Oliva view from Santa Anna hill by V. Barreres (2016), modification: cut

Vitruvio
International journal of Architecture Technology and Sustainability
Volume 1 Is 2

The need for municipal action planning against flood risk: the risk-informed journey of the municipality of Oliva (Spain)

Juan R. Porta-Sancho[1], Jesica T. Castillo-Rodríguez[2,3], Ignacio Escuder-Bueno[2,3] Sara Perales-Momparler[4]

[1]Oliva City Council, Oliva
[2]Universitat Politècnica de València, Research Institute of Water and Environmental Engineering (IIAMA-UPV)
[3] iPresas Risk Analysis (Spin-off Universitat Politècnica de València)
[4] Green Blue Management, Valencia

ABSTRACT

Society demands higher safety levels, including those actions related to urban planning and protection against natural hazards and manmade threats. Therefore, authorities respond to these demands through new regulatory and operational frameworks to cope with existing and future risks. The Spanish regulatory framework regarding flood risk management, based on the European context, defines the required procedures for emergency management, involving all authorities responsible for civil protection and urban planning. This framework requires all municipalities at medium or high flood risk to develop and implement local action plans against flood risk (PAMRI, by its acronym in Spanish), which must include a risk estimation, analysis and evaluation, along with the description of actions for a risk-informed urban planning and emergency management. The City Council of Oliva developed the corresponding plan, approved by the regional government in June 2016, including new aspects such as the figure of the Technical Director, and a comprehensive and quantitative flood risk analysis to support decisionmaking on emergency management and planning.

KEYWORDS

flood risk, emergency action planning, civil protection

http://dx.doi.org/10.4995/vitruvio-ijats.2016.6849

1. OBJECTIVES

This paper describes the state-of-the-practice on local flood risk management in Oliva (Valencia, Spain) to show the need for flood risk reduction actions at local scale, in line with urban planning and civil protection, in deed, the need for considering urban planning and flood emergency management from a comprehensive and risk-informed perspective, to establish appropiate actions before, during and after a flood event.

The effective management of flood emergency events (including all stages from prevention, action to back to normal situation) requires a set of different but complementary tools that aim at minimizing the impact of floods to the population, the economy and the environment.

It is then justified the need for improving exposure and vulnerability reducing flood hazards. Flood risk analyses provide information on the hazard, but in general do not include quantitative estimations of potential consequences to the population and the property.

This paper is focused on two areas of competence at local scale: urban planning and civil protection. These two areas converge since urban planning should take into account flood exposure and vulnerability and establish the required corrective measures to reduce risk.

Based on available studies carried out by or for the City Council of Oliva, related to flood risk prevention and planning at local scale, this paper provides a short discussion on their outcomes and conclusions for flood risk management.

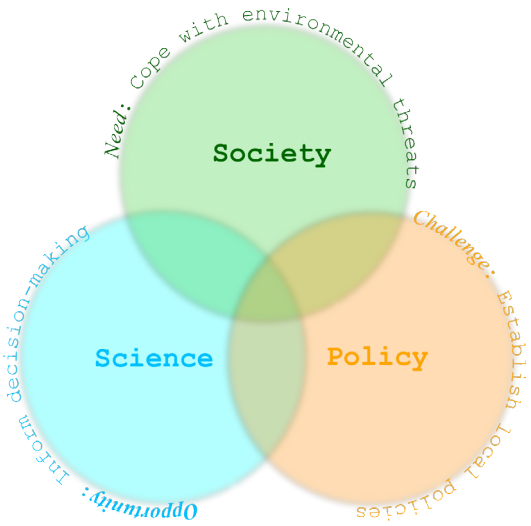


Figure 1.

Connections among science, policy and society in terms of flood risk management.

2. INTRODUCTION TO THE CASUISTRY AND CONTEXT OF THE MUNICIPALITY OF OLIVA

It is widely known that flood events in the Valencian region may cause significant economic and societal impacts. Some examples are the flood events ocurred in Oliva in 2007 (Figure 2) and 2002 (Figure 3).

In this section, a summary of factors and conditions related to the municipality of Oliva are provided.

The municipality of Oliva, in La Safor district, is located at the southern part of the Valencia province (Spain).

Climate in this area is typically Mediterranean, with high to moderate intensity rainfall events, with an average annual rainfall of 850 mm, having recorded a maximum rate of 817 mm in 24 hours (3 November 1987), the highest record in Spain up to date.

The municipality extends over an area of approximately 60 square kilometers. It has a coastline of 8.5 km and a coastal alluvial plain followed by mountain valleys up to 464 meters above sea level.

