FLOOD-serv

D 2.2. ANALYSIS ON EMERGENCY FLOOD MANAGEMENT PUBLIC SERVICES REPORT

Regulatory models, organizational models and ICT use

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Glossary of terms and abbreviations

***Bridging mechanisms**: instruments implemented to connect actors, rules, resources and discourses in different governance arrangements, in order to deliver more coherent flood risk management (Source: STAR-Flood project).*

***De-centralization:** the distribution of authority and responsibility from central to local authorities (See also: Subsidiarity).*

***Explicit and Implicit data provision:** the intended and volunteered observations by citizens, collected using photos, apps or dedicated sensor technology addressing a problem vs. citizen observations that are collected and mined from social media (Source: Wehn et al. 2015).*

***FD** - **Flood Directive**: the European Directive (2007/60/EC) aims to reduce and manage flood risks, requiring member states to carry out a preliminary assessment of flood risks, to draw up flood risk maps and to implement flood risk management plans focused on prevention, protection and preparedness.*

***FRGA - Flood Risk Governance Arrangements:** the actor networks, rules, resources, discourse and multi-level coordination mechanism through which flood risk management is pursued (Source: STAR-Flood project).*

***FRM - Flood Risk Management:** an instrument implemented to reduce the likehood and the impacts of floods, which integrate prevention, protection and preperadness strategies.*

***FRS - Flood Risk Strategies:** the different dimensions of Flood Risk Management. Risk prevention, Flood defence, floodo mitigation, flood preparation, flood recovery.*

***FoEm - Forecasting and Emergency:** activities aimed to anticipate, prepare, plan and manage relief efforts.*

***Governance:** according to UN refers to the structures and processes that are designed to ensure accountability, transparency, responsiveness, rule of law, stability, equity and inclusiveness, empowerment, and broad-based participation.*

***IFM - Integrated Flood Management:** is a process that promotes an integrated, rather than fragmented, approach to flood management (Source: APFM).*

***Legislative Density:** the quantity and stratification over time of legal regulations.*

***Organization:** a model of solidarity and cooperation, integrating not only of the operational aspects of the actions but also of their meanings, including rules and authority, roles and skill, communications and resource allocations.*

***Prev- Prevention:** activities designed to predict and mitigate risks.*

***Rec - Recovery:** activities aimed to restore damage and start rebuilding.*

***Resilience:** the capacity to react and recover quickly from the damaging effext of hazards.*

***RA - Risk Assessment:** the procedure of assessing the adverse affects of natural phenomena, based on the probability that loss will occur and the extent of damage.*

***Subsidiariety**: the principle by which powers shoul be exercised as soon as possible to citizens. According to the proximity principle, the goal is to reach a certain objective at the lowest level of government which is capable of effectively act.*

***VPN - Virtual Private Network**: a private network, secured by encryption and other security mechanism that ensure that only authorized users can access the network.*

***WMO - World Meteorological Organization WMO:** funded in 1873, from 1950 is the specialised agency of the United Nations for meteorology (weather and climate), operational hydrology and related geophysical sciences*

Executive summary

The report aims to define key concepts about public management of flood emergency focusing the use of ICT.

In particular, within the WP2, the Task 2.2 is devoted to analyze the pre-existing regulative models, the organizational structures and the use of ICTs. This kind of analysis is strategic in order to identify levels of responsibilities and authorities and whose structure is in charge with a particular task or may have specific data to communicate. By doing this, we expect the findings of the Task 2.2 would help in designing and implement flexible applications, easily suitable in different contexts.

The introductive sections illustrates the key concepts about public services to manage Flood Risk and emergency and the use of ICT, provides a critical overview of the research carried out at European level on Flood Risk Management, and finally describe the methodology adopted to conduct the comparative analysis. An in-depth exploration of data recollected in D2.1 (especially for the reconstruction of the regulatory models and for the organizational analysis) was integrated with administration of a questionnaire on to pilot cases: Municipality of Genova, Italy; Municipio Vila Nova de Famalica, Portugal; IP Tulcea, Romania; Municipality of Bilbao, Spain; Bratislava Self-governing Region, Slovakia. Goal of the questionnaire was to assess modalities, goals, and actors involved in the use of ICTs in Flood Risk Management.

We have organized the report trying to identify, in each dimension of analysis, similarities and differences between the five pilots, stressing eventual specificities found for each level of analysis.

Regulatory models analysis contributes to understand opportunities and constraints to take in account in the design and validation of applications and helps to identify the relations among actors and the allocation of responsibility.

The exploration of national, local and subsequent legislation allows to clearly identify which institution or administrative structure has the responsibility of providing information and managing communication flows.

We suggest to distinguish the five pilots according to two characteristics: the "legislative density" (the quantity and stratification over time of legal regulations) and the degree of verticalization/de-centralization in the allocation of authority and responsibility.

"Legislative density" (quantity and stratification over time of legal regulations) is higher in Italy, Portugal and Romania, lower in Slovakia and Spain.

Verticalization vs. De-centralization in the allocation of authority and responsibilities (basically higher verticalization in Portugal and Romania).

We also find some characteristics and trends shared by all pilots: the involvement of multiple levels of authority: local, intermediate and national; the pluralisation of the actors involved, also as a consequence of the common trend toward the shift from management of emergency toward risk assessment, prevention and resilience; the inclusion of citizens and civil society.

The organizational analysis and the analysis of the use of ICTs allow to step forward in the individuation of actors, their responsibility and their interaction in order to better clarify the relations between involved actors, their roles, and their concrete activities in the emergency flood management.

The goal is to verify if formal allocation of authorities goes hand in hand or present some incongruences with the organizational model implemented and how both reflect in the use of ICTs.

In particular, we identify roles and allocation of authorities in three phases of Flood Risk Management:

PREVENTION - activities designed to predict and mitigate risks;

FORECASTING AND EMERGENCY - activities aimed to anticipate, prepare, plan and manage relief efforts;

RECOVERY - activities aimed to restore damage and start rebuilding.

In the organizational analysis we reconstruct the structure of the ICTs activities, the differences in the use of databases, the similarities in the use of social network and local VPN.

The exploration of the organizational models suggests that the five project partners present some relevant differences in terms of organizational and regulatory models, as well as in ICT use, but also some similarities.

We stress, among the main similarities, that the local level is the prevailing level of responsibility allocation in all pilots, while the forecasting and alarm system are managed above all at the national level in all pilots.

Also some differences are reported: Vila Nova and Bilbao present organizational models with exclusive allocation of responsibility; Genova, Tulcea and Bratislava present organizational models with shared allocation of responsibility.

The similarities in the use of ICTs in Flood Risks Management regard the use of VPN and intranet to communicate decisions; the use of web to present risk scenarios and forecast; the use of direct broadcast to inform and to alarm citizenship.

We emphasis that relevant differences concern how in the selected regions the web is used to make the contents and prescription of emergency plan available to citizenship: each pilot has implemented different communication strategies.

In the following section we try to systematize and to generalize the knowledge generated beyond pilots, in order to provide some general indication for the implementation of service platforms able to support a better coordination and citizens involvement in Flood Risk Management.

We finally provide some practical suggestion to be followed in order to project the Flood-serv platform service. We conclude the report suggesting that the findings of the comparative regulatory analysis, the organizational analysis, together with the analysis of the use of ICTs, may be adopted as a check tool for the testing and the validation of the service applications.

Ideally, the structure of service applications should fit with the organizational structure and the regulative models adopted and with the consequent hierarchical structure and the subsequent distribution of roles.

1. State of Question

1.1. FLOOD-serv project: framework of reference

FLOOD-serv project's goal is to implement service application that will enhance the involvement of the citizen and will harness the collaborative power of ICT networks to raise awareness on flood risks and to enable collective risk mitigation solutions and response action. This goal fits with the overall goal pursued by EU, that is, to increase countries cooperation in order to reduce flood risk and to implement more efficient instruments to prevent and manage emergency in different environmental and urban contexts[1].

More specifically, the goal of the project is to empower local communities to directly participate in the design of emergency services dealing with floods mitigation actions; harnessing the power of new technologies, such as social media, and mobile technologies to increase the efficiency of public administrations in raising public awareness and education regarding floods risks, effects and impact; encouraging the development and implementation of long-term, cost-effective and environmentally sound mitigation actions related to floods though an ICT-enabled cooperation and collaboration of all stakeholders: government, private sector, NGOs and other civil society organizations as well as citizens.

These general goals can be achieved by systematizing and making easily and publicly accessible all available data; improving warning and emergency communication; providing support for the public authorities and government institutions' hazard mitigation efforts, including planning and action coordination; ameliorating the information on risk exposure and the public's capability to prepare, respond, recover and mitigate the impacts of these events.

To better achieve these goals the implemented applications should not only be characterized by a modular structure in order to adapt to different kind of users, but the implemented applications should also be able to adapt to different contexts and to different needs, originating from different models of intervention.

In fact, the five pilots involved in the FLOOD-serv project diverge both in terms of environmental characteristics and in terms of emergency and prevention organizational and regulatory models. The organizational and regulatory comparative analysis is strategic in designing and implementing flexible applications, to identify levels of responsibilities and authorities, whose institution or structure is in charge with a particular task or may have specific data to communicate.

1.2 Goal of the report

Goal of the D2.2 is to define key concepts about public management of flood emergency focusing the use of ICT, according to Task 2.2, that is devoted to analyze the pre-existing regulative models, the organizational structures and the use of ICTs.

[1] The five pilot cases are: Municipality of Genova, Italy; Municipio Vila Nova de Famalicao, Portugal; IP Tulcea, Romania; Municipality of Bilbao, Spain; Bratislava Self-governing Region, Slovakia.

Through an in-depth exploration of data recollected in D2.1 and ad hoc data, recollected thanks to a questionnaire focused on modalities, goals, and actors involved in the use of ICTs in FRM, administered to pilots (See § 2.2 below).

The analysis has been conducted with the goal to detect similarities and differences between the five pilots, and stressing eventual specificities found for each level of analysis.

The regulatory models analysis contributes to understand the opportunities and constraints to be taken into account during the design and validation of applications and helps to identify the relations among actors and the allocation of responsibility. Yet, the regulatory models analysis is not easily fulfilled and it should be considered a kind of transversal task to be fine tuned during the project. This kind of analysis can help to identify, in different contexts, the different level of authorities, the different actors who share responsibilities and what role they play in the communication of the flow management. This analysis provides key information to better identify the key actors who are responsible of activating and managing the final applications developed in the scope of this project.

We have critically analysed the previous research, data and project available, mainly at European level, in FRM and in the use of ICTs to promote coordination between a plurality of actors, dimension of interventions and levels, and to involve citizens.

Goal of this contextualization is twofold:

1) To provide practical suggestion to be followed in order to project the Flood-serv platform service. The document suggests some points of attention to be develop especially in WP3 and WP5, and especially in the development of FLOOD-serv System Components; in preparing a semantic Wiki for increasing public collective awareness and preparedness; in improving the Citizen Direct Feedback; in defining, implementing and executing various kinds of tests for all the components of the FLOOD-serv platform).

2) To Generalize and systemize the knowledge generated beyond pilots, in order to provide some general indications for the implementation of service platforms able to support a better coordination and citizens involvement in FRM.

2. Previous research and method

2.1. Previous research

In the last decade the interest toward FRM has strongly raised, at international and at national level. At European level, in particular, a plurality of projects have been devoted to improve the knowledge, to implement innovative strategies and to assess and promote the sharing of models and tools. FLOOD-serv project can be conceived as in continuity with previous European projects, devoted to promote innovation in FRM.

Focusing in the last decade, the first European project dealing with FRM is CRUE ERA-NET (2004-2009). The project, involving 16 partners, has been set up to consolidate existing European flood research programmes, and to promote best practice and identify gaps and opportunities for collaboration, with the goal to improve flood management in European countries (www.crue-eranet.net). The countries involved are Austria, Belgium, Finland, France, Germany, Hungary, Ireland, Italy, Poland, Spain, Netherland and United Kingdom.

The 2nd ERA-NET CRUE Funding Initiative "Flood Resilient Communities – Managing the Consequences of Flooding" (2008-2012; 6FP) was launched in 2008 to support the implementation of the EU Floods Directive (2007/60/EC) by improving knowledge, tools and strategies for FRM with the goal to support and develop an extensive co-ordination and integration of regional, national, and European research programmes, projects and policies in the field of FRM. The funding initiative encompasses three complementary projects: FREEMAN, IMRA and URFlood FREEMAN was aimed to analyze risk perception, focusing in communication, performance of risk management plans and early warning systems. The main goals were to convey the concept of resilience to decision makers, flood managers and the general public; to identify important factors that affect flood resilience as well as strategies and measures that increase flood resilience; to identify quick wins to enhance flood resilience on case study level (www.feem-project.net/FREEMAN). UrlFlood analyzed flood risk communications and interpretation in a broader context of social, cultural and individual behaviour. The IMRA project examined risk awareness and public participation "focusing on social milieus for a tailor-made participation campaign and developing a new indicator-based model for the assessment of institutional stakeholder cooperation". The countries involved are the same included in the previous project: Austria, Belgium, Finland, France, Germany, Hungary, Ireland, Italy, Poland, Spain, Netherland and United Kingdom.

Another 6FP funded project dealing with FRM and explicitly aimed to support the FLOOD Directive is FLOODsite (2004-2009). FLOODsite (www.floodsite.net), according to the project description, covers the physical, environmental, ecological and socio-economic aspects of floods from rivers, estuaries and the sea. It considers flood risk as a combination of hazard sources, pathways and the consequences of flooding on the "receptors" – people, property and the environment. In this perspective, FRM is view as a process which comprises pre-flood prevention, risk mitigation measures and preparedness, backed up by flood management actions during and after an event. The involved countries are Belgium, Czech Republic, France, Germany, Hungary, Italy, Netherlands, Spain, and UK.

FLOOD CBA project (www.floodcba.eu) was aimed to establish a sustainable Knowledge Platform for the use of stakeholders dealing with the Cost-Benefit Analysis (CBA) of flood

prevention measures in the context of different socio-economic environments within the EU. Among the specific goals go the project were the widening of Networking actions; the analysis of stakeholders' requirements and gathering of background information; the consultation of actions and development of supporting and knowledge exchange tools (Mysiak 2013). The project was realized by a consortium of six partners coming from Greece, UK, Romania, Portugal, Germany and Spain.

The FP7 EU funded STAR-FLOOD project (2012-2016) deals closely with the FLOOD-serv objective, even it is focused on the FRS and FRGA, and only indirectly deals with the use of ICT. The compared different European FRM, focusing in the subsequent FRGA adopted, in order to identify common traits and differences. STAR-FLOOD project investigated FRM Strategies in 18 vulnerable urban regions in six European countries: Belgium, England, France, the Netherlands, Poland and Sweden, focusing in flood risk governance arrangements from a combined public administration and legal perspective (www.starflood.eu). The project highlights similarities and differences between countries, in terms of FRS (prevention, defence, mitigation, preparation and response) and FRGA, defined as "the institutional constellations resulting from an interplay between actors and actor coalitions involved in all policy domains relevant for FRM—including water management, spatial planning and disaster management; their dominant discourses; formal and informal rules of the game; and the power and resource base of the actors involved (Diepering 2013; Hegger *et al.* 2013).

Finally, WeSenseit and Anywhere projects are strongly correlated with the FLOOD-serv project.

