Enhancing flood risk maps by a participatory and collaborative design process

G. Minucci[1], D. Molinari[2], G. Gemini[3], S. Pezzoli[3]

[1] Department of Architecture and Urban Studies, Politecnico di Milano, Milan Italy

[2] Department of Civil and Environmental Engineering, Politecnico di Milano, Milan, Italy

[3] Poliedra, Politecnico di Milano, Milan, Italy

Corresponding author: Guido Minucci, guido.minucci@polimi.it

Keywords: co-mapping labs, flood risk maps, participatory processes, flood risk

Abstract

The European Floods Directive (2007/60/EC) requires Member States to make flood hazard and risk maps available to the public. Yet, making flood risk maps available is not enough to inform the public about risk, they need to be understood correctly. Which are the elements that make risk maps suitable and clear for non-expert citizens? Which is the information expected by local technicians in flood risk maps? In order to answer to these questions, co-mapping labs were organised within the project "Flood-IMPAT+: an integrated meso- & micro-scale procedure to assess territorial flood risk" in the city of Lodi, Northern Italy. The co-mapping labs involved representatives of the civil society, economic activities and local institutions responsible for flood risk management. They were asked to examine flood maps developed within the project with respect to their components of hazard, exposure, vulnerability and damage in order to collect guidelines for increasing communicative effectiveness of the maps. Contributes from participants were fundamental to understand the type of information and language that make flood risk successfully represented for and understood by different end-users. Currently, the same maps provided in flood risk management plans are consulted by those who are involved in planning processes, emergency overcoming, risk mitigation or simply exposed to risk. On the contrary, co-mapping labs highlighted the need to produce maps calibrated on stakeholders' needs, i.e. which supply different information according to the map final use. In this regard, the effectiveness of the tool map itself was questioned and the request for a mix of tools combining hard copies of the maps and Information Systems allowing the combination and the query of interchangeable layers of information arose. In addition, the labs underlined the need to enhance the governance between the actors responsible for flood risk management as well as the need of the public and the civil society of being involved in the flood mapping process and supported in their understanding. In conclusion, the co-mapping labs had the added value to be an experience of collaborative inquiry and participatory design in flood risk communication, supplying suggestions and recommendations that should be incorporated in the design of novel flood hazard and risk maps.

Introduction

With the issuing of the Floods Directive (Directive 2007/60/EC), the European Commission imposed on the Member States a specific path for the definition of flood risk management plans (FRMPs), assigning to communication and public participation a strategic role in the process, for the purposes of sharing and legitimizing the tool. The path illustrated in the directive is characterized by three implementation stages, each with specific obligations and deadlines, within a management cycle with a periodicity of six years (i.e. each stage must be repeated and revised every six years). The second stage of the process, which ended in 2015 and it is currently under revision, concerns the development of flood hazard and risk maps as a cognitive basis for the development of FRMPs. The flood maps contained in the FRMPs are, however, often seen as a technical and not a communication tool. The contents of the maps often do not correspond to the requirements of end-users (Meyer et al. 2012). As Hagemeier-Klose and Wagner (2009) point out, with their analysis of several European cases, the information contained in flood maps is often designed and displayed in a way that cannot be easily understood by the public and/or is not suited to the needs of the experts (for example for planning processes or risk management by public authorities). Furthermore, the two authors underline the need to clearly explain the technical terminology used in the maps, if this cannot be avoided. In fact, in the last decade, drawbacks of existing flood maps have been the objective of several research works. The EXCIMAP project (EXCIMAP, 2007) provided, thorough an overview of existing flood mapping practices at the European level, recommendations on the contents of flood maps for different users, and the required data to meet these requirements. The projects RISKCATCH (Fuchs et al., 2009) developed guidelines on visualization and design aspects of flood risk maps. Projects like RISK MAP (2009 – 2011) and DIANE-CM (2009-2011) have worked on understanding how the involvement and participation of end-users in the process of developing maps could be used to overcome the difficulties described above and improve the communication instrument (Evers et al. 2012, Meyer et al. 2012). A further study is presented by Luke et al. (2018) on improving the utility and relevance of flood hazard maps, through the co-production of maps which are responsive to flood risk management end-users' needs. These projects, as well as other experiences of participatory mapping available in the literature (Hagemeier-Klose and Wagner, 2009; Luke at al. 2018), have worked almost exclusively on flood hazard maps.

In a context where the second flood risk management cycle of the Floods Directive is not ended and the Member States have not adopted the revised maps yet, this contribution describes the methodology adopted and the results obtained by a pilot experience of collaborative mapping laboratories conducted within the project "Flood-IMPAT +: an integrated meso- & micro-scale procedure to assess territorial flood risk". The Flood-IMPAT+ project had a dual objective. The first was to develop flood risk assessment methodologies, consistent with the different spatial scales required by risk management, and exhaustive with respect to the multiplicity of elements that may be affected in case of flood (such as population, residences, infrastructures, etc.). The second was to develop and disseminate knowledge on both the results of the project and on flood risk in general, through the active involvement of citizens, practitioners and all the possible stakeholders, in the different phases of the project. The work described in this paper refers to the second objective.

In the paper, the co-mapping process is illustrated in detail, with respect to both specific results and general recommendation towards more comprehensible and usable flood risk maps. Unlike previous experiences, the process described in this paper focused on risk maps in relation to all risk components of hazard, exposure, vulnerability and damage. The components were outlined for the five exposed sectors analysed by the project: population, residential buildings, industrial and commercial activities, agricultural activities and critical services.

Methodology

Stakeholder involvement and participatory approaches have been identified as key to face the complex and potentially conflict-ridden process of flood risk management (Abbott, 2007; Watson et al., 2009; White et al., 2010; Vojinovic and Abbott, 2012, Geaves, L. H., Penning-Rowsell, 2016). In particular, public participation in flood risk management proved to have potential normative and instrumental benefits, for instance, in terms of individuals involved in the process or benefit for the process or the output (Landström et al., 2011, Lane et al., 2011; Evers, 2012). Participative processes must be carefully designed as a wrong definition of the process may lead to undesirable results like unbalanced participation, i.e. domination by certain persons or institutions, identification of non-implementable solutions/results, increased and unjustifiable costs; this is the reason while studies from Germany, Austria and Great Britain have rather low ambitions concerning the 'active involvement' requirement by the FD (Newig et al., 2014; Hedelin, 2015; Moon et al., 2017). This section explains how collaborative mapping were designed and implemented within the Flood-IMPAT+ process, with the main objective of getting representative, significant and shared results from the participants.

Background

The project was based on the investigation of a case study that is the town of Lodi (in the Lombardy Region, North of Italy), affected in 2002 by an extensive flood due to the overflowing of the Adda River, one of the main tributary of the Po River. The flood caused damage to large urban and rural portions of the city. The limited extension of the investigated area (Lodi is a town of 45,000 inhabitants with a municipal area of 40 km^2) makes the city of Lodi an interesting case study for the experimentation of knowledge dissemination activities that actively involves different stakeholders.

Identification of stakeholders

The way a participatory mapping process should be set up and conducted depends largely on the purpose of the process itself. Defining the goal is, therefore, a key issue that needs to be clarified at the beginning of the process. In this specific case, the mapping laboratories had the primary objective of increasing the knowledge of flood risk and its explicative variables to a variety of stakeholders in order to encourage the adoption of proper risk mitigation actions at different levels of the society. This has been achieved by pursuing a shared representation of hazard, exposure, vulnerability and damage, which is understandable and useful to the various end-users.