It is remarkable the complex hydrological system formed by the river courses Rambla Gallinera, Alfadalí, Font-Vall de les Fonts, the Pego-Oliva marsh natural reserve located at the south of the municipality, and the dunes along the coast.

The censed population of Oliva is of 26,190 inhabitants. The main town is situated at the intersection of the mountainous area with the plain. There are other urban districts destinated mainly to second residence and located mainly on the coast. Other minor residential areas are located along the inner part of

Vitruvio
International journal of Architecture Technology and Sustainability
Volume 1 Is 2

the municipality.
Agriculture plays a significant role in the economic sector of Oliva, which is focused exclusively on orange production, but the most important contribution to job creation relies on the tourism, followed by industry.
Human activity has modified the territory throughout history. The first interference were the settlements in the highlands, close to the plain, for defensive reasons and to avoid the effects of heavy rainfall events. The area was subsequently modified to adequate the land to population growth and the demand for new crops. A complex water drainage network of interconnected brooks and irrigation ditches is the result of such land transformation.
The population settlement in the plain area resulted in the development of several structural measures aiming at protecting people against flooding. However, the drainage network is currently insufficient due to its partial modification by the urban development and crop substitution by irregular housing construction, increasing flood vulnerability in areas along the coastline.

Figure 2.

Local road near Jovades industrial area, 2007

3. BACKGROUND RELATED TO URBAN FLOOD RISK MANAGEMENT IN OLIVA

In the last 40 years, mainly due to the increase of human activity on the territory, the occurrence of episodes of intense rains and the transfer of administrative competences to regional and local levels, have increased flood risk awareness of involved actors.

3.1 FLOOD RISK MANAGEMENT: THE NEED FOR ACTION AT LOCAL SCALE

The City Council of Oliva aims at managing flood risk from a comprehensive and integrative perspective. Within the local flood risk management framework, flood risk analysis should include a detailed identification stage concerning flood hazard and vulnerability, to support risk mitigation and emergency prevention planning.
In 1994, after developing the Territorial Emergency Action Plan in Oliva, and later in 2000 after approval of the Special Plan against Flood Risk of the Valencian region, the need for local action planning against flood risk, structured in three axes:

Figure 3.

Flooding at local road in Oliva, Rambla Gallinera course, 2002.

- To comply with the regulatory framework.
- To provide technical, accesible and easy-to-use tools that allow data gathering, information analysis and the use of geographic information systems (GIS).
- To coordinate all actors involved on flood risk management to ensure that objetives of the risk management strategy are efficiently and correctly achieved.

In this section, a description of the regulatory context influencing flood risk management in Oliva is provided. Projects and studies that different administrations have undertaken are also included, remarking the level of demand of required flood risk action plans.

3.2 LOCAL FLOOD RISK MANAGEMENT: THE REGULATORY CONTEXT

The main regulatory instruments that integrate the current regulatory framework for civil protection, flood risk planning and management are listed in this setion, along with their impact on local flood risk management in Oliva. In general, based on their level of implementation, four categories can be distinghished: European, national, regional and local regulatory instruments. However, in this section, instruments are presented in chronological order:

- The Spanish Constitution (1978), which requires authorities to guarantee the right to life and integrity for all citizens.
- The Local Government Regulatory Law 7/1985, which established local competencies in terms of civil protection.
- Law 17/2015, which amends Law 2/1985, establishing Civil Protection as a public service oriented to the study and prevention of collective high risk, extraordinary disaster and public calamity situations that could endanger massively life and physical integrity of people, ensuring an adequate response in case of emergency, through the National Civil Protection System, which will develop planning actions through Territorial Plans (general scale for any situation of risk) and Special Plans (to deal with a specific risk in a given territory). Consequently, Oliva City Council, in 1992, prepared and approved its Local Basic Plan against flooding. This Plan included a preliminary analysis of historical flood events.
- Law 2/2013 and Royal Decree 876/2014, which refer to coastal protection and flooding.
- Royal Decree 407/1992, which states that flood emergencies should be considered as part of Special Plans, defining their basic content.
- The Territorial Emergency Plan of the Valencian Community (1993), which highligths the impact of flood risk at regional scale and the need for developing a Special Plan.
- The Territorial Municipal Emergency and Plan of Oliva (1994), which recommends to develop a local action plan against flooding.
- Basic Guideline of Civil Protection Planning against Flooding Risk (1995), which established the content for Special Plans to ensure standardization at national scale and to guarantee coordination among emergency services. However, this Guideline did not include the content of required flood hazard studies neither the technical aspects to be considered.
- The Director Plan for flood protection in La

Flood hazard level	High frequency (T=25 years)	Medium frequency (T=100 years)	Low frequency (T=500 years)
Flood depth (>0.8m)	1	2	5
Flood depth (<0.8m)	3	4	6

Table 1.

