive bibliographical review, the analysis has covered the empirical evidence gap in the SMCE field by providing a systematic inventory of SMCE case studies. In our framework three main reasons why sustainability can be addressed in SMCE have been provided, namely, (i) operationalization of the strong sustainability principle, (ii) incorporating the social actors’ views through participative processes, and (iii) searching for compromise solutions when implementing SMCE.

The analysis undertaken reveals, first, that in general SMCE and the NAIADE aggregation method have been jointly applied. NAIADE does not fulfil all the desirable properties for sustainability assessment, but it does involve operationalization of the strong sustainability principle. The strong sustainability principle depends to a large extent on the aggregation method applied in the analysis step of the SMCE process. In this respect, we advocate using partially non-compensatory methods and a non-compensatory application of such methods. In such a way, the sustainability of social-ecological systems would be favoured as the strong sustainability principle is pursued over the weak sustainability principle.

Secondly, participatory processes, closely linked to the local scale, must take into account the global implications of the social-ecological problem addressed, which is a challenge from the operational point of view. Also, a diverse narrative is necessary in such cases, linking the local scale with global implications as *glocal* problems are dealt with. The influence of the social actors in setting the criteria is decisive insofar as it reflects their vision of sustainability, for which the use of weights in setting the criteria should be favoured. Transparency is also necessary throughout the participatory process, in particular with regard to making explicit the technical parameters used.

Thirdly, the analysis reveals that reaching compromise solutions in practice is not easy. However, without compromise solutions sustainability may be at risk because the evaluation alternatives are not necessarily durable over time. What stands out most in the analysis results is that only in one case out of the 41 analysed were the SMCE evaluation results later implemented as a policy option. So SMCE application has been focused on methodological and research approaches, rather than used in real policy settings where recommendations as regards alternatives may be effectively implemented. However, this outcome is not surprising given that only research papers have been analysed, so this limitation may be overcome in the future, for instance by means of the inclusion of grey literature in the analysis.

Nonetheless, the analysis also shows that SMCE can contribute to sustainability public decision-making as an instrument that facilitates the selection of policy-oriented options. However, for SMCE to be effectively used in public decision-making, a new narrative on sustainability by public bodies would be desirable, incorporating elements such as complexity, incommensurability and uncertainty. This new narrative would be favoured if accompanied by making SMCE and other MCDA participatory methods a legal requirement when evaluating public projects.

Finally, some cases have also shown that the strong sustainability principle, together with the precautionary principle, can be a *normative* requirement from the beginning of the evaluation process. However, although neglecting these principles may jeopardize searching on the ground for a *sustainable* evaluation alternative, it is impossible to ignore the fact that it would be at the mercy of the veto power of certain social actors, which could derail application of the strong sustainable principle. A more detailed analysis of the features of the evaluation alternatives would also provide a more accurate interpretation in terms of sustainability, so it would be necessary to gather first-hand information in each case analysed, a task that goes beyond the scope of this study.

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Declaration of Competing Interest

None

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Annex

Table A.1
Systematic inventory of SMCE case studies.