The definition of actors to involve in the process is the second step of the process design. The analysis of the stakeholders/end-users and the mapping of their interactions is critical to this step. In the project, the identification of the actors was carried out based on a substantial premise: the will to involve both the institutional and the civil sides, as representatives of the whole society. Besides, it was decided to work in small groups in order to ensure an active and operative involvement of all the participants.

The result of this ambition was the creation of two worktables: (1) one dedicated to government bodies, composed by technicians and experts; (2) the other one involving citizens and representatives of the civil and economic society such as community groups, non-governmental organizations and professional associations. In particular, by the close investigation of the case study area, the following actors were involved in the first group: representatives from the different units of the Lombardy Region Authority in charge of territorial planning, civil protection and agriculture management, the District Authority of the Po River, the Provincial Authority, the reclamation consortium of Muzza (i.e. one of the main artificial channel that derives from the Adda River), the Territorial Hospital Agency. Concerning the actors to be included in the second group, we first mapped the organizations listed in the official website of the municipality of Lodi, and placed in the expected flooded area according to the currently adopted hazard map. Among the different organizations, we were able to identify nearly thirty stakeholders, of which we selected those actors that had some preliminary knowledge on flood risk acquired, for instance, from personal or professional experience or through formal school education. In details, we were able to involve actively non-governmental organisations (WWF and Red Cross), community groups (5), trade and industrial unions (3), agriculture associations (1), professional associations (the Association of Engineers and Architects of Lodi), one journalist and also students from scientific high schools. The "bridge" between the group of institutional experts and the one composed by entrepreneurs' associations, civil society and citizens was identified in a specific group of actors, namely the civil protection volunteers.

This group owns characteristics that make it a perfect link between the other two. Specifically, civil protection volunteers are citizens with knowledge of specific risk management tools. Civil protection volunteers have then taken part in both worktables to share the visions of the two groups.

Participatory and collaborative mapping laboratories

The project included three collective mapping laboratories for each workgroup.

According to the general aim of the process, the first laboratory, "A shared legend on flood risk", worked on the sharing of the different objectives of risk maps by the different end-users, and on the co-design of the different contents, through the analysis of "first attempt" maps elaborated by the research group on the bases of the results of the Flood-IMPAT + project.

More in detail, the first laboratory started with an ice-breaker brainstorming, aimed at investigating the participants' perception of the concept of "flood risk" and of the usefulness of the risk maps themselves (Figure 1).

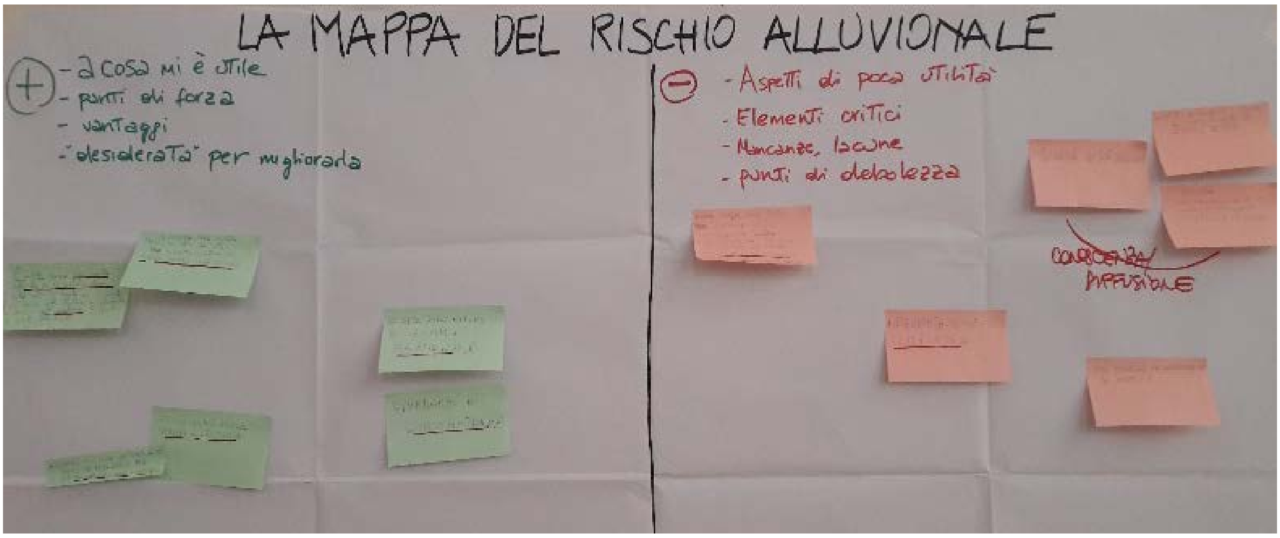


Figure 1: the first co-mapping laboratory ice-breaker brainstorming results.

Afterwards, each participant was asked to evaluate both the hazard maps and the exposure, vulnerability and damage maps proposed for the different sectors being studied (population, residences, services, economic subjects, agriculture) according to cartographic aspects, mapped data, scales of representation, additional geospatial data and attributes. Besides, in order to avoid any case of domination by certain persons or organisation, each participant was asked to illustrate their standpoint during the open-discussion sessions. Comments and suggestions provided by participants in each of the two worktables were recorded and summarized on the billboard by the facilitator, clustering the positive comments on one side and the critical points/suggestions on the other (Figure 2). At the end of the laboratory, each participant was asked to express their level of individual satisfaction for each map (in terms of their clarity, comprehensibility and usefulness) through a simple "traffic light" rating (green - clear, yellow – to be improved and red – not clear) mechanism as shown in Table 1 and 2.

For each issue raised during the first laboratory some solutions were proposed by the research team, which were presented, discussed and evaluated by the participants in the second laboratory.

During the analysis, the two worktables were treated as equals, which implies that they both had the same right to influence the decision-making process. This choice aimed at creating an open and reciprocal exchange while allowing the identification of different or similar opinions and values of the world between different actors, as well as at ensuring that all participants influence the final decision-making process.

Figure 2: the first co-mapping laboratory group discussion activities.

MAPS	***CIVIL SOCIETY VOTE***
Hazard	
Exposure – Residential building sector (reconstruction cost, K€)	
Exposure – Population (number of inhabitants)	
Damage - Residential building sector (K€)	
MAPS	***BUSINESSES VOTE***
Hazard	
Exposure – Agriculture (cadastral parcel - €. Month Apr., Jul., Nov.)	
Vulnerability – Agriculture (cadastral parcel - €. Month Apr., Jul., Nov.)	
Damage – Agriculture (cadastral parcel - €. Month Apr., Jul., Nov.)	
MAPS	***EXPERT VOTE***
Hazard	
Exposure – Residential building sector (reconstruction cost, K€)	
Vulnerability – Agriculture (cadastral parcel - €. Month Apr., Jul., Nov.)	
Damage - Residential building sector (K€)	

Table 1: an extract of the result of the vote carried out by each working group in the first co-mapping lab

The second laboratory, "My own map", worked on two different aspects. As anticipated, the laboratory started with the return of the results of the previous meeting, with particular reference to the response strategies adopted by the research group to refine the maps and the legends on the bases of the comments received, After the group discussion on further developments and improvements to be made to the maps, recorded by the facilitator, the first phase of the work ended with a new “traffic light” vote of the maps, which overall garnered more favour than during the first meeting.

