

Main issues concerning landslide mapping harmonization in EU Member States. The JRC way forward

Javier Hervás

**Land Management and Natural Hazards Unit
Institute for Environment and Sustainability
European Commission - Joint Research Centre (JRC)
javier.hervas@jrc.it**



Having in mind the EU Soil Thematic Strategy, what would be suitable and feasible to be mapped in EU Member States (in a harmonized manner)?

Spatial distribution of past (and current) landslide occurrence, including also main landslide characteristics and possibly classified by type and activity ?	Landslide inventory maps (and landslide density maps as a by-product)
Proneness or probability of landslide occurrence (of certain type and magnitude) in a given area ?	Landslide susceptibility maps
Probability of occurrence of landslides of certain type and magnitude in a given area within a given period of time ?	Landslide hazard maps
Potential damage or losses caused by landslides to individuals and property ?	Landslide risk maps

Landslide zonation maps: Some remarks (1)

- **Susceptibility maps:** Most methods and models use landslide inventories and terrain or geo-environmental parameters related to landsliding (see “Common Elements” in the Proposal for a EU Soil Framework Directive)
 - Qualitative and semi-quantitative methods:
 - Direct mapping (geomorphological): based on air/satellite imagery analysis and field surveys
 - Indirect mapping: based on weighting of parameter maps and classes within maps
 - Maps are difficult to compare (not harmonized), as they are based on expert judgement. Suitable for mapping at various scales
 - Quantitative methods/models:
 - Statistical (bivariate and multivariate): Combine statistically detailed information on past landslide occurrence and a set of terrain or geo-environmental parameters. Provide relative weighting values for the parameters selected
 - Deterministic: Based on slope stability analysis. Usually require slope, geomechanical and groundwater data, as well as PGA data in seismic areas. Provide mainly safety factors
 - Maps are easier to compare if required input data are available. Statistical methods are suitable for mapping at various scales. Deterministic modelling is mainly suitable for large-scale mapping

Landslide zonation maps: Some remarks (2)

- **Hazard maps:** Need landslide spatial data (inventories), timing/frequency information (ideally historical data of first-time landslide occurrence and reactivations) and terrain or geo-environmental parameter data
 - ➔ Probabilistic models of magnitude-frequency relationships for past landslides are difficult to establish in many areas because of lack of suitable historical data (e.g. landslide frequency records, cause-effect relationships, magnitude of events, etc)
- **Risk maps:** Need information on
 - Landslide hazard (landslide hazard maps)
 - Elements at risk (“exposure”): their amount and value
 - Vulnerability: degree of loss

Risk can be evaluated either qualitatively or quantitatively, as well as separately for individuals and property

 - ➔ Quantitative risk assessment (QRA) requires collecting comprehensive data that may not be available in many areas
- **Other zonation maps**
 - **Density maps:** Based on landslide inventories. Use expert-selected mapping units
 - ➔ Maps do not show where landslides may occur in the future

Harmonized mapping and map content issues

- Common terrain or geo-environmental parameters/factors (“common elements” or criteria)
 - Common mapping approaches/methods/models
 - Common representation scale(s)
 - Common mapping units, etc.
 - Zonation representation: Susceptibility/hazard/risk numerical index vs. descriptive classes (number and colours)
 - Possible inclusion of (major) landslide bodies as polygons, lines or point features (depending on the scale) within the zonation map
 - Landslide types depicted (classification)
 - Common nomenclature (do we need a simple and updated glossary?)
 - Basic common symbology
 - Etc...
- Geodiversity and differences in climatic and seismic conditions and data availability both between and within Member States must be born in mind for harmonized mapping methods and map content

Common elements or criteria for the identification of areas at risk of landslides, as included in the EC Proposal for a Soil Framework Directive (22.9.2006)

- Soil typological unit (STU) (soil type)
- Occurrence/density of existing landslides
- Bedrock
- Topography
- Land cover
- Land use (including land management, farming systems and forestry)
- Climate
- Seismic

Review:

- Which elements are more relevant? Which ones are less relevant?
- Should new elements be included? Should some elements be excluded?
- Should some elements be redefined?