The analysis of the use of ICTs to promote cooperation between a plurality of actors and to increase citizen participation in FRM has been recently developed by EC funded (7FP) WeSenseit (www.wesenseit.com). The project is devoted to develop a citizen-based observatory of water, which will allow citizens and communities to become active stakeholders in information capturing, evaluation and communication. The project proposes a data collection, an identification of a first layer made of "low-cost, static and portable devices that sense and transfer water information when automatically monitored or when initiated by citizens from their mobile devices"; a second layer made of "techniques to harness citizens' Collective Intelligence", as information, experience and knowledge embodied within individuals and communities. The goal is to contribute to define applications able to enable direct messages to the authorities (with mobile-phone pictures, messages, etc.) and in terms of crowd-sourcing (e.g. by mining social networks like Twitter and Facebook, as well as bulletin boards, RSS feeds, etc.). Goal of WeSenseit is to innovate the FRM by integrating the existing database actively including citizens and their direct knowledge and to promote the shift from a one-direction to bi-directional fluxes of communication supporting the exchange of environmental information and experiences between citizens and authorities and supporting decision making and governance within an e-collaboration framework. The result will be a validated citizen observatory for water, combining innovative sensor devices and the exploitation of collective intelligence.

The citizen water observatory is being tested and validated in three case studies in Doncaster (United Kingdom), Delft (the Netherlands) and Vicenza (Italy). The ambition is "fundamentally change the traditional concept of environmental monitoring and forecasting, as well as models of governance".

The Horizon2020 funded project ANYWHERE (www.anywhere-h2020.eu) is "to enable society as a whole and the main civil protection agencies to respond more rapidly than today to extreme climate and weather events, and to better cope with the high social, environmental and economic impacts related to these extremes. The Project will establish a pan-European platform on extreme climate risks that will enable to identify, in a number of geographic

regions, critical situations that could lead to loss of life and economic damages. Such early-warning should enable to improve protection measures and, in case of catastrophic situations, ameliorate the coordination of rescue operations". The countries involved are Belgium, Finland, France, Germany, Italy, Netherland, Slovakia, Spain, Sweden, Switzerland, United Kingdom.

The review of the European project committed to FRM, and more specifically on the use of ICTs in FRM, reveals that some countries have been highly involved in comparative analysis (among the countries involved in FLOOD-serv Italy and Spain), while other have been less involved (Romania, Slovakia and especially Portugal). For the latters data and literature are available to a lesser amount. On the other hand, the involvement of countries where less research and data on FRM has available represents an addedd value of the Flood-serv project.

Table 1 *European funded projects on Flood Risk Management in the last decade*

Project	Website	Years	Partners	Goal
FLOODsite	www.floodsite.net	2004-09	Belgium, Czech Republic, France, Germany, Hungary, Italy, Netherlands, Spain, United Kingdom.	To cover the physical, environmental, ecological and socio-economic aspects of floods from rivers, estuaries and the sea.
CRUE ERA-NET	www.crue-eranet.net	2004-09	Austria, Belgium, Finland, France, Germany, Hungary, Ireland, Italy, Poland, Spain, Netherland, United Kingdom.	To consolidate existing European flood research programmes, and to promote best practice and identify gaps and opportunities for collaboration, with the goal to improve flood management in European countries.
2nd CRUE ERA-NET	www.crue-eranet.net/	2008-12	Austria, Belgium, Finland, France, Germany, Hungary, Ireland, Italy, Poland, Spain, Netherland, United Kingdom.	To support the implementation of the EU Floods Directive. Three complementary projects: FREEMAN (aimed to analyze risk perception, focusing in communication, performance of risk management plans and early warning systems), , IMRA (aimed to examin risk awareness and public participation) and URFlood (aimed to analyzed flood risk communications and interpretation).
STAR-FLOOD	www.starflood.eu	2012-16	Belgium, England, France, the Netherlands, Poland, Sweden	To analyze and compare different European Flood Risk Strategies and Flood Risk Governance Arrangements adopted in different European countries from a combined public administration and legal perspective.
WeSenseit	www.wesenseit.com	On going	Vicenza (Italy), Delft (Netherland), Doncaster (United Kingdom)	To develop a citizen-based observatory of water, which will allow citizens and communities to become active stakeholders in information capturing, evaluation and communication
Anywhere	www.anywhere-h2020.eu	On going	Belgium, Finland, France, Germany, Italy, Netherland, Slovakia, Spain, Sweden, Switzerland, United Kingdom	To enable society as a whole and the main civil protection agencies to respond more rapidly than today to extreme climate and weather events, and to better cope with the high social, environmental and economic impacts related to these extremes.

2.2. Method

The D.2.2, in the context of FLOOD-serv project, in continuity with the above mentioned researches, is devoted to define key concepts about public management of flood emergency focusing the use of ICT. In particular, within the WP2, the Task 2.2 is devoted to analyze the pre-existing regulative models, the organizational structures and the use of ICTs. This kind of analysis is strategic in order to identify levels of responsibilities and authorities and whose structure is in charge with a particular task or may have specific data to communicate. By doing this, we expect the findings of the Task 2.2 would help in designing and implement flexible applications, easily suitable in different contexts.

The comparative analysis has been carried out combining a review critical of the literature on FRS and FRGA in European countries, a desk analysis of the legislation, the organizational model and the use of ICTs in the five pilots, and in-depth exploration of the data recollected in D2.1. These resources and date were integrated with ad hoc data recollected administering a questionnaire on ICTs use to the five pilots: Municipality of Genova, Italy; Municipio Vila Nova de Famalica, Portugal; IP Tulcea, Romania; Municipality of Bilbao, Spain; Bratislava Self-governing Region, Slovakia.

In the comparative analysis of pilots, the common reference context is the management of flood risk and emergency; so this complex organizational action has been specified in operational phases and related component activities:

Phase 1 - Prevention (activities designed to predict and mitigate risks)

- Definition of probable risk scenarios
- Identification of priorities for action
- Provision/setting of resources
- Implementation of actions aimed at reducing risks
- Information and training
- Urban planning and land defence.

Phase 2 - Forecasting and Emergency (activities aimed to anticipate, prepare, plan and manage relief efforts)

- Definition of risk scenarios
- Preventive and during-the-flood communication
- Resources planning (funds, staff and equipment)
- Preparatory activities of staff, equipment and procedures
- Forecasting and nowcasting
- Alarm system
- Emergency response management

Phase 3 - Recovery (activities aimed to restore damage and start rebuilding)

- Definition of scenarios resulting in the risk assessment

- Resources planning (funds, staff and equipment, structure, administrative procedures)
- Implementation interventions

This structural-functionalist scheme of interpretation of the FRM has been set up according to the terms and definitions contained in the Italian national legislation (in particular in the Law 225/1992 and in the Law 100/2012 on Civil Protection), with the specifications related to the assessment and management of flood risk derived from the Directive 2007/60/EC.

The functionalist scheme has been used both in the first part of analysis, for the construction of the summary tables of the contents deriving from the D2.1 report, and in the second part for the construction of the survey questionnaire on the use of the ICT and the related analysis. (See in Appendix 1 the questionnaire).

The comparative analysis of the regulative models and the organizational models - and the subsequent analysis of the use of ICTs - were carried out relying in the assumption that "the structural elements of water governance consist of four dimensions: institutions, actor networks, multi-level interactions, governance modes" (Wehn at al. 2015; cfr. Pahl-Wostl, 2009).

The methodological approach, focused on the individuation of similarities and differences, is followed in order to make possible the implementation of a flexible service platform.

3. Analysis on the characteristics and specificities of existing flood risk management public services

3.1. Regulatory models

3.1.1 European regulations

At the European level, the key milestone in flood prevention legislation is the Floods Directive 2007/60/EC, which has been defined as the “daughter directives” of the previous Water Framework Directive (Directive 2000/60/EC). Both directives establish binding objectives to be transposed into national laws, that is, they provide goals that should be reached, but they do not prescribe the manner in which the goals should be achieved (Priest et al. 2016). Goal of the Floods Directive was to encourage European Countries to move from flood defense to a risk management approach.

The Floods Directive requires member States to follow a three-step procedure:

1. Implementation of the Preliminary Flood Risk Assessment;
2. Preparation of the Flood Hazard Maps;
3. Adoption of the Flood Risk Management Plans.

The Floods Directive 2007/60/EC entered into force on 26.11.2007 (OJ L 288, 6.11.2007, art. 18), and was transposed on 26.11.2009 (art. 17). Among the most relevant following steps the Preliminary Risk Assessment was approved on 22.11.2011 (art. 4 &5). On 22.12.2012 the Public Participation Process started (art. 9.3 & 10). On 22.12.2013 it were implemented the Flood Hazards Risk Maps and on 22.12.2015 the FRM Plans (art. 7) were approved.

The implementation of Floods Directive 2007/60/EC required Member States a strong a radical redefinition of the overall regulations, the governance arrangements, the operative models adopted, as an overcoming of state-based, hierarchical, defensive and "technical" approach to intervention. In facts, the diversification of FRM Strategies is accompanied by a diversification in rules and regulations (Diepering et al. 2013). Member States were asked to ensure the appropriate administrative arrangement and to identify and empower the competent authority, for the application of the rules in each River Basin District lying within their territory (Hegger et al. 2013).

The goal is to promote a shift from Flood defence to social resilience, which emphasis the capacity to resist, to absorb and recover, and to adapt (Alexander et al. 2016a). Different strategies are integrated: flood risk prevention; flood defence; flood mitigation; flood preparation; flood recovery: while flood defence and flood mitigation focus on reducing the likelihood and magnitude of flood hazards, flood prevention helps to reduce exposure; while flood preparation and recovery both deal with the potential consequences of floods. Strategies should, however, be implemented in such a way that they fit in their physical and institutional contexts" (Hegger et al. 2016).

Both FRS and FRGA were deeply ridefined, in order to promote cooperation among different actors, integrate a plurality of strategies in a common framework, avoid fragmentation between actors, levels and sectors. In facts, "in contrast to the flood defense approach, FRM necessitates the involvement of diverse policy domains, such as spatial planning and emergency management, and a broad range of public, private, and civil society actors (Mees et al. 2014), but this require new, more complex and flexible organizational models.

Each Member States incorporated the Floods Directive 2007/60/EC in its legislation.

The Preliminary Flood Risk Assessment, whose deadline was in December of 2011, was implemented at national level in Italy, Portugal Romania, Slovakia and Spain prior to this date. Only in Italy the Preliminary Flood Risk Assessment was approved prior to the implementation of the Floods Directive 2007/60/EC. In the Spanish case, an updated version was approved in January of 2016.

3.1.2 A comparative analysis of regulatory models in the selected regions

EU Institutions, by establishing a common regulatory framework and implementing its Directives, promote a convergence of national legislations.

National implementation of the FRM Directive should lead to the development of an intergovernmental integrated FRM on an European scale and to "make a gradual change from a safety culture to a risk culture in Europe". (Müller, 2013).

The comparative analysis of regulatory models - carried out in-depth exploring the data recollected in D.2.1 - was aimed to explore the characteristics of the legal framework in the five regions. The analysis allowed to identify the main characteristics of the regulatory models implemented. In particular, we single out two dimensions:

- the "legislative density" that shows the frequency of law production

- the degree of verticalization/de-centralization that shows the distribution of authority and responsibility.

In both dimension it's possible to detect similarities and differences.

1. - **"Legislative density"**. We can identify countries where civil protection and prevention and management of flood risks are regulated by a complex system of norms, which were approved several decades ago; and countries where the regulatory production is lower and more recent. Where the normative is older, as it is the case of Italy, we observe a stronger regulative stratification, with a high number of important subsequent legislation.

Table 2 *Legislative density*

	National legislation	Regional/provincial legislation	Subsequent legislation
Italy	2	/	10
Portugal	15	/	/
Romania	8	/	9
Spain	2	5	2
Slovakia	5	/	5

2. - **Verticalization vs. De-centralization in the distribution of authority and responsibility**. The five member States represented in the project are characterized by different models of de-centralization. The administrative structure of the five involved countries is different in terms of the relation among national and regional levels. In Spain, for example, the Basque Region has a high degree of autonomy.

The characteristics of the State-regions relation are reflected in the pattern of the regulatory models controlling civil protection and Floods Risk and Hazard Prevention and Management. In such countries where a vertical power structure prevails, authority and responsibility are concentrated on national institutions and structures, and the local authorities have mainly operative functions.

Table 3 *Levels of authority according to regulatory model*

Country	Municipal	District/ County Prefettura	River Basin	Regional	National	Total N.
Italy	x	x		x	x	4
Portugal	x	x			x	3
Romania	x	x	x		x	4
Slovakia	x	x			x	3
Spain	x			x	x	3

In countries characterized with a greater level of regional autonomy, also the responsibility on Flood Risk Prevention and Management is more equally shared among national, regional, and municipal authorities.

In each of the States represented in the project, the authority and responsibility are - with different degrees - shared by a plurality of actors, including water and basin administration. The authority of this kind of independent institution is relevant especially in the Romanian case: the Romanian Water Regional Administration is in charge of establishing the strategy for defence against floods. Civil protection structure is normally placed under the jurisdiction of the Council of Ministers and the Ministry of Interior.

On the other hand, some relevant similarities can be identified. In particular, in every country we observe the involvement and the cooperation of national, regional - in Italy and Spain - and municipal administration - all pilots , while the role played by independent structures is different, such basin administration. The regulatory models, in most cases, are defined by the national framework law, which is implemented by regional and local legislation.

The analysis of the legislation allows to identify a common trend toward the shift from management of emergency to risk assessment, prevention and resilience. The widening of the scope of normative regulations promotes a pluralisation of the actors involved.

Other common trend is the inclusion of citizens and civil society and the promotion of cooperation. We observe a shift from a traditional state-oriented governance toward more collaborative models (van Buuren *et al.*, 2012).

All considered, we can identify a partial process of convergence between regulatory models but national and regional specificities are still relevant, and we consider that, according to European Floods Directive (2007/60/EC), the FRM plans "must be coordinated on the level of river basin districts across administrative and national boundaries" (Hartmann, Spit, 2016).

3.1.3 Main findings. Indications emerging from the comparative analysis of regulatory models for the implementation of service application

There is no service application directly congruent to different contexts. In other words, a service application cannot be considered neutral with respect to the regulatory context where it is implemented. As the goal of the FLOOD-serv is to design applications able to be applied in different contexts, these applications need to be flexible and adaptable.

The five pilots of the project diverge both in terms of environmental characteristics and in terms of organizational and regulatory models (see Table 4). Accordingly, organizational and regulatory comparative analysis is strategic to design and to implement flexible applications, to identify levels of responsibility and authority, to clearly understand which institution or structure is in charge of a particular organizational role or communicative task.

Regulatory models analysis contributes to understand opportunities and constraints to take in account in the design and validation of applications and helps to identify the relations among actors and the distribution of responsibilities. It helps to clearly identify which institution or administrative structure has the responsibility of providing information and managing communication flows. Ideally, organizational structure of service applications should fit with the organizational structure and the regulative models adopted and with the consequent hierarchical structure and the subsequent distribution of roles.

In order to achieve this goal, a comparison between the structure of the implemented service application and the regulatory models is worthy to be made in different steps of the project,

as a key instrument for validating the applications. The goal of this kind of comparison is to test the function of the application itself, in order to reach a clear attribution of roles and responsibilities.

Table 4 *Characteristics and specificities emerging from regulatory models comparison*

Characteristics	Similarities	Involvement of multiple levels of authority: local, intermediate and national (all pilots).
		Pluralisation of the actors involved, also as a consequence of the common trend word the shift from management of emergency toward risk assessment, prevention and resilience (all pilots).
		Inclusion of citizens and civil society (all pilots).
	Differences	"Legislative density" (quantity and stratification over time of legal regulations), higher in Italy, Portugal and Romania, lower in Slovakia and Spain.
		Verticalization vs. De-centralization in the distribution of authority and responsibilities (basically higher verticalization in Portugal and Romania).
Specificities	Inclusion of independent institutions (i.e. water and basin administrations) - I.e. IP Tulcea	

3.2 Organizational models

3.2.1 Public regulatory environment

Organization is a model of solidarity and cooperation, integrating not only of the operational aspects of the actions but also of their meanings, including rules and authority, roles and skill, communications and resource allocations. From the point of view of the process, elements, their relations and orientations characterize the different models (Lasswell, 1950).