Classification of flood hazard levels (PATRICOVA, 2015).

Safor (1995), including coordinating actions and actors involved on flood risk management for all municipalities within La Safor district.
- Decree 81/2010, which approved the Special Plan against Flood Risk of the Valencian Community, which includes the main functions and content of Local Action Plans to be developed by municipalities classified at medium or high risk. However, this plan did not describe how to develop such plans at local scale. Oliva was classified at medium risk level.
- Law 10/2001, which approved the required budget for undertaking "Flood routing civil works in Rambla Gallinera river course in Oliva (Valencia)".
- Law 13/2010, which regulates civil protection actions and emergency management at regional scale, defining civil protection plans as response tools against risks, requiring the development of Territorial Emergency Plans.
- Territorial Action Plan for Flood Risk Prevention in the Valencian Community (PATRICOVA), published in 2003 and reviewed by Decree 201/2015, represents the planning, coordination and protection tool at regional scale to reduce flood risk with focus on decreasing the potential economic impact in flood prone areas.

PATRICOVA represented a key element within the regulatory framework, based on a risk classification resulting from combining two concepts: hazard and vulnerability, defined as follows:

- Flood hazard in terms of probability of ocurrence of the flood event in a given area.
- Flood vulnerability in terms of potential damages.

PATRICOVA defines six hazard levels based on flood frequency and flood depth, as shown in Table 1, where T denotes the return period of the flood event. PATRICOVA also includes what measures can be applied to reduce flood hazard (structural measures), and to decrease flood vulnerability (e.g. urban planning, emergency management, public education and risk awareness campaigns). However, maps for urban planning and regulatory chapters are the only binding content of this regional plan.
Beyond approval of PATRICOVA in 2003, the following instruments are here worth mentioning:

- Law 4/2004, which required to reconsider urban planning and to avoid urban development in flood risk areas.
- Law 10/2004, which required planning actors to classify land based on risk classification, not allowing urban developments in flood prone areas.
- Law 16/2005, which required the development of environmental studies on the impact of new urban developments on risks due to natural hazards.
- Decree 67/2006, which required that urban planning actions were in line with the guidelines and regulations included in PATRICOVA, and to establish procedures for collaborating with Civil Protection agencies on emergency management.
- EU Floods Directive 2007/60/CE, which required all Member States to consider the impact of urban planning on flood risk, along with the development of flood risk maps and management plans at river basin district level.
- Royal Decree 903/2010, which incorporates the requirements of the EU Floods Directive into the national regulatory framework, aiming at evaluating flood risks and improve coordination among public administrations and the society to reduce potential flood consequences.

More recently, Royal Decree 1/2011 set the following principles:

- To reduce risks from natural hazards.
- To integrate green infrastructures in flood risk areas.
- To integrate policies related to flood risk management in urban planning, based on the guidelines of PATRICOVA.
- To analyze risk for urban planning as described in PATRICOVA.

All described instruments represent a complex but interconnected regulatory context that influences local flood risk and civil protection management, defining the objectives of any flood risk management strategy and aiming at ensuring the appropriate procedures for urban planning from a risk-informed point of view.
Based on the described framework, it should be distinguished the need for analyzing flood risk in Oliva. A study including a detailed flood risk analysis was required to support the City Council on the appropriate decisions for flood risk and civil protection planning and management.

3.3 LOCAL FLOOD RISK MANAGEMENT IN OLIVA: OBJECTIVES

The circumstances which contributed to develop the studies described later in section 3.4, included:

- Disposition of local authorities to cope with flood risk through reviewing the General Urban Planning Plan and the development of the Local Action Plan against flood risk (PAMRI).
- Regulatory requirement at regional scale after approval of the Special Plan against Flood Risk in 2000.
- Need for a more detailed cartography than the information used at regional level for flood risk characterization in PATRICOVA.
- Participation of the City Council in the framework of European Projects: QUATER and DAMAGE.
- Construction of flood routing civil works in Rambla Gallinera river course.
- Implementation and use of Geographic Information Systems (GIS) as a management tool at local scale.

All previous factors supported the need to carry out a flood hazard analysis with the following characteristics:

- To consider a specific area (3500 Ha), limited by the AP-7 highway and the sea.
- To develop a spatio-temporal analysis of overflows, including all river courses and brooks.
- To use a digital elevation model (DEM) to develop the required 2D hydraulic model and to analyze system response, flow directions and flooded areas, including hydraulic characteristics of the flood event: flood depths, velocities, and flow rates.
- To be approved by regional government, in line with the existing regulatory framework.
- To comply with outcomes of the DAMAGE project.

