4th International Symposium on Flood Defence:
Managing Flood Risk, Reliability and Vulnerability
Toronto, Ontario, Canada, May 6-8, 2008

Institute for Catastrophic Loss Reduction

FLUVIAL ENVIRONMENT PLANNING (PEF) IN CATALONIA: HARMONIZING RIVER AND FLOODPLAIN RESTORATION WITH HUMAN DEVELOPING

Fleta J.[2]; Garcia, E[1].; Gode, L[1].; Gracia, A[1].; Moxo, D[1].; Verdu, J[1].
1. Catalan Water Agency ; Barcelona, Spain
2. Catalan Geological Institute

ABSTRACT: Since 2000, the Catalan Water Agency has been developing a new approach for fluvial management, linking environmental protection and restoration of riverside areas with flood defence, urbanism and land use planning. Taking into account the EU Water Framework Directive and Flood Directive, a holistic study of river dynamics is conducted including hydrology, hydraulics, morphodynamics and riparian ecology. At the same time, relying on stakeholder participation, a future model of river and floodplain is defined through scheduled management and public work actions. As outcome, river area is delimited into three zones with diverse land use restrictions according to regional urbanism laws and to the EU directives.

Key Words: land use planning; river restoration; flooding; EU Water Framework Directive; EU Flood Directive.

1. INTRODUCTION

Since 2000 the Catalan Water Agency (ACA), has been developing a new approach for fluvial management, linking environmental protection and restoration of riverside areas with flood defence and land use planning.

Fluvial Environment Planning (PEF) of Catalan basins has being developed through a multidisciplinary analysis and a comprehensive view of riparian ecology and all hydrological-hydraulic and morphodynamics phenomena.

Up to now, 40% of the River Basin Districh (as defined by the WFD) have been analyzed. As result a Management Plans has been obtained, who will help to achieve both the requirements established by the European Commission and the Catalonian authorities.

1.1 Flood area experience

The ACA has conducted studies on several spatial scales, in order to obtain flooding risk cartography all around Catalonia, providing information of potential danger.

Hydraulic models of all watersheds bigger than 80 km^2 have been developed, which means mapping around 4,500 km of river network. On the remaining river reaches (70,500 km), potential geomorphologic flooding areas have been mapped, working together with the Catalan Geological Institute.

1.2 Information accessibility

Enhancing access to information through the website of the ACA (http://mediambient.gencat.cat/aca/en/inici.jsp) has been lately a major objective under development.

The goal is to give to all citizen a quick and easy access to the best available information, making available not only not only studies, but also technical criteria and methodologies.

Providing access to information clearly enhances participation on decision making and improves results of management plans.

2. PEF OBJECTIVES

Overarching objectives of PEF are obtaining a diagnosis referred to current state of the river network, exploring natural phenomena and processes that determine the behavior of fluvial space. Taking into account all relevant aspects of this complex ecosystem as well as a comprehensive solutions proposal to manage and solve different hydraulic or environmental conflicts.

To achieve this goal, its necessary to work in multidisciplinary approaches and disciplines, keep in mind that rivers are not processes or objects created by men and natural systems are fairly vulnerable.

Main objectives to point out are:

- To determine the design of the flow discharges for different recurrence periods.
- Assessment of the ecological status of river ecosystems, taking into account its terms of reference.
- To delimitate the riverside areas to determine suitable land use, according to ecological dynamics and hydraulic behavior.
- To reach a measure schedule, properly valuated, prioritized and identifying those responsible for conducting each measure.
- To define the criteria for management and intervention.

3. METHODOLOGY

3.1 Cartography

Different digital cartography of several institutions and administration were available. Among these, a digital elevation model of of 1 m cells size obtained by a LIDAR flight, and delivered as part of an agreement between Catalan Water Agency and Cartographic Institute of Catalonia.

