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Prescriptive conflict prevention analysis: An application to the 2021 update of the Austrian flood risk management plan

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ABSTRACT

Flood events have become more frequent in Europe, and the adaptation to the increasing flood risks is needed. The Flood Directive set up a series of measures to increase European resilience, establishing Flood Risk Management Plans (FRMPs) at the level of the river basin district as one relevant action. In order to efficiently fulfil this objective, the involvement of stakeholders as well as the analysis of their roles, responsibilities, and demands has been considered to be crucial to develop FRMPs. As a result, the hypothesis tested in this paper is that a consensus solution for the 2021 update Austrian Flood Risk Management Plan is feasible. To demonstrate this, both in-depth interviews and questionnaires to key Austrian stakeholders are implemented. The information collected in both participatory techniques are then used to run a conflict prevention analysis. The results show that (a) improving the coordination among regions and including better land-use planning approaches are preferable to a hypothetical business as usual scenario; and (b) a consensus solution for the 2021 update Austrian FRMP might be achievable on the basis of both a deep discussion on the state-of-the art and green infrastructure development.

1. Introduction

One of the most relevant flood events ever occurred in the Upper Danube basin was recorded in June 2013, with maximum flood discharges at Vienna. This location has been affected by a series of major flood events along history: 1899, 1954, 2002, and 2013 (Blöschl et al., 2013). According to these authors, maximum flood discharges were identified in the year 2013 with 11 000 $m^3 s^{-1}$, 10 300 $m^3 s^{-1}$ in 2002, 9 600 $m^3 s^{-1}$ in 1954, and 10 500 $m^3 s^{-1}$ in 1899. The one produced in 2002 has been considered the trigger for the EU Floods Directive (EC, 2015).

Due to the fact that climate change is one more flood triggering factor among others, such as spatial and temporal distributions of rainfall at catchment scale, catchment morphology and runoff response (Garambois et al., 2014), adaptation to climate change has been considered essential for current societies (EEA, 2013, 2014; IPCC, 2014). However, adaptation cannot be implemented in any way, since uncoordinated and disperse pieces of legislation might reduce disaster response capabilities (Mysiak et al., 2013). As a consequence of the necessity of having a coordinated flood policy, the European Commission launched the Floods Directive in 2007, called *'Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks'*, with the purpose of setting up a series of measures to increase European resilience to flood risks (EC, 2007). The main objective of this Directive is establishing Flood Risk Management Plans (FRMPs) at the level of the river basin district, with the intention of reducing the potential negative consequences of flooding for human health, the environment, cultural heritage and economic activity (EC, 2007).

In order to efficiently fulfil the objective established in the Directive, a proper involvement of stakeholders as well as the analysis of their roles, responsibilities, and demands has been considered to be crucial to develop disaster risk management plans (Holub and Fuchs, 2009), including FRMPs (Fleischhauer et al., 2012), having noticed that the participation of key stakeholders in FRMPs might increase resilience to flood events (Schelfaut et al., 2011) and stick up for flood risk management inherent complexities (Löschner et al., 2016). As a result of the relevance of including stakeholders in flood governance, this paper pursues the analysis

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of potential stakeholder's agreement with the foreseen 2021 update version of the Austrian FRMP. This analysis is therefore based on both in-depth interviews and questionnaires to Austrian main stakeholders. This conflict prevention analysis will show (a) to what extent the stakeholders will support the inclusion of new measures in the current plan, and (b) the potential stakeholders' coalitions which might come out from the process of updating the current FRMP.

2. Theoretical framework of conflict/consensus analysis

The application of conflict/consensus analysis to flood risk management is aimed at determining «the level of acceptability of the risk, caused by the implementation of the regional plan, and the need for mitigation and adaptation measures to avoid/prevent or limit/minimise this risk» (Helbron et al., 2011, p. 94). But implementing those measures might be the origen of conflicts among stakeholders (Menzel and Buchecker, 2013; Tseng and Penning-Rowsell, 2012), being the resolution of those conflicts the main objective of conflict/consensus analysis (Stepanova and Bruckmeier, 2013). However, the procedure to be applied to help solving conflicts might differ.

Griewald and Rauschmayer (2014) suggest that understanding the conflicts need a capability approach based on both semi-structured interviews with stakeholders and document analyses. The authors analysed a flood protection conflict produced by the implementation of measures based on cutting down trees in a protected area in Leipzig (Germany). Their conclusions indicate that the adoption of capability-based analysis might bring useful insighths in the understanding of conflicts, improving flood risk governance. Helbron et al. (2011) proposed the use of environmental indicators within a Strategic Environmental Assessment approach to manage flood risk policy conflicts. This method of analysis was not however based on stakeholders' involvement, but on potential conflicts that might arise in land-use planning. The authors highlighted that the application of this method is useful for the identification of potential conflicts, providing a good framework for the proposal of specific measures to minimise flood risk in urban areas.

Integrated assessments can also be found in the literature, such as the one implemented for air pollution management (Corral-Quintana, 2004), water resources management (De Marchi et al., 2000; Paneque-Salgado et al., 2009), sustainable mobility planning (Hernández-González, 2014; Hernández-González and Corral-Quintana, 2016), flood risk management (Löschner et al., 2016), or coastal management (O'Toole et al., 2013). These studies showed that conflict analysis might be handled through the use of methodology combinations, such as institutional analysis, participatory techniques, and multi-criteria evaluation methods. These studies revealed that conflict/consensus analysis might either end well (reaching consensus or compromise solutions), indicating that collaboration among institutions and stakeholders might reduce conflicts and help conflict resolution (Löschner et al., 2016; Lubell, 2004; Sabatier et al., 2005), or might not (compromise solutions cannot be found and polarised positions between stakeholders linger on).