Based on the aforementioned circumstances and outcomes from the flood hazard analysis, the following objectives were established to develop a local action plan for Oliva:

- To analyze existing flood hazard levels and risk to be compared with results from PATRICOVA.
- To prioritize structural and non-structural actions for flood risk management.
- To provide a document to support the new General Plan for Urban Planning, and the required actions for civil protection and emergency planning.
- To provide a risk model for supporting decisionmaking on emergency management.
- To support data gathering and management of reported rainfall and flood events.
- To establish procedures for technical and operational support to local actors on flood risk management.
- To use up-to-date GIS information to estimate flood risk.

3.4 PREVIOUS STUDIES THAT INFLUENCED LOCAL FLOOD RISK ACTION PLANNING IN OLIVA

The most relevant studies related to flood risk analysis at local scale in Oliva included:

- Flood hazard study (carried out by INTERCONTROL in 2005).
- Flood routing civil works and improvement of the drainage system of Rambla Gallinera and Serpis river basin (carried out by Acuamed in 2006).

- Hydraulic modelling of flood plain areas in river courses: Serpis, Rambla Gallinera, Bullent and Molinell (developed by TYPSA in 2010).

These studies represented the benchmark works for the flood hazard study, introduced in Section 3.3, and developed in 2012 by TYPSA (engineering consultancy), as required by PATRICOVA. This study was approved on March 7, 2014, including the use of high-detail cartography information.
After approval of this study by the regional government, the City Council requested in 2014 the declaration of Oliva as high flood risk municipality, given that the major part of the municipal and supra-municipal infrastructures and all coastal urban centers are at risk of flooding. However, this application has not been resolved yet. Based on outcomes of the flood hazard study, the City Council was disposed to perform the Local Action Plan against flood risk (PAMRI). Thus, the Plan was developed from 2014 to 2016 and finally approved by the regional goverment in June 2016.
So far, only 20 of the 136 required local action plans to be developed by municipalities within the Valencian Community have already been finished and approved.

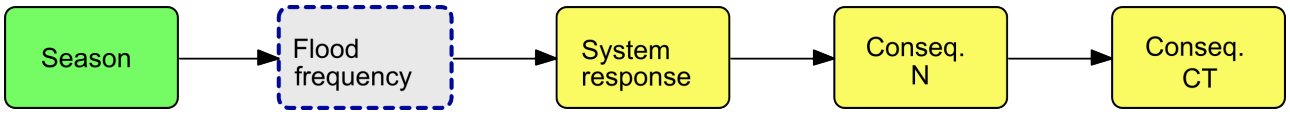
4. LOCAL ACTION PLAN AGAINST FLOOD RISK FOR THE MUNICIPALITY OF OLIVA

To comply with regulatory requirements in terms of both Civil Protection and Urban Planning, the City Council of Oliva proceeded in 2014 to take the necessary actions to elaborate a quantitative flood risk analysis that would complement and be the basis for developing the Local Action Plan against flood risk (PAMRI).
Based on the Emergency Municipal Territorial Plan (1994) and the guidelines provided by the Regional Government for developing these plans, the PAMRI contains required documents and annexes to start the process of improved local flood risk management.
In this section, contributions provided for this Plan, beyond the minimum content proposed by the regional government, are briefly described:

- Developing a quantitative flood risk analysis, identifying not only potential consequences for the current situation but also enabling the comparison of different scenarios and evaluate the impact on risk of future actions, including both structural and non-structural measures (emergency action plans, public communication campaigns, warning systems, etc.). For that purpose, the database EIEL (Regional survey on Infraestructures and Equipment) has been used to obtain detailed information on urban and rural land uses in Oliva to characterize flood vulnerability.
- Incorporating the role and functions of the Technical Director of the Plan, responsible for the technical performance and implementation. This role arises from the need for a more integrative perspective regarding civil protection and flood risk governance, merging all different phases of emergency management (prevention, action and back to normal situation).