The second part of the laboratory was instead dedicated to the identification of the possible and most suitable tools and methods for the dissemination of the maps produced for FRMPs, to a wider community of stakeholders. Each end-user composing the civil society workgroup were questioned about identifying preferred bodies acting as a mediator (to be recorded with light green post-it® on the billboard) and preferable communication means (in yellow post-it® on the billboard) by which the District Authority (being appointed by law to manage the participatory process in FRMPs) should communicate, in order to foster the dissemination and understanding of maps. While the institutional and technical workgroup was asked to define how the District Authority could improve its capacity to reach the different end-users, using the resources already available in terms of intermediaries and tools at the territorial level. Each participant to the working groups, also with reference to the "category of subjects" of which he/she was representative at the working table, expressed their ideas and proposals, and the group then commented and discussed the contributions collected on the map (Figure 3).

Figure 3: the second co-mapping laboratory group discussion activities.

MAPS	***CIVIL SOCIETY AND BUSINESSES VOTE***									
Hazard – Water depth										
Hazard – Flooded area and isochronous (rare event)										
Vulnerability – Residential buildings (level of maintenance)										
Damage – Agriculture (Agriculture (cadastral parcel - €. Month Nov.)										

MAPs	EXPERT VOTE								
Hazard – Water depth, flooded area and isochronous (rare event)									
Vulnerability – Residential buildings (level of maintenance)									
Damage – Agriculture (Agriculture (cadastral parcel - €. Month Nov.)									

Table 2: an extract of the result of the vote carried out by each working group in the second co-mapping lab

The third laboratory comprised two public events, respectively dedicated to the public and to the institutional and the scientific communities. These events aimed at showing and presenting the produced maps to a wider public (expert and non-technical people) than the one involved in the two worktables, in order to maximize the comprehensibility of the contents of the maps, improve knowledge and increase awareness of a vast range of users.

Specific results

The participation of a wide variety of stakeholders in the laboratories has been evaluated as very fruitful by the subjects involved, and has been proved to make them more aware of the complexity of the topic, the tools currently available and to increase their personal responsibility. In particular, the group of civil protection volunteers strongly appreciated the possibility of interacting with institutional decision-makers, of acting as a promoter, as a link between the two worktables, of the requests made by the citizens and of having the possibility of influencing the process and the final result of the presented maps. The methodology used to define the working methods between the groups and the scheduling of the activities made it possible to create an active and operational comparison among all the different subjects and in particular, between the researchers, as suppliers of the maps/knowledge being evaluated, and the participants to laboratories as end-users.

Overall, the co-mapping process generated two types of results. The first result is associated with the co-production of maps for the case study area, based on shared knowledge on what is the expected information and how it should look like, according to the different stakeholders involved in the participatory process. As a second result, the laboratories allowed the identification of the most suitable ways/tools to widespread results of flood risk assessment to a wide community, and of which are the reference actors for the different stakeholders from whom they expect to be informed or to whom they request information on flood risk.

1. *Co-production of risk maps*

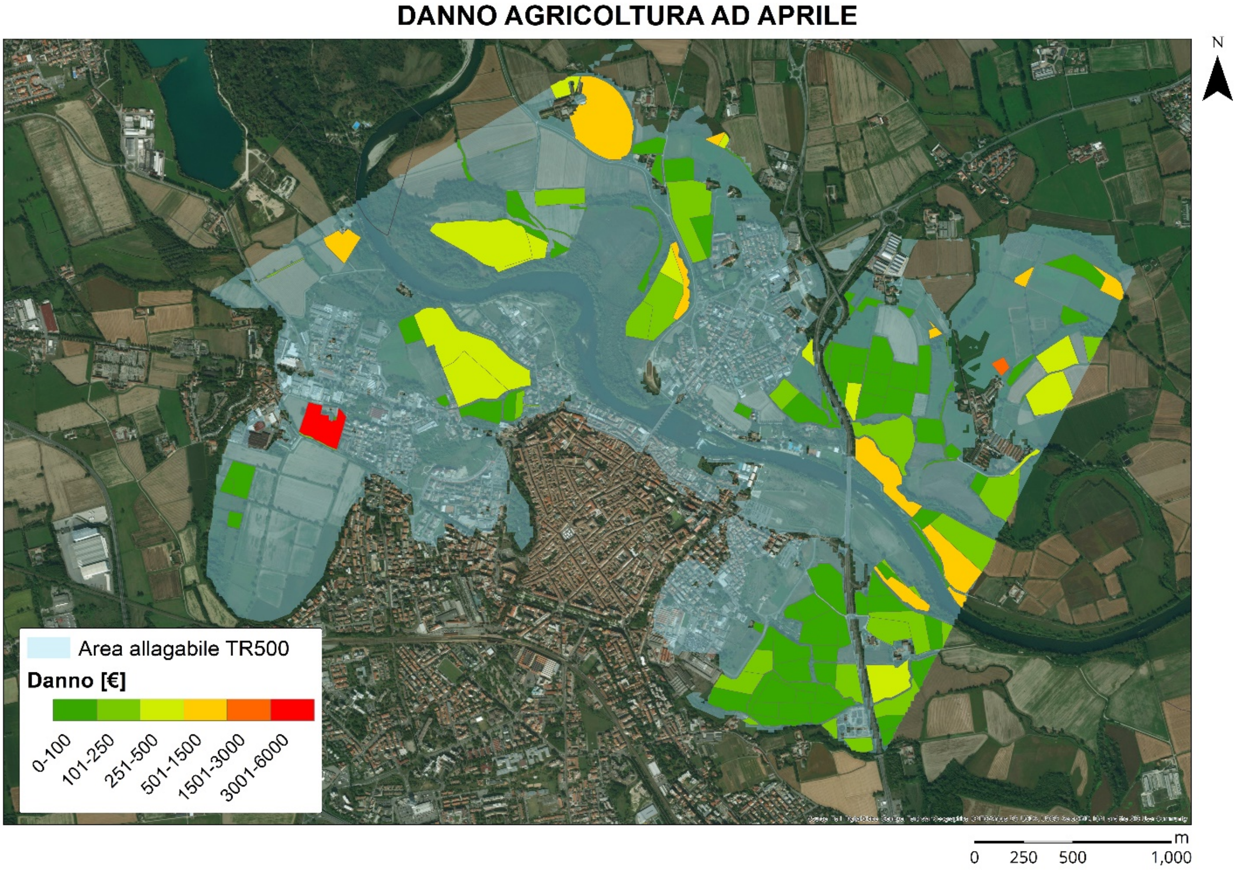
As previously explained, the co-production of risk maps took place on the bases of consecutive revisions of "first attempt" maps by the research team, on the bases of suggestions and recommendations given by the participants in the laboratories. Table 3 summarizes the requested revisions of the end-users from both workgroups and the actions undertaken by the research team to satisfy such requirements. Requested revisions generally fell into three categories: (i) cartographic aspects (e.g. colours and map titles), (ii) clarification on mapped data and (iii) additional geospatial data and/or attributes to be shown on the map. Besides, as specified in Table 4, the revision process allowed:

- identifying and agreeing on a set of parameters to be displayed on the maps, for the different types of map (i.e. hazard, exposure, vulnerability and damage) and for the sectors considered within the study;
- defining for which purposes a given parameter can be used for, such as strategic or emergency planning or cost-benefit analysis of risk mitigation measures;