Henry Mintzberg (1992) classified organizational models as simple, functional (machine and professional bureaucracy), divisionalized (product based) and adhocracy.

Simple structures are characterized by direct supervision and strategic apex. Functional organizations are traditional business hierarchies in which the key parts are techno structure and tasks are grouped by functional areas. The machine functional models are most effective in organizations where routine processes are performed; professional bureaucracy uses standardized skills in this process type. In divisional models, people are grouped by a common factor such as product, location or customer population. Adhocracy, like an open structure, with mutual adjustment, is most effective in organizations where non-routine processes are performed.

There are different possibility to mix this models; matrix organization combines both functional and product model elements, using cross-functional teams; people work on projects and report to both a functional manager and a project manager.

The presence of a heavily structured public regulatory environment (see part 2.1 of this Report and Report D2.1, section 3) determines, in all the pilot cases, organizational models characterized by hierarchies of authority and responsibility, combined machine and professional functional elements with a rigid competences separation of divisional model.

The public regulatory environment differs in the complexity of national, regional and local norms (see Table 2) and in the prediction of hierarchical levels of authority and responsibility (see Table 3).

Based on the information collected in Report D2.1, main operative phases of FRM - derived from Italian Law 225/1992, art.2 – are related with organizational levels to each pilots, to underline a primary responsibility of activities (R) or a secondary/support responsibility (S) (see Table 5).

The structured public regulatory environment determines in all pilots specific hierarchies between levels:

- National or regional levels generally set up risk scenarios and are responsible for forecasting and alarm system (see Figure 1); local levels support with information the superior levels;

- Local level operates to prepare, plan and manage relief efforts (see Figure 2), involving higher levels in the absence of resources or authority; national and regional levels operate coordination and providing general infrastructure;

- Local levels restore damage and start rebuilding (see Figure 3), with coordination of regional and national levels.

Through the definition of norms, plans and programs, in all pilot cases we highlighted the will to concentrate and to uniquely identify the responsibility, the roles of authority, the places of individual or collegial decision (relief coordination centres, operative rooms and committee, joint operative centres), ensuring at the same time the plurality of information elements deriving from decentralization of monitoring and surveillance.

Table 5 *Relation between activities and organizational levels*

Operative phases	*Activities*	*MUNICIPALITY OF GENOVA ITALY*				*MUNICIPIO VILA NOVA DE FAMALICAO PORTUGAL*			*IP TULCEA ROMANIA*				*MUNICIPALITY OF BILBAO SPAIN*			*BRATISLAVA SELF-GOVERNING REGION SLOVAKIA*		
Pilot site flood management Governance Structure		MUNICIPALITY	DISTRICT (PREFETTURA)	REGION	NATIONAL	MUNICIPALITY SMPC - COM	DISTRICT CDOS	NATIONAL ANPC - CNOS	LOCAL	COUNTY (REGIONAL)	RIVER BASIN DISTRICT	NATIONAL GIES	MUNICIPAL	AUTONOMOUS GOVERNMENT	NATIONAL NCEPC	LOCAL MUNICIPAL	DISTRICT	NATIONAL
PREVENTION: activities designed to predict and mitigate risks	Definition of probable risk scenarios	S		R		S	R			S	R			R				R
	Identification of priorities for action	R		S		R			S	S	R			R				R
	Provision/setting of resources	R				R				R				R		R		
	Implementation of actions aimed at reducing risks	R				R			R		R		R	S		R		
	Information and training	R		S	S	R			R	S			R	S		R	S	R
	Urban planning and land defence.	R				R			R		R		R	S			R	

Operative phases	*Activities*	*MUNICIPALITY OF GENOVA ITALY*				*MUNICIPIO VILA NOVA DE FAMALICAO PORTUGAL*			*IP TULCEA ROMANIA*				*MUNICIPALITY OF BILBAO SPAIN*			*BRATISLAVA SELF-GOVERNING REGION SLOVAKIA*		
Pilot site flood management Governance Structure		MUNICIPALITY	DISTRICT (PREFETTURA)	REGION	NATIONAL	MUNICIPALITY SMPC - COM	DISTRICT CDOS	NATIONAL ANPC - CNOS	LOCAL	COUNTY (REGIONAL)	RIVER BASIN DISTRICT	NATIONAL	MUNICIPAL PEMU	AUTONOMOUS GOVERNMENT	NATIONAL	LOCAL MUNICIPAL	DISTRICT	NATIONAL
FORECASTING AND EMERGENCY: activities aimed to anticipate, prepare, plan and manage relief efforts	Definition of risk scenarios	R				R				R	S		R			R		
	Preventive and during-the-flood communication	R				R				R			R			R	R	
	Resources planning (funds, staff and equipment)	R	R			R				R	S		R			R		
	Preparatory activities of staff, equipment and procedures	R		R		R				R			R			R		
	Forecasting and nowcasting			R			S	R			R	R			R		R	R
	Alarm system	S		R			S	R			R	R	R			R		
	Emergency response management	R	S	S		R	S	S	S	R			R			R	R	
RECOVERY: activities aimed to restore damage and start rebuilding	Definition of scenarios resulting in the risk assessment	R				R				R			R			R		
	Resources planning (funds, staff and equipment, structure, administrative procedures)	R		R		R	S			R			R			R		
	Implementation interventions	R		S	R	R				R			R			R		

Figure 1 *Prevention – Primary responsibility* 1: Local level (Local, Municipality); 2: Intermediate level (District, Region, County, River basin district, Autonomous government); 3: National level*

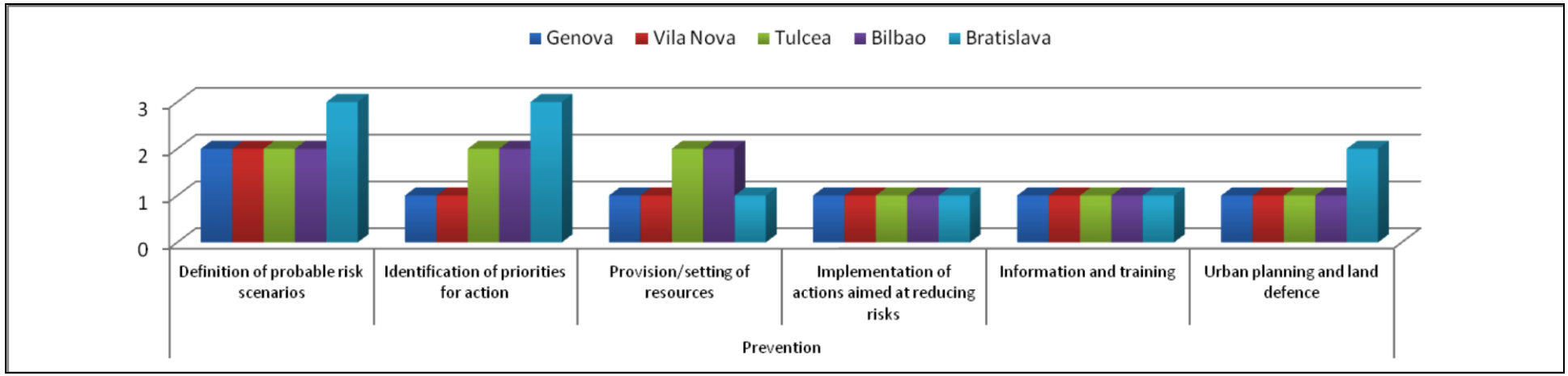
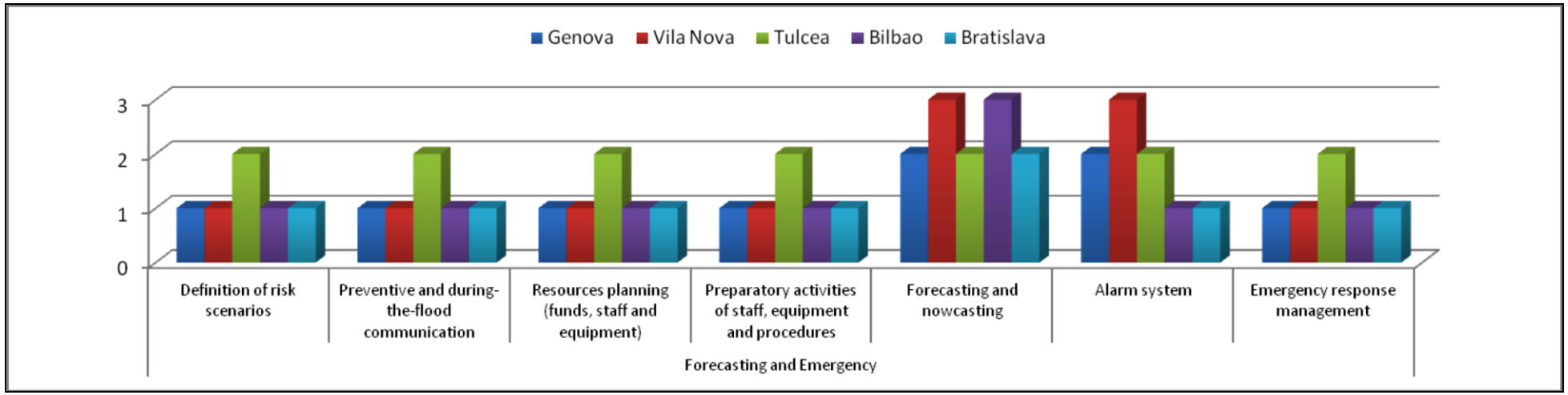
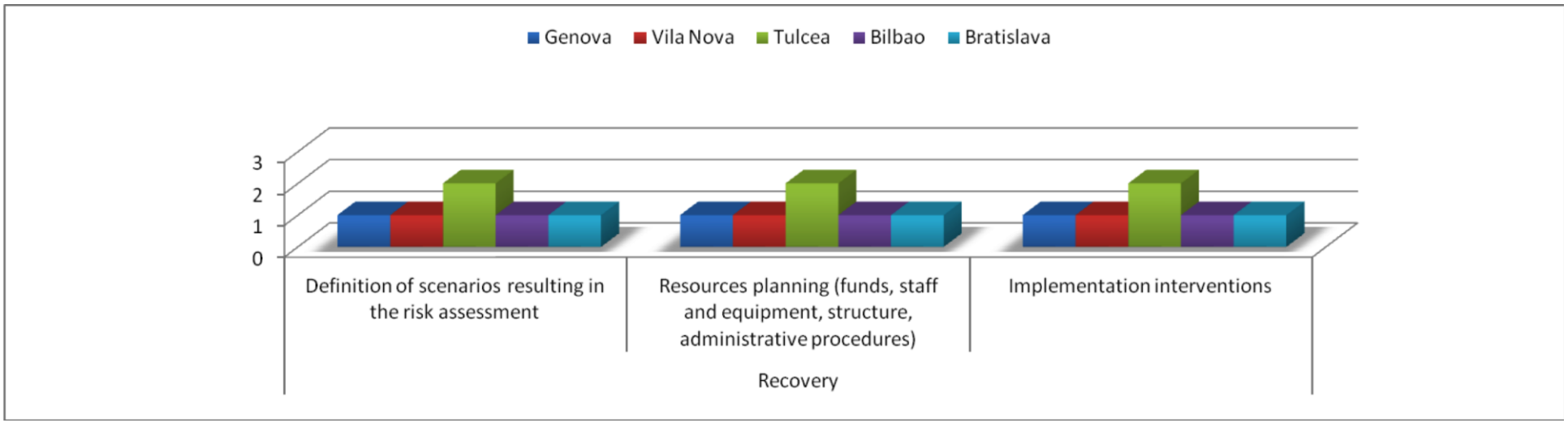


Figure 2 *Forecasting and emergency* – Primary responsibility 1: Local level (Local, Municipality); 2: Intermediate level (District, Region, County, River basin district, Autonomous government); 3: National level*



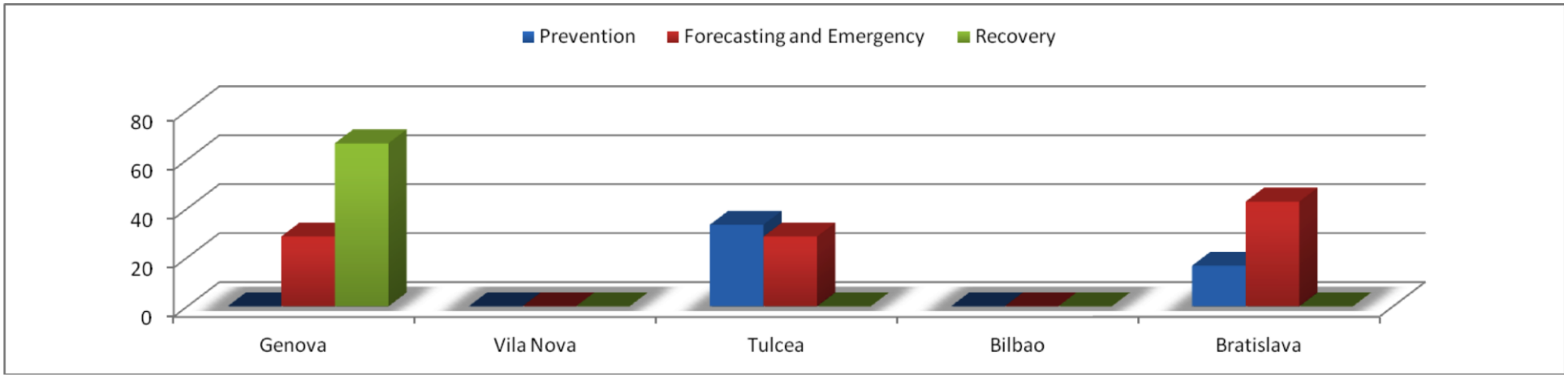
* In case of primary responsibility shared in two levels in these Figures is considered the lower.

Figure 3 *Recovery – Primary responsibility* 1: Local level (Local, Municipality); 2: Intermediate level (District, Region, County, River basin district, Autonomous government); 3: National level*



*In case of primary responsibility shared in two levels in these Figures is considered the lower.

Figure 4 **Shared primary responsibility (percentage)**



3.2.2 Main findings. Indications emerging from the comparative analysis of organizational models for the implementation of service application

The analysis of organizational models coming from the D2.1 allows to observe some similarities overall the selected pilot cases (see Table 6): the first one is that the local level is the prevailing level of responsibility allocation, above all in recovery phase. Then we can find a tendency to refer to higher levels above all in definition of probable risk scenarios and in the identification of priorities for action as well as in forecasting and in alarm system.

Another characteristic emerging from the comparison of organizational models is the difference between two groups. In the first group we can find Vila Nova and Bilbao. Responsibility is here allocated to a one level, having the exclusive responsible for the specific action or process. In the second group we find the others: they tend – in different ways and degrees – to share some specific actions, for example in forecasting and emergency phase. It means that there are usually two levels of authority overall some phases of the FRM (before, during, and after).

Tulcea IP shows as specific characteristic the prevailing of the intermediate level in managing the most of actions.

Table 6 *Characteristics and specificities emerging from organizational models comparison*

Characteristics	Similarities	Local level as prevailing level of responsibility allocation (all pilots)
		Forecasting and alarm system are managed above all at the national level (all pilots)
	Differences	Different presence of exclusive or shared responsibility: Vila Nova and Bilbao present organizational models with exclusive allocation of responsibility; Genova, Tulcea and Bratislava present organizational models with shared allocation of responsibility
Specificities	In Tulcea's organizational model an intermediate level, the river basin authority, plays a central role.	

4. Use of ICT to support emergency flood management service

4.1 Flood risk management and ICT

The analysis of relation between main activities in FRM and organizational levels in order to identify responsibility highlights the presence in several activities of a plurality of institutions involved, often with the similar role and sometimes with the similar degree of authority, that issues to integrate organizational elements into a matrix model.

The hierarchical and functional patterns deriving from the regulatory model, usually derived from national laws, change during design and application of flood emergency plans, sometimes with unexpected effects. FRM requires the construction of complex and flexible organizations capable of responding, in the various scenarios that are part, to multiple political and social issues (governance structure and organization for each pilots are displayed in Report D2.1, section 2).