General features						Process steps							Results		
						Problem Definition		Structure the Problem	Evaluation	Analysis					
No.	Year	Author(s) ref.	Place	Subject	Funding	Social-ecological problem	Public participation method*	No. Crit. / No. Alter.	Technical method	Aggregation method	Sensitivity analysis	Social evaluation	Best ranked alternative features	Compromise solution	Implementation
C1	1998	Haastrup et al. (1998)	Provinces of Sicily, Italy	Urban waste management policy	Pub. Adm. contract	Different opposing strategies	Interviews; consultations; study of available material	5 / 5	Scenario Evaluation Models	NAIADE	No	Yes	Maximize recycling and compost	Maximize recycling and compost (majority of participants in favour)	Not specified
C2	2000	De Marchi et al. (2000)	Troina, Sicily, Italy	Provision and management of water	Not specified	Wasting the potential of water resources vs. taking full advantage of water resources	In-depth interviews; surveys of residents	9 / 8	Non-specific	NAIADE	No	Yes	Information campaign about water resources (increase public knowledge and awareness)	Technical alternative not socially supported	Not specified
C3	2002	Torrieri et al. (2002)	Vesuvius area, Naples, Italy	Urban contingency policy	Not specified	Different conflicting patterns of population and economic activity distribution	Expert discussions; semi-structured interviews	13 / 4	SWOT Analysis	REGIME and NAIADE	Comparison results of REGIME and NAIADE	Yes (NAIADE)	Concentration of population in three territorial areas and improve tourist sector	Not specified	No
C4	2006	Gamboa (2006)	Aysen region, Chile	Regional development	Publicly funded research project	Development based on the aluminium industry vs. development based on other activities	In-depth interviews; focus groups; workshops with minors (14–18 years of age)	9 / 3 (3 scenarios in 2 distinct periods)	Non-specific	NAIADE	Variation of γ	Yes	Depending on the period, BAU and integrated alternative (BAU+ aluminium project sector)	No compromise solution	No
C5	2007	Gamboa and Munda (2007)	Urgell and Conca de Barberà, Catalonia	Location of wind farms	Publicly funded research project	Wind energy vs. maintenance of land and landscape	In-depth interviews; focus groups	9 / 7	Non-specific	Condorcet Rule	No	Yes	CBST, ST and L technically better; but L and R (*modified* alternatives) the only technically and socially acceptable ones	L (26 windmills with 39 MW power capacity)	Not specified
C6	2007	Tarrasón et al. (2007)	Taradell, Catalonia	Fertilization of land for crops	Publicly funded research project	Different conflicting fertilization techniques	In-depth interviews with property owners	6 / 4 (*Technical*) 5/4 (property owners)	Non-specific	REGIME and NAIADE	Use of both methods and in REGIME variation of relative weight criteria	Implicit: use of both technical IM and of property owners	Composted sludge the most suitable in terms of soil, vegetation, costs and toxicity	Not specified	Not specified
C7	2008	Munda and Russi (2008)	Natural Park of Montseny, Catalonia	Rural electrification	Publicly funded research project	Solar energy vs. traditional electric supply	In-depth and telephone interviews; meetings with experts	9/3 (Natural Park Service); 4/4 (property owners); 5/3 (residents)	Non-specific	Condorcet Rule	Variation of relative weight criteria	No	Photovoltaic system, depending on participants and sensitivity analysis	Not specified	Not specified
C8	2008		Yalova, Turkey					9 / 4		None	No		Unclear	Not specified	No

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Table A.1 (*continued*)

General features						Process steps							Results		
						Problem Definition		Structure the Problem	Evaluation	Analysis					
No.	Year	Author(s) ref.	Place	Subject	Funding	Social-ecological problem	Public participation method*	No. Crit. / No. Alter.	Technical method	Aggregation method	Sensitivity analysis	Social evaluation	Best ranked alternative features	Compromise solution	Implementation
		Özkaynak (2008)		City planning and governance	Grant funded by university	Multifaceted urban problems	Interviews; focus groups; workshops		Historical and Institutional Analysis			Yes (NAIADE)			
C9	2008	Roca et al. (2008)	Lido de Sète, France	Coastal erosion risk	Publicly funded research project	Protection of the shoreline vs. retreating from the coastline	In-depth interviews; meetings with representatives of all participants	8 / 9	Non-specific	NAIADE	REGIME: variation of relative weights criteria	No	Technically, alternative improvements corresponding to the retreating from the shoreline scenario	Not specified	Not specified
C10	2008	Scolobig et al. (2008)	Malborghetto-Valbruna, Italy	Flood risk mitigation	Publicly funded research	Flood-mitigation alternatives in conflict	Semi-structured interviews; questionnaire	10 / 6	Narrative Analysis	NAIADE	No	Yes	Two holistic and integrated alternatives to local knowledge	Narrative of social actors presents dilemmas among alternatives	Not specified
C11	2009	Paneque et al. (2009)	Costa del Sol, Andalusia	Provision and management of water	Not specified	Multiple conflicting forms of water provision and management	In-depth interviews; focus groups; local population surveys	11 / 8	Non-specific	NAIADE	IM according to social actors	Yes	Alternatives of water demand management	Solutions of the authorities do not correspond with the results of the analysis	No
C12	2009	Siciliano (2009)	South Tuscany, Italy	Sustainable agriculture	Publicly funded research project	Wheat production vs. land preservation	Surveys of specific social actors; in-depth and telephone interviews	8 / 3	Non-specific	NAIADE	Variation of α, of γ, and of different operators (minimum, *Z*-Z, simple product)	No	Organic cultivation practice (introduction or maintenance of organic agricultural methods)	Integrates three dimensions through the criteria (economic, ecological and social)	Not specified
C13	2010	Garmendia et al. (2010)	Biosphere Reserve of Urdaibai, Basque Country	Integrated management of coastal areas	Publicly funded research project	Multiple uses and activities in conflict	In-depth interviews; open presentation; focus groups	8 / 11	Non-specific	NAIADE	Variation of γ	Yes	Alternatives to conservation (no-dredge scenario) and submerged (minimum-dredging scenario)	Conservation (do not allow dredging and direct public resources into conservation measures)	No
C14	2010	Pearson et al. (2010)	Rocky Point, Southeast of Queensland, Australia	Scenarios of sustainable land use in peri-urban areas	Publicly funded project	Agriculture and outdoor activity planning vs. residential and commercial development	Committees; public presentations; focus groups; questionnaires; semi-structured interviews	10 / 4	Ecosystem Services Analysis	NAIADE	No	Yes	None	Not specified	3 of the 4 land use scenarios adopted by local government in planning framework
C15	2011	Antunes et al. (2011)	Caia, Portugal	Irrigation management	Publicly funded research project	Different opposing management alternatives	Semi-structured interviews; workshops	13 / 6	Non-specific	AHP	Variation of weights of criteria	Yes (NAIADE)	Modernization/ substitution of irrigation systems	No compromise solution (the best alternative is socially controversial)	No
C16	2011	Monterroso et al. (2011)	Lake Izabal, Guatemala	Analysis of invasive species	Publicly funded research project	Different means of control and management in conflict	In-depth interviews; Focus groups; Workshops	7 / 5	Non-specific	NAIADE	Minimum operator and variation of γ	Yes	Control measures (integrates different control measures approved by the EIA)	Mechanical extraction minimizes social conflict	No
C17	2011							9 / 3		NAIADE		Yes			No