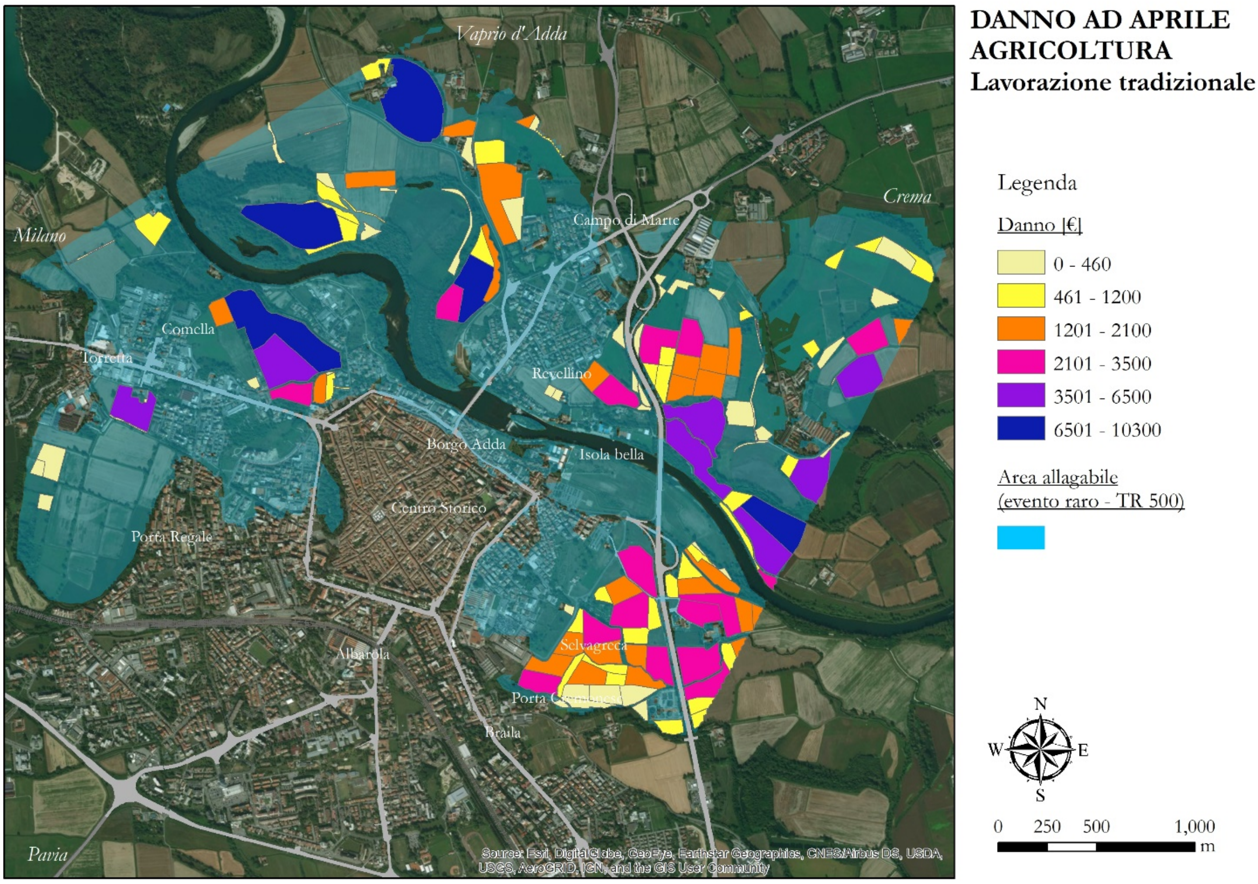
- identifying the interest of the different end-users (e.g. layman, farmer, business man and expert) in having access to a specific parameter;
- defining, when possible, the scale of data representation (micro- and/or macro-scale) for each parameter, in order to meet different stakeholders' needs;

Cartographic aspects

From the cartographic point of view, several requested revisions were common to the participants of both worktables. Most of the requests focused on the use of colours. On the one hand, end-users preferred to avoid the use of graduation of colours (in favour of different colours) to represent different values of a single parameter (e.g. different values of water depth), due to difficulties in the interpretation of similar graduation. On the other hand, requests related to the use of transparencies for the different contents represented in the map (in order to guarantee the readability of the background map) contextually to the use of a background map in greyscale or in black-and-white to guarantee consistencies between colours in the map and those in the legend. The use of hatching has then been requested as an alternative to the use of colours so as to increase accessibility to maps for partially sighted or colour-blind people. However, the use of (cross-) hatching together with transparencies prevented the readability of the map. In response to this request, the proposed solution (Figure 4) was to use colour scales that do not simultaneously use the red and green colours so as to respond to the most common form of colour blindness, i.e. red-green dyschromatopsia (Davidoff et al. 2016). Another emerged issue was related to the use of toponymy, to support users in orienting in the map. On this point, improvements were possible only thanks to the participatory mapping process. For instance, the name of the neighbourhoods and the best-known place of destinations were attributed thanks to citizens. Regarding the number of classes used to represent different values of a parameter, we encountered the same problem identified by de Moel et al. (2009). In the first version of the maps, too many classes were used and this made difficult for the map-reader to make a distinction between the meaning of each class; therefore, in the second version, we limited the number of classes to four/five. According to participants in laboratories, a key role is finally played by symbols: the latter are seen less useful for representing the flood hazard or risk itself, but they can provide important benefits for the characterization of the exposed elements (i.e. number of pupils) or the identification and localization of strategic buildings and critical facilities (e.g. governmental and administrative buildings, safe areas or cultural heritages).



DANNO AGRICOLTURA AD APRILE
N
Area allagabile TR500
Danno [€]
0-100
101-250
251-500
501-1500
1501-3000
3001-6000
0 250 500 1,000
m



DANNO AD APRILE
AGRICOLTURA
Lavorazione tradizionale
Legenda
Danno [€]
0 - 460
461 - 1200
1201 - 2100
2101 - 3500
3501 - 6500
6501 - 10300
Area allagabile (evento raro - TR 500)
Vaprio d'Adda
Milano
Crema
Campo di Marte
Comella
Torretta
Revellino
Borgo Adda
Isola bella
Centro Storico
Porta Regale
Selvagreca
Albarola
Pavia
N
W
E
S
0 250 500 1,000
m

Figure 4: damage map to agriculture parcels in April presented to both groups on the first co-mapping lab (on the top); Damage map to agriculture parcels in April designed based on preferences of the second co-mapping lab participants (at the bottom). Map content includes flood extent for a rare event (RT 500 years) and highlights agricultural parcels potentially affected and related damages in monetary terms.

Mapped data

A problematic element, recurrent also in other researches on the same subject (Hagemeier-Klose and Wagner 2009; van Alphen et al. 2009; Meyer et al. 2012), is linked to the use of technical terminology. Especially critical is the use of the term "return period" in flood hazard maps because, as recognised in the literature, it is difficult for the public to understand the concept of probability and therefore of low-probability risks (Bier 2001). A first option to overcome this problem, provided by the participants, was to avoid the use of technical terms in the maps, in favour of descriptive terms (e.g. rare event instead of 200 years' event); this could, however, lead to subjective interpretations. Another option, advanced by the civil society during the second laboratory, was to link flooding scenarios to past real events, in order to allow people comparing events and understanding their intensity. In fact, providing to people past real events to be used as reference points may increase the awareness of people about future or expected risks (i.e. flood events) and have the potential to be understood by a wide audience. On the contrary, this solution has to deal with several problems. First, the memory of disasters (e.g. a flood event) fades away after some years (Fanta et al. 2019) as well as the level of risk perception decreases along time. Second, past real event represents only a picture of a dynamic condition (where the state of the places could be changed after or following the flood event provided as a reference) so that future events can present different characteristics in terms of hazard and impacts. In addition, such reference point may not be entirely grasped by people not belonging to a place or by whom is new in town.