Among the studies that have found compromise solutions is the one developed by De Marchi et al. (2000). This analysis was conducted in Troina (Sicily) focused on water resources management. The problem began with the perception of an under-exploitation of the potential availability of water resources. The authors found that the best alternative, based on the multi-criteria evaluation, was an information campaign on the functioning of the water cycle. However, this alternative was considered socially unstable. Therefore, an alternative based on the combination of producing bottled mineral water and recreational activities in the forest was considered a good compromise solution, on the basis of stakeholders support.

Nevertheless, as pointed out above, conflict resolution is not always achievable. Corral-Quintana (2004) highlighted that even though a common agreement on air pollution policies in Tenerife (Canary Islands) could have been obtained, power relations exerted by several stakeholders pushed the business as usual situation forward. The same conclusions were detected in the analysis developed by Hernández-González (2014) and Hernández-González and Corral-Quintana (2016). These researchs developed a conflict analysis after assessing different sustainable mobility policies in Tenerife. Although the scientific assessment and stakeholders preferences mostly coincided, the union of local governments and regional lobbies held back sustainable options. Paneque-Salgado et al. (2009) also detected that local governments might not be willing to implement alternative water management policies other than their own proposal, albeit better and more socially accepted policies have been found.

Feliciano et al. (2014) pointed out that solutions to climate change mitigation in rural areas might be difficult to achieve as a consequence of physical-environmental constraints, lack of information and education, personal interests and social values. Other authors mention that conflicts exist since participation preactices are politicised and some powerful groups are very active in pursuing their personal interests in the decision-making processes (Kuhlicke et al., 2016; Tseng and Penning-Rowsell,

Table 1
Different methodologies to handle conflicts.

Environmental conflict	Methodology	Source
Transport planning	Multi-criteria and stakeholder analyses	Bana e Costa et al. (2001)
Natural resources management	Longitudinal approach	Blackstock et al. (2015)
Coastal fisheries	Stakeholder analysis	Bruckmeier and Larsen (2008)
Climate change mitigation	Stochastic Actor-oriented model	Ingold and Fischer (2014)
Farmland uses	Direct interviews and document analysis	Darly and Torre (2013)
Water resources management	Collaboration analysis	Lubell (2004)
	Advocacy coalition framework	Lubell et al. (2014)
	Multi-group evaluation	Giordano et al. (2007)
	Bayesian Belief Network	Giordano et al. (2013)
Flood protection	Capability-based analysis	Griewald and Rauschmayer (2014)
	Use of environmental indicators	Helbron et al. (2011)
	Exploratory research approach	Thaler and Levin-Keitel (2016)
Management of hill areas	Adaptive conjoint analysis	Morgan-Davies and Waterhouse (2010)
Reuse of brownfields	Multi-criteria decision analysis	Morio et al. (2013)
Land-use planning	Social impact assessment	Peltonen and Sairinen (2010)
	Content analysis of print media reports	von der Dunk et al. (2011)
Biodiversity management	Conceptual framework	White et al. (2009)

2012). Furthermore, conflict resolution based on participatory planning could be costly in terms of time and knowledge creation, and the cotribution of participating planning might be smaller than expected in theory (Menzel and Buchecker, 2013). More case studies have been identified in the literature review, as shown in Table 1.

Even though the Flood Directive is not as optimistic as the Water Framework Directive regarding the application of participatory processes in water management governance (Newig et al., 2014), in this paper a conflict/consensus analysis based on stakeholders engagement is applied. Thus, our approach embraces the concept of “participatory logic” that consist of establishing «*a process whereby stakeholders engagement in the initial project setting continues even when the project moves from temporary organization to a more permanent institution*» (O'Toole et al., 2013). The participatory logic approach applied here is based on institutional analysis, questionnaires, and in-depth interviews. The approach will be presented below.

3. Material and methods: conflict/consensus analysis for flood risk management

Corral-Quintana (2004) has been one of the pioneers proposing a procedure to implement institutional analyses. However, alternatives procedures can also be consulted in Koontz (2006) and Imperial (1999). Corral-Quintana (2004) suggests that exploring institutions and stakeholders should be split up into two steps: (a) a definition and description of the problem or conflict (Section 3.1.1), and (b) a presentation of the stakeholders involved in planning matters (Section 3.1.2). These two steps allow the analysts to build up a certain number of alternatives (in this case scenarios) to be analysed (Section 3.1.3). This practice also needs a series of participatory tecniques in order to be successful. As seen in Table 2, there are, on the one hand, framing techniques and, on the other hand, participatory techniques available to collect the information required for the institutional analysis. The techniques highlighted with a tick indicate those which have been applied in this case study. The general approach is however shown beloow in Fig. 1.

3.1. Institutional analysis: the current austrian flood risk management plan

Institutional analysis has accordingly been defined as the process which explores different structures and social relations that are embedded in policy making, all this with the intention of improving the understanding of how decisions are made (Corral-Quintana, 2004). That process is understood as the social context shaped by restrictions, rights and obligations (Bromley, 1989; Commons, 1961; Schmid, 1972), as well as by the absences of rules (Ostrom, 2005). Moreover, this process has a twofold direction, i.e. institutions shape stakeholders' behaviour, but the latter can also affect governance (Vatn, 2005). This double direction implies that the institutional context changes, and this is a key reason to explore and understand the process of policy-making (Corral-Quintana, 2004). In this context, analysing social actors' perceptions and their stakes, as well as the relations produced among them are needed (Tseng and Penning-Rowsell, 2012). Therefore, an institutional analysis should include legal, political and administrative structures, as well as the processes of policy-making (Ingram et al., 1984).