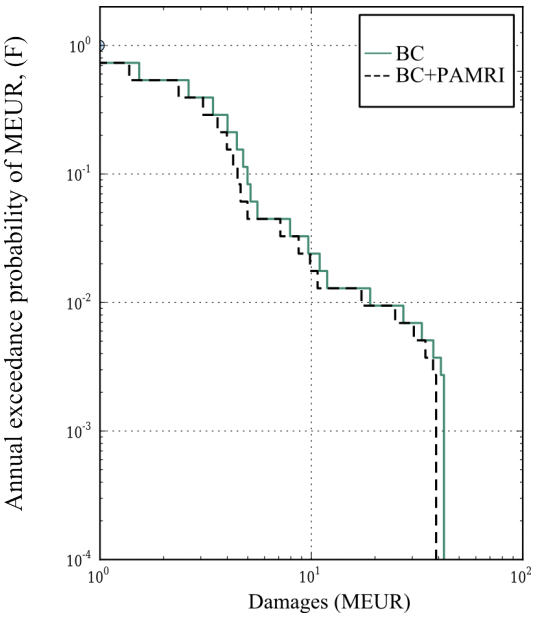
4.1 FLOOD RISK ANALYSIS

A qualitative and quantitative risk assessment was carried out for supporting the development of the Plan.
Qualitative risk analysis was based on the criteria defined in PATRICOVA, to establish an updated classification of flood hazard levels based on flood frequency and depth.
Quantitative risk analysis was based on the methodology developed within the framework of the SUFRI project, Sustainable Strategies of Urban Flood Risk Management with non-structural measures to cope with the residual risk (Escuder-Bueno et al., 2012), funded by the former Spanish Ministry of Science and Innovation. A risk model is performed to calculate societal and economic risk due to flooding (Castillo-Rodríguez et al., 2014), and allows its representation through FN and FD curves (where F denotes the



▲ Figure 4.

Influence diagram representing the risk model (nodes include information on loads, system response and consequences).



▼ Figure 5.

Cumulative annual exceedance probability (F) of the level of economic potential consequences in million Euros: Base case (BC) and scenario after implementing the Plan (BC+PAMRI).

annual cumulative exceedance probability of the level of potential consequences in terms of life-loss, N, or economic damages, D). Input data for the risk model was obtained based on flood hazard analysis, system response against such flood events and estimation of potential consequences for the population affected by flooding and for the property.

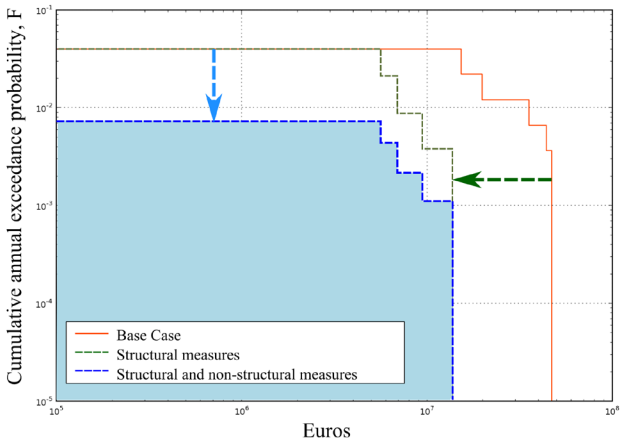
The detailed description of the methodology for quantitative risk estimation and analysis can be found in (Castillo-Rodríguez et al., 2016).

The flood hazard study conducted in 2012 was used as a basis for analyzing potential flood events and system response of all river courses that integrate the system in Oliva. This study was completed by an ad hoc analysis of potential flood consequences.

The process for flood risk analysis was divided into three stages:

- Flood characterization: Estimation of the probability of occurrence and analysis of rainfall events that result in flooding.
- System response characterization: Flood depths and velocities as a result of rainfall events within the river catchment area.
- Characterization of potential consequences: Estimation of consequences in terms of potential affected population, injuries, life-loss, and economic costs.

There exist different methodologies in the literature



▲ Figure 6.

Theoretical impact of risk reduction structural and non-structural measures.

for estimating consequences from flooding (e.g. Jonkman, 2007). The methodology used to conduct life-loss estimations for this urban area was based on the procedure proposed by the Spanish Ministry of Agriculture, Food and Environment (MAGRAMA), in a guideline published in 2013 for elaborating flood risk maps at river basin district scale (MAGRAMA, 2013). This guide refers to the method proposed by DEFRA (Department for Environment, Food and Rural Affairs of United Kingdom), responsible for establishing flood risk policy and regulatory context in UK (DEFRA, 2006).

Economic consequences were estimated based on the methodology proposed in PATRICOVA (Generalitat Valenciana, 2015), by analyzing direct and indirect costs from expected flood depths, depth-damage curves and reference costs per land use type.

Three flood events were analyzed to provide input data for the risk model, with return periods from 25 to 500 years.

By integrating all information concerning loads, system response and consequences within the risk model, as shown in the influence diagram in Figure 4, five nodes. Five nodes incorporate information on moment of the year when the flood occurs, flood frequency, system response and consequences in terms of life-loss (N) and costs (CT).

Results were obtained and are shown in an FD curve in Figure 5. The area under the curve represents the expected annual economic risk expressed in million euros per year. This figure shows 2 scenarios: the current situation, denoted as Base Case (BC), and the scenario after implementing the Local Action Plan (PAMRI). Although the effect on the FD curve might seem weak, the expected reduction on annual economic risk would be 10 times higher than the annual costs of implementing the plan.