3.2 Characterization

Both physical and biotic environment, has been characterized in two different areas using two scales. As a first approximation, the whole basin is studied, dealing with characterization of certain aspects (such as hydrology or biological territorial connectivity). In the second instance, at river plain scale, environment study is based on an accurate work to characterize the river and the flood area.

At river scale, morphology of the mainstream has been studied, including flow data gauging stations considering the sediment transport.

Ecological characterization includes a description of habitats and natural environments, biological connectors, areas of interest at eco-specific functional level, macro fauna, wildlife associated vertebrate, scenic areas, as well as identification of natural areas with some specific legal protection has been analyzed in the area.

Finally, its includes an inventory of cultural heritage (historical, artistic, architectural, archaeological and ethnological aspects) for the purpose of to develop of the measures program proposals.

3.3 Diagnosis

Diagnosis elements, so-called “singular points”, have been classified in 6 categories by its typology (Infrastructure, Structures and Others) or the physical phenomena (Hydraulic, Morphodynamics and environmental). Thus, according to phenomena, there are three typologies of singular points:

- **Flooding area**; determines the potential risk of the element and danger information according to a hydraulic model in the main river and by geomorphologic criteria for the rest.

- **Morphodynamics;** not only considering erosion/sedimentation of thalweg, but also physical barriers and physical continuity model.

- **Riverside environment;** including both positive and negative impacts on the environment of the river area for each studied issue.

It has been decided to use the word "singular" instead of "black“ or “Critical” to name this type of element, so that aspects related to flooding risk are included in addition to those referred to environmental and morphodynamics aspects that are of a great importance in the EU directives.

Diagnosis concludes with a summary of the state of the river courses and a list of singular points with their corresponding summary sheets. The use of these mentioned elements will monitor future developments of the river in terms of management and restoration.

3.4 Measure program

The main objective of this stage is to analyze and evaluate the feasibility of various measures, taking into account different criteria. This step includes prioritizing evaluated proposals and to identify those responsible for its promotion.

The performance measures are grouped into two different types:

- **Infrastructural measures**: this classification includes those actions which involve a change in the current state of the river area to mitigate or resolve the hydraulic constrains (regardless of "hardness" aspect respect for the natural terrain). Examples of these actions are: deviations and new channels, embankments reinforced with concrete or bioengineering techniques,

empowerment flood storage areas, recovery or enhancement of riparian vegetation, re-naturalization of a river stretch, restoration of ancient meanders, and other actions.

- **Management measures**: includes a set of no-structural measures such as changes in land use planning, expropriations, regulating discharges, regulating agricultural activities, protection of areas of scenic or ecological zoning, and so on.

Its concludes with a summary diagnosis and conclusions of the state of the river courses considering all the proposed measures.

3.5 Fluvial Environment Plan (PEF)

Final step of the managenement of the PEF includes the technical documents to perform the legal basis or regulations on which it will considered for the whole future management of the watershed.

- Fluvial dynamics description
- Flood discharge normalization
- Fluvial zonification
- Land use constraints
- Measure program
- Management criteria

4. FLUVIAL ZONIFICATION

The river area is defined by the riverbed area and those strips of land linked to the preservation of aquatic ecosystems and the current flow regime and floodplains for extraordinary flood with the geomorphologic consideration.

4.1 Fluvial area

This area of the river includes the river bed and its banks as determined by a flooding episode recurrence period of 10 years, with the continuity on hydraulic and environmental aspects and the preservation of the river ecosystem.