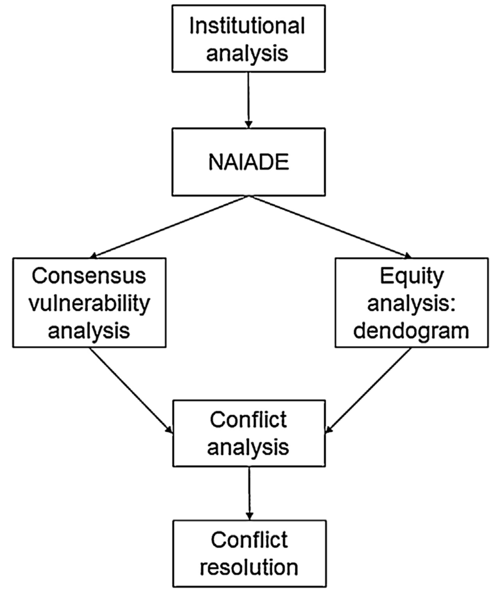

Fig. 1. Structure of the prescriptive conflict prevention analysis developed in this case study.

As mentioned above, the first step of the institutional analysis consists of defining and describing the problem at hand. This is the purpose of next section.

3.1.1. A brief definition of the problem

Due to its climate and its geography, Austria has extensive experience on floods (see Section 1). Recent devastating events include the floods of 2002, 2005 and 2013. Because of its location in the Alpine arc (2/3 of Austrian territory is alpine), less than 40% of the territory is suitable for permanent settlement and in Alpine areas less than 15% of the area is suitable for permanent settlement. In fact, river valleys and basins have always represented important settlement locations. Also because of its geographic location and climatic condition, Austria is rich in rivers and streams, over 100 000 km of rivers and streams flow through Austria.

Austria is a federal state divided into 9 regions (Länder): Burgenland, Carinthia, Lower Austria, Salzburg, Styria, Tirol, Upper Austria, Vienna and Vorarlberg. At the federal level the Ministry for Agriculture, Forestry, Environment and Water (BMLFUW) is responsible for the ‘Water Law’, where the ‘Floods Directive’ has been transposed. The BMLFUW competence is exerted also through the torrents and avalanche control service (WLV), divided into 7 sections dislocated across the 9 regions. Also at the federal level the Ministry of Internal Affairs (BMI) plays an advisory role with respect to matters related to emergency and civil protection, while the Ministry of Transport and Technology (BMVIT), through the company Via Donau, is responsible for flood management over

Table 2
Several participatory techniques for institutional analysis.

Framing techniques		Participatory techniques	
Press review		In-depth interviews with stakeholders	✓
Legal documents review	✓	Surveys to population	
In-depth interviews with experts	✓	Focus groups	

Source: Corral-Quintana, 2004; De Marchi et al., 2000; Hernández-González, 2014; Kuhlicke et al., 2016; Paneque-Salgado et al., 2009.

the rivers Danube, Thaya and March (BMLFUW, 2006). At the regional level the BMLFUW competence is exerted through the 9 regional sections of the flood control management service (BWV). This latter service is directly responsible for spatial and emergency planning. Although the 'Floods Directive' has been formally transposed into the federal 'Water Law' most of the practical flood risk management measures follow from the spatial and emergency planning which is entirely under the competence of each region.

From the administrative point of view, the FRMP is discussed and elaborated by a committee on flood risk management, formed by representatives of the key institutional actors mentioned above. The committee however also sends out its preliminary deliberation to various stakeholders (e.g., non-governmental organizations like World Wildlife Fund; hydropower companies like Verbund AG for consultation). The input provided by the various stakeholders are then discussed and incorporated into the management plan. Following this process, as of July 2015, a preliminary version of the Austrian FRMP existed. The plan has been subsequently circulated for evaluation by the public and various stakeholder, before being finally approved.

The administrative structure of Austria has the potential to generate conflicts, given the relatively large numbers of actors (operating at different levels) involved in flood risk management. In particular, two main issues appear to be critical. On one hand, given the prominence of regional administrations and central government in spatial and emergency planning, the coordination among the various regional legislations into a coherent national plan is often referred to as critical. This is what we label an institutional challenge. On the other hand, in other instances, the main difficulties appear to be technical and related to the elaboration, understanding and improvement of hazard maps. This is what we refer to as a technical challenge. In this article we aim at understanding the position of the various actors, with respect to these two broadly defined challenges and assessing the possibility of building consensus in the review of the flood risk management plan.

Institutional issues have also been reported as potential obstacles to flood risk resilience in Austria, such as the lack of mainstreaming adaptation into the current spatial planning legislation, and the current despise for the performance of local structural measures (Holub and Fuchs, 2009). Thaler and Hartmann (2016) highlight that Austrian flood risk management plans are top-down and expert-driven, leading to technocratic decision-making that excludes local actors and stakeholders from flood risk governance. Furthermore, Thaler et al. (2016) point out that there is (a) a lack of co-operation between regional authorities and a low co-operation in land-use planning; (b) a lack of technology knowledge and expertice among politicians and; (c) a the lack of common management approaches between Public Administration.

There have also been identified conflicts of interests. For example, Holub and Fuchs (2009) reported that areas of interest for settlement and economic activities are hazardous areas in terms of flood risks. As a consequence, there seems to be conflicts between stakeholders, since several of them pursue economic growth whlists others are more interested in land-use management restrictions (Thaler et al., 2016).

Several authors have suggested that the implementation of certain specific-oriented measures could be of use to increase resilience against flood risks in Austria. For instance, (a) risk transfer options based on economic incentives, (b) go in depth into prevention and precaution in disaster risk management planning, and (c) awareness raising campaigns (Holub and Fuchs, 2009). Other authors highlight the need for closer co-operation and stakeholders' engagement in flood risk management (Thaler et al., 2016), in order to tend to more partnerchip approaches (Thaler , 2014).