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Table A.1 (*continued*)

General features						Process steps							Results		
						Problem Definition		Structure the Problem	Evaluation	Analysis					
No.	Year	Author(s) ref.	Place	Subject	Funding	Social-ecological problem	Public participation method*	No. Crit. / No. Alter.	Technical method	Aggregation method	Sensitivity analysis	Social evaluation	Best ranked alternative features	Compromise solution	Implementation
		Oikonomou et al. (2011)	LIC Natura 2000 Kalloni, Lesbos, Greece	Planning based on ecosystem functions	Publicly funded research project	Urban development and coastal exploitation vs. preservation of natural resources	In-depth interviews; questionnaires; participative observation		Ecosystem Functions Analysis		Variation of γ, and of thresholds		Implementation of the management plan and partial implementation of the management plan	Partial implementation of the management plan	
C18	2012	Bernal and Zografos (2012)	Los Monegros, Aragon, Spain	Irrigation systems as socioeconomic development strategy	Not specified	Environment threatened and affected by agricultural irrigation systems	In-depth interviews; focus groups	15 / 4	EMSU – Eco-integrated Methodology for the Management of Structural Uncertainty	None	No	No	Global responsibility (in terms of sustainability)	Not specified	No
C19	2012	Siciliano (2012)	Chongming Island (Hongxing village), China	Rural planning	Not specified	Diverse effects of rural urbanization policies	Interviews	6/3 (village level); 4/3 (household level)	Societal metabolism	None	No	No	Unclear	Not specified	No
C20	2013	Aydin et al. (2013)	Turkey	Genetically modified (GM) cotton farming	Not specified	Potential risks and benefits of GM crops	In-depth interviews	9 / 4	Non-specific	Not specified	No	No	If economic dimension prevails: GM farming; If social dimension prevails: "ecological farming	If economic and social dimension equally: good agricultural practices	No
C21	2013	Domènech et al. (2013)	Metropolitan Area of Barcelona, Catalonia	Non-conventional water resources (NCWR)	Publicly funded research project	NCWR – business as usual vs. NCWR – decrease in growth paradigm	Online questionnaire	8 / 4	Non-specific	C-K-Y-L (based on Condorcet Rule)	No	Yes (NAIADE)	Recycled water and rainwater, depending on weighed criteria	No compromise solution, although rainwater has wide support	No
C22	2014	Borzoni et al. (2014)	Mt. Amiata, Tuscany, Italy	Geothermal power	Not specified	Projects planned by a private company vs. opposition to projects planned	Semi-structured interviews	11 / 7	Non-specific	Condorcet Rule	Increasing weight of each criterion; variation of indifference thresholds	No	*Re*-organization plan and a new 40 MW power plant	Not specified	No
C23	2015	Acosta and Corral (2015)	Tenerife, Canary Islands, Spain	Forest planning and management	Publicly funded research project	Free access to forest tracks vs. traffic regulations on forest tracks	Interviews; surveys; focus group	23/5 (forest planning); 20/5 (forest management)	Non-specific	NAIADE	Variation of α, of γ, and of different operators (minimum, Z-Z, simple product)	Yes	Planning: pre-paid charge for traffic circulation; management: Improving forest infrastructures	Planning: combination of pre-paid charge for traffic with maintaining the current situation for residents; management: no compromise solution	Not specified
C24	2015	Corral et al. (2015)	Fuerteventura, Canary Islands, Spain	Crops for biofuel	Research project funded by	Different alternatives to crops and production of	In-depth interviews	12/16 (Phase I); 6/16 (Phase II); 10/8 (Phase III)	Mapping through GIS	NAIADE	No	No	Crop growth on appropriate land with irrigation from recycled urban	No compromise solution	No