It must be stressed, however, than the trade-off about the need of technical information by technicians and the difficulty in interpreting such information by lay people clear emerged during the laboratories. For this reason, and because it is our idea that it is necessary that the public starts becoming familiar with, even if complex, certain concepts, our solution to the problem was to suggest using risk maps as a tool to explain technical concepts in a simple and understandable way (so as to favour the spread of the risk culture), for example, by combining technical terminology with immediate and easy understanding for the more general public.

Another point highlighted during the co-mapping laboratories concerns the need of developing an aggregated exposure map, including all analysed sectors. It is worth noting that the issue concerning the development of such a map is related to the fact that exposure of the different sectors is often expressed in different metrics, such as monetary value, number of items, etc., so that their overlapping is too complex if not impossible. Starting from the idea that the assignment of a weight to the single sector to create a sort of multi-criteria exposure map goes beyond the technical contents requirements of a map and becomes more a political issue, a first test was carried out by aggregating the different sectors on the base of their presence or absence in the flooded area; such map resulted, however, to be very confused and difficult to read. Thus, a further attempt to both allow a first degree of comparability between the exposed sectors and improve the previous map was taken; it was decided to aggregate only those sectors for which an economic value is available, whereas for all the other sector an infographic was provided.

Additional geospatial data and attributes

It is important to underline how the co-mapping process has even more emphasized what was already highlighted by the literature, relatively to the need of producing maps which are "weighted" on the needs of the different end-users (Meyer et al. 2012). Specifically, the laboratories highlighted significant differences in the degree of refinement of the analysis, of the scale of representation and of the detail of the information, necessary for each subject. For example, regarding the vulnerability of residential buildings, with respect to the representation of the different vulnerability parameters considered by the project (Dottori et al. 2016), citizens have shown interest in the representation of the only parameter of their direct interest, i.e. the maintenance level of the building, since they can deal with and intervene on it. Differently, people responsible for emergency management identified the number of floors as the relevant information to be mapped whereas technicians with planning duties found of great interest the possibility to have mapped all the different vulnerability parameters (considered pleonastic by the previous subjects), since the availability of such detailed information is useful to define possible intervention strategies. With respect to this, we proposed to maintain the representation of the whole set of parameters in the maps, leaving the users the choice of using information of their interest.

Another important issue emerged during the discussion concerns the spatial scale at which data to be mapped are available and must be represented. During the co-mapping labs we proposed maps at two different scales: the micro- and the macro-scale. Micro-scale maps reported information at the object level (e.g. a residential building, an economic activity, etc.) while meso-scale maps reported information at spatial aggregation units, i.e. census blocks. However, misunderstandings were recorded during the laboratories on this point, above all on the meaning of data usually available at the meso scale (i.e. as an average value of the parameter of interest for the census block) but mapped at the micro scale. The adopted solution was to map information only at the minimum scale at which related data are available. Moreover, to guarantee consistency among maps produced in different places, it was decided to map only those data which are available for the whole country or at least, at the River District level.

2. *Dissemination and communication tools*

Tackling the theme of the tools to be used and the role of the different subjects in sharing and disseminating the maps, the two workgroups stated different needs, but they both emphasized various possibilities to increase awareness, improve and favour the communication process among the various institutional bodies, and between institutions and the civil society. The workgroup composed by the civil society underlined the need that, accordingly to the principle of subsidiarity, authorities and bodies closer to them (for example, the Municipality Authority, the mass media) should act as an intermediary between administrations owning knowledge and maps on flood risk and the public. Furthermore, it has been pointed out that the dissemination of such topic cannot simply be limited to the fact that "the information has been made available" (e.g. on the websites). In fact, activities aiming at involving and informing the public, such as public meetings, informative days or practical emergency exercises, must be envisaged by whom is responsible for the flood risk management and the related dissemination of information.

With respect to the role of the different institutions and organizations responsible for flood risk management, the experts' workgroup remarked instead upon the need to strengthen both the vertical and the horizontal governance among institutions, in order to co-organize in a more effective and efficient way the actions undertaken by each institution, and to better respond to the requests coming from the different stakeholders

A further point that emerged, in this case from the experts' working group, is the need not only to define maps based on the requirements of the different end-users, but also to discern between "institutional maps", which respond to given characteristics defined by law (i.e. the Floods Directive), and maps for the general public and/or for specific sectoral needs.

General recommendations

A first general recommendation for enhanced, more informative and understandable flood maps regards the scale of representation. In fact, the scale of representation (from the object level to the regional scale) and the level of details of the available data allow different types of analyses, even by the same user. As one of the main purposes of flood maps (developed for both citizens and technicians) is to identify sectors and areas at high risk so as to draw a picture of where there is a requirement for mitigation efforts, the scale of representation should be defined according to the level at which the mitigation measures under investigation work, which generally changes with the stakeholder(s) involved in the intervention. For example, data representation at the object level (e.g. a building, a farm, a business) is usually of interest for private subjects, while aggregation and representation of contents at the census block level fits for maps addressed to public authorities, from the municipal level upwards. Certainly, the availability and representation of disaggregated data at the lower scale possible (i.e. individual object scale) provides larger opportunity of analysis, and should be preferred when available, as subsequent aggregation at higher scales is always possible. Whereas the combination of information at different scales should be avoided because it may determine misleading results.

The second set of recommendations regards visualisation elements. Although often overlooked, such elements are key for map usability, as the method of representation of map contents largely determines the effectiveness of the information transfer to the end-users. From the co-mapping laboratory experience, and in some cases from confirmation in the literature, we can supply the following suggestions:

- The identification of the areas at risk is critical and should be strongly highlighted and differentiated from the safe area. It means that information on the flood extend must be always displayed, not only in hazard maps but also in exposure, vulnerability and damage maps (see Figure 4). Moreover, background information should be kept in pale or black-and-white colours.
- The use of toponymy is key for map comprehension; in addition, the visualization of the river(s) and/or channel(s) is useful to facilitate users' orientation.
- Concerning the legend, the topics should be organized in a manner that supports map comprehension. A further understanding with respect to what Meyer at. (2009) suggest regarding the fact that the legend should be sufficiently large, on the right side and with a limited amount of information, it is that the main topic of the map should be always listed as first, followed by the hazard information (i.e. extension of the flooded area) and finally by background data.
- The selection of colours to be used should ideally guarantee the readability of the information from everyone. Since such level of equality might be difficult to be reached, maps should be drowned to respond at least to the more common typology of colour-blindness. The level of transparency used to show the elements in the map should be the same as the one used in the legend (see. Figure 4) in order to maintain coherence between the two. In addition, all texts represented in the map should be sufficiently large and shading should be avoided because determines a reduction in readability.
- The number of classes of value used to represent the different contents should be limited to a maximum of five classes in order to keep the map readable.
- Self-explanatory symbols, not only in terms of describing functions (e.g. a red cross to identify hospitals), but also of in terms of relevance and seize of the mapped element (e.g. increasing number

of person symbols to represent increasing population density) are useful for map comprehension by lay people.

Further recommendations are specifically related to the four different types of maps analysed during the co-mapping laboratories (such as hazard, exposure, vulnerability and damage maps) and are discussed in the following subsections, with respect to maps addressed to technicians and maps for citizens.

1. Recommendations on the content of technical flood maps

Hazard maps

With regard to hazard information, as required by the Floods Directive and stated by Meyer et al (2012), detailed information on flood extent and water depth for events with different probabilities of occurrence is (at least) required. Concerning the water depth and its representation in classes of value, it is useful to provide information on the confidence intervals of the estimation, in order to guarantee consistency and trust of the given information. In addition, information on flow velocity, duration of the flood as well as isochronous and flood regression times can also be helpful for flood risk management.