3.1.2. The stakeholders involved

As a first step in accomplishing this objective, the key stakeholders involved in the Austrian FRMP have been identified by consultation of official documents from BMLFUW. Secondly, consultations with experts at the *Institute for Environment and Sustainability of the Joint Research Centre (IES JRC)* were used to identify a number of additional stakeholders: representatives from the International Commission for the Protection of the Danube River (ICPDR), hydropower companies, non-governmental organizations and institutions from regional governments. With this information at hand, a preliminary set of key stakeholders were interviewed between mid-May and early June 2015 (first round). The purpose of this first round of interviews has been twofold: (a) to obtain a better understanding of the Austrian flood risk management governance structure and (b) to identify all key stakeholders.

A second round of interviews has taken place between mid-June and July 2015. Interviews with stakeholders operating at federal level were carried out in person, while those with regional players (with the exception of the actors in the regional/municipal administration of Vienna) were carried out by phone. All the contacted stakeholders (16) responded to the interview request, with the exception of the administration of Upper Austria (94%

Table 3
List of stakeholders contacted.

Institution	Type of institution	Role
BMLFUW (1)	Federal Ministry	Austrian delegate to the ICPDR
BMLFUW (2)	Federal Ministry	Responsible for the elaboration of the FRMP
BMVIT	Federal Ministry	Responsible for internal navigation on river Danube
BMI	Federal Ministry	Responsible for civil protection
Verbund Hydropower	Hydropower Company	Hydropower company
Via Donau	Danube river management company	Responsible for the maintenance and navigability of river Danube
WWF	Environmental organization	Environmental protection
MA45 Vienna	Regional administration	Responsible for flood protection in regional government
Burgenland	Regional administration	Responsible for flood protection in regional government
Carinthia	Regional administration	Responsible for flood protection in regional government
Lower Austria	Regional administration	Responsible for flood protection in regional government
Salzburg	Regional administration	Responsible for flood protection in regional government
Styria	Regional administration	Responsible for flood protection in regional government
Tirol	Regional administration	Responsible for flood protection in regional government
Upper Austria	Regional administration	Responsible for flood protection in regional government
Vorarlberg	Regional administration	Responsible for flood protection in regional government

response rate). The complete list of stakeholders is shown in Table 3.

Both rounds of in-depth interviews provided enough information to the analysts in order to built two scenarios for the current FRMP and a clear position of stakeholders with respect to both scenarios. This will be discussed in the next section.

3.1.3. The scenarios proposed to the current situation

The Floods Directive requires each Member State to come up with a FRMP by December 2015. As of July 2015, a preliminary version of the Austrian FRMP exists. The plan is currently being circulated for evaluation by the public and various stakeholders, before being finally approved.

In general the FRMP is structured around the five stages of awareness, preparation, aftercare, prevention and protection. Overall, a set of twenty-two measures has been included in the current FRMP. In terms of awareness, the most important measures relate to the provision of information to the public about the dangers of floods. Ultimately complete protection from floods is not feasible. For this reason it is important that the public is aware of risks and minimizes exposure. In terms of preparation (i.e., actions just prior to the occurrence of a flood event), the use of forecasting models and early warning systems is deemed to be relevant. In terms of aftercare (i.e., actions taking place after a flood event), priority measures include the maintenance of water bodies and protection infrastructure. Prevention measures focus mainly on the updating of the already existing risk maps and the creation of plans at both catchment area level, regional and supra-regional level. In terms of protection, the priority is given to non-structural measures (e.g., restoration of flood plains). The role of structural measures appears less important for the future, particularly because 88% of high flood risk zones are already adequately protected by structural interventions.

The Floods Directive also establishes in the Article 14.3 that «the flood risk management plan(s) shall be reviewed, and if necessary updated, (. . .), by 22 December 2021 and every six years thereafter» (EC, 2007, p. 33). Consequently, the possibility of either continuing the current FRMP or its improvement is opened. As mentioned before, after two rounds of in-depth interviews, the analysts could identify two potential scenarios to be considered in the 2021 FRMP update version. Both scenarios were proposed by the stakeholders. Essentially, the scenarios consisted of (1) prolonging the current situation with small changes, and (2) updating the current FRMP around the concepts of co-ordination and co-operation. However, this last scenario could imply several changes addressing institutional aspects (e.g., better coordination among various actors) and/or the improvement of technical aspects (e.g., better forecasting methods). Therefore, according to the stakeholders, the scenarios to be assessed are the following:

- Scenario 1: continuing the current FRMP. This policy option would consist of introducing minimum changes to the current plan. Only upgrading the flood hazard and risk maps, and adapting the existing measures to the new situation are considered.
- Scenario 2: improving the current FRMP. This improvement would involve the inclusion of a series of new measures. They can be split up into three blocks, from the more relevant to the less according to the stakeholders views:

1. Block A. Very important measures. They consist of two actions: (a) to improve land-use planning so as to prevent the construction of buildings and infrastructure in flood-prone areas. This is regional competence, therefore, an appropriate implementation of this action would also require (b) to improve the coordination among regions and local authorities in charge of flood prevention and land-use planning.
2. Block B: Important measures. They contain three actions: (a) to introduce better forecast models, as well as better alarm plans, as long as they are technologically feasible, (b) to increase the participation of the community within the FRMP updating process, and (c) to introduce private commitment in flood prevention, such as flood insurances, and house protection.
3. Block C: Other actions: (a) to increase flood risk management staff in the public administration, (b) to improve the maintenance of dams, (c) to introduce more transparency in the process of updating the FRMP, (d) to overcome financial constraints, and (e) to increase the rate of green infrastructure as passive flood protection measures, such as restoring floodplains or wetlands.

These two scenarios proposed by the stakeholders will be compared using the conflict analysis tools provided by the multi-criteria evaluation method NAIADE. This method will be presented in the next section.

3.2. NAIADE: a conflict analysis tool

NAIADE (**N**ovel **A**pproach to **I**mprecise **A**ssessment and **D**ecision **E**nvironments) is the method used to implement the consensus analysis (Munda, 1995). NAIADE is an outranking multi-criteria evaluation method intended to compare alternatives based on a set of criteria. Furthermore, and this will be the tool to be used in this case study, NAIADE allows the analysts to implement a conflict/consensus analysis based on stakeholders standpoints. A ranking of alternatives according to stakeholders' opinions, as well as the potential formation of coalitions can be given.

