HYDROGEOLOGICAL RISK

(LANDSLIDES AND MINOR RIVERS FLOODING)

The following are assessed:

• **landslide phenomena**: landslides due to collapse and overturning, landslides due to rotational and translational sliding, slow-moving landslides, surface landslides, mixed-type landslides;

• **rapid flow phenomena**: rapid debris and mud flows, channelled and unchannelled, mainly affecting slopes but which can also spread to riverbeds;

• **runoff phenomena**: widespread or concentrated runoff with accelerated erosion, transport and sedimentation of material;

• **flooding and erosion phenomena on minor watercourses**: rapid rises in the water level of the minor hydrographic network, lateral and bottom erosion with transport and sedimentation of material. The sections subject to assessment for these phenomena are minor torrential watercourses that underlie small basins.

The main factor triggering and developing the above phenomena is rainfall, which can cause them to occur. The intensity and duration of rainfall or snowmelt, soil saturation conditions, accompanied by specific local geological and geomorphological conditions, determine the type and intensity of the phenomena that may occur.

At the level of individual slopes, it is currently not possible to predict either meteorological phenomena or the consequent triggering and subsequent evolution of landslides and rapid flows (in terms of the moment of triggering, speed and extent of the affected area), nor is it possible at the level of individual minor basins to predict the onset of flooding and erosion phenomena on the minor torrent network, as there is no instrumental monitoring network or adequate scale modelling available. Consequently, unlike the case for floods of major watercourses, no meteorological, hydrological or hydraulic monitoring documents are issued during the event.

The colour code assessment during the forecast phase is carried out on mountain and hill alert areas. In lowland areas, the assessment only concerns phenomena affecting minor watercourses belonging to the natural network.

The following are taken into account:

1. the rainfall predicted by meteorological models (intensity, duration and quantity) or snowmelt;

2. the results of landslide prediction models which, calibrated on past events, give an area-wide probability of landslides occurring;

3. the state of the territory, through the analysis of the amount of rainfall or snowmelt in the previous period, any landslides already known to have occurred in the territory, the hydrometric

levels in the minor hydrographic network, as well as the presence of any known vulnerabilities in the territory.

It should be emphasised that, since the hydrogeological fragility of the territory is extremely variable, there may be situations where slopes are in a precarious state of equilibrium, in which even very low rainfall or limited snowmelt, which would be tolerable elsewhere, can trigger landslides. Furthermore, it should be remembered that evidence of landslides in progress may also appear several days after the end of rainfall and continue for an indefinite period, even weeks, despite having presumably been triggered by the initial weather event. Consequently, for the purposes of alerting the public, even in periods classified as green, the occurrence of some landslide phenomena cannot be ruled out, although these should be considered rare or residual cases.

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

HYDROGEOLOGICAL RISK (LANDSLIDES AND MINOR RIVERS FLOODING)		
COLOUR CODE	**EVENT SCENARIO**	**POSSIBILE EFFECTS AND DAMAGE**
GREEN	No significant phenomena are expected, although the following cannot be ruled out at local level: - in the event of isolated downpours: occasional landslides due to collapse (including isolated boulders), limited surface landslides, occasional runoff and rapid rises in water levels in minor rivers and streams; - in the days following precipitation events that have already ended: occasional landslides due to slippage or slow flow on slopes in particularly fragile hydrogeological conditions.	Unpredictable, occasional damage cannot be ruled out.
YELLOW	**Localised phenomena** may occur, such as: - landslides due to collapse (including isolated boulders) and overturning, landslides due to slow sliding and flowing, mixed types of landslides, surface landslides interfering with the uphill or downhill slopes of the road network; - rapid debris and mud flows, channelled and unchannelled; - runoff with accelerated erosion, transport and sedimentation of material; - rising water levels in minor rivers and streams with associated bank erosion, sedimentation and solid transport along minor rivers and streams and possible flooding of neighbouring areas, also due to local criticalities (subsidence, narrowing, bridge span obstructions, etc.). Even in the absence of rainfall, snowmelt can cause localised phenomena such as erosion, landslides and rapid debris or mud flows in small basins; surface runoff with possible transport of material.	Occasional danger to human safety with possible loss of life due to accidents. - Localised damage to infrastructure, buildings and agricultural activities, construction sites, civil and industrial settlements affected by landslides or located near minor rivers and streams. - Temporary interruptions to the road and/or rail network near watersheds, canals, low-lying areas (underpasses, tunnels, road depressions, etc.) and downstream of sections of slopes affected by landslides or near minor rivers and streams.
ORANGE	**Widespread phenomena** may occur, such as: - landslides due to collapse (including isolated boulders) and overturning, landslides due to slippage and slow flow, even deep and extensive ones, mixed types of landslides, surface landslides interfering with the uphill or downhill slopes of the road network; - rapid debris and mud flows, channelled and unchannelled; - runoff with accelerated erosion, transport and sedimentation of material; - significant rises in water levels with associated phenomena of bank erosion, sedimentation, solid transport and riverbed diversion along minor rivers and streams with possible flooding of neighbouring areas, also due to local criticalities (collapses, narrowings, bridge obstructions, etc.). Even in the absence of rainfall, in the event of snowmelt, significant landslides may occur, even rapidly, in particularly fragile hydrogeological conditions, due to soil saturation.	Danger to human safety with possible loss of life. - Widespread damage to residential areas, infrastructure, buildings and agricultural activities, construction sites, civil and industrial settlements affected by landslides or located near minor rivers and streams. Widespread disruption to the road and/or rail network near watersheds, downstream of sections of slopes affected by landslides or near minor rivers and streams.

HYDROGEOLOGICAL RISK (LANDSLIDES AND MINOR RIVERS FLOODING)		
COLOUR CODE	**EVENT SCENARIO**	**POSSIBILE EFFECTS AND DAMAGE**
RED	**Numerous and/or extensive** phenomena may occur, including: - landslides due to collapse and overturning (even involving large volumes), landslides due to slow sliding and flowing, even deep and large ones, mixed types of landslides, surface landslides interfering with the uphill or downhill slopes of the road network; - rapid debris and mud flows, channelled and unchannelled; - runoff with accelerated erosion, transport and sedimentation of material; - significant rises in water levels with associated phenomena of bank erosion, sedimentation, solid transport and riverbed diversion along minor rivers and streams and extensive flooding of neighbouring areas; - rockfalls in several parts of the territory.	Serious danger to human safety with possible loss of life. - Extensive damage to buildings and inhabited areas, agricultural activities and crops, construction sites and civil and industrial settlements affected by landslides or located near minor rivers and streams. - Extensive disruption to the road and/or rail network near watersheds, downstream of sections of slopes affected by landslides or near minor rivers and streams.