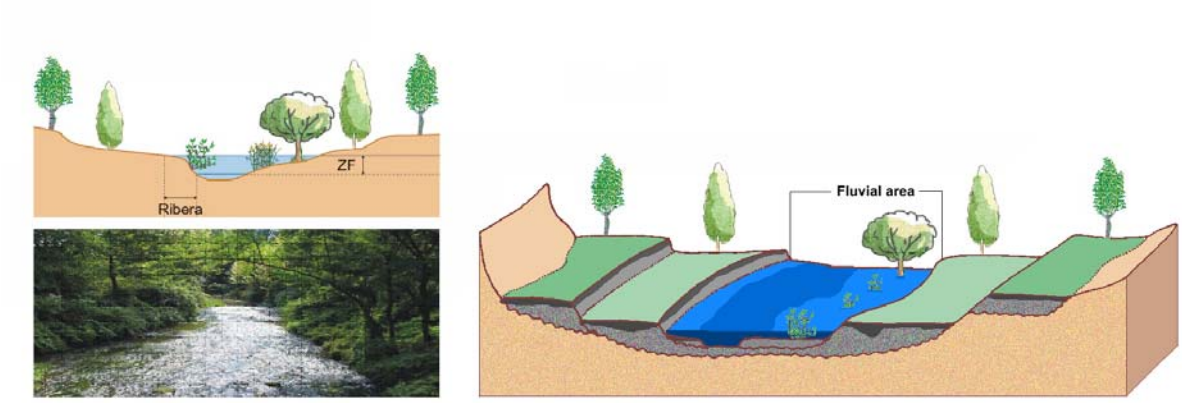

Figure 1 Fluvial area

In this area, figure 1, is not supported the urban use, except works related to the preservation and improvement of the functionality of environmental and hydraulics.

Exceptionally the implementation of a channeled infrastructures through the waterway area is admitted, without distortions in the hydraulic functionality and morphodynamics. Other uses, such as the implementation of facilities for the transport of hazardous materials and / or priority substances that could be a potential risk of contamination in the watertable, are not allowed.

Cross road infrastructures must respect the continuity of functionality of environmental hydraulics.

4.2 Hydric system

This area of the river is determined by a flooding episode recurrence period of 100 years, giving continuity and hydraulic connection, and which limits to preserve the flood system (conveyance) in floods events.

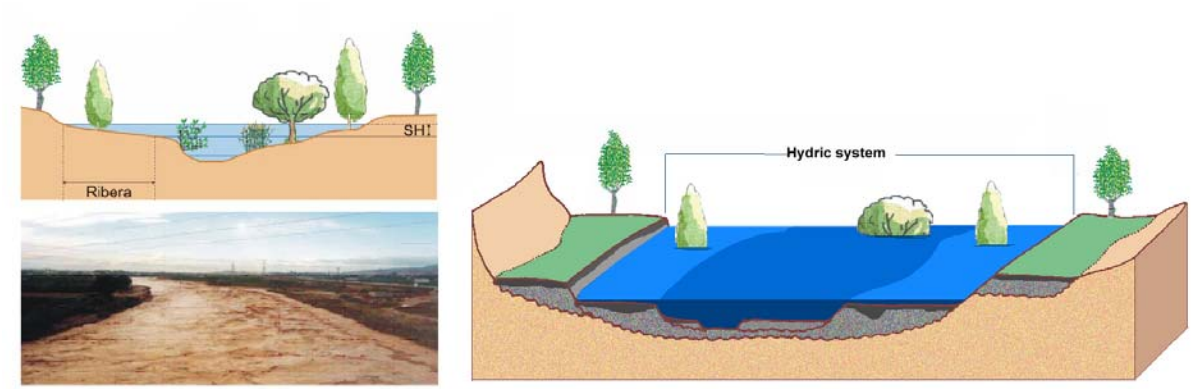

Figure 2 Hydric system

This area, figure 2, it's not permitted for the urban activities that involve a change of the terrain topography. Land uses allowed in the zone include:

A) Agriculture: grass, horticulture, viticulture, turf, forestry, outdoor nursery crops and wild. It is not permitted the establishment of greenhouses or closures of any kind between plots.

B) Industrial uses - commercial: green areas.

C) Residential uses: lawns, gardens and playgrounds.