An equity matrix is therefore created using stakeholders' linguistic assessments of the scenarios proposed by themselves. The horizontal axis of this matrix is used to present the scenarios to be assessed, and the vertical left-side axis is used to present the stakeholders involved in the analysis. The cells inside reflect the judges given by the stakeholders to each scenario. This equity matrix is presented in Table 4.

The previous matrix provides two different kind of information, as already mentioned (see Fig. 1). On the one hand, a ranking of alternatives according to stakeholders' standpoints (see Fig. 2). The comparison of alternatives is performed through the distance produced between alternative $\boldsymbol{a}$ and $\boldsymbol{b}$ for the stakeholder view $\boldsymbol{j}$. These linguistic variables are coped with fuzzy sets (see Annex I), that are later used to calculate the *semantic distance* (see Annex II).

Table 4
Equity matrix: how stakeholders see the scenarios.

Actor	Scenario 1	Scenario 2
WWF	Bad	Good
BMLFUW (2)	Good	Very good
BMI	Good	Perfect
BVIT	More or less good	Good
BMLFUW (1)	Moderate	Good
Verbund	Good	Very good
Via Donau	Good	Good
Carinthia	More or less good	Very good
Styria	More or less good	Perfect
Vienna	Moderate	Good
Burgenland	Good	Perfect
Vorarlberg	Very good	Very good
Salzburg	Very good	Perfect
Lower Austria	Good	Good
Tirol	More or less good	Very good

Source: in-depth interviews.

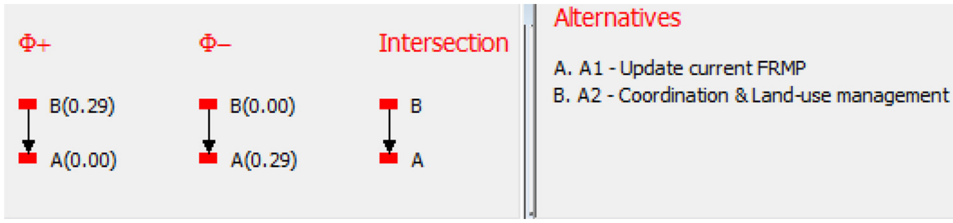

Fig. 2. Consensus vulnerability analysis: a ranking of scenarios according to stakeholders' views.

Once the *semantic distance* is computed, a ranking of alternatives can be implemented based on *preference relations* and pairwise comparison of alternatives (Munda, 1995). Firstly, *preference relations* are calculated, consisting of an index of credibility of the statements that an alternative is *much better, better, approximately equal, equal, worse* and *much worse* than another. The credibility index goes from 0 (definitely non-credible) to 1 (definitely credible). The definition of the six preference relations can be consulted in Munda (1995) and JRC (1996).

Secondly, an aggregation algorithm of the *credibility indexes* is used in order to calculate a *preference intensity index* and correspondent *entropies* of one alternative with respect to another. Thus, *preference intensity indexes* indicate how good an alternative is with respect to another; meanwhile, the *entropy* is an index that estimate the variance of the *credibility indexes* above a certain threshold given by the method and used for sensitivity analysis. Finally, a ranking of alternative (in this case scenarios) is produced based on the *preference intensity indexes* and *entropies* (see Fig. 2 for the ranking of alternatives).

On the other hand, a dendrogram of coalitions can be shown as well (see Fig. 3). The *semantic distance* is also used, but, in this case, to calculate the similarity indexes among the stakeholders. Thus, a *similarity matrix* is hence derived from the *equity matrix* (Table 4). The *similarity matrix* offers an index, for each pair of stakeholders i, j, of the similarity produced over the proposed scenarios. This index S_{ij} estimation is given in Annex III. These algorithms are used to analyse possible coalition formation and the degree of conflict among stakeholders. Thus, the algorithm indicates the groups whose interests are closer to the others. The degree of similarity among stakeholders (coalition) is measures between 0 and 1. Therefore, a value close to 1 implies a greater degree of similarity, and then a greater chance of creating coalition. Meanwhile, a value close to 0 might suggest a potential conflict between stakeholders. In section 4, the presentation of both results are given.

4. Results and discussion

The first result that can be derived from the interviews undertaken is the *equity matrix*, presented in Table 4. This table shows the stakeholders' views regarding each scenario by means of linguistic variables. Thus, the second result can be derived from Table 4, which is a ranking of alternatives according to stakeholders' views, which is called a *consensus vulnerability analysis* (see Fig. 2).

Fig. 2 shows two separate rankings and an intersection of both. The first ranking ϕ^{+} is based on a *better* and *much better* preference relation, with a value going from 0 to 1. This value indicates to what extent scenario 2 is *better* than scenario 1. The second ranking ϕ^{-} is however based on a *worse* and *much worse* preference relation, with the value between 0 and 1 indicating to what extent scenario