Exposure maps

A representation by sectors (e.g. population, residential buildings) provides a complete picture of the exposed elements and so of the maximum expected damage.

Incremental analysis, and then representation, of the exposure can be carried out on the base of the available data. The first level refers to a qualitative analysis describing the different typologies of the exposed elements. The second level, i.e. quantitative analysis, provides specific information on the extension of the exposed elements such as the total surface of residential buildings, the number of schools for each typology and the associated number of pupils for school, the number of people within each census block. These two levels of analysis provide useful information not only for spatial and strategical planning but also for emergency management. The third level is the one where monetary information comes in, for instance, the cost of building reconstruction, the added value or the salaries paid by each business activities. Such level support cost-benefit analyses of risk mitigation measures.

Concerning the agricultural sector, and specifically crops, seasonal exposure maps should be provided as the presence of a specific crop on the field depends both on the vegetative stage of the plants in the season under consideration and on rotation practices.

Vulnerability maps

Developing maps for each vulnerability parameter, and each sector, considered in the risk assessment, could be helpful for end-users in order to identify the different damage drivers and thus provide support in policy and program definition. If possible, a synthetic index should be used in order to show overall vulnerability hot spots for each sector; however, it must be stressed that the definition of such an index cannot be a purely technical issue as the weight to be assigned to each parameter partly depends on the adopted damage model but must be also agreed and shared among the different stakeholders. Concerning the agricultural sector, and specifically crops, as for exposure, seasonal vulnerability maps should be provided, as the damage susceptibility of crops strongly depends on the vegetative stage of the plants. Concerning the networks, and in particular the road system, information should be given both on physical (i.e. structural) and functional vulnerability since they both provide relevant information for emergency management. At last, mapping information on the composition of the population in terms of age groups and long-term ill people can be helpful, in particular for managing emergency cases.

Damage maps

Damage maps show the spatial distribution of the expected damage, for a specific event scenario. Such maps should be developed for each exposed sector, for which a consistent damage model is available. The damage should be expressed, when possible, in monetary terms so as to support cost-benefit analysis of flood mitigation measures or the appraisal of insurance premiums. As for hazard, when representation in classes of value is adopted, it is useful to provide information on the confidence intervals of the estimation. In the case of damage to agriculture, a range of damage value should be provided, in order to take into account variability given by seasonality and crops rotations.

<u>Recommendation on the content of flood map for the civil society</u>

Hazard maps

Information on the flood extent and the spatial distribution of water depth was considered critical and mandatory by the civil society. Moreover, detailed information concerning water depths within the first 50 cm from the ground level is required as it could be helpful for agriculture, commercial and industrial activities.

As many of end-users of the civil society are not familiar with the concept of return period, it would be better to join technical information on the return period with the terminology adopted by the Floods Directive (i.e. very rare, rare and frequent events), together with the reference to the same directive in order to enhance awareness and knowledge on this topic.

Exposure maps

With regards to exposure, detailed information at the micro-scale (e.g. object level) is required by end-users. This is particularly relevant for property owners in order to be able to identify if their property would be affected by flood, and in case of which scenario. In addition, the use of the replacement values to estimate exposure at the micro-scale could help in enhancing risk communication and awareness.

Vulnerability maps

Mapping vulnerability parameters providing information on the characteristics contributing to worsening the possible damage to a property could be helpful in promoting the adoption of individual mitigation and adaptation measures to reduce flood risk.

Damage maps

Damage maps provide useful information to the property owner (e.g. dwelling, business or parcel) in particular if the damage is represented at the micro scale and is expressed as the expected damage according to the intensity of event, such as very rare, rare and frequent. In fact, as for vulnerability, this information could support owners in the identification and the selection of possible mitigation measures to individually adopt in the prevention and emergency phases (e.g. by focusing on most frequent damage).

Discussion

Experience from the co-mapping laboratories demonstrated that, despite it was a time and resources-consuming activity, participatory processes involving different sectors of the society are a powerful tool to tailor and enhance the contents of the maps on the basis of stakeholders' requirements. It is worth noting that, on the bases of the results obtained in the co-mapping activity, the District Authority of the

Po River (which was involved in the co-mapping labs and is appointed by law to deliver the revised version of the flood risk maps by 2021) expressed the willingness to rerun the pilot experience as one of the official participatory activities required by the Flood Directive.

Specifically, the experience described in this paper highlighted how, by building a shared and agreed content and representation mode, issues of readability and usability identified by Hagemeier-Klose and Wagner (2009) and Meyer et al. (2012) can be overcome. Participatory processes as the one here described can be not only handy in identifying the main contents and the manner to visualize information but also to identify the more appropriate scale of analysis to support decision-making processes and to satisfy requests put forward by the different users being technicians or non-professional. In addition, collaborative processes create an opportunity to share among stakeholders the needs, the issues and the complexities characterizing each sector and the interlinkages between sectors. Nevertheless, it has to be said, confirming what stated by Evers et al. (2012), that available and suitable quality data and robust flood models are pre-requisites for co-mapping as suitable and reliable modelling of hazard, vulnerability and risk are key elements of the process.

The process described in this paper created also a window of opportunity to discuss with different stakeholders the limitation of maps, and to explore other tools to disseminate information on flood risk as well as to exchange ideas on how information on a map is interpreted and how to facilitate the understanding of mapped data. In this regards, paper maps (being static) do not always respond to the different stakeholders' needs while Internet and the use of Web GIS or web application allow sharing a wide range of information in a more interactive and collaborative way (Hagemeier-Klose and Wagner, 2009). The use of such tools should then be promoted in flood risk management and communication, above all considering that, nowadays, the dissemination of information via the Internet is an easy and habitual way to bring information to people. Nonetheless, hard copies of maps are still needed not only because not all people are Internet connected but also because, if positioned in appropriate installations in town or countryside, maps can be a useful tool to inform people about flood risk, as well as in case of emergency, when access to digital tools might be limited.

Co-mapping labs corroborated previous evidences that further improvements in sharing information and maps on flood risk are required, and social media could play a relevant role in the risk prevention and all other risk management phases. As emphasized by the case study, the dissemination of flood risk maps it is not just a matter of tools but also of engagement of agencies responsible for flood risk management or recognized as such. Direct involvement of authorities responsible for flood risk management (i.e. district authorities) but also of other organizations and institutions recognized as possible knowledge-broker, such as land reclamation authority for farmers, trade unions for businesses or teachers for students (as also suggested by Gaillard and Pangilinan 2010), is required by different end-users. A mix of tools for sharing and disseminating maps and flood risk information, together with an implemented state of subsidiarity could be the more successful strategy to bring suitable and understandable information to all the stakeholders. Informing every single citizen is hard and probably not feasible for a set of different reasons. However, much effort is required, also in the light of the Floods Directive philosophy asking key agencies responsible for flood risk management to adopt a more participatory approach, to foster collaboration with third parties, and to experiment a mix of tools to inform the public as part of their regular activity.

Conclusions

The co-mapping laboratories highlighted how making flood risk maps available is not a sufficient action to inform the public of the risk. It is necessary, in fact, that the information represented by these maps are correctly interpreted and shared, and for this reason, it is essential to work on the level of knowledge and awareness of risk among the population. Experience discussed in this paper demonstrated that participatory activities can be used by researchers, governmental and non-governmental staffs to share and disseminate, at different levels of the population, general or specific results of risk analyses; by direct involvement, people became more familiar with such topic, increase risk understanding, and become more prone to the adoption of mitigation practices (Stirling, 2006).

