HYDRAULIC RISK

(RIVERS FLOODING)

River flooding phenomena in the drainage network and major watercourses are assessed on a regional scale, 'for which it is possible to forecast the evolution of events based on instrumental monitoring of hydrometric levels'.

Hydraulic criticality is also assessed for watercourses covered by the flood service, which are not monitored by instruments: in this case, the assessment is carried out exclusively on the basis of rainfall forecast by meteorological models, bearing in mind the limitations of forecasting for small basins.

The main indicator for assessing hydraulic risk is the water level in major watercourses. It is assumed that the severity of the possible effects of flooding on the surrounding areas can generally be considered proportional to the water level reached, as it is impossible to know and predict on a regional scale the critical issues of the hydrographic network and the areas crossed, which may arise during flooding and can only be identified on a local scale and through direct observation.

For each section of river equipped with instruments, a system of three hydrometric levels is defined, which distinguish four levels of hydraulic criticality in the area, corresponding to colour codes from green to red, and which generally identify the following situations:

• **Level 1:** hydrometric levels corresponding to the complete occupation of the low-water channel, significantly below ground level. Indicates the passage of a minor flood, which may, however, require some hydraulic manoeuvres or preventive actions on the watercourses.

• **Level 2**: hydrometric levels corresponding to the occupation of floodplains or natural expansion areas of the watercourse, affecting embankments where present, and may exceed the ground level. Indicates the passage of a significant flood, with widespread erosion and solid transport.

• **Level 3**: hydrometric levels corresponding to the occupation of the entire river section, close to the maximum recorded levels or the embankment margins. Indicates the passage of an exceptional flood, with significant and extensive erosion and solid transport.

By definition, **hydrometric levels are an indicator of flood risk**, especially in the valley sections of major watercourses, where there are floodplains and defence embankments and where flood services are provided. In the unembanked mountain sections of major watercourses, hydrometric thresholds can be used not only as an indicator of local danger, but also as an early warning indicator of corresponding level exceedances in the valley sections, correlated with the most frequent types of flooding.

The hydrometric levels have been shared by the ARPAE-SIMC Functional Centre with the technical entities responsible for hydraulic territorial monitoring: AIPo, Land Reclamation Consortia, Regional Agency for Territorial Safety and Civil Protection. The threshold values are continuously verified and updated as necessary, particularly following significant events that alter the characteristics of watercourses, in order to make them more representative of possible event scenarios in the area

The colour code assessment during the forecasting phase is carried out by considering:

1. the rainfall predicted by meteorological models, compared with statistical thresholds of average rainfall for the area calibrated on past events;

2. the peak flood levels predicted by the hydrological-hydraulic models available for major watercourses, compared with the system of three hydrometric thresholds defined in the instrumented river sections;

3. the state of watercourses, in terms of initial hydrometric levels, the functionality of existing hydraulic and flood defence works, and any known vulnerabilities in the region.

The peak flood levels referred to in point 2, considered in the assessment of hydraulic risk during the forecasting phase, are predicted by hydrological-hydraulic models in mountain hydrometric sections with tributary basins of sufficient size for reliable weather forecasting, and in the hydrometric sections downstream of these.

The following is a list of the major watercourses for which hydraulic criticality is assessed:

- Tidone
- Trebbia
- Aveto
- Nure
- Chiavenna
- Arda
- Stirone
- Ceno
- Taro
- Parma
- Baganza
- Enza
- Crostolo
- Secchia
- Panaro
- Samoggia
- Lavino
- Reno
- Navile-Savena abbandonato
- Idice
- Quaderna
- Sillaro
- Santerno
- Senio
- Lamone

- Marzeno
- Montone
- Rabbi
- Ronco
- Bevano
- Savio
- Pisciatello
- Rubicone
- Uso
- Marecchia
- Conca

On minor torrential watercourses, which underlie small tributary basins of the major watercourses listed above, where it is not possible to predict flood evolution on the basis of instrumental monitoring, the only indicator for predicting possible rises in hydrometric levels can be the intensity and duration of rainfall. Since these rises are often rapid and may be accompanied by erosion-sedimentation and solid transport phenomena, which interact closely with slope dynamics, they fall within the scope of hydrogeological risk assessment.

The event scenarios and possible effects and damage to the territory, corresponding to the different colour codes from green to red, are summarised in the following table.

HYDRAULIC RISK (RIVERS FLOODING)		
COLOUR CODE	**EVENT SCENARIO**	**POSSIBILE EFFECTS AND DAMAGE**
GREEN	No significant phenomena are expected.	Unpredictable, occasional damage cannot be ruled out.
YELLOW	**Localised phenomena** may occur, such as: - rising water levels in major waterways, above threshold 1; - rising water levels in the drainage network. Even in the absence of rainfall, river flooding in major waterways can cause hydraulic criticality.	Occasional danger to human safety with possible loss of life due to accidents. Limited damage to hydraulic and bank protection works, agricultural activities, construction sites, civil and industrial settlements in riverbeds and/or near major watercourses or the drainage network.
ORANGE	**Widespread phenomena** may occur, such as: - significant rises in the water levels of major watercourses, above threshold 2, with flooding of neighbouring areas and floodplains and damage to embankments; - significant rises in water levels in the drainage network, with difficulties in water disposal and possible flooding of neighbouring areas; - bank erosion, sedimentation and solid transport, riverbed diversion; - partial or total blockages of bridges over major watercourses. Even in the absence of rainfall, river flooding in major watercourses can cause hydraulic criticality.	Danger to human safety with possible loss of life in flooded areas or areas close to watercourses. - Damage to watercourse containment, regulation and crossing structures. - Damage to infrastructure, buildings and agricultural activities, construction sites, civil and industrial settlements located in floodplains or flood-prone areas and/or near the drainage network, also due to the impossibility of discharging water from the secondary network into larger watercourses.
RED	**Numerous and/or extensive phenomena** may occur, such as: - river flooding of major watercourses exceeding threshold 3, possible flooding even in areas distant from the river, widespread erosion of river banks, sedimentation, solid transport and riverbed deviation; - significant rises in the hydrometric levels of the drainage network with possible overflowing and flooding of neighbouring areas; - overtopping, siphoning, breach of embankments, gushing, overtopping of bridges and other crossing structures, meander jumps, partial or total blockages of the spans of bridges over major watercourses. **Even in the absence of rainfall**, the passage of river floods in major watercourses can cause hydraulic criticalities.	Serious danger to human safety with possible loss of life in flooded areas or areas close to waterways. - Partial or total damage to embankments, bridges and other hydraulic works, railway and road infrastructure close to waterways. Extensive damage to essential service infrastructure, buildings, agricultural activities, construction sites, civil and industrial settlements affected by flooding, including due to the inability to discharge water from the secondary network into major waterways.