FLOOD MAPPING

CHAPTER 09

Definitions

- **Flood risk** is the combination of the probability of a flood event and of the potential adverse consequences to human health, the environment and economic activity associated with a flood event.
- **Flood hazard maps** shows areas which could be flooded according to three probabilities (low, medium high) complemented with: type of flood, the flood extent; water depths or water level as appropriate; where appropriate, flow velocity or the relevant water flow direction.
- **Flood risk maps** indicate the potential adverse consequences associated with floods under several probabilities, expressed in terms of: the indicative number of inhabitants potentially affected; type of economic activity of the area potentially affected; installation which might cause accidental pollution in case of flooding; potentially affected.
- **Flood plain maps** indicate the geographical areas which could be covered by a flood (from all sources except sewerage systems) according to one or several probabilities: floods with a very low probability or extreme events scenarios; floods with a medium probability (likely ***return period ≥100y***); floods with a high probability, where appropriate.
- **Residual risk** is the portion of risk remaining after flood risk management actions have been implemented and taken into consideration.

Use of flood maps

The maps serve at least one of the three purposes of ***flood risk management***:

(i) Prevent the build-up of new risks (planning and construction),

(ii) Reduce existing risks, and

(iii) Adapt to changing risks factors.

Flood maps *are primarily used for:*

• Flood Risk Management Strategy (prevention, mitigation)
• Land-use planning, land management
• Emergency planning
• Public Awareness rising
• Private sector, in particular insurance sector

Flood maps may be required for other activities that may be less systematic in application, localized in demand or necessary as secondary or supplementary information for decision-making on issues not directly related to flooding, such as environmental planning or soil contamination after flood.

Flood Hazard Maps

Flood hazard maps shall cover the geographical areas which could be flooded using at least three scenarios: **low, medium, and high** probability of occurrence. For each scenario the flood extent, the water depths or water level, as appropriate, and where appropriate the flow velocity, **have to be represented on the maps.**

"*The* ***flood hazard maps*** *include historic as well as potential future flood events of different probability, illustrating the intensity and magnitude of hazard in a selected scale and are at the basis of considerations and determinations in land use control, flood proofing of constructions and flood awareness and preparedness****"***

Points to note in relation to ***floodways*** are that:

- *Most conveyance of floodwater along a particular flowpath occurs in floodways*
- *Flow velocity in floodways may be relatively high compared to other areas of the floodplain*
- *blocking the floodway will either raise flood levels or redirect flood flows*
- *Floodways may have very low flow velocities*
- *floodways are generally areas where development is undesirable due to:*
  - the potential to redirect flows
  - the level of **potential danger** to personal safety
  - significant **financial losses** due to the damage potential

Floodways need to be examined in a range of events. For example, an area which may be flood storage or flood fringe in the planning level flood may become a floodway in an extreme event or new floodways may develop. These need to be identified and the risk to development identified.

Approaches to Assessing Floodways in Modeling

There is no definitive method of deriving **floodway** limits in models. It is generally an iterative process requiring judgment by an experienced modeler/practitioner. However, the following overall limits provide some guidance:

- ***The minimum width of any floodway*** in the planning level flood should be assumed to be the top of bank on each side of the main channel of the flow path.
- In major drainage areas where roadways carry a high proportion of flow the entire road reserve could be considered a floodway. If floodways extend into private property the characteristics outlined above should be used.
- In western rural floodplain floodway limits are documented in Floodplain Development Guidelines or Rural Floodplain Management Studies where available.

An iterative method that can be considered in defining the approximate limits of *floodways* is reducing conveyance by altering cross sections and examining the impacts in relation to whether:

- there is a significant effect on upstream flood levels and/or
- there is a significant diversion to an existing flow path and/or
- A significant new flow path or floodway develops due to the change
- This approach may assist in determining the extent of floodway limits.

Flood Hazard Maps: Basic Information

The proper use and application of flood hazard maps into planning processes and awareness campaigns require the consideration of some very basic information on the map. The most important aspects are:

- **Title of the map:** making clear reference to the map content such as - Flood parameter: Flood extent, depth, flow velocity, past event - Probability consideration: defining more precisely what mean low, medium and high probability of occurrence,
- **Location of the map** as part of the catchment or country: provision of a small inset map
- **Legend:** - parameters shown on the map with easy to read symbols or colour schemes; - class or ramp for numerical values
- **North and scale:** preferably using scale bar as this allows for changes in page size Responsible authority or institute with address, website (and/or telephone number) • Base date for the data and date of publication
- **If necessary:** a disclaimer, including remarks on the quality of information can be added.