In fact, besides maps improvement, a further, less tangible (but not less relevant) outcome of the co-mapping laboratories, is the indication that participatory processes are a useful tool to increase in layman or non-expert people the capacity of activating self-protective and risk mitigation actions. Indeed, some of the participants expressed their willingness to explore solutions to reduce the vulnerability of their houses to flood risk, while some of the students involved in the project demonstrated an active curiosity in better understanding how an emergency plan is designed and can be enforced, and expressed interest in having thematic activities regarding risk and risk management at school. A further demonstration of how valuable participatory activities are/were is given by the activation of a partnership among the scientists involved in the Flood-IMPAT+ project and the main provincial hospital of Lodi (who participated in the labs) to improve the emergency management plan of the health structure.

From another point of view, co-mapping labs corroborated evidences from previous research that maps must be able not only to provide content, albeit complex, in a simple and clear way but also that they should meet as much as possible the needs and purpose of the different user(s); as to say that each type of user should correspond to his own map. From this perspective, the map tool (being static) has turned out to be inadequate, little able to respond to the different purposes of the end-users, since it is not possible to query and/or organize information in maps in multiple interchangeable layers as needed. Laboratories also highlighted that dissemination flood maps cannot simply be limited to the fact that "the information has been made available" (e.g. on the websites). In this regard, the laboratories highlighted that a systemic communication approach is the most effective to disseminate the results to a broader audience. Such an approach progressively combines tools, physical and digital devices (e.g. hard-copy maps and online webgis), and methods as face-to-face activities (e.g. workshops, roundtables and consensus conferences) with more online activities (e.g. simulation games, citizen panels, internet forums, online collaborative modelling and consensus conferences), on the bases of the numerousness of the stakeholders involved in the process. Last but not least, researchers notice how participatory mapping approaches, as general participation activities, were able to help increase acceptance and build trust among public, private, scientific and civil society actors.

Acknowledgments

This research has been supported by the Fondazione Cariplo (grant no. 2016-0754) under the project "FloodIMPAT+: an integrated meso & micro scale procedure to assess territorial flood risk"**.**
The authors thank Alice Gallazzi and Marta Galliani from the Department of Civil and Environmental Engineering of Politecnico di Milano, for their valuable support in the co-mapping process.

Reference

1. Abbott, M.B. 2007. Stakeholder participation in creating infrastructure, New Civ. Eng., 160(1):26-32
2. Begg, C. 2018. Power, responsibility and justice: a review of local stakeholder participation in European flood risk management, Local Environment, 23:4, 383-39

3. Bier, V. 2001. On the state of the art: Risk communication to the public. Reliability Engineering & System Safety. 71. 139-150.
4. Davidoff C., Neitz M., Neitz J. 2016. Genetic Testing as a New Standard for Clinical Diagnosis of Color Vision Deficiencies. Transl Vis Sci Technol. 6;5(5):2.
5. de Moel, H., van Alphen, J., and Aerts, J. C. J. H. 2009. Flood maps in Europe – methods, availability and use, Nat. Hazards Earth Syst. Sci., 9, 289–301.
6. Dottori F., Figueireo R., Martina M. L. V., Molinari D. and Scorzini A. R. 2016. INSYDE: a synthetic, probabilistic flood damage based on explicit cost analysis. Nat. Hazard Earth Syst. Sci., 16, 2577 – 2591, 2016.
7. Ever, M. 2012. Participation in Flood risk Management An introduction and recommendations for implementation, Universitetstryckeriet, Karlstad.
8. Evers, M., Jonoski, A., Maksimovič, C., Lange, L., Ochoa Rodriguez, S., Teklesadik, A., Cortes Arevalo, J., Almoradie, A., Eduardo Simões, N., Wang, L. & Makropoulos, C. 2012. Collaborative modelling for active involvement of stakeholders in urban flood risk management, Nat. Hazards Earth Syst. Sci., 12, 2821–2842.
9. Excimap. 2007. Handbook on good practice on flood mapping in Europe. European Exchange Circle on Flood Mapping
10. Fanta, V., Šálek, M. & Sklenicka, P. 2019. How long do floods throughout the millennium remain in the collective memory?. Nat Commun 10, 1105.
11. Fuchs, S., Spachinger, K., Dorner, W., Rochman, J., and Serrhini, K. 2009. Evaluating cartographic design in flood risk mapping, Environ. Hazards, 8, 52–70.
12. Gaillard, J.C., Pangilinan, M.L.C.J.D. 2010. Participatory mapping for raising disaster risk awareness among the youth. Journal of Contingencies and Crisis Management, 18(3), pp. 175-179.
13. Geaves, L. H., Penning-Rowsell, Edmund C. 2016. Flood Risk Management as a public or a private good, and the implications for stakeholder engagement, Environmental Science & Policy, 55:281-291
14. Hagemeier-Klose M. and Wagner K., 2009. Evaluation of flood hazard maps in print and web mapping services as information tools in flood risk communication, Nat. Hazards Earth Syst. Sci., 9, 563–574.
15. Haughton, G., Bankoff, G., Coulthard, T.J. 2015. In search of 'lost' knowledge and outsourced expertise in flood risk management, Trans. Inst. Br. Geogr., 40, 375-386
16. Landström, C., Whatmore, S.J., Lane, S.N., Odoni, N.A., Ward, N., Bradley, S. 2011. Coproducing flood risk knowledge: redistributing expertise in critical 'participatory modelling', Environ. Plan. A, 43, 1617-1633
17. Luke, A., Sanders, B. F., Goodrich, K. A., Feldman, D. L., Boudreau, D., Eguiarte, A., Serrano, K., Reyes, A., Schubert, J. E., AghaKouchak, A., Basolo, V., and Matthew, R. A. 2018. Going beyond the flood insurance rate map: insights from flood hazard map co-production, Nat. Hazards Earth Syst. Sci., 18, 1097–1120.
18. Meyer, V., Kuhlicke, C., Luther, J., Fuchs, S, Priest, S., Dorner, W, Serrhini, K., Pardoe, J., McCarthy, S., Seidel, J., Palka, G., Unnerstall, H., Viavattene, C., & Scheuer, S. 2012. Recommendations for the user-specific enhancement of flood maps, Nat. Hazards Earth Syst. Sci., 12, 1701–1716.
19. Moon, J., Flannery, W., Revez, A. 2017. Discourse and practice of participatory flood risk management in Belfast, UK, Land Use Policy 63, 408–417
20. Newig, J., Challies, E., Jager, N., Kochskämper, E. 2014. What Role for Public Participation in Implementing the EU Floods Directive? A comparison with the Water Framework Directive,

early evidence from Germany, and a research agenda, Environmental Policy and Governance, 24, 275-288.