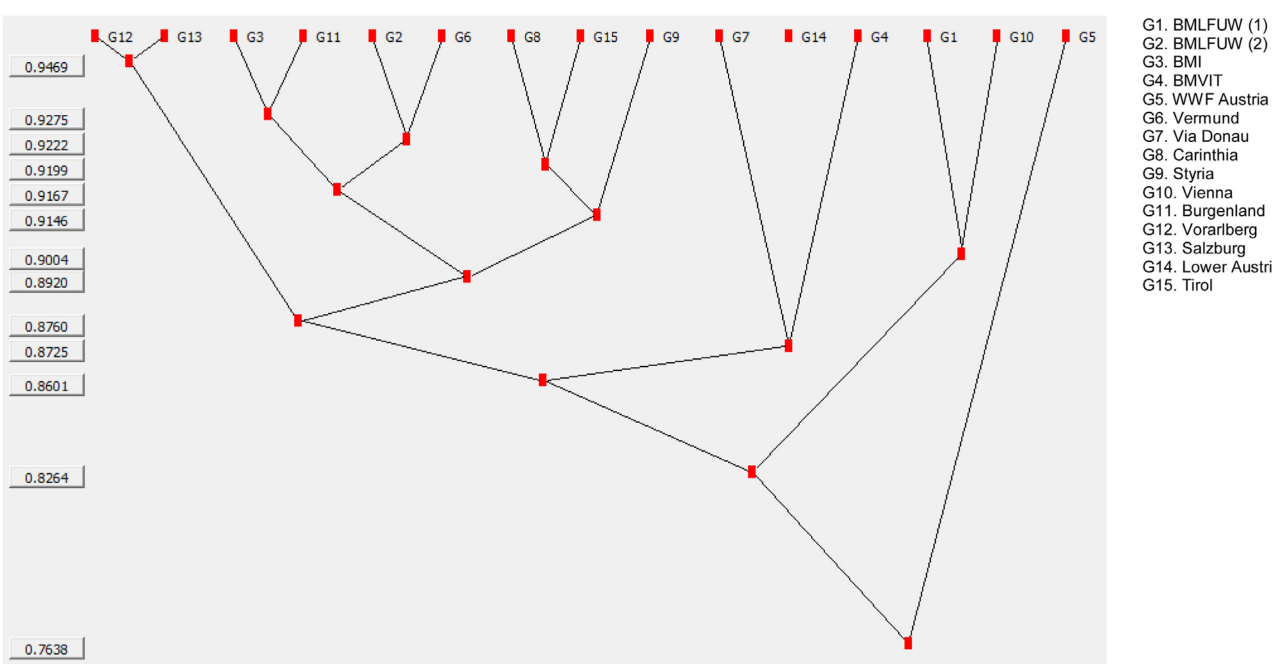

Fig. 3. Equity analysis: a dendrogram.

2 is *worse* than scenario 1. The intersection indicate that scenario 2 (or alternative B) is superior to scenario 1 (or alternative A) according to stakeholders' views. These results are coherent since scenario 2 is better for most of the stakeholders and never worse (see Table 4).

As seen in Fig. 2, better co-ordination between Public Administrations and mainstreaming flood risk management within land-use planning appear to be much desirable than a business as usual situation. However, scenario 2 has to be put into practice by means of specific measures. BMLFUW (1) mentioned in the interviews that green infrastructure should be encouraged, such as giving more room to rivers and restoring degraded rivers. The same opinion was given by WWF, i.e. natural options should be encourage over grey infrastructure, since adaptation by this means would also imply climate change mitigation. BMLFUW (2) mentioned that building specific codes for spatial planning is required, such as preventing constructions in flood-prone areas, as mentioned also by Burgenland. Creating economic incentives for risk-aware behaviour based on insurance solutions has support among several stakeholders as well, such as BMVIT and BMFUW (2). This measure has been pointed out by Holub and Fuchs (2009) as a good adaptation option.

However, more important than the proposal of adaptation measures is the stakeholder's support they may have or not. This is the analysis given in Fig. 3. This figure, as mentioned above, represents a dendrogram that reflects the level of conflict among stakeholders. It is aimed at understanding stakeholder dynamics through possible stakeholders' coalitions. A series of values are shown on the left-side vertical axis. These values are between 0 (complete disagreement) and 1 (complete agreement). As a consequence, a series of coalitions could be formed between stakeholders. At least, four groups of stakeholders could therefore take place in the future.

The first group could be formed by Vorarlberg (G12) and Salzburg (G13), since they have a very close opinion in both scenarios (0.9434). They both coincide in considering scenario 1, i.e. the business as usual situation, as a very good scenario. Essentially, they do not see specific challenges in the current situation. There are specific plans per region and consider that they know how to manage floods. Furthermore, they both believe that both areas might be assumed to be resilient against floods. However, they both consider that improving flood forecast models and flood risk maps could be of use.

The second group could be developed by BMI (G3) and Burgenland (G11), also with a close vision of the issue (0.9275). Burgenland states they have no challenges, although they might have problems concerning lack of personal to work on flood risk prevention. This stakeholder also considers that land-use planning rules should be more severe in flood-prone areas, i.e. construction in risky areas should be prevented. On the other hand, the main issue for BMI was the difficulty in operationalizing the use of the risk maps, for which they would not have sufficient expertise in-house.

The third potential coalition is the one formed by BMLFUW (2) (G2) and Verbund (G6) with a similarity index of 0.9199. BMLFUW (2) claims for better coordination and the development of building codes for land-use planning. This group also considers the introduction of economic incentives by means of insurance in order to promote adaptive changes in private decisions.

As seen, the previous two groups of coalitions might also be colligated (91.7% of agreement according to the dendrogram). Thus, both coalitions might form a more powerful group based on the improvement of coordination among regions and better land-use planning by means banning construction in flood-prone areas.

The fourth coalition might be formed by Styria (G9) and Vienna (G10). These two actors mostly agree on considering the current situation as "not fully resilient". According to both of them, new actions are needed. For example, they both assume that better forecast models are required to estimate properly flood risks. However, Vienna insisted on improving coordination among regions and institutions, especially regarding land-use planning at administrative levels.