Flood Extent Map/Flood Plain Map

The flood extent map is the most widely distributed instrument. The European flood directive requests flood extent maps for an extreme (low probability) and a ***≥100-years*** scenario (*medium probability*). And where appropriate, a high probability scenario can be added.

Map content

- The potential flood extent for single or a small range of flood event frequencies has to be presented as a surface covering the topography. For reference roads, railways, houses, property boundaries and the permanent water bodies from which the floods may originate may be included. In addition, the protecting effect of defense works and areas designated for flood storage may be included.
- The flood extent for one particular recurrence interval
- The flood extent is given for return periods *10-, 30-, 50-, 100-, 300* years, extreme event for return periods *30-, 100-, 300-*, is used to mark the so-called *residual danger*.
- There is no difference made between water *floods* and *sediment accumulation*.

Map use

- Serves as a basic product to establish danger maps and risk maps
- Land use planning (legally binding)
- City and village planning
- Rural planning
- Risk management
- Awareness building (particularly when combined with past events) Scale considerations
- Detailed scale required if flood map is used for urban planning (1:2,000 to 1:25,000), particularly if in mountainous or hilly areas where affected territory is narrow.
- Overview scale possible for rural planning in large flood plains (1:100,000 to 1:1,000,000). The scales used to present that data must be appropriate to the original scale and accuracy of the modeling and mapping work.

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Color scheme

In practice the color frequently used for the flood extent information is **blue**: *e.g. dark blue for* ***frequent floods*** and **light blue** for the ***areas covered during less frequent floods***.

Flood Depth Map

The **flood depth map** is a widely distributed instrument in European countries. The values of water level (depth) can be derived from flow models (2D and 1D) for river flooding, from statistical analyses or from observations.

Normally in rivers numerical models have to be used and for lakes and sea statistical methods can be used. There is a wide range of applications of such maps.

Flow Velocity and Flood Propagation Map

The European flood directive asks for maps which represent the **flow velocity**, where appropriate. Flow velocity information is much more difficult to get than water depth information. Normally reasonable flow velocity information can be derived only from 2D-flow models and in some cases also from 1D-flow models. There are few examples where flow velocities are shown on maps. Such products are highly technical.

Flood Danger Map

The **flood danger map** combines various flood parameters to form a level (degree) of danger (*depth, velocity, debris often combined with recurrence interval*). The information can be of qualitative or quantitative type. The color scheme utilized is of particular importance as the colors represent also the level of severity, i.e. a direct link to possible impact. This type of map is not requested by the flood directive but it is useful, e.g. for *land use planning*.

Flood risk maps

"**Flood risk** is the combination of the probability of a flood event and of the potential adverse consequences to human health, the environment and economic activity associated with a flood event."

Flood risk maps shall show the potential adverse consequences associated with floods, expressed in terms of the following:

(a) The indicative number of inhabitants potentially affected;

(b) Type of economic activity of the area potentially affected;

(c) other information which the Member State considers useful such as the indication of areas where floods with a high content of transported sediments and debris floods can occur and information on other significant sources of pollution.

The Notion of Risk and Its Representation on Maps

$$Risk = C * p_h$$

Where

C is the *potential adverse consequence* ((taking into account factors such as exposure and vulnerability) and

p_h the probability of the hazardous process.

Risk is expressed as a potential loss in a particular area (e.g. ha, km^2) within a given period of time (in general one year).

$$C = V * S (m_h) * E$$

Where **V**, **S** and **E** are the vulnerability parameters:

V = *value of the element at risk*: in money terms or human life

S = *susceptibility*: damaging effect on element at risk (as a function of magnitude of hazard; e.g. depth-damage and damage-duration curves). The susceptibility ranges from **0 to 1**.

E = *exposure*: the probability of the element at risk to be present while the event occurs. The exposure ranges from **0 to 1**.

☆ *The following information can be **mapped** with regard to **flood risks**:*

- Individual vulnerability parameter "***Value***" as a direct demand of the flood directive

  -**Population:** number of people, special groups, etc.

  -**Economic assets and activity:** private property, lifelines, infrastructure, etc.; type of production, number of jobs, etc.

  -**Environmental issues:** installations potentially damaging the environment.
- Potential adverse consequence (*flood damage; loss per unit area*) = ***V * S * E***
- Risk (loss per unit area in a given period of time)