The United Nations International Strategy for Disaster Reduction (UN/ISDR) identifies key players in the disaster warning and management process (explanation of key players is derived from C. Wattegama, 2007):

- Communities, particularly those most vulnerable, are vital to people-centred FRM systems. Their input into system design and their ability to respond ultimately determine the extent of risk associated with flood hazards. Communities should be aware of potential negative impacts to which they are exposed and be able to take specific actions to minimize the threat of loss or damage. The different characteristics of these communities have been distinguished in the general project documents and in Report D2.1, section 2. In each emergency plan of pilot cases there are elements for self protection.
- Local governments should have considerable knowledge of the flood hazards to which their communities are exposed. They must be actively involved in the design and maintenance of systems, and understand information received to be able to advise, instruct or engage the local population in a manner that increases their safety and reduces the potential loss of resources on which the community depends. Each pilots has an emergency plan, where flood risk and vulnerability of communities are considered (see Report D2.1 table 22).
- National governments are responsible for policies and frameworks that facilitate the management of flood risk, in addition to the technical systems necessary for the preparation and issuance of timely and effective hazard warnings for their respective countries. The government supports local communities and local governments to develop activities to predict and mitigate risk, to anticipate, prepare, plan and manage relief efforts, to develop operational capabilities is an essential function to translate early warning knowledge into risk reduction practices. In all pilots, national level assures coordination and provides general infrastructure.

- Non-governmental organizations (NGOs) play a critical role in raising awareness among individuals and organizations involved and in the implementation of systems, particularly at the community level. In addition, they play an important advocacy role to help ensure that FRM stays on the agenda of government policy makers. In Genova Municipality, local and regional civil protection volunteers collaborate both in emergency monitoring activities and during operational intervention; in Bilbao pilot VOST EUSKADI (Digital Emergency Volunteers Association of Euskadi) collaborates to support Municipal Operational Coordination Centre in preventive and during-the-flood communication.
- In all pilots the scientific community plays a critical role in providing specialized scientific and technical input to assist governments and communities in developing systems. Their expertise is critical to analysing the communities flood risks, supporting the design of scientific and systematic monitoring and warning services, fostering data exchange, translating scientific or technical information into comprehensible messages, and disseminating understandable warnings to those at risk. In Italy, Portugal, Romania, Slovakia and Spain, national agencies use experts from the scientific community to define scenarios and to forecast.
- The private sector has a diverse role to play, including developing early warning capabilities in their own organizations. The private sector is also essential as they are usually better equipped to implement ICT-based solutions. This kind of EU project is a clear example of this type of collaboration; each pilot has technical partners in the design and implementation of ICT solutions.
- The media plays an important role in improving the flood disaster consciousness of the general population and in disseminating early warnings. The media can be the critical link between the agency providing the warning and the general public. All pilots use a plurality of media to inform citizens before and during the emergency (see Table 13).

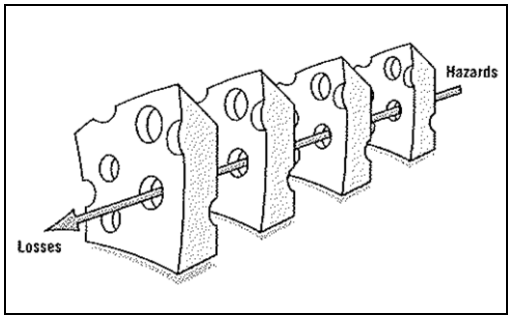
Multilevel governance questions related to regulatory models interact with this complexity of key parties that play major roles in risk management.

Communication and information, through technological support, constitute the common elements that enter into the relationship between individuals, groups, institutions, levels and territorial spheres. They act as support, media, and structure in order to transmit the content, but also they are pattern and model to set up organization in order to communicate decisions.

ICT is the plot on which the elements of persistence in organizational models (security protocols, data bases, roles) are set up but at the same time represents the multiplier of organizational innovation processes (wiki, network learning) within the FRM and the system approach to manage risk.

Furthermore, ICT allows to manage the redundancy of organizational answers and system defensive layers in order to avoid the effect “Swiss cheese” (see Figure 5)

Figure 5 *"Swiss cheese" model of how defences, barriers and safeguards may be penetrated by an accident trajectory*



4.1.2 Methods and Procedures

A key assumption in projecting service application able to enhance the involvement of the citizen and will harness the collaborative power of ICT networks to raise awareness on flood risks and to enable collective risk mitigation solutions and response action is that "its realization will be socially shaped, including by local patterns of participation" (Wehn et al. 2015).

"The ability to use information and communications technology (ICT) is now assumed by most commentators to be a prerequisite to living and working in the information society" (Selwyn, 2003). ICT is transforming society, from education to civic engagement, from employment to leisure. Using information technology is nothing less than "the indispensable grammar of modern life" (Wills, 1999). ICT is transforming networks, which constitute the plots of management structures and processes, altering both traditional spatial and temporal dimensions and organizational decentralization.

"Flood risk management must recognize the increasing interconnectivity between physical infrastructure and economic systems and the important role of human factors in determining flood risk. Innovative technologies are emerging to help manage flood risk, but these are not always straightforward to implement and technology alone will not address all our challenges" (Jonkman, Dawson, 2012).

The use of ICTs are more and more crucial in FRM, both in spreading information and in facilitating communication, and in promoting awareness and in enhancing cooperation. In the general context of the shift from the traditional government paradigm to the inclusive governance paradigm, an increasing importance is given of the inclusion of citizens and stakeholders. "Therefore, transparency and communication play a crucial role in FRM (Flood Risk Management), since it depends greatly on social factors such as awareness, preparedness, and capacity for coping with a flood event. Furthermore, it is expected that citizens who are potentially affected by floods will become involved in various measures and actions" (Evers *et al.,* 2016).

ICTs and service platforms can be used to implement a two-way communication paradigm between citizens and decision makers, enabling citizens to engage in innovative ways, such in ICT-enabled citizen observatories, or through other forms of eParticipation in local FRM (Wehn, Evers, 2015).

To inventory these characteristics and specificities in the use of ICT in FRM, the pilot cases were questioned using an open questionnaire that returned the general elements presented in Tables 7, 8, 9, 10 and 11.

These tables explain in details the use of ICT in the main operative phases and activities of FRM.

Each pilot case uses ICT to answer specific issues related to communities, multilevel government, NGOs, private systems and media, so that information collected in the tables sometimes does not provide a complete comparison but only a juxtaposition of elements.

In the various regulatory models and organizational models found in pilot cases, ICT is widely used in the various activities of FRM. In particular it is found that:

- a large and common use of on-line data base to define probable risk scenarios, identify priorities for action, urban plan and land defence (all pilots, see Report D2.1 table 22);

- a different use of intranet and VPN to provide/set resources, plan resources (funds, staff and equipment), set preparatory activities of staff, equipment and procedures to manage emergency response, define scenarios resulting in the risk assessment and implementation interventions (Bratislava pilot uses Municipal flood-rescue plans; Bilbao uses specific software; Genova, Vila Nova and Tulcea use databases in local organizational units);

- a use of plurality of channels for preventive and during-the-flood communication, to implement actions aimed at reducing risks, inform and train, in forecasting and nowcasting, in alarm system (all pilots).

The observed data allows highlighting common innovation needs in process management, in the plan resources and preparatory activities of staff, equipment and procedures, to grant updating and persistence of data and ICT structural strength and redundancy.

Table 7 *Use of ICT to support emergency flood management service - Genova Municipality*

Operative phases	*Activities*	*ICT in activities*	*Short description*
Prevention: activities designed to predict and mitigate risks	Definition of probable risk scenarios	□ [Regione Liguria web site] http://www.regione.liguria.it/argomenti/conoscere-e-vivere-il-territorio/protezione-civile-e-ambiente/protezione-civile/carte-della-criticità.html □ Municipal data bases in VPN	Mapping of hydraulic hazard areas and basin plans Identification of the exposed elements Definition of risk-specific vulnerabilities
	Identification of priorities for action	□ Municipal data bases in VPN	Identification of areas (streets, town parks, car parks, etc.), buildings (houses, shops, etc.) or activities (weekly markets, school activities, etc.) subject of restriction measures (major decree)
	Provision/setting of resources	□ Municipal data bases in VPN	Identification of resources to deal with emergencies (in documentation/databases of Municipal organisational units)
	Implementation of actions aimed at reducing risks	□ Municipal data bases in VPN	Identification of the characteristics of the exposed people and specific vulnerabilities (in documentation/databases of Municipal civil protection)
	Information and training	□ [Regione Liguria web site] http://www.regione.liguria.it/argomenti/conoscere-e-vivere-il-territorio/protezione-civile-e-ambiente/protezione-civile.html □ [Comune di Genova web site] http://www.comune.genova.it/servizi/protezionecivile	Carrying out of periodic campaigns of information on risks (i.e. Book multilingual http://www.comune.genova.it/content/libro-sicurezza-senza-confini#node-67768) Carrying out of practice drill for command roles and simulations in the risk areas
	Urban planning and land defence.	□ Geoportale (Mapstore) http://geoportale.comune.genova.it	Drafting of thematic maps by using catalogue/database of geographic and geo-referenced information
Forecasting and Emergency: activities aimed to anticipate, prepare, plan and	Definition of risk scenarios	□ Municipal data bases in VPN	Provision of City Emergency plan (http://www.comune.genova.it/content/piano-di-emergenza-del-comune-di-genova-0) and Operative methods for specific risk

manage relief efforts	Preventive and during-the-flood communication	☐ Municipal VPN and mailing list ☐ National civil protection VPN ☐ Comune di Genova web site ☐ Municipal Social network (Facebook, twitter) ☐ Radio channels ☐ Toll free number ☐ SMS, App IO NON RISCHIO, road information panels, AMT Simon system	Management and coordination of communications by Municipality Operative Centre (COC) - Civil Protection operative room.
	Resources planning (funds, staff and equipment)	☐ Municipal VPN	Municipal police Civil protection NGO (Municipal) Civil protection NGOs (Regional) Primary health care services (ANPA - Associazione Nazionale Pubbliche Assistenze) Muncipal service companies (AMIU - ASTER - AMT)
	Preparatory activities of staff, equipment and procedures	☐ Municipal VPN	Checking the availability of staff and equipment during “Attenzione” phase (in Municipal organisational units, Civil protection NGOs and service companies)
	Forecasting and nowcasting	☐ [Regione Liguria - ARPAL - Civil protection Meteorological-Hydrologic Centre] CFMI-PC Forecasting: http://www.allertaliguria.gov.it Nowcasting: http://www.allertaliguria.gov.it/dati_tempo_reale.php ☐ Municipal network monitoring rainfall and hydrological system (Project open data)	CFMI-PC exercises the functions and activities of forecasting, monitoring and surveillance of the meteorological and hydrological risk for the purposes of civil protection with context indicators and status indicators; The Municipality uses status indicators (instrumental monitoring with 26 pluviometer and 20 hydrometer) and territorial NGO safeguards
	Alarm system	☐ [Regione Liguria web site] http://www.allertaliguria.gov.it ☐ Municipal VPN and mailing list	The website of regional Agency defines/represents the different alert states. In municipal organization e-mails spread the information
	Emergency response management	☐ COC Informative system	Municipality operative centre (COC) operative room Local police operative centre operative room Link to other operative rooms (Fire department, Police, Highways and rails system, local public transport, etc.)

Recovery: activities aimed to restore damage and start rebuilding	Definition of scenarios resulting in the risk assessment	□ Municipal data bases in VPN	Activation of procedures, including online complaint for damages
	Resources planning (funds, staff and equipment, structure, administrative procedures)	□ Municipal data bases in VPN	Identification of resources for reconstruction/repair (in documentation/databases of Municipal organisational units)
	Implementation interventions	□ [Regione Liguria web site] □ Municipal data bases in VPN	Project management

Table 8 *Use of ICT to support emergency flood management service - IP TULCEA*

Operative phases	Activities	ICT in activities	Short description
Prevention: activities designed to predict and mitigate risks	Definition of probable risk scenarios	□ [*Delta* Tulcea Emergency Situation Inspectorate] http://www.isudelta.ro/ □ *Delta* Tulcea Emergency Situation Inspectorate VPN □ [Dobrogea-Litoral Water Branch- Water Management System, Tulcea] http://www.rowater.ro/SCAR/Planul%20de%20management.aspx?RootFolder=%2fTEST%2fPlanul%20de%20Management%20al%20Districtului%20Interna%C8%9Bional%20al%20Dun%C4%83rii%20-%202015&FolderCTID=&View=%7b09A44A07-3C1F-4CC7-B88F-9EFD9B0C4777%7d	Mapping of hydraulic hazard areas and basin plans Identification of the exposed elements Definition of risk-specific vulnerabilities
	Identification of priorities for action	• Municipal data bases in VPN	Identification of areas (streets, town parks, car parks, etc.), buildings (houses, shops, etc.) or activities (weekly markets, school activities, etc.) subject of restriction measures (major decree)

	Provision/setting of resources	• Municipal data bases in VPN	Identification of resources to deal with emergencies (in documentation/databases of Municipal organisational units)
	Implementation of actions aimed at reducing risks	• Municipal data bases in VPN	Identification of the characteristics of the exposed people and specific vulnerabilities (in documentation/databases of Municipal civil protection)
	Information and training	□ [*Delta* Tulcea Emergency Situation Inspectorate] http://www.isudelta.ro/	Carrying out of periodic campaigns of information on risks Carrying out of practice drill for command roles and simulations in the risk areas
	Urban planning and land defence.	• Municipal data bases in VPN	Drafting of thematic maps by using catalogue/database of geographic and geo-referenced information
Forecasting and Emergency: activities aimed to anticipate, prepare, plan and manage relief efforts	Definition of risk scenarios	□ *Delta* Tulcea Emergency Situation Inspectorate VPN □ [Dobrogea-Litoral Water Branch- Water Management System, Tulcea] http://www.rowater.ro/Situaia%20hidrologic%20zilnic/Forms/AllItems.aspx	The county organization, management and conduct of intervention lies directly to the Operational Centre of the Inspectorate for ***Delta* Tulcea Emergency Situation Inspectorate** that provides professional services for emergencies- fire-fighters, civil protection, logistics and volunteer services for emergency situations in the cities, towns, public institutions and businesses who can provide the technical means for appropriate intervention. Provision of Tulcea Risk Management Plan [*Delta* Tulcea Emergency Situation Inspectorate] http://www.isudelta.ro/; Operative methods for specific risk
	Preventive and during-the-flood communication	□ Municipal mailing list □ *Delta* Tulcea Emergency Situation Inspectorate VPN □ *Delta* Tulcea Emergency Situation Inspectorate □ web site □ Tulcea Social network (Facebook, twitter) □ Local Radio channels □ 112 –Emergency tel. no □ SMSs	Management and coordination of communications by Municipality Operative Centre (COC) - Civil Protection operative room.