Not only coalition formations can be seen in this analysis, but also the differences between stakeholders. For example, the distance between the representatives of BMLFUW (1) (G5) and BMLFUW (2) (G2) is remarkable, even though they belong to the same institution. On the one hand, BMFUW (1) indicated how the main challenge has been to coordinate the positions of the different Austrian regions, without referring to any specific pressing need for changes and improvements. BMLFUW (2) on the other hand, although expressed confidence in the ability of the current FRMP to provide a high coverage against floods, stated in the importance of establishing economic incentives (by means of insurance) to promote adaptation among private individuals. This difference however can be explained by the different competences these two actors have. In particular BMLFUW (2) is directly responsible for the elaboration of the FRMP at the national level, and has been directly involved in the coordination of the different regions quite successfully (from his own perspective). As such this actor perceives that future and more important challenges lie somewhere else. BMLFUW (1), on the other hand, is responsible for representing the Austrian position in an international context and has been less involved in the elaboration of the FRMP.

Lastly, the distance produced between WWF Austria (G5) and the rest of the stakeholders is also remarkable. Actually, it is the largest. WWF stated that resilience and robustness against flood risks is not guaranteed under this FRMP. First of all, this actor declares that mistakes have been made in past land-use planning, being this situation complicated to turn over. They also mentioned the existence of big hydropower lobbies which might not be sensible to adaptation issues, especially when dams might be one more additional flood triggering factor. WWF also mentioned that green infrastructure, such as giving more space to rivers, and restoring wetlands and floodplains have not properly been considered in the current FRMP, and they pointed out that adaptation to flood risks should rely more on green infrastructure than in grey one, due to the fact that the former not only implies adaptation but also mitigation to climate change.

Considering all these results together, the authors believe that despite the previous mentioned disagreements, a consensus might be feasible if a participatory and scientifically-based focus group discussion is conducted between all the stakeholders involved. Actually, a stronger effort should be done to engage BMLFUW (1) and WWF in the discussion for the FRMP, especially in the framing part (how they see the current situation) and in the proposal of adaptation policy options.

Initially, a discussed diagnosis of the current situation might be desired in order to bring all the stakeholders to a closer conclusions on the state-of-the-art. In fact, these two stakeholders (BMLFUW (1) and especially WWF) consider that the business as usual scenario cannot be prolonged in the future. Meanwhile, WWF does not consider Austria to be resilient to flood risks; instead, they define the current situation as «bad». These distances could perhaps be clarified in public debates.

Last but not least, to engage WWF outlook in the revision of the FRMP would also be desirable since they seem the group that shows more opposition to the current FRMP. Therefore, WWF might join to a plan that takes into consideration a more intense use of green infrastructure as an adaptation option. This is, in fact, an adaptation policy that is not only supported by WWF, but also by BMLFUW (1) and the European Union's climatic policy (European Commission, 2013).

5. Conclusions

Due to its climate and geography, Austria has recently suffered from devastating flood events. Because of its location in the Alpine arc (2/3 of Austrian territory is alpine), less than 40% of the territory is suitable for permanent settlement and in Alpine areas less than 15% of the area is suitable for permanent settlement. Thus, areas of interest for settlement and economic activities are hazardous areas in terms of flood risks, leading to conflicts between those stakeholders interested in economic growth and those others more interested in land-use management restrictions.

Apart from these topographical issues, institutional difficulties also appear to be important. Lack of mainstreaming adaptation into sectoral policies, technocratic decisions, low cooperation among regions, and lack of politician knowledge have been pointed out in this paper. Moreover, technical difficulties associated with the elaboration, use and interpretation of more and more complex risk maps have also been mentioned. As a consequence of these conflicts, a consensus for the 2021 update of the Austrial Flood Risk Management Plan might be apparently difficult to reach.

We have proposed and implemented an consensus analysis approach in order to (a) identify potential coalitions between stakeholders, (b) identify potential conflicts between them, as well as (c) potential points in common that could be of use to reduce future conflicts. The analysis applied a prescriptive conflict prevention analysis consisting of both in-depth interviews and questionnaires to Austrian key stakeholders. These stakeholders engagement in the proposal of scenarios showed that there are two directions to go through when updating the current plan. The first would consist of updating flood hazard and risk maps after incorporating the latest flood models available, and the second would introduce a new package of measures, although the most important ones are those enhancing coordination among regions and implementing better land-use planning.

Accordingly, the first result pointed out that most of the stakeholders prefer the latter scenario that includes an enhancement of coordination among regions and also an improvement in land-use planning, than the business as usual prolonged. Secondly, most of the stakeholders already considered a business as usual situation as resilient, but three stakeholders to whom resilience is rather moderate (BMLFUW (1) and Vienna) or bad (WWF). Therefore, there seems to be a certain disagreement on the state-of-the-art regarding flood risk in Austria.

Regarding the future desired scenario based on an improvement of coordination among regions and land-use planning, there could potentially be conflicts concerning the specific adaptation measures proposed. Generally speaking, there seems to be two stakeholders (BMLFUW (1) and WWF) who may apparently have more difficulties to be engaged in the update FRMP, since these two stakeholders support the enhancement of green infrastructure in the FRMP. However, the authors believe that a consensus solution for the 2021 update Austrian FRMP might be achievable if all the stakeholders debate together about the state-of-the-art and if green infrastructure is taken into account as a relevant adaptation policy option for Austria as has already been recommended by the European commission.

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Annex I: the linguistic variables.

The linguistic variables defined in Table 5 uses fuzzy sets demarcated in a 0–1 scale (JRC, 1996). Fig. 4 shows the intersections points of the functions that define each fuzzy set and their membership values.

Source: JRC (1996).

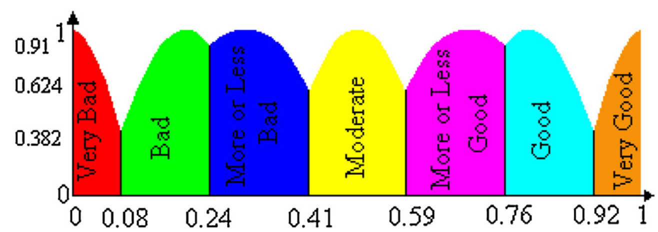


Fig. 4. Intersections points of the functions that define linguistic variables.