D) Recreational uses public and private: outdoor sports courts, rest areas, swimming areas, nature reserves hunting, parks, hunting and fishing, hiking or circuit riding, golf courses. The implementation of these activities can not assume significantly altering the natural conditions of the land affected or the establishment of obstacles to the flow. It's not permitted the establishment of camping areas or campsite services.

E) Public infrastructure: ponds and pumping stations both wastewater and water intended to supply.

Exceptionally, the creation of infrastructure services and buried pipes, if adequately protected against flood erosion are supported. It is not allowed in this area the implantation facilities for the transport of dangerous goods, priority substances that could be a risk of contamination of the watertable or the develpment of made-man landfills

The road infrastructure will have to respect a zone free of width necessary to preserve the flood system (conveyance) in floods events and ensure the continuity of the water system.

4.3 Flooding zone

Is the area determined by the fooding episode of recurrence period of 500 years, and which limits the preservation of the floodplains by extraordinary episodes.

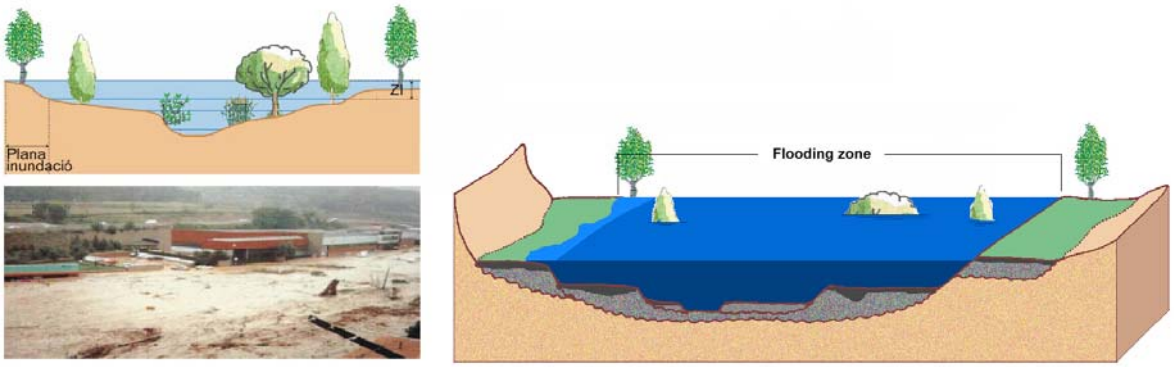

Figure 3 Flooding zone

This area, figure 3, its includes the following limitations for the land use:

A) Residential areas and camping services camping uses: no risk of moderate flooding episode.

B) Industrial - commercial use: no risk of serious flooding episodes.

C) Public infrastructures: the sewage treatment plant (WWTP) and associated facilities at the stations treatment of drinking water (ETAP) uses: no risk of serious flooding episodes.

It's not supported the placement of non-inert materials landfills in this area.

5. CONCLUSIONS

- The main objective of PEF is preserve and improve the functionality of hiydraulics, morphodynamics and environment, with the goals of decrease the flood risk and to obtain a good ecological state of water bodies.

- PEF approach means for each basin a holistic study of river dynamics, including hydrology, hydraulics, morphodynamics and riparian ecology.

- To provide the access to information, facilitates the participation of different actors and improved global and local results.

- Through stakeholder participation, a future model of river and floodplain is defined through scheduled management and public work actions.

- PEF studies are becoming a key reference for environment and urbanistic planners in Catalonia.

- PEF studies imply continuous updating old-fashioned technical criteria and enhancing of state-of-the-art techniques (such as sampling methodologies, LIDAR DEM, 1D-2D coupled models, or sediment transport models)

- Establishment of consensed criteria for the local government intervention in river area, the elaboration of studies and projects and to coordinate with other plans and programs.

- Fluvial zonification is the issue that allows the rational use of territory respecting the environment.

ACKNOWLEDGMENTS

We thank all people, organizations and institutions that have participated in the elaboration of the Fluvial Environemnt Plan.