	Resources planning (funds, staff and equipment)	□ *Delta* Tulcea Emergency Situation Inspectorate data bases	At county level, the professional public communitarian services for emergency situations is represented by the ***Delta* Tulcea Emergency Situation Inspectorate** subordinated to the General Inspectorate for Emergency Situations (GIES) and provide - in their areas of competence - guidance and control of prevention and management of emergencies. To handle inter-ministerial and cross-cutting coordination, the County Committee for Emergency Situations Tulcea is led by the county prefect. The local committees are chaired by the mayor and endorsed by the prefect. Inter-agency coordination during flood emergencies is managed by a person (action commander) nominated by County Committee, depending on the nature or the extent of the event or on the number of forces involved.
	Preparatory activities of staff, equipment and procedures	□ *Delta* Tulcea Emergency Situation Inspectorate VPN	Gathering forces and means in order to move to action is performed after receiving the written, acoustic or optical signal message transmitted from control point of the *Delta* Tulcea Emergency Situation Inspectorate.
	Forecasting and nowcasting	□ *Delta* Tulcea Emergency Situation Inspectorate VPN □ [Dobrogea-Litoral Water Branch- Water Management System, Tulcea] http://www.rowater.ro/Situaia%20hidrologic%20zilnic/Forms/AllItems.aspx □ National Institute of Hydrology and Water Management (INGHA) site and VPN http://www.inhga.ro/diagnoza_si_prognoza_dunare	National Institute of Hydrology and Water Management provides services in the field of hydrology and water resources management to support activities and decisions related to the effective management of water resources of the decision-makers in the field: Romanian National Waters Administration and the Ministry of Environment, Water and Forests Romanian National Waters Administration is the national authority which manages the national network of hydrological measurements, hydro-geological and quality of water resources in the public domain. National Weather Forecast Administration
	Alarm system	□ *Delta* Tulcea Emergency Situation Inspectorate VPN and mailing list	Alerting intervention can be made by any person who becomes aware of the production or the imminence of an emergency. Receiving the alert is made via dispatch with single call number 112. *Delta* Tulcea Emergency Situation Inspectorate decides to alert the population after analysing data from the Romanian National Waters Administration, from the Weather forecast Institute and from the National Institute of Hydrology and Water Management.

	Emergency response management	• *Delta* Tulcea Emergency Situation Inspectorate VPN	Acknowledgment, assessment, decision making and giving the order to intervene are activities that start immediately after arriving on the scene continues during the situation and consist of direct research and obtain the data required for the decision. The decision making centre is the County Committee for Emergency Situations Tulcea - led by the county prefect and *Delta* Tulcea Emergency Situation Inspectorate is the operational and interventional organization.
Recovery: activities aimed to restore damage and start rebuilding	Definition of scenarios resulting in the risk assessment	*Delta* Tulcea Emergency Situation Inspectorate VPN	Activation of procedures, including online complaint for damages
	Resources planning (funds, staff and equipment, structure, administrative procedures)	*Delta* Tulcea Emergency Situation Inspectorate VPN	According to the Local Plan for Risk Management
	Implementation interventions	*Delta* Tulcea Emergency Situation Inspectorate VPN	Tulcea County Police Department, Red Cross Branch Tulcea, Public Health Department Tulcea, Tulcea Defence Ministry Units. Tulcea Environmental Protection Agency, Tulcea Water Management System, Tulcea Forestry Department are involved in recovery operations: Providing transportation and means of intervention forces, evacuees and other resources; Providing water and food for people and animals affected or evacuated; Disinfection and pest control supervision contamination, assessment of health and health monitoring of the population; Ensure the equipment for carrying out support functions (vaccines, biocides, syringes, masks, land and river transport); Social assistance to people affected by disasters; psychological assistance to people affected by disaster; Rehabilitation of the affected area; Temporary re-establishment of normality; Rehabilitation of the affected area; Maintaining and restoring public order Supervision of the degree of contamination, assessment of the effects on the environment and decontamination of water courses; Conducting decontamination of the population, of areas and

			reserves; □ assessment of the effects on the environment and decontamination of water courses; □ Identification of resources for reconstruction/repair .

Table 9 *Use of ICT to support emergency flood management service - Bratislava Self Governing Region*

Operative phases	***Activities***	***ICT in activities***	***Short description***
Prevention: activities designed to predict and mitigate risks	Definition of probable risk scenarios	□ Website of Ministry of Interior (MoI) – brief: http://www.minv.sk/?Predpovede_a_vystrahy □ Guide of MoI: http://www.petrzalka.sk/wp-content/uploads/2013/01/4-Prirucka-ministerstva-vnutra.pdf □ http://www.bratislava.sk/VismoOnline_ActionScripts/File.ashx?id_org=700000&id_dokumenty=11026135	Definition of civil hazards such as floods, leakage of dangerous materials, storms, blizzards, high temperatures, accidents, Warning of citizens, What to do in emergency, etc. Cons: Everything in text format, not visualised, relatively extensive reading
	Identification of priorities for action	Guide of MoI: http://www.petrzalka.sk/wp-content/uploads/2013/01/4-Prirucka-ministerstva-vnutra.pdf	Rules rather than priorities
	Provision/setting of resources	□ Municipal flood-rescue plans (document)	Identification of resources to deal with emergencies (in documentation/databases of Municipal organisational units) Few flood-rescue plans published by municipalities on Internet
	Implementation of actions aimed at reducing risks	Municipal flood-rescue plans (document)	Identification of the characteristics of the exposed people and specific vulnerabilities (in documentation/databases of Municipal civil protection)
	Information and training	• www.shmu.sk • Civil protection communication (CO) • http://www.zachranari.sk • http://www.bratislava.sk/VismoOnline_ActionScripts/File.ashx?id_org=700000&id_dokumenty=11026135 • http://www.petrzalka.sk/oblasti/civilna-ochrana/	Flood-risk basins and areas on a map Public Weather/Flood forecasts "Young rescuer" NGO providing eLearning training with focus on children Information for public on plans for civil protection published by municipalities of BSK
	Urban planning and land defence.	• BSK Geoportal: http://www.region-bsk.sk/clanok/geoportal-bsk-informacny-system-verejnej-spravy-175172.aspx?q=Y2hudW09MQ%3d%3d	Geo-database on map with resolution 1: 36 000 do 1: 72 000.

Forecasting and Emergency: activities aimed to anticipate, prepare, plan and manage relief efforts	Definition of risk scenarios	• Municipal flood-rescue plans	These plans are made public only for few municipalities
	Preventive and during-the-flood communication	☐ Municipal flood-rescue plans and contact lists ☐ District office via 112 coordination centre ☐ Municipality web-site ☐ Municipal Social network (Facebook) ☐ National Radio channels (Slovensky rozhlas) ☐ National TV (STV1), local TVs ☐ Municipality tel. number ☐ Sirens	District office via 112 coordination centre informs municipalities via phone about 2nd and 3rd degree of flood emergency Several communication channels utilized to communicate emergencies toward public
	Resources planning (funds, staff and equipment)	☐ Municipal flood-rescue plans (document)	Few flood-rescue plans published by municipalities on Internet
	Preparatory activities of staff, equipment and procedures	☐ Municipal flood-rescue plans (document)	Contains staff, flood equipment location and contacts as well as set of procedures to Flood Flood-trolley (a wagon with equipment needed in flood) Cons: no drones
	Forecasting and now casting	☐ http://www.shmu.sk ☐ http://www.pmo.cz/cz/situace/ ☐ http://www.pmo.cz/cz/situace/povodnove-zpravodajstvi/	Main meteorological and hydrological forecasting and now casting portal for Slovakia Hydrological situation of Morava river areas, including section for flood news
	Alarm system	☐ http://www.petrzalka.sk/wp-content/uploads/2013/01/Prehlad-varovnych-siren.pdf	Siren system list published by some of BSK municipalities
	Emergency response management	☐ Line 112 – coordination centres of integrated rescue system within under district offices	Links and coordinates Medical emergency units, Police and Fire-fighters
Recovery: activities aimed to restore damage and start rebuilding	Definition of scenarios resulting in the risk assessment	• Municipal flood-rescue plans (document)	-

	Resources planning (funds, staff and equipment, structure, administrative procedures)	• Municipal flood-rescue plans (document)	-
	Implementation interventions	• Municipal flood-rescue plans (document)	-

Table 10 *Use of ICT to support emergency flood management service - Municipality of Bilbao*

Operative phases	***Activities***	***ICT in activities***	***Short description***
Prevention: activities designed to predict and mitigate risks	Definition of probable risk scenarios	• [Basque Agency for Water (URA) web site] • http://www.uragentzia.euskadi.eus/informacion/documentacion-del-proyecto-de-plan-de-gestion-del-riesgo-de-inundacion-2015-2021-correspondiente-a-la-demarcacion-hidrografica-del-cantabrico-oriental/u81-0003413/es/ • Software for Municipal Emergency Plan (PEMU) and municipal databases. Software in updating process.	Flood Risk Management Plan for the Hydrographic Basin)(2015-2021) Hazard and Risk Maps Preliminary flood risk assessment (E.P.R.I)
	Identification of priorities for action	• Municipality of Bilbao web site]	Identification of areas (streets, town parks, car parkings, etc.), buildings (houses, shops, etc.) or activities (weekly markets, school activities, etc.) subject of restriction measures (major decree)
	Provision/setting of resources	• Software for Municipal Emergency Plan (PEMU) and municipal databases. Software being updated.	Identification of resources to deal with emergencies (in documentation/databases of Municipal organisational units)
	Implementation of actions aimed at reducing risks	• Municipal databases. (Bilbao Municipal Information Systems (CIMUBISA))	Identification of the characteristics of the exposed people and specific vulnerabilities (in documentation/databases of Municipal civil protection)
	Information and training	• [Municipality of Bilbao web site] • Notices from the municipality of Bilbao. http://www.bilbao.eus/cs/Satellite?cid=3000075232&language=es&pageid=3000075232&pagename=Bilbaonet%2FPage%2FBIO_ListadoAvisos	Carrying out of periodic campaigns of information on risks Carrying out of practice drill for command roles and simulations in the risk areas

		• [Security Area (Civil Protection).web site] • Notices from the Security Area (Civil Protection). http://www.bilbao.eus/cs/Satellite?c=Page&cid=3000047271&language=es&pageid=3000047271&pagename=Bilbaonet%2FPage%2FBIO_homeArea • Notices from the Security Area (Civil Protection). • [Emergency Attention Directorate of the Basque Government web site] http://www.euskadi.eus/gobierno-vasco/-/prevencion-seguridad-emergencias/	Emergency action plan. Implementation of protection plan and integration in others of superior scope. Forms for the management of emergencies. Emergency Legislation
	Urban planning and land defence.	• Geoportale (Mapstore) http://www.geobilbao.net/ • [Urban planning web site] http://www.bilbao.eus/cs/Satellite?c=Page&cid=3000047303&language=es&pageid=3000047303&pagename=Bilbaonet%2FPage%2FBIO_homeArea	Drafting of thematic maps by using catalogue/database of geographic and geo-referenced information
Forecasting and Emergency: activities aimed to anticipate, prepare, plan and manage relief efforts	Definition of risk scenarios	• Software for Municipal Emergency Plan (PEMU) and municipal databases. Software in process of updating.	Provision of City Emergency plan and Operative methods for specific risk
	Preventive and during-the-flood communication	• [Emergency Attention Directorate of the Basque Government web site] - SOS-Deiak https://twitter.com/112_sosdeiak?lang=es • [Emergency Attention Directorate of the Basque Government web site] http://www.euskadi.eus/gobierno-vasco/emergencias-112/ • [Basque Agency for Water (URA) web site] http://www.uragentzia.euskadi.eus/u81-0002/es/ • [National Agency of Meteorology (AEMET) web site] http://www.aemet.es/en/lineas_de_interes/meteoalerta • [Basque Agency for Meteorology (EUSKALMET) web site] http://www.euskalmet.euskadi.eus/s07-5853x/es/meteorologia/pronos.apl?e=8 • [Municipality of Bilbao web site] http://www.bilbao.eus/cs/Satellite?cid=3000005415&language=en&pagename=Bilbaonet%2FPage%2FBIO_home • Municipal Social network (Facebook, twitter, …)	Management and coordination of communications by Municipal Operational Coordination Centre (CECOPAL)

		• Municipality free phone number (010). • Municipal Press Office • VOST EUSKADI (Digital Emergency Volunteers Association of Euskadi - ONG) http://www.vosteuskadi.org/ • Radio channels (TETRA) • Phone, mobile, SMS, mailing • Municipal WiFi (500 WIFI hotspots) • Software for Municipal Emergency Plan (PEMU) and municipal databases. Software being updated.	
	Resources planning (funds, staff and equipment)	• Software for Municipal Emergency Plan (PEMU) and municipal databases. Software in process of updating.	Municipal police Civil protection Fire-fighters Social Action Floods operational procedure Primary health care services Municipal services
	Preparatory activities of staff, equipment and procedures	• Software for Municipal Emergency Plan (PEMU) and municipal databases. Software in updating process.	Checking the availability of staff and equipment.
	Forecasting and nowcasting	• [National Agency of Meteorology (AEMET) web site] http://www.aemet.es/en/ • [Basque Agency for Meteorology (EUSKALMET) web site] http://www.euskalmet.euskadi.eus/s07-5853x/es/meteorologia/pronos.apl?e=8 http://www.euskalmet.euskadi.eus/s07-5853x/es/meteorologia/bol.apl?e=5 • [Emergency Attention Directorate of the Basque Government web site] http://www.euskadi.eus/gobierno-vasco/emergencias-112/ • [Emergency Attention Directorate of the Basque Government web site] - SOS-Deiak https://twitter.com/112_sosdeiak?lang=es • Software for Municipal Emergency Plan (PEMU) and municipal databases. Software being updated.	EUSKALMET (in collaboration with AEMET) exercises the functions and activities of forecasting, monitoring and surveillance of the meteorological and hydrological risk for the purposes of civil protection with context indicators and status indicators; The Municipality uses status indicators as meteorological stations operated by the Emergency Attention Directorate of the Basque Government. Emergency Attention Directorate of the Basque Government (SOS-Deiak) handles all sorts of emergency call and alerts involving then all required resources and authorities.
	Alarm system	• [National Agency of Meteorology (AEMET) web site]	

		http://www.aemet.es/en/lineas_de_interes/meteoalerta • [Basque Agency for Meteorology (EUSKALMET) web site] http://www.euskalmet.euskadi.eus/s07-5853x/es/meteorologia/pronos.apl?e=8 • http://www.euskalmet.euskadi.eus/s07-5853x/es/meteorologia/bol.apl?e=5 • Software for Municipal Emergency Plan (PEMU) and municipal databases. Software in process of updating.	
	Emergency response management	• Municipal Operational Coordination Centre (CECOPAL)	Municipal Operational Coordination Centre (CECOPAL) The coordination element of the PEMU for the direction and control of emergency operations. The headquarters where the Executive Board is located, providing all necessary infrastructure for the coordination of the actions. CECOPAL centralizes all the information about the evolution of the emergency and the actions taken to control them, setting priorities and transmitting to the other bodies the necessary orders.
Recovery: activities aimed to restore damage and start rebuilding	Definition of scenarios resulting in the risk assessment	• Software for Municipal Emergency Plan (PEMU) and municipal databases. Software in process of updating.	Activation of procedures, including online complaint for damages
	Resources planning (funds, staff and equipment, structure, administrative procedures)	• Software for Municipal Emergency Plan (PEMU) and municipal databases. Software in process of updating.	Identification of resources for reconstruction/repair (in documentation/databases of Municipal organisational units)
	Implementation interventions	• Software for Municipal Emergency Plan (PEMU) and municipal databases. Software in process of updating. • [Municipality of Bilbao web site] • http://www.bilbao.eus/cs/Satellite?cid=3000005415&language=es&pagename=Bilbaonet%2FPage%2FBIO_home • http://www.bilbao.eus/cs/Satellite?c=Page&cid=3009011008&language=es&pageid=3009011008&pagename=Bilbaonet%2FPage%2FBIO_formulario	Extraordinary interventions (e.g., floods related) within the analysis framework of PEMU. Non-extraordinary interventions, through the services (web site, toll free municipal number010, social network (Facebook, twitter), etc.) of the municipality. Other interventions managed through the complaints and suggestions box.