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Table A.1 (*continued*)

General features						Process steps							Results		
						Problem Definition		Structure the Problem	Evaluation	Analysis					
No.	Year	Author(s) ref.	Place	Subject	Funding	Social-ecological problem	Public participation method*	No. Crit. / No. Alter.	Technical method	Aggregation method	Sensitivity analysis	Social evaluation	Best ranked alternative features	Compromise solution	Implementation
					a private company	biofuel in conflict							water and 100% evapotranspiration		
C25	2015	Etxano et al. (2015)	LIC Natura 2000 Gárate-Santa Bárbara, Basque Country	Planning and managing of protected areas	Pub. Adm. contract	Conservation of native species vs. expansion in wine-growing production	Open presentation; in-depth interview; focus groups	8 / 8	Discrete Choice Experiment; Landscape Biogeographic Evaluation	NAIADE	Variation of α, and of γ	Yes	Strengthening of high ecological values with additional compensation	Strengthening of high ecological values with additional compensation	Not specified
C26	2015	Kolinjivadi et al. (2015)	National Park of Shivapuri-Nagarjun, Nepal	Water management	Publicly funded research	Economic effects of Payments for Environmental Services (PES) vs. human well-being and capacities linked to the PES	Semi-structured interview; focus groups; in-depth interviews; open presentation	11 / 10	Non-specific	NAIADE	Variation of γ, and of preference thresholds	Yes	Payments to citizens/user groups (equal payments scenario)	No compromise solution	Not specified
C27	2015	Vallejo et al. (2015)	Yasuní, Ecuador	Exploitation of oil resources	Publicly funded research project	No-extraction of crude oil vs. extraction of crude oil	Workshops; Delphi method	19 / 4	Non-specific	NAIADE	Yes (not specified)	No	No-extraction of crude oil from Yasuní-ITT	No compromise solution	No
C28	2016	Hernández and Corral (2016)	Tenerife, Canary Islands, Spain	Passenger transport by land	Not specified	Different transport method alternatives	In-depth interviews; focus groups	26 / 5	Non-specific	NAIADE	IM according to social actors	Yes	Improve current public transport system, and introduce dissuasive measures for car use	No compromise solution	No
C29	2016	Scuderi and Sturiale (2016)	Sicily, Italy	Phytosanitary emergency	Not specified	Diverse strategies for managing *Citrus Tristeza virus*-infected fruit yards	Interviews; focus groups	4 / 3	Non-specific	NAIADE	No	Yes	Co-habitation with the CTV and progressive eradication	Co-habitation with the CTV and progressive eradication	No
C30	2016	Walter et al. (2016)	Íntag, Ecuador	Exploitation of mineral resources	Publicly funded research	No-extraction of copper vs. copper extraction	Workshops; Interviews; assemblies	7 / 4	Non-specific	None	No	No	None	None	No
C31	2017	Grima et al. (2017)	Cuitzmala, Jalisco, Mexico	Regional planning in water basin	Publicly funded research project	Ecological deterioration of the water basin vs. preservation of the water basin	Open presentation; workshops; focus groups	20 / 3	Fuzzy Cognitive Mapping	OPTamos (based on AHP)	No	Implicit (focus group of validation)	Mixed land use with partial financing of the PES	Mixed land use with partial financing of the PES	No
C32	2017	Lutz et al. (2017)	Four munici palities in Austria	Local food supply systems	Publicly funded research project	Diverse forms of farmer cooperation	Workshops; qualitative interviews	12 / 8	Non-specific	AHP	No	No	Improving logistics	Not specified	No
C33	2017	Martínez-Sastre et al. (2017)	Sierra Morena, Jaen, Spain	Regional planning in Mediterranean landscape	Publicly funded research project	Deterioration derived from changes in ground uses vs. preservation of	Semi-structured interviews; workshop	6 / 6 (technical IM and social IM)	Mapping through GIS	NAIADE	Variation of α, and of γ	Yes	Mosaic landscape (multifunctional landscape in terms of ES	Uncertainty over Mosaic landscape as compromise solution	No