Perfect

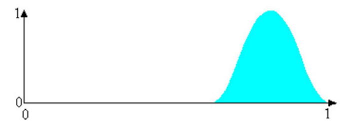
$$\mu_{Perfect}(x) = \begin{cases} 1 & X = 1 \\ 0 & X \neq 1 \end{cases}$$

Very good

$$\mu_{VeryGood}(x) = \begin{cases} 4\left(\frac{x-0.8}{0.2}\right)^4 & 0.8 \leq x < 0.9 \\ \left[1 - 2\left(\frac{1-x}{0.2}\right)^2\right]^2 & 0.9 \leq x \leq 1 \\ 0 & otherwise \end{cases}$$

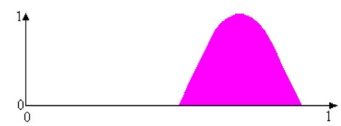
Good

$$\mu_{Good}(x) = \begin{cases} 0 & otherwise \\ 2\left(\frac{x-0.6}{0.2}\right)^2 & 0.6 \le x < 0.7 \\ 1-2\left(\frac{1-x}{0.2}\right)^2 & 0.7 \le x \le 0.9 \\ 2\left(\frac{1-x}{0.2}\right)^2 & 0.9 < x \le 1 \end{cases}$$



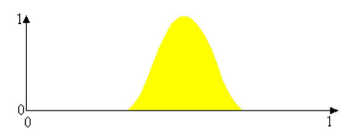
More or less good

$$\mu_{MoreOrLessGood}(x) = \begin{cases} \sqrt{2}\left(\frac{x-0.5}{0.2}\right) & 0.5 \le x < 0.6 \\ \sqrt{1-2\left(\frac{x-0.7}{0.2}\right)^2} & 0.6 \le x \le 0.8 \\ \sqrt{2}\left(\frac{0.9-x}{0.2}\right) & 0.8 < x \le 0.9 \\ 0 & otherwise \end{cases}$$



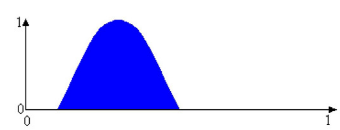
Moderate

$$\mu_{Moderate}(x) = \begin{cases} 2\left(\frac{x-0.3}{0.2}\right)^2 & 0.3 \le x < 0.4 \\ 1-2\left(\frac{x-0.5}{0.2}\right)^2 & 0.4 \le x \le 0.6 \\ 2\left(\frac{0.7-x}{0.2}\right)^2 & 0.6 < x \le 0.7 \\ 0 & otherwise \end{cases}$$



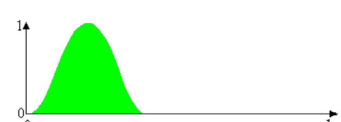
More or less bad

$$\mu_{MoreOrLessBad}(x) = \begin{cases} \sqrt{2}\left(\frac{x-0.5}{0.2}\right) & 0.1 \le x < 0.2 \\ \sqrt{1-2\left(\frac{x-0.7}{0.2}\right)^2} & 0.2 \le x \le 0.4 \\ \sqrt{2}\left(\frac{0.9-x}{0.2}\right) & 0.4 < x \le 0.5 \\ 0 & otherwise \end{cases}$$



Bad

$$\mu_{Bad}(x) = \begin{cases} 0 & otherwise \\ 2\left(\frac{x}{0.2}\right)^2 & 0 \le x < 0.1 \\ 1-2\left(\frac{x-0.2}{0.2}\right)^2 & 0.1 \le x \le 0.3 \\ 2\left(\frac{0.4-x}{0.2}\right)^2 & 0.3 < x \le 0.4 \end{cases}$$



Very bad

$$\mu_{VeryBad}(x) = \begin{cases} 4\left(\frac{0.2-x}{0.2}\right)^4 & 0.1 < x \leq 0.2 \\ \left[1-2\left(\frac{x}{0.2}\right)^2\right]^2 & 0 \leq x \leq 0.1 \\ 0 & otherwise \end{cases}$$

Extremely bad

$$\mu_{ExtremelyBad}(x) = \begin{cases} 1 & X = 0 \\ 0 & X \neq 0 \end{cases}$$

Annex II: the *semantic distance*.

The *semantic distance* measures the distance between two functions, taking into account both the position and the shape of these two functions. Then, the formal definition of the *semantic distance* is as follows (Munda, 1995):

Given two fuzzy sets $\mu_1(x)$ and $\mu_2(x)$, let us define $f(x) = k_1\,\mu_1(x)$ and $g(y) = k_2\,\mu_2(x)$, where $f(x)$ and $g(y)$ are two functions obtained by scaling the ordinates of $\mu_1(x)$ and $\mu_2(x)$ through k_1 and k_2, such that:

$$\int_{-\infty}^{+\infty} f(x)dx = \int_{-\infty}^{+\infty} g(y)dy = 1$$

The *semantic distance* $S_d(f(x), g(y))$ between the two fuzzy sets is as follows: if $f(x)$ is defined on $X = [x_L, x_U]$ and $g(y)$ is defined on $Y = [y_L', y_U']$, where sets **X** and **Y** can be non-bounded from one or either sides, then:

$$S_d\Big(f(x), g(y)\Big) = \int_X \int_Y |x-y| f(x) g(y) dx dy$$

Annex III: the similarity index.

$$s_{ij} = \frac{1}{(1+d_{ij})}$$

Where d_{ij} is the distance between stakeholder i and stakeholder j which is computed as follows:

$$d_{i,j} = \sqrt[p]{\sum_{k=1}^{N} (S_k(i,j))^p}$$

Where $S_k(i,j)$ is the semantic distance between stakeholder i and stakeholder j in the assessment of scenario k, meanwhile N is the number of scenarios. $p > 0$ is a parameter used for sensitivity analysis.

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