Table 11 *Use of ICT to support emergency flood management service - Municipio de Vila Nova de Famalicao*

Operative phases	*Activities*	*ICT methods and tools in activities*	*Short description*
Prevention: activities designed to predict and mitigate risks	Definition of probable risk scenarios	• Municipal data bases in VPN • www.vilanovadefamalicao.org/op/document/?co=1494&h=b3858	Mapping of flood risk areas and identification of exposed elements and vulnerability.
	Identification of priorities for action	• http://www.cm-vnfamalicao.pt/_plano_diretor_municipal_2	Identification of the most vulnerable and susceptible areas to be affected by a certain risk.
	Provision/setting of resources	• Municipal data bases in VPN	Identification of resources to deal with emergencies (in documentation/databases of Municipal organisational units)
	Implementation of actions aimed at reducing risks	• Municipal data bases in VPN	Identification of the characteristics of the exposed people and specific vulnerabilities (in documentation/databases of Municipal civil protection)
	Information and training	• http://www.cm-vnfamalicao.pt/_avisos_3 • http://www.cm-vnfamalicao.pt/_informacoes	Information available on the municipality's website with alerts, warnings, advices and procedures in the event of a major accident or catastrophe.
	Urban planning and land defence.	• http://81.90.61.41:8082/pmots_vnf/c?_act=page&_name=mapvnf • http://www.cm-vnfamalicao.pt/_plano_diretor_municipal_2	Drafting of thematic maps by using catalogue/database of geographic and geo-referenced information. The municipal directorial plan defines the rules of land use and occupation.
Forecasting Emergency: activities aimed to anticipate, prepare, plan and manage relief efforts	Definition of risk scenarios	• www.vilanovadefamalicao.org/op/document/?co=1494&h=b3858	Aims to minimize the adverse effects resulting from the occurrence of a major accident or catastrophe.
	Preventive and during-the-flood communication	• Municipal VPN and mailing list • National civil protection VPN • Municipality web site • Municipal Social network (Facebook, twitter) • Radio channels • SMS	Management and coordination of communications by Municipality Operative Centre - Civil Protection headquarters.
	Resources planning (funds, personnel and equipment)	• Municipal VPN	Civil protection agents Municipal service companies Private companies
	Preparatory activities of staff, equipment and procedures	• Municipal VPN • www.vilanovadefamalicao.org/op/document/?co=1494&h=b3858	Checking the availability of staff and equipment during “Attenzione” phase (in Municipal organisational units, Civil protection NGOs and service companies)
	Forecasting	• *https://www.ipma.pt/pt/* • *http://www.meteoalarm.eu/* • *http://www.prociv.pt/pt-pt/Paginas/default.aspx*	Sites of organizations that allow monitoring of the evolution of meteorological conditions.
	Alarm system	• http://www.prociv.pt/pt-pt/Paginas/default.aspx • Municipal VPN and mailing list	The alert system is the responsibility of the national civil protection authority which establishes the level of alert and prevention.

	Emergency response management.	• Operations centre	An operational centre is set up in the headquarters of the civil protection where the municipal civil protection committee that has the responsibility of emergency response management.
Recovery: activities aimed to restore damage and start rebuilding	Definition of scenarios resulting in the risk assessment	• Municipal data bases in VPN	Activation of the procedures provided in the municipal emergency civil protection plan
	Resources planning (funds, staff and equipment, structure, administrative procedures)	• Municipal data bases in VPN	Identification of resources for reconstruction/repair (in documentation/databases of Municipal organizational units)
	Implementation interventions	• Municipal data bases in VPN • http://www.cm-vnfamalicao.pt/	Dissemination and identification of interventions.

4.2 Applications and Tools

Some of the media - both traditional and new - can be effectively used for risk management. Some may be more effective than the rest depending on the nature of the risk, disaster, the regions affected, the socio-economic status of the affected communities and their political architecture. Comparing application and tools, it is not a question of one medium against another, all are means to a common goal of passing along risk management and disaster warnings as quickly and as accurately as possible (for the list of media considered see UNDP, *ICT in Disaster Management*, 2007).

The most traditional electronic media, television, radio and satellite radio have a high effectiveness in most activities of FRM because even in developing countries and rural environments where the tele-density is relatively low, they can be used to spread information and communication, warning quickly to a broad population. The only possible drawback of these two media is that their effectiveness is significantly reduced at night, when they are normally switched off. All pilots use this media for preventive and during-the-flood communication.

Amateur radio (also known as 'ham radio') operators have assisted their communities and countries during disasters by providing reliable communications to disaster relief organizations at a moment's notice – especially when traditional communications infrastructure breaks down. Municipality of Bilbao pilots involves amateur radio for preventive and during-the-flood communication.

Telephones (fixed and mobile) can play an important role in warning communities about the impending danger of a disaster. Mechanisms called 'telephone trees' can be used to warn communities. An important media drawback is the congestion of phone lines that usually occurs immediately before and during a disaster, resulting in many phone calls in that vital period that cannot be completed. Municipality of Genova uses telephones for preventive and during-the-flood communication to a specific group of particularly vulnerable citizens in the "red zone".

Short message service (SMS) is a service available on most digital mobile phones that permits the sending of short messages (also known as 'text messages', 'SMSes', 'texts' or 'txts') between mobile phones, other handheld devices and even landline telephones. SMS works on a different band and can be sent or received even when phone lines are congested. SMS also has another advantage over voice calls in that one message can be sent to a group simultaneously. All pilots use this service, with different complexity of structure and goals.

Though not necessarily as an ICT-based solution, sirens can be used in tandem with other ICT media for final localized delivery. Bratislava pilot uses this solution for preventive and during-the-flood communication.

Internet and intranet represent two different communicative contexts, combining elements such as administrators, users, media and audience, based on a common platform. They have high penetration in communities (social networks and clouds) and in organizations (CMS and VPN for shared application management) and are used in each pilot by professionals such as first responders, coordinating bodies, etc. The characteristic relation between main FRM activities and ICT tools for each pilot site are summed up in Table 13.

4.3 Main findings. Indications emerging from the comparative analysis of use of ICT to support emergency flood management service

From the evaluation of the collected information it is possible to identify as a prevalent orientation the use of intranet and VPN for the limited transmission of information and the use of the web and traditional mass media for direct broadcast; ICT in FRM does not just have to meet functional requirements in relation to the organizational model but it must deal with public regulatory environment. In particular, assigning a direct broadcast growth value (from 1 to 4), to each class of tools:

- the number of classes of ICT tools used by pilot ranges from 0 to 4 (see Figure 6), as most of the actions are based on a single class of ICT tools; only to alarm and to communicate during-the-flood all pilots use as much as possible of communication channels;

- the direct broadcast grade ranges from 0 to 10 (as sum of values, see Figure 7); pilots use Internet through thematic web sites, to present the risk scenarios, also by providing complex databases and GIS systems, to inform citizens: but they mainly use VPN and different intranet structures both as places for gathering and distributing information and as media for transmitting decisions.

Municipality of Genova pilot case shows a particular singularity for the presence of an articulated multichannel information and a high degree of dissemination of information in preventive and during-the-flood communication, probably linked to the reduced warning times of the dangerous events (see Table 12).

Table 12 *Characteristics and specificities emerging from ICT use models comparison*

Characteristics	Similarities	Use of VPN and intranet to communicate decisions all pilots).
		Use of web to present risk scenarios and forecast (all pilots).
		Use of direct broadcast in all the possible ICT tools to inform and to alarm citizenship (all pilots).
	Differences	Use of web to make the contents and prescription of emergency plan available to citizenship (each pilot has implemented different communication strategies).
Specificities	Use of Telephones (fixed and mobile in Municipality of Genova pilot).	
	Involvement of ONGs in ICT management (Digital Emergency Volunteers Association of Euskadi – ONG in Bilbao pilot)	

Table 13 *ICT in main flood risk management activities*

Operative phases	*Activities*	*MUNICIPALITY OF GENOVA ITALY*				*MUNICIPIO VILA NOVA DE FAMALICAO PORTUGAL*				*IP TULCEA ROMANIA*				*MUNICIPALITY OF BILBAO SPAIN*				*BRATISLAVA SELF-GOVERNING REGION SLOVAKIA*			
Pilot site flood management Governance Structure		VPN - MAIL	MOBILE APP	WEB - SOCIAL NET	RADIO - TV	VPN - MAIL	MOBILE APP	WEB - SOCIAL NET	RADIO - TV	VPN - MAIL	MOBILE APP	WEB - SOCIAL NET	RADIO - TV	VPN - MAIL	MOBILE APP	WEB - SOCIAL NET	RADIO - TV	VPN - MAIL	MOBILE APP	WEB - SOCIAL NET	RADIO - TV
PREVENTION: activities designed to predict and mitigate risks	Definition of probable risk scenarios	x		x		x		x		x		x		x		x				x	
	Identification of priorities for action	x						x		x						x				x	
	Provision/setting of resources	x				x				x				x						x	
	Implementation of actions aimed at reducing risks	x				x				x				x				x			
	Information and training			x				x		x						x		x		x	
	Urban planning and land defence.			x				x		x						x				x	

Operative phases	*Activities*	*MUNICIPALITY OF GENOVA ITALY*				*MUNICIPIO VILA NOVA DE FAMALICAO PORTUGAL*				*IP TULCEA ROMANIA*				*MUNICIPALITY OF BILBAO SPAIN*				*BRATISLAVA SELF-GOVERNING REGION SLOVAKIA*			
Pilot site flood management Governance Structure		VPN - MAIL	MOBILE APP	WEB - SOCIAL NET	RADIO - TV	VPN - MAIL	MOBILE APP	WEB - SOCIAL NET	RADIO - TV	VPN - MAIL	MOBILE APP	WEB - SOCIAL NET	RADIO - TV	VPN - MAIL	MOBILE APP	WEB - SOCIAL NET	RADIO - TV	VPN - MAIL	MOBILE APP	WEB - SOCIAL NET	RADIO - TV
FORECASTING AND EMERGENCY: activities aimed to anticipate, prepare, plan and manage relief efforts	Definition of risk scenarios	x						x		x				x						x	
	Preventive and during-the-flood communication	x	x	x	x	x		x	x	x		x	x	x		x	x	x		x	x
	Resources planning (funds, staff and equipment)	x				x				x				x						x	
	Preparatory activities of staff, equipment and procedures	x				x		x		x				x						x	
	Forecasting and nowcasting			x				x		x		x		x		x				x	
	Alarm system	x		x		x		x		x				x		x				x	
	Emergency response management	x				x				x				x				x			
RECOVERY: activities aimed to restore damage and start rebuilding	Definition of scenarios resulting in the risk assessment	x				x				x				x						x	
	Resources planning (funds, staff and equipment, structure, administrative procedures)	x				x				x				x						x	
	Implementation interventions	x		x		x		x		x				x		x				x	

Figure 6. *Number of ICT tools use in flood risk management activities for pilots*

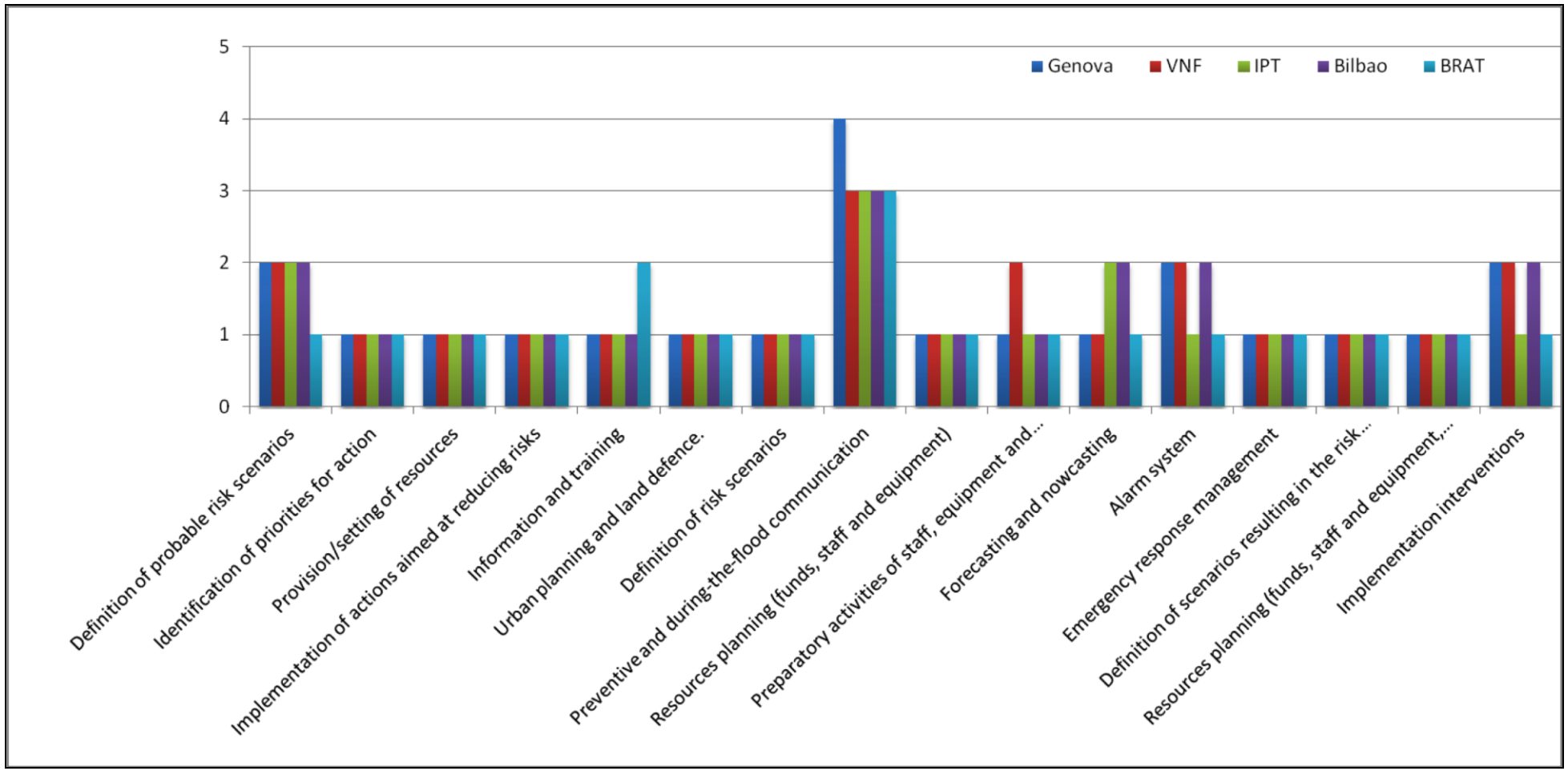
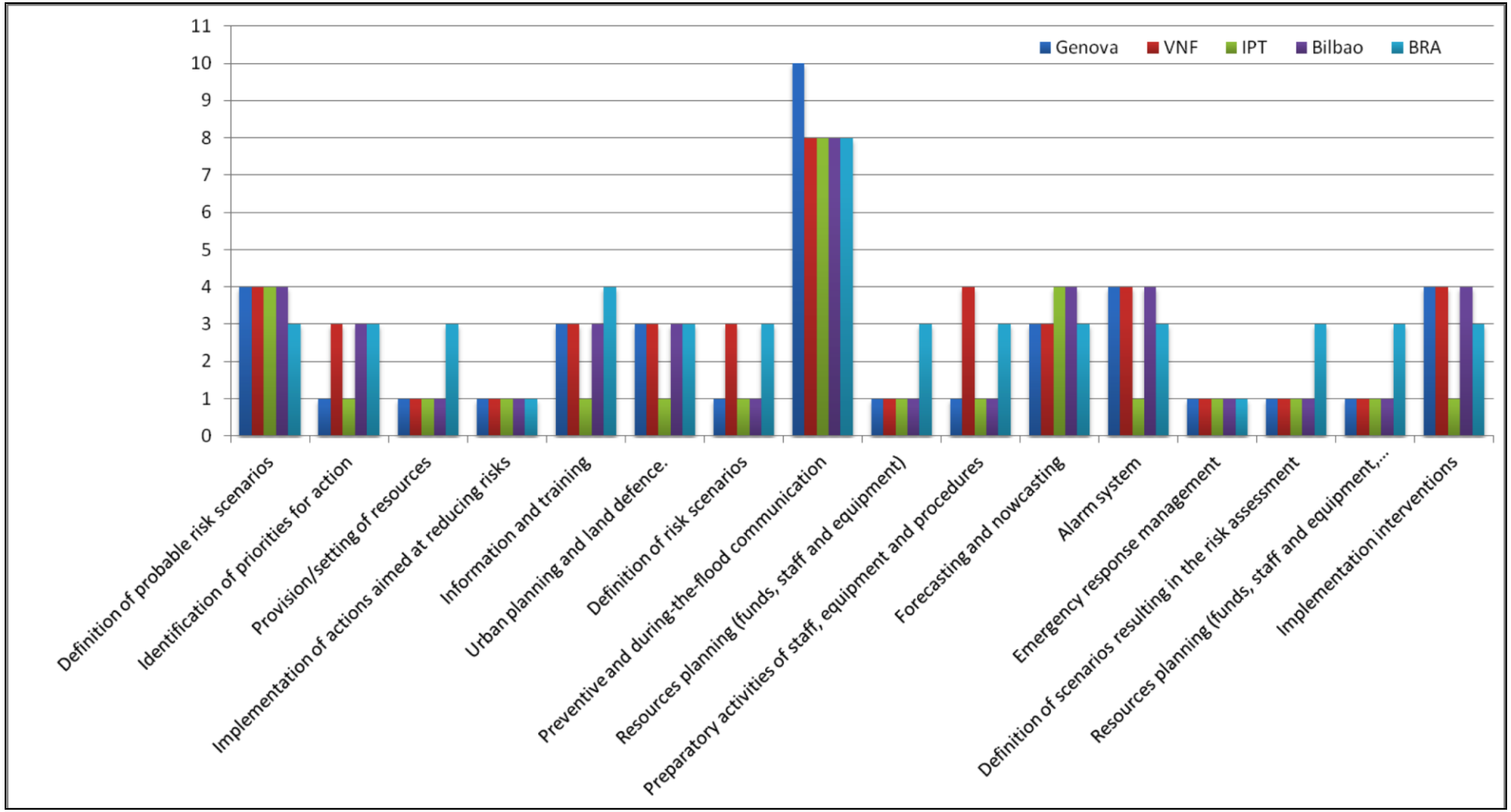