Outcomes from the risk model can be used to assess the impact of future structural and non-structural risk reduction measures, by comparing the current situation and the situation after implementing those measures. Figure 6 shows a hypotethical example for 3 scenarios: Base Case, the situation after implementing non-structural measures (thus

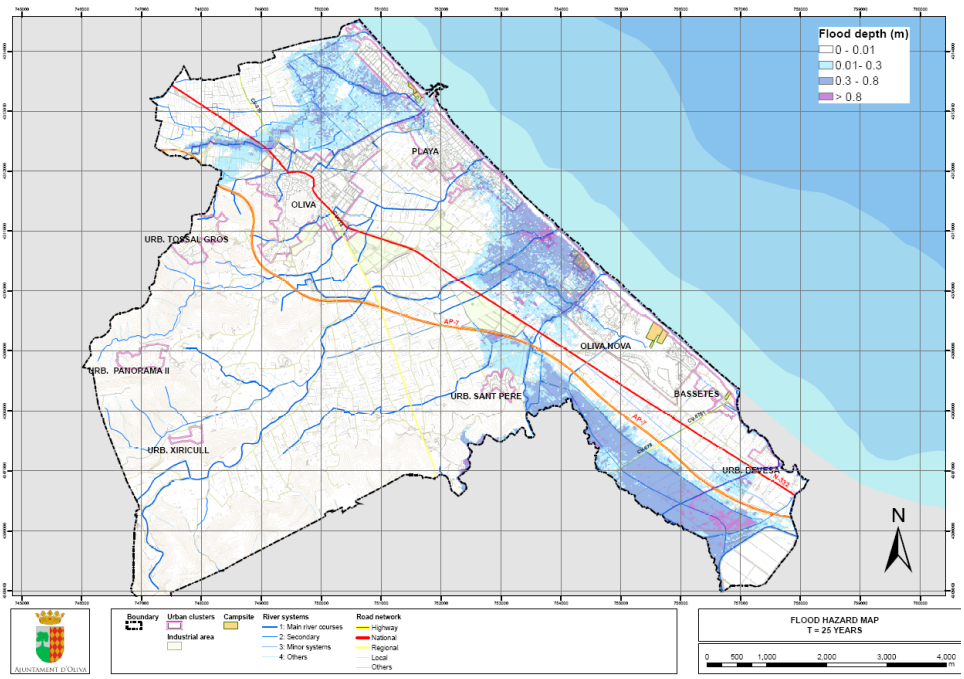


Figure 7.

Flood hazard map for the flood event of 25 years of return period.

reducing consequences, in the horizontal axis), and the situation with both structural and non-structural measures (reducing risk in both axis, probability and consequences).
Finally, results from the risk model were used as a basis for the identification and prioritization of critical and monitoring points in Oliva, supporting decisionmaking on where to act and how to proceed in case of emergency.
An example of flood hazard and risk maps developed within the Plan to support emergency management is shown in Figure 7.

4.2 THE ROLE AND FUNCTIONS OF THE TECHNICAL DIRECTOR OF THE LOCAL ACTION PLAN AGAINST FLOOD RISK

The local action plan against flood risk (PAMRI) of the municipality of Oliva included an innovative aspect with the definition of the Technical Director. The main functions include analyzing the emergency event and supporting the Director on decisionmaking related to required actions before, during or after a flood emergency event.
The definition of such role responds to the need for direct technical support to the Director of the Plan in order to:

- Decide on the most appropiate actions to deal with situations that may result in emergency, and the implementation of measures to protect the population, the environment, property and personnel assigned to the Plan.
- Establish the information to be communicated to the population during an emergency and the content of warning messages to be issued through communication channels established by the Plan.
- Ensure updating, maintenance and operativity of the Plan.

The figure of the Technical Director of the Plan ensures the correct updating, maintenance and operativity of the Plan, providing a comprehensive perspective including technical and operational aspects for emergency management at short-, mid- and long-term.