21. Stirling, A. 2006. Analysis, participation and power: justification and closure in participatory multi-criteria analysis. Land Use Policy, 23, 95-10
22. van Alphen, J., Martini, F., Loat, R., Slomp, Robert and Passchier, R. 2009. Flood Risk Mapping in Europe, Experiences and Best Practices. Journal of Flood Risk Management. 2. 285 - 292.
23. Vojinovic, Z., Abbott, M.B. 2012. Flood Risk and Social Justice: From Quantitative to Qualitative Flood Risk Assessment and Mitigation, IWA Publishing.
24. Watson, N., Kashefi, E., Medd, W., Walker, G., Tapsell, S., Twigger-Ross, C. 2009. Institutional and social responses to flooding from a resilience perspective. In: P. Samuels, S. Huntington, W. Allsop, J. Harrop (Eds.), Flood Risk Management: Research and Practice, Taylor & Francis Group.
25. White, I., Kingston, R., Barker, A. 2010. Participatory geographic information systems and public engagement within flood risk management, J. Flood Risk Manag., 3 (4), 337-346

	1° Co-mapping lab	**2° Co-mapping lab**
Topic	**Critical issues**	**Solutions**
General Observations	Do not use "full" colours, but "transparencies" to make clear what is under the floodable area.	Use of transparencies.
	Use hatches instead of colours to make the maps readable for visually impaired users (e.g. colour blindness).	Use of colours that respond to the first degree of colour blindness. The use of hatches reduce the legibility of the map.
	Add more information/toponymy to better identify locations on the map.	Addition of the names of the main districts and directions of the road system.
	Change base map to make it more understandable (e.g. road map).	No changes. The use of other maps limits the readability of the map.
Hazard	The return period information is not correctly understood and considered.	Changed with the information on the probability of the event according to FRMPs nomenclature (very rare, rare, and frequent).
	For agriculture sector :the greatest damage occurs in the first centimetres of flooding, so the subsequent classes are not very significant while a higher resolution for low heights would be appropriate.	No changes. The creation of hazard maps for specific users is a point to be addressed in the discussion on "diffusion tools".
	Imagine a representation even "not from above".	3D representation is possible, but adequate IT support is required.
	It would be useful to have maps of water velocity, flood duration, flow direction and flooded area over time (isochronous maps)	Based on the outputs of the adopted hydraulic model it is possible to build velocity maps and isochronous flood maps. Warning: you can only do this if you have a proper hydraulic model
Exposure	The exposure maps of the different sectors should be overlaid to capture the various problems that persist in the area (houses, population, and agriculture).	Creation of exposure maps for "functions".
	Instead of "exposure", the wording "exposed value" would be clearer.	Use of the suggested wording.
	Information on the population is preferable as a density.	Development of the exposure map in terms of population density.
	A dynamic representation of the population would be helpful.	No changes. The data is not available

Vulnerability/Damage Residential buildings	The colours used to distinguish "excellent" from "good" is not appropriate, as they are too similar. Colours used to represent damage classes slightly differ from the background, the colour range used should be changed.	Proposed new colours.
	A single vulnerability parameter is useful for citizens: level of maintenance. To understand which vulnerability parameters should be displayed among those considered by the model, it would be necessary to understand which ones weight most on the damage, for example by looking at historical data. The vulnerability parameter "year" is misleading: how does it affect damage?	Representation of the most influential parameters according to the damage model and citizens' needs (due to the absence of historical data). To sum, mapped parameters are: maintenance level, building type, building structure, finishing level.
	Citizens/civil society are interested in representation at the microscale, as it makes the risk more communicable and increases awareness	Keeping both representation units, mesoscale and microscale in order to satisfy users' requirements and needs.
	Mapping the data available at the mesoscale to the microscale is of little use from the owner's point of view.	Adopted as minimum representation scale the data availability scale.
	In the mesoscale representation the average vulnerability values present in that area are usually attributed; this information can be used by planners for an assessment of the average vulnerability at the basin scale, but not for citizens who no longer recognize themselves in the information on the map	No changes. The representation of the distribution of vulnerability values in the mesoscale representation is difficult and makes the map unreadable. A table could be linked to the map.
	There would be interest in a representation of the information for components (e.g. damage to the floor, fixtures, systems).	No changes. The data are available but their representation requires the creation of many maps. Topic to be discussed under "dissemination tools".
Vulnerability/Damage of agriculture	Information on the prevailing crop is not relevant; knowledge of all crops is necessary. The same for the damage.	Crop information has been tabulated.
	The rural buildings and other rural activities such as livestock farms are not mapped, which are decidedly important for quantifying possible damage.	A map showing the exposure of livestock farms has been added.
	To consider rotation: one hypothesis could be to produce maps with exposure ranges in order to take into account the rotation of the crops in the particles. The same for the damage.	Work in progress.
	Exposure in terms of PLV not useful.	Removal of "exposed value" map.
	Open question: the evaluation of vulnerability/damage for the month of July is not useful, as it is the month in which the probability of flood events is very low. Vice versa, in November, when flood events are more probable, there is no agriculture in existence, but the estimate of the damage to the soil could have consequences on the following season.	Maps for the month of July have been eliminated; we kept maps for April and November, i.e. the months in which floods occur most frequently, from historical analyses
Vulnerabilities/Damage of businesses	The vulnerability in terms of NACE categories is of little significance for operators in the sector.	We proposed a reclassification based on the type of expected damage and new maps with indicators of vulnerability to indirect damage.
	In addition to the information on the location of the property, it may be significant to have the surfaces affected	No changes. Businesses surfaces are not available and will not be available under the new privacy law (GDPR).
Services and Facilities	Long-term care facilities should also be mapped (e.g. residences for the elderly).	Information is not currently available.

	The word "hospitals" is generic, it would be better to detail if there is an emergency room, resuscitation, etc..	Information inserted in the map. Warning: this information is not available at the River District level.
	It would be useful to represent helicopter landing points and emergency storage points.	The landing points of the helicopters have been mapped, not the storage points, of close relevance only to the management of the emergency.

Table 3: critical issues and solutions proposed during the participatory mapping process

Map	Sector	Parameters	Scale of representation		Users				Scope		
			micro	macro		Economic Sector					
			("building /object" level)	(census level)	Layman	Agric.	Businesses and services	Experts	strategic planning	CBA	emergency planning
Hazard		· Water extent			x	x	x	x	x	x	x
		· Water depth			x	x	x	x	x	x	x
		·Velocity				x		x	x		x
		· Duration				x	x	x		x	x
Exposure	population	·Number of inhabitants/Km2		x				x	x	x	x
	residential buildings	· Reconstruction cost		x	x			x	x	x	
	commercial and industrial activities	· Position	x				x	x	x	x	x
		·Number of employee per firm	x				x	x	x	x	x
		·Added value per firm	x				x	x	x	x	
		·Salaries paid per firm	x				x	x	x	x	
	agriculture	· Position	x	x		x				x	
	breeding	· Position	x			x				x	x
	public and governmental buildings	· Position	x		x	x	x	x	x	x	x
	critical infrastructure	*Road system* · Reconstruction cost	x					x	x	x	
	facilities and services (including emergency services)	· Position	x		x	x	x	x	x	x	x
	environment and cultural heritage	· Position	x		x			x	x	x	x
Vulnerability	population	·Age		x				x	x	x	
		·People younger than 10 years old		x				x			x
		·People older than 65 years old		x				x			x
		·Number of foreign inhabitants		x				x	x		
	residential buildings	· Building typology	x					x	x	x	
		·Structural typology		x				x	x		
		·Level of maintenance	x		x			x	x		
		·Finishing level		x				x	x	x	
	agriculture	·Typologies of crops	x	x		x					
		·Main crop per parcel	x	x		x					
		·Minimum tillage	x	x		x					
		·Traditional tillage	x	x		x					
	critical infrastructure	*Road system* · Reconstruction cost	x					x	x	x	x
	residential buildings	·Damage to residential buildings	x	x	x			x	x	x	
	agriculture	·Damage to main crop per parcel	x	x		x			x	x	
		·Damage minimum tillage per month	x	x		x			x	x	
		·Damage traditional tillage per month	x	x		x			x	x	

Table 4:Best scale(s) of representation, possible users and uses of all the maps discussed during the laboratories, as emerged from the discussion in the two worktables .