Figure 7. *Direct broadcast grades for ICT tools use in flood risk management activities for pilots*



5. Empowering knowledge beyond pilots

5.1 Connections with other project's findings

5.1.1 Regulatory models

The approach adopted by the EU Flood Directive reflects the general shift from government to governance, that is, from a traditional top-down, vertical and hierarchical approach to decision-making and administration, to a horizontal, reticular, horizontal, non hierarchical approach, promoting the involvement of different institutional levels, experts and stakeholders. The governance approach emphasis the role of third sector organizations, private companies, and citizens (Scharpf 1999; Schmidt 2013; Driessen *et al.*, 2012). The EU Flood Directive promotes the development of a novel kind of FRM, integrating a plurality of FRS and reflecting in new multi-actor, multi-level and multi-dimensional FRGA (Hegger et al. 2016), where duties, rights and powers are shared by of the various organizations involved. The main guiding principle of the FRM model proposed by EU are subsidiarity and solidarity. According to the *subsidiarity principle, a*certain objective should be reached at the lowest level of government which is capable of effectively addressing a problem (Ranjault 1992). Indeed, some countries are characterized by a mayor level of de-centralization (Italy, Spain), while in other countries involved in the project (especially Portugal and Romania) the level of de-centralization is lower.

In case as Italy, where a national FRM model was adopted 20 years back, the implementation of the EU Floods Directive (2007/60/EC) provided an opportunity to reform the regulative model and to revise the model of FRGA and confront the shortcomings encountered by the preexisting model (Mysiak et al. 2013), toward a more inclusive, multi-dimensional and multi-level model.

The shift from the "classical" strategy of reactive disaster response to pro-active risk reduction, integrating a bottom-up approach to the traditional top-down approach is promoted also by the UN. In 2017, the World Meteorological Organization (WMO) has implemented a new guidance document aimed to support the design of well-balanced strategies for Integrated Flood Management. Goal of the Integrated Flood Management (IFM) approach is "to maximize the productivity and efficient use of floodplains and coastal zones, while minimizing the loss of life and impact on livelihoods and assets through protective measures. Absolute protection from flooding, however, is impossible. In planning for IFM, therefore, there is a need to decide what level of risk is acceptable, to decide how safe is safe enough" (https://public.wmo.int/en/media/news/new-guidance-supports-integrated-flood-management).The guidelines are based on the Associated Programme on Flood Management implemented in 1999 by Global Water Partnership and WMO project, which focus on the

implementation of integrated flood management in policy and practice, promoting - in line with the EU Flood Directive 2007/60/EC.
The FD and, with it, the adoption of the a novel approach to FRS and Organization, in some countries, as Italy, has been implemented adapting a preexisting and "stratified", dense, legislation. In other countries the definition of a national model of FRM follows the implementation of FD.

An open, plural and integrated approach to FRM is required also to be able to adapt to different regulatory models.

5.1.2 Organizational models

In a research conducted on the State of affairs in FRM in EU countries prior to the implementation of the EU Flood Directive Klijn et al. (2008) state the convergence of the national approaches to FRM from defence to resilience through a a combination of 1) appropriate governance and institutional arrangements, 2) the implementation of physical and non-structural measures, and 3) the maintaining and optimising the performance of these measures. The move from flood protection and defence. It's nevertheless stress that difference are relevant, in terms of centralization/decentralization, role os the State, inclusion of NGOs and private actors, openess to citizens contribution.

The organizational model analysis implemented within Flood-serv project confirms that the shift from government to governance approach and the from defence/protection towards resilience reflects in multi-dimensional, multi-level and multi-actor models of FRM. As a result we observe not only the involvement of multiple levels of authority: local, intermediate and national (all pilots) and the inclusion of citizens and civil society. The shift is also accompanied by the overcoming of the traditional idea that protection against flooding is a pure collective good and thus ideally managed by public authorities, opening the door to a greater integration of public and private services (Meijerink and Dicke 2008; Penning-Rowsell 2016) in the organizational model adopted to manage FRM.

The driving force of the trend of convergence are: 1) the shift from government to governance, decentralization and the pursuit of the principles of sussidiariety and solidarity (legal and politics/policy dimension); the shift from defence and control toward risk-based approach and resilience (strategy dimension) and 3) the development of information technology (technological dimension).

Differences can be explained making reference to a plurality of factors.
Among the relevant factors explaining differences in FRS and FRGA, besides hydrological (nature of floods, flash floods, precipitation), geographical (factors of vulnerability, landscapes) and socio-economic characteristics (degree of development, resources) we identify the characteristics of the legal system, the administrative model and the governance arrangements.

A key factor in explaining the persistence of differences is represented by inherited organizational tradition at the moment of the implementation of the EU Flood Directive. Some countries had a well-established and long-held approach to managing flood risk, whereas others lag behind. In the former the implementation of the FD required a double mechanism of adaptation (of the existing legislations and models to the FD but also of the FD

to the preexisting legislations and models), in the latter the implementation of the FD directly reflected in the new Flood Risk legislation.

5.1.3 Use of ICTs

The establishment of public participation mechanisms to ensure citizens' involvement in the flood management cycle is one of the goal established by the European Flood Directive 2007/60/EC. "Innovative means, such as citizen observatories enabled by information and communication technologies, have the potential to provide citizens with a substantially new role in decision-making" (Wehn et al. 2015).

A recent analysis carried out by Wehn et al. (2015) within WeSenseIt project focused in the potentialities of ICT-enabled citizen observatories in FRM. "The key aspect of these observatories is the direct involvement of user communities in the data collection process: it enables citizen involvement by collecting data via an innovative combination of easy-to-use sensors and monitoring technologies as well as harnessing citizens' collective intelligence, i.e. the information, experience and knowledge embodied within individuals and communities communicated via social media (e.g. Twitter, Facebook, etc.) and dedicated mobile applications". The authors stress that "in this scenario, citizen involvement can span from data collection and provision (e.g. monitoring water levels using a range of sensors), feedback and knowledge exchanges (via mobile apps or online platforms) to actual involvement in decision- making (online or face-to-face) in order to harness environ- mental data and knowledge to effectively and efficiently manage flood risk. This provides the potential for a distinctly different role for citizens (i.e. involvement in data collection) compared to earlier conceptualisations of citizen participation in decision-making" (Wehn et al, 2015). The authors distinguishes between an 'implicit data provision', which refer to citizen observations that are collected and mined from social media, and an 'explicit data provision', referring to the intended and volunteered observations by citizens, collected using photos, apps or dedicated sensor technology. The results of the analysis, carried out in three case studies (Delft, Doncaster, Vicenza) is that "it is during recovery and mitigation that the authorities experience citizen awareness of flood risks at its lowest level. This is where citizen observatories enabled by ICTs can play a role, potentially triggering interest, raising awareness among citizens and providing an 'entry point' to greater citizen participation via their engagement in explicit data collection. However, given the differing perceptions by the authorities" (ivi). It's nevertheless recognized that "not all citizens may be in a position to, or interested in, participating in flood risk management": for this reason, the implementation of the service platform should be accompanied by initiative of sen sibilization and aimed to promote interest. The current use of ICTs in the five pilots allow to state that there is a great unexpressed potential of citizens' participation through ICTs to be promoted and nurtured by implementing the service platform.

5.2 A focus on private companies and their role on support emergency flood management service

In the pilots of FLOOD-serv project private services are involved mainly as services providers, as weather forecast.
Widening the gaze we can nevertheless identify a plurality of potential subjects involved. A list of potential private stakeholders is provided by Bosher (2013). The list include a plurality if

subjects as Urban Planners, Civil engineers, Structural Engineers, Architects/Engineering consultant Urban planners, Emergency/risk managers Developers, Contractors, Client, Utilities companies, Insurers, Professional organisations.

In some European countries as UK and in France, insurance companies are involved FRS. In the French case, a bridging-mechanism between prevention and recovery is the Natural Disaster Scheme (CAT-NAT), introduced in 1982 as a hybrid insurance system based on the obligatory involvement of both the State and insurance companies. In the case of an extreme catastrophic event CAT-NAT gives insurers the opportunity to refuse to refund in the case of non-compliance with the regulation on flood prevention. In UK, "the transition to risk-reflective pricing in 25 years will incentivise homeowners to invest in *e.g.* property-level measures" (Matczak et al. 2016). The government involved the Association of British Insurers (ABI) in the implementation of a Flood Risk Report template for homeowners to declare their resilience measures to their insurance provider.
Recently, Geaves et al. (2016) stressed the potential, increasing role of private services, in cooperation with public services, in the production and management of "public priority goods" - different from 'pure' public goods, characterized by non-rivalry and non-excludability - and which defined as services deemed as essential to public wellbeing regardless of characteristics, toward a public-private partnership in FRM.

The development of a pro-active and personalised citizen-centric public service application may offer a great contribution to promote a better integration of a plurality of publics, third sector and private actors, as national - public and private - flood forecasting services, civil protection authorities and the European Commission's Emergency Response Coordination Centre (ERCC) in the production and circulation of dynamic information. To integrate static and dynamic database, elaborated by different actors and at different levels and to promote their effective and rapid circulation, also among citizens, is a strategic goal, according with the strategies elaborated by EFAS (https://ec.europa.eu/echo/what/civil-protection/emergencyresponse-coordination-centre-ercc_en), which underlines the importance of implementing an efficient communication between all different stakeholders involved in FRM.
In this respect, a strong connection with existing database - also at EU level, is necessary.
The major service to be integrated, in this perspective, are the Copernicus Emergency Management Service (Copernicus EMS) - http://emergency.copernicus.eu - which provides information for emergency response in relation to different types of disasters, including meteorological hazards, geophysical hazards, deliberate and accidental man-made disasters and other humanitarian disasters as well as prevention, preparedness, response and recovery activities. Copernicus EMS is structured in three dimension:

1) Mapping of Emergency Situations;
2) European Flood Awarness System (Monitoring and forecasting of flood events across Europe and providing with a wide range of complementary, added value flood early warning information including risk assessment up to ten days in advance);
3) European Forest Fire Information System (EFFIS) and Global Wildfire Information System (GWIS).

Quoting the "Copernicus User Uptake. Engaging with public authorities, the private sector and civil society", (2016), there is a clear need of a systemic and integrated framework to ensure continuity and sustainability of (User Uptake) initiatives. Furthermore, the diversity of

the (potential) user communities in public and private sectors and the dispersion of users at different geographic levels within public authorities, cause user uptake initiatives to be complex to manage". The same report enumerate 450 user uptake activities. Some of these care disegned, or can be used for the FRM, and are addressed to civil protection bodies, public administration, voluntary organizations, private organizations and citizens. Particularly relevant, in matter of FRM, is EFAS, The European Flood Awareness System, implemented according to the 2010 European Commission's communication "Towards a Stronger European Union Disaster Response", which stress the importance of strengthening concerted actions in case of natural disasters including floods, representing the first operational network for hydrology in Europe. The plurality of centre involved in the networks collect, elaborate and disseminate data regarding the probability for flooding (www.efas.eu).

Another strategic database is the Disaster Risk Management Knowledge Centre, which provides EU Member States and the disaster risk management community with an online repository of disaster related research results and access to a range of networks and partnerships (http://ec.europa.eu/echo/files/aid/countries/factsheets/thematic/disaster_risk_management_en.pdf

5.3. Remaining gaps in knowledge

Scientific research in Europe on risk mitigation has developed a lot over the past decade. It is believed that an effort not yet fully carried out is in the identification of a semantic map of common risk in Europe. With this expression we intend to refer to the concepts that are used in different countries to translate the different types of risk into operational actions. An attempt in this direction was made by the Office for Disaster Risk Reduction (https://www.unisdr.org/who-we-are/mandate) elaborating a text (Terminology: Basic terms of disaster risk reduction: http: / /www.unisdr.org/files/7817_7819isdrterminology11.pdf) "to promote a common understanding and use of disaster risk reduction" (ibid.). The text was updated in 2009 (http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf) and "widely disseminated international standard terminology related to disaster risk reduction, at least in all official United Nations languages, for curriculum and public information programs, and for the development of information, as well as for the public information programs (ibid.) The document has been further updated recommending the establishment of an open-ended intergovernmental expert working group (https://www.preventionweb.net/english/professional/terminology/).

However, this effort seems to be insufficiently implemented at an operational level.

Using as an example two pilots of FLOOD-serv (Table 14) it can be seen how the same concepts at the base of the operational interventions are conceived differently from each other and compared to mentioned document.

It is particularly important to provide a common semantic map of the operational concepts underlying the three phases of the FRM that go beyond mere translation; this new sematic map would improve:

1) the incrementality of the official definitions of the risk and, with it, the adaptability to different situations and the transferability of concepts

2) the involvement of civil society in updating and increasing the operational definitions of key concepts

3) the regulatory harmonization

4) the dissemination of best practices

This approach would be aligned with "Priority 1. Understanding disaster risk. Disaster risk management should be based on an understanding of the risk of vulnerability, capacity, exposure of persons and assets, and hazard characteristics and the environment. Such knowledge can be used for risk assessment, prevention, mitigation, preparedness and response" (https://www.unisdr.org/we/coordinate/sendai-framework). (See also: https://www.preventionweb.net/files/44983_sendaiframeworksimplifiedchart.pdf).

Having a common operating language, adopted by the institutions and by the actors directly involved in FRM, with regard to Prevention, Forecasting and Emergency and Recovery would strengthen the possibility of analyzing the procedures and identifying critical issues despite the variegated landscape of cases. In particular, would be focused dimensions relating to: the structure of decision making, the flood management, the governance and the legal framework. We believe that this could be a good direction to improve the constrain between institutions, actor networks, multi-level interactions, governance modes in the FRM.