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Table A.1 (*continued*)

General features						Process steps							Results		
						Problem Definition		Structure the Problem	Evaluation	Analysis					
No.	Year	Author(s) ref.	Place	Subject	Funding	Social-ecological problem	Public participation method*	No. Crit. / No. Alter.	Technical method	Aggregation method	Sensitivity analysis	Social evaluation	Best ranked alternative features	Compromise solution	Implementation
						Mediterranean landscape							supply and human well-being)		
C34	2018	Corzo and Gamboa (2018)	San Mateo de Huanchor, Peru	Mining liabilities	Publicly funded research grant	Conflicts between local communities and mining companies	Interviews	None	Atomic Absorption Analysis; Water Quality Analysis	None	No	No	None	None	No
C35	2018	Etxano et al. (2018)	Mutriku, Basque Country	Rural planning	Publicly funded research project	Different values and rural development models in conflict	Open presentation; semi-structured interviews; focus groups	6 / 5	Landscape Biogeographic Evaluation	NAIADE	Variation of α, and of γ	Yes	Intense promotion of new agrarian models and intense promotion of native forest	Intense promotion of new agrarian models	To be decided
C36	2018	Sturiale and Scuderi (2018)	Catania, Sicily, Italy	Urban planning	Project funded by university	Alternatives in conflict within the eco-social-green planning model	Focus groups	21 / 3	Non-specific	NAIADE	No	Yes	Social Hypothesis (creation of green areas with a social function)	Social Hypothesis	No
C37	2019	Benitez-Campo and Peña-Salamanca (2019)	El Cerrito, Valle del Cauca, Colombia	Pollution in wastewater	Grant funded by university	Recycling and minimization of chromium loads vs. high costs of implementing technologies	Semi-structured interviews	7 / 3	Non-specific	Condorcet Rule	Equal weight to all dimensions	No	Biotechnological alternative complemented with cleaner production practices	Not specified	No
C38	2019	Bottero et al. (2019)	Kwun Tong, Hong Kong	Urban planning	Grant funded by university	Different urban planning alternatives at stake	Questionnaire surveys of experts	7 / 5	Non-specific	NAIADE completed by MAVT	Variation of criteria weight (MAVT)	Yes	Low density housing	Low density housing	No
C39	2019	Sturiale and Scuderi (2019)	Catania, Sicily, Italy	Urban planning	Project funded by university	Different scenarios of green urban planning at stake	Questionnaires; focus groups	21 / 3	Non-specific	NAIADE	No	Yes	Hypothesis Inclusive (creation of green areas with inclusive and social functions)	Hypothesis Inclusive	No
C40	2019	Maes et al. (2019)	Rwenzori Mountains, Uganda	Disaster risk reduction policy	Not specified	Different disaster risk reduction measures	Focus groups; semi-structured interviews	11 / 26	Delphi Method; Discourse Analysis	AHP	Comparison of relative scores for each set of weight and relative scores for equal weights	No	Unclear. Depends on both regional areas and criteria weighting	Not specified	No
C41	2020	Bottero and Datola (2020)	Collegno, Italy	Urban regeneration	Not funded	Different regeneration strategies at stake	Focus group	19 / 6	Stakeholder Circle Methodology	NAIADE	No	Yes	City and Craft (valorisation of the economic activities)	City and Craft	No

Source: own elaboration.

Legend: No.: Number of case study; Author(s) ref.: Bibliographical reference of author(s); No. Crit. / No. Alter.; Number of criteria and alternatives.

Note (*): Public participation concerns all steps although it has been included in Problem definition because it starts in the first step.

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