5 . CONCLUSIONS AND FUTURE ACTIONS

Society demands concrete and acurate actions to achieve high life quality standards (sustainability, safety, etc.), both from the urban planning and civil protection perspectives. There are available regulatory and planning tools, along with other modeling tools and human resources with the required expertise to reach those goals, hence authorities should respond to such demands with appropiate policies based on risk information. Therefore, it is imperative a high political engagement to improve civil protection and flood risk management at urban scale.
Therefore, involved technical personnel should receive adequate trainning to acomplish flood risk management actions. In addition, high risk awareness and public engagement, through information and communication campaigns, are needed for an effective flood risk reduction. As described in this paper, qualitative and quantitative risk estimations may help to better communicate existing risk and to inform decisions for flood risk management.
The methodology used for vulnerability estimation and risk analysis may become a useful tool for developing local action plans against flood risk in a more standarized and robust way. It is worth mentioning the importance of having detailed information on land uses, building typologies and population distribution to estimate vulnerability. Thus, a detailed inventory on building typology will allow to reduce uncertainty on economic flood consequence estimations thus it is of high importance to encourage involved authorities to promote such data gathering and analysis in order to improve and update future flood risk assessments.
For the case study of Oliva, risk analyses have shown the impact on risk reduction of past and ongoing structural measures for flood routing in Rambla Gallinera river course, which have been decisive for reducing flood risk in the southern area of the town and in a signficant part of the municipality.

The implementation of the local action plan against flood risk (PAMRI) will allow to complete flood risk reduction with non-structural measures such as improved emergency management, communication and public warning. The long-term flood risk reduction strategy in Oliva aims at integrating both structural and non-structural measures towards a smarter, more efficient and effective flood risk governance. Therefore, incorporating urban drainage innovative solutions such as SuDS (Sustainable Drainage Systems) might represent a step further on flood risk management at urban scale (Perales-Momparler et al., 2015), reducing risk from pluvial flooding, then accompanying current actions against river flooding.

ACRONYMS

BC	Base Case
CT	Total costs
D	Damage due to flooding
DEFRA	Department for Environment, Food and Rural Affairs of United Kingdom
DEM	Digital Elevation Model
EIEL	Regional survey on Infrastructures and Equipment
EU	European Union
F	Cumulative annual exceedance probability
GIS	Geographic Information System
MAGRAMA	Spanish Ministry of Agriculture, Food and Environment
N	Loss of life due to flooding
PAMRI	Local action plan against flood risk
PATRICOVA	Territorial Action Plan for Flood Risk Prevention in the Valencian Community
SuDS	Sustainable Drainage Systems
SUFRI	Sustainable Strategies of Urban Flood Risk Management
T	Return period

ACKNOWLEDGMENTS

Research activities related to the work described in this article are part of the INICIA project, "Metodología de evaluación de INversiones en Infraestructuras del Ciclo Integral del Agua basada en indicadores de riesgo y de eficiencia energética", within the framework of the National Programme for Research Aimed at the Challenges of Society "Retos 2013", with reference BIA2013-48157-C2-1-R-AR.

REFERENCES

Acuerdo de 28 de enero de 2003, del Consell de la Generalitat, por el que se aprueba definitivamente el Plan de Acción Territorial de carácter sectorial sobre Prevención del Riesgo de Inundación en la Comunidad Valenciana (PATRICOVA). [2003/1034] (DOCV núm. 4429 de 30.01.2003).

Castillo-Rodríguez, J. T., Escuder-Bueno, I., Altarejos-García, L., and Serrano-Lombillo, A.: The value of integrating information from multiple hazards for flood risk analysis and management, Nat. Hazards Earth Syst. Sci., 14, 379-400, doi:10.5194/nhess-14-379-2014, 2014.

Castillo-Rodríguez, J. T., Escuder-Bueno, I., Perales-Momparler, S., and Porta-Sancho, J. R.: Enhancing local action planning through quantitative flood risk analysis: a case study in Spain, Nat. Hazards Earth Syst. Sci., 16, 1699-1718, doi:10.5194/nhess-16-1699-2016, 2016.

Constitución Española (BOE núm. 311, de 29.12.1978)

Decreto 1/2011, de 13 de enero, del Consell, por el que se aprueba la Estrategia Territorial de la Comunitat Valenciana [2011/235] (DOCV núm. 6441 de 19.01.2011)

Decreto 201/2015, de 29 de octubre, del Consell, por el que se aprueba el Plan de acción territorial sobre prevención del riesgo de inundación en la Comunitat Valenciana [2015/8835] (DOCV núm. 7649 de 03.11.2015)

Decreto 243/1993, de 7 de diciembre, del Gobierno Valenciano, por el que se aprueba el Plan Territorial de Emergencia de la Comunidad Valenciana (DOGV núm. 2171, de 24.12.1993)

Decreto67/2006, de 19 de mayo, del Consell, por el que se aprueba el Reglamento de Ordenación y Gestión Territorial y Urbanística. [2006/6112] (DOCV núm. 5264 de 23.05.2006)

Decreto 81/2010, de 7 de mayo, del Consell, por el que aprueba el Plan Especial ante el Riesgo de Inundaciones en la Comunitat Valenciana [2010/5363] (DOCV núm. 6265 de 12.05.2010)

DEFRA: FD2321/TR1 – The Flood Risks to People Methodology, London, 2006. Available at: www.defra.gov.uk/environ/fcd/research (last access: February 2016).

Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, Official Journal of the European Union, 6.11.2007.

Escuder-Bueno, I., Castillo-Rodríguez, J. T., Zechner, S., Jöbstl, C., Perales-Momparler, S., and Petaccia, G.: A quantitative flood risk analysis methodology for urban areas with integration of social research data, Nat. Hazards Earth Syst. Sci., 12, 2843-2863, doi:10.5194/nhess-12-2843-2012, 2012.

Generalitat Valenciana: Plan de Acción Territorial sobre prevención del Riesgo de Inundación en la Comunitat Valenciana (PATRICOVA), Valencia, 67–72, 2015.

Jonkman, S. N.: Loss of life estimation in flood risk assessment, Ph.D. thesis, Delft University of Technology, Delft, the Netherlands, 2007.

Ley 10/2001, de 5 de julio, del Plan Hidrológico Nacional (BOE núm. 161, de 06.07.2001)

Ley10/2004, de 9 de diciembre, de la Generalitat, del Suelo No Urbanizable. [2004/12638] (DOCV núm. 4900 de 10.12.2004).

Ley 11/2005, de 22 de junio, por la que se modifica la Ley 10/2001, de 5 de julio, del Plan Hidrológico Nacional (BOE núm. 149, de 23.06.2005)

Ley 13/2010, de 23 de noviembre, de la Generalitat, de Protección Civil y Gestión de Emergencias [2010/12771] (DOCV núm. 6405 de 25.11.2010)

Ley 16/2005, de 30 de diciembre, de la Generalitat, Urbanística Valenciana. [2005/14692] (DOCV núm. 5167 de 31.12.2005).

Ley 17/2015, de 9 de julio, del Sistema Nacional de Protección Civil (BOE núm. 164, de 10.07. 2015)

Ley 2/1985, de 21 de enero, sobre protección civil (BOE núm. 22, de 25.01.1985)

Ley 2/2013, de 29 de mayo, de protección y uso sostenible del litoral y de modificación de la Ley 22/1988, de 28 de julio, de Costas (BOE núm. 129, de 30.05. 2013)

Ley 4/2004, de 30 de junio, de la Generalitat, de Ordenación del Territorio y Protección del Paisaje [2004/6916] (DOCV núm. 4788 de 02.07.2004)

Ley 5/2014, de 25 de julio, de la Generalitat, de Ordenación del Territorio, Urbanismo y Paisaje, de la Comunitat Valenciana. [2014/7303] (DOCV núm. 7329 de 31.07.2014)

Ley 7/1985, de 2 de abril, Reguladora de las Bases del Régimen Local (BOE núm. 80, de 03.04.1985)

MAGRAMA: Propuesta de mínimos para la metodología de realización de los mapas de riesgo de inundación, Ministerio de Agricultura, Alimentación y Medio Ambiente, Madrid, Spain, 2013 [In Spanish] http://www.magrama.gob.es/es/agua/temas/gestion-de-los-riesgos-de-inundacion/ (30/10/2016)

Perales-Momparler, S., Andrés-Doménech, A., Andreu, J., and Escuder-Bueno, I.: A Regenerative urban stormwater management methodology: The journey of a Mediterranean city, Journal of Cleaner Production, 109, pp.174-189, doi: 10.1016/j.jclepro.2015.02.039, 2015.

Plan Básico Municipal de Oliva para la lucha contra inundaciones. Ayuntamiento de Oliva, mayo 1992.

Plan de defensa contra avenidas de la comarca de La Safor. Confederación Hidrográfica del Júcar, agosto de 1999.

Plan Territorial Municipal Frente a Emergencias del Municipio de Oliva. Ayuntamiento de Oliva, junio de 1994.

Real Decreto 407/1992, de 24 de abril, por el que se aprueba la Norma Básica de Protección Civil (BOE núm. 105, de 1 de mayo de 1992)

Real Decreto 876/2014, de 10 de octubre, por el que se aprueba el Reglamento General de Costas (BOE núm. 247, de 11.10.2014)

Real Decreto 903/2010, de 9 de julio, de evaluación y gestión de riesgos de inundación (BOE núm. 171, de 15.07.2010)

Resolución de 31 de enero de 1995, de la Secretaría de Estado de interior, por la que se dispone la publicación del Acuerdo del Consejo de Ministros por el que se aprueba la Directriz Básica de Planificación de Protección Civil ante el Riesgo de Inundaciones (BOE núm. 38, de 14.02.1995)

Vitruvio
International
journal of
Architecture
Technology and
Sustainability
Volume 1 Is 2