Table 14 *Toward a semantic map of risk: findings from two pilots of FLOOD-serv.*

Key concepts	UNISDR, Terminology (2017) https://www.preventionweb.net/english/professional/terminology/#R	1 Tulcea 2 (Danube flood risk management plan)	Genova (Genova emergency plan)
Risk	The term "Risk" is not available There are: "Residual risk": The disaster risk that remains in unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained. "Risk transfer": The process of formally or informally shifting the financial consequences of particular risks from one party to another, whereby a household, community, enterprise or State authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party.	Combination of the probability of flooding and potential adverse consequences for human health, the environment, cultural heritage and economic activity associated with a flood; Water Law no. 107/1996	The Risk (R) defines, in a given area, the probability that an event prefigured, expected and / or in progress, despite the actions of contrast, determines a certain degree of effects hierarchically and quantitatively estimated, on the elements exposed to the danger of event itself in this area (Dir.PCM February 27, 2004)
Dangerousness	Not available	Occurrence of a dangerous natural event, including its probability of occurrence; Government Decision no. 106/2016	Probability of occurrence, within a certain area and in a given time interval, of a natural or anthropic phenomenon of assigned intensity

Vulnerability	Vulnerability The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.	Lack or loss of strength in the face of destructive forces or damage. Government Decision no. 106/2016	Degree of capacity or incapacity of a system / element to resist the natural or anthropic event by suffering or not suffering damage. It can be expressed with a number between 0 (no damage) and 1 (total loss). In the most simplified methods, the vulnerability is prudentially considered equal to 1, making the transition from the mapping of the elements exposed to that of the potential damage immediate (estimated damage equal to the value of the element itself).
Potential damage	Not available	Goods and number of people in the affected area. Government Decision no. 106/2016	Predictable loss profile as a result of a natural or anthropic phenomenon of given intensity, a function of both the value and the vulnerability of the exposed element.
List of persons, activities, necessities exposed to risk	Not available	There is not an official list. The concept is not present with this term, though, the terms used that are semantically similar are in the 1st Chapter of the Flood Risk Management Plan is the Overview of the basin / hydrographic area (issues to be addressed). They are as follows: Relief; Geology; Climate; Water resource; Soil; Biodiversity; Population and human settlements; Land use; Economic activity; Infrastructure; Recreation and tourism; Cultural heritage.	Housing settlements; Schools of every order and degree; Sports activities; Health facilities; Business; Public outdoor places; Collective activities; Infrastructures and works relating to traffic; Industrial and manufacturing settlements, distribution networks

5.4. Practical suggestions

1) The comparative regulatory analysis and the organizational analysis, together with the analysis of the use of ICTs carried out in the D2.2 may be adopted as a check tool for the testing and the validation of the service applications, in order to implement a flexible service applications, able to provide this kind of bridging mechanism.

2) The findings of the D2.2 can be valuable in order to achieve the goals of the WP3 (developing the FLOOD-serv system components), and WP5, in particular, for the organization and use of open data, for the implementation of the communication system devoted to recollect information and other contents, to predispose other service applications devoted to increase information, communication, collaboration and participation among public institutions, stakeholders, NGOs and citizens.

3) Ideally, the structure of service applications should fit with the organizational structure and the regulative models adopted and with the consequent hierarchical structure and the subsequent distribution of roles.

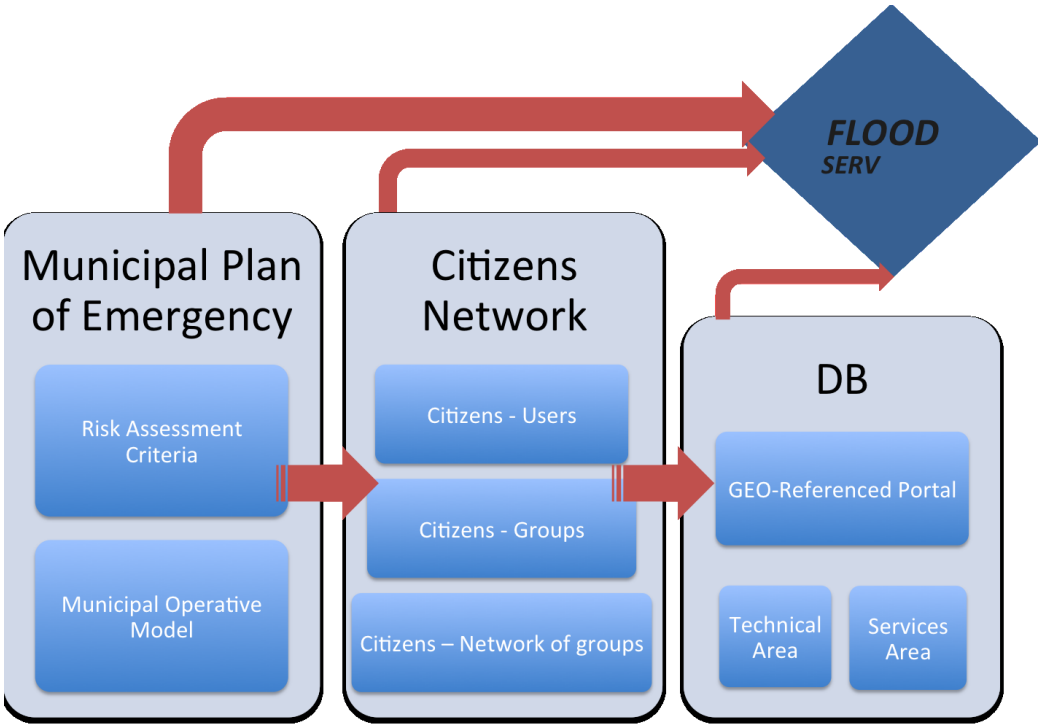
4) According to the difference regulatory models and the consequent authority and responsibility distribution, the same operative role may be played - in different contexts - by different institutional actors. Furthermore, while in some context a responsibility is attributed to a single actor, in other contexts more than an actor can share the responsibility. Therefore, due to this kind of difference, the final applications implemented in the FLOOD-serv project should be adapted considering the specific requirements of each pilot.

5) According to EFAS “any national, regional or local authority that is legally obliged to provide flood forecasting services or has a national role in flood risk management within its country and the European Commission Services can become an EFAS partner” (https://www.efas.eu/partners.html): it’s suggested to put in touch FLOOD-serv with these Agencies for each pilot. The Partners List is available at: https://www.efas.eu/partners.html.

6) According to the development of a collaborative platform it could be used an approach (synthetized in Figure 8, useful for Genova) through wich the Emergency plan and the citizens involvement define criteria in selecting and in producing data for the updating of the platform.

7) Empower the connections with other ongoing project about flood risk and other dimension of risk (for example organizing an annual meeting sharing principal findings)

Figure 8. *Municipal plan of Emergency, citizen network and DB*



6. Conclusions. Overall lessons learned, recommendations and perceived challenges

Goal of WP2 was to describe and compare the characteristics and specificities of FRM public services in the selected regions.

Goal of the task 2.2, within the WP2, was to carry out a comparative analysis of the regulatory models, the organizational structures and the USE of ICTs in the five pilots of the FLOOD-serv project.

The comparative analysis was mainly conducted using the data recollected in D2.1, especially for the reconstruction of the regulatory models and for the organizational analysis[2], while the analysis of the use of ICTs was implemented analysing the data recollected administering a questionnaire to the five pilots.

All together, the goal of the analysis carried out was to provide a clear understanding of which institutions or structure is in charge of a particular organizational role or communicative task.

As a result, we find out that the five pilots present some relevant differences in terms of organizational and regulatory models, as well as in ICT use, but also some similarities. The first ones should be considered as challenges for the next WPs; the second ones should be considered as opportunities to design the platform (see Tables 4, 6, and 12).

For the purposes of the project the identification of similarities and differences in the regulatory and in the organizational structure, as well as the exploration of the use of ICTs represent a crucial task in order to design and implement service applications able to fit to differentiated contexts in terms of authority, accountability and relationships between the actors involved.

Considered the above mentioned limits, the three dimensions of this analysis allows to better identify, for each context, opportunities and constraints, relations between actors, hierarchies, allocation of authorities and responsibilities, to identify the degree of verticalization vs. decentralization. Finally, the analysis allowed to verify how the formal allocation of authorities goes hand in hand or present some incongruence with the organizational model implemented and how both reflect in the use of ICTs.
Regulatory model analysis contributes to understand opportunities and constraints to take in account in the design and validation of applications and helps to identify the relations among

[2] A more detailed analysis of the legal texts and a in-depth exploration of the organizational models should require a more complex approach, and it would go far beyond the objectives of the D.2.2.

actors and the distribution of responsibilities. It helps to clearly identify which institution or administrative structures have the responsibility to provide information and to manage communication flows.
In most of the countries we identify a clear vertical structure of responsibility and authority, from the national to the local level.
Fundamental and framework law are implemented at national level and implemented at regional and local level.
In Spain, the normative confers more authority to the autonomous Basque region. In Slovakia, the bigger responsibility in implementing flood management falls in the district office, in other countries this responsibility falls on the Mayor. In Romania, the River Basin District plays a particularly relevant role.
The organizational analysis allows to step forward, from the individuation of actors, their responsibilities and their relations to better clarify the relation between involved actors, role, and concrete activities.
The organizational analysis confirms the existence of different models in order to manage activities in each level. A network model versus a hierarchic model is identified.
Despite this organizational difference, we can identify a common effort to organize the different levels involved in to integrate information and decisions.
The comparative analysis of ICT use in the different activities of FRM allows to complete the picture and to further better identify the sharing of authorities and responsibilities.
As a result of this analysis, we reconstruct the structure of the ICTs activities, the differences in the use of databases, the similarities in the use of social network and local VPN.
In each dimension of analysis we summarized the main characteristics (similarities and differences) and we stressed any specificities.
Similarities are the effect of the implementation of FD and, more generally, reflect the common shift from government to governance and toward the greater inclusion of stakeholders and citizens.
The analysis of regulatory models implemented in the five pilots suggest that even after the implementation of Floods Directive 2007/60/EC differences and specificities between national models persist.
Due to the plurality of context and tradition, and despite the process of convergence, we cannot identify one-size-fits solution for addressing FRGA challenges. In other worlds, there is no service application directly congruent to different contexts. In other words, a service application cannot be considered neutral with respect to the regulatory context where it is implemented.

The following sentence, reported in the final report of the STAR-Foold project, is fully applicable to the analysis carried out in D2.2: "The selected countries are not fully representative of FRM arrangements in Europe and therefore do not allow for general statements applicable to the entire EU. They do, however, reflect divergent forms of flood risk governance and provide exemplars for understanding how different approaches to coproduction in FRM have emerged within different socio-cultural, socioeconomic, and socio-political settings" (Matczak et al. 2016). “This kind of pluralization is not inherently problematic, as each states - and each case, inside the states - has its specific characteristics". As a result, "countries have developed flood risk policies in an autonomous way, permitting the tailoring of responses to local flood risk situations (including flooding type, severity, and extent) as well as recognizing the political priorities and existing legal context" (ivi), Co-production, co-planning, co-delivery, comprensive production are the key elements characterizing Multilevel and Multiactor Resilient FRM. Yet, these new priorities can be accomplished in different context according to specifities and inherited governance traditions. What it is common is that governance arrangements need to be more and more

flexible and adaptable in order to promote an effective interaction between actors (Biermann et al. 2009).

The awarness of this plurality help in identifying design principles and condition able to improve stakeholders cooperation and citizens engagement in different settings. Increasing complexity characterizing the pluralization of actors, dimensions and levels involved in FRM is accompanied by opportunities and risks. The more important opportunity lyes in the fact that the involvement of a plurality of actors allow to include a diverse set of resources and capacities which are not all available within governmental institutions" (Matczak et al. 2016).

The main risk is fragmentation. One of the mail suggestions emerging by STAR-Flood Project is that in order avoid fragmentation, and to turn diversity in richness, connections and coordination instruments - or bridging mechanism - are to be implemented, in order to promote the implementation of plural, multidimensional and multi-actor, flexible strategies, involving public and private actors and different policy levels and policy sectors (Gilissen *et al. 2016*). Bridging mechanism are expected to facilitate either integration between strategies and/or FRGA.

"Since the FRM system is conceptualized as the overall institutional system, comprising all (types of) actors, values, principles, norms, rules, regulations, and procedures relating to FRM in a country (based on) bridging mechanisms between strategies involve these characteristics. Strategies can be implemented in various institutional and governmental circumstances and this remains relevant also for the development of bridging mechanisms. In other words, in order to deliver more coherent FRM, bridging mechanisms are to connect actors, rules, resources and discourses in different governance arrangements" (Matczak et al. 2016).

A plurality of bridging mechanism can be implemented. Interdisciplinary and stakeholders Forum and policy advisor board member, for example, act as actors-driven bridging mechanism. Other bridging mechanism are rules-driven (i.e. Rules bridging FRM and spatial planning; Rules bridging flood warning and emergency management). Every discourse which contribute to connect FRM policy domain with other policy domains act as a discourse-driven mechanism. Finally, Flood Risk Maps and Flood Hazard Maps are example of Technological bridging mechanisms aimed to facilitate multi-actor working (Mees *et al.* 2016).

Goal of FLOOD-serv, making reference to the types of bridging mechanism defined in STAR-FLOOD project, is to provide a technological bridging mechanism, acting as a pro-active and personalized citizen-centric public service application that will encourage citizens' involvement and will the involvement of the citizen and will harness the collaborative power of ICT networks (networks of people, knowledge and sensors) to raise awareness on flood risks and enable collective risk mitigation solutions and response actions.

This kind of bridging mechanism, accordingly with the findings of the regulation model analysis and the comparative analysis of organizational models here conducted, is fundamental in order to promote the development of multi-actor, multi-sector and multilevel setting, favoring horizontally (different public administration and institutions; NGOs, public and private services) and vertically (different levels of government) joint working, involving all relevant stakeholders (Green & Penning-Rowsell 2010; Rowe & Frewer 2005).

In facts, the Flood-serv application goals is to facilitate linkages between FRS and to promote a truly multi-level and multi-actor FRGA, helping overcome fragmentation and promote

sharing, cooperation and coordination between public, third sector, private actors, and citizens, and a clear division of responsibility.

As the goal of the FLOOD-serv is to design applications able to be applied in different contexts, these applications need to be flexible and adaptable, as it can act as a bridging mechanism promoting coordination and cooperation (cfr. Meet 2015). To play this role, the service application need to be thought as a instrument of simplification, aimed to turn complexity and plurality in a resource and not in a factor of fragmentation. In order to do this, it need to be sufficiently flexible to involve different actors, to integrate different strategies and to adapt to different context and to fit with different political systems, legislative models and organizational traditions. As five pilots of the project diverge both in terms of environmental characteristics and in terms of organizational and regulatory models (see Table 4). Accordingly, organizational and regulatory comparative analysis is strategic to design and to implement flexible applications, to identify levels of responsibility and authority, to clearly understand which institution or structure is in charge of a particular organizational role or communicative task.

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Appendix I - The questionnaire

Operative phases	*Activities*	*ICT in activities*	*Short description*
PREVENTION: activities designed to predict and mitigate risks	Definition of probable risk scenarios	☐	
	Identification of priorities for action		
	Provision/setting of resources	☐	
	Implementation of actions aimed at reducing risks	☐	
	Information and training	☐	
	Urban planning and land defence.	☐	
FORECASTING AND EMERGENCY: activities aimed to anticipate, prepare, plan and manage relief efforts	Definition of risk scenarios	☐	
	Preventive and during-the-flood communication	☐	
	Resources planning (funds, personnel and equipment)	☐	
	Preparatory activities of staff, equipment and procedures	☐	
	Forecasting and nowcasting	☐	
	Alarm system	☐	
	Emergency response management	☐	
RECOVERY: activities aimed to restore damage and start rebuilding	Definition of scenarios resulting in the risk assessment	☐	
	Resources planning (funds, staff and equipment, structure, administrative procedures)	☐	
	Implementation interventions	☐	