Landslide mapping scale(s)

Various possibilities

Unique scale across Europe versus two scales:

- Common medium to small scale for nation-wide mapping (i.e. smaller or much smaller than 1:50,000, e.g. 1:1,000,000)
 - Consider “Tier 1” approach (see Günther’s)
- Common medium to large scale (e.g. equal or larger than 1:25,000) for either/and:
 - High landslide density areas, selected on the basis e.g. of major landslide-prone geological units, or small catchments or municipalities
 - Potential risk areas, based e.g. on population density and concentration of major/critical infrastructure and industrial installations
 - “Tier 2” areas identified by the “Tier 1” approach (see Reichenbach’s)

Landslide classification

Various possibilities based on:

<p>Movement type and main material involved (e.g. from Varnes, Cruden & Varnes, Brunsten, Hutchinson, Dikau et al.)</p>	<p>Ideal but complex. Evidence not always clear without in-depth investigations. Compatibility problems between many existing maps. More appropriate for medium to large scale inventories and zonation maps</p>
<p>Main type of movement (e.g. slides, flows, falls, complex), with or without specifying main material involved</p>	<p>Somehow simplistic but practical at small scales (e.g. administrative region or nation-wide)</p>
<p>Depth of sliding surface (e.g. shallow vs. deep seated landslides)</p>	<p>Imprecise determination in some quick surveys. Suitable for very small scales (e.g. nation-wide)</p>
<p>According to speed (e.g. fast vs. slow moving landslides)</p>	<p>Subjective limit, difficult to determine for many old landslides. Suitable mainly for early warning and civil protection purposes</p>
<p>According to the state of activity (e.g. active, dormant and relict, or active and inactive)</p>	<p>Suitable but sometimes difficult to determine without in-depth investigations (e.g. historical records, remote sensing and instrumentation techniques)</p>
<p>Combination of several of the above-mentioned criteria</p>	<p>Suitable but some redundancy could be expected depending on the combined classification criteria selected</p>

Data formats and accessibility issues

- Use of common data exchange formats for integration of new maps at European level (likely under the coordination of JRC)
 - Consideration of open source map formats versus “de facto” commercial standards (e.g. ESRI’s)
 - Will integration of currently available landslide databases in Member States be feasible? (issue not so relevant for databases dealing only with inventories)
 - Spatial data integration with those of other soil threats included in the Proposal for a EU Soil Framework Directive
- Use of common metadata standard
- Data accessibility
 - Preferably web-based
 - Public or restricted? Is it worth to be considered by a scientific working group?
- Compliance with the INSPIRE Directive

The JRC way forward

Main objective

- To provide scientific and technical support to the European Commission's DG Environment and other relevant Services (e.g. DG Research and others) on landslide related issues concerning the EU Soil Thematic Strategy and the related Proposal for a Framework Directive

Main initial activities envisaged

- To create, coordinate and actively contribute to a European landslide working group to help meeting the above-mentioned objectives, through collaborative discussions and research
- To provide the Commission with information on landslide mapping and monitoring concepts and approaches as well as on landslide databases available in Europe (report in progress)
- To carry out a comprehensive survey of landslide spatial and alphanumeric databases available in Member States and in Candidate Countries
- To build partnerships with international and national organizations and research groups dealing with landslides

European Landslides Working Group

Proposed objectives

- Provide scientific and technical advice and assistance to JRC on its landslide-related scientific and scientific activities in support to EU policy making, with main focus on the EU Soil Thematic Strategy, through collaborative discussions and research
- Liaise and build partnerships with other international organizations and associations dealing with landslide hazards (e.g. EuroGeoSurveys, ESA, ICL, CERG, UNESCO, UN-ISDR, IUGS, IAEG, IAG, EFG...)
- Promote and participate in international initiatives and research projects regarding mainly landslide prevention and mitigation and geospatial information systems jointly with other partners
- Produce or contribute to the Commission or other international landslide reference reports, articles in scientific journals and conference papers. Possible organization of specific sessions in major conferences

European Landslides Working Group

Membership and operation (1)

- Membership should combine expertise and different views from geological surveys, research organizations and universities
- Membership is open to landslide experts
- Initial membership will include a small number of members from the above-mentioned organisations, while being extensible to additional and/or temporary members in order to cater for specific activities upon request from Commission services, including also JRC, as well as from international and working group members' organizations
- Membership should be compatible with that of other working groups
- Work duplication with that of other committees or working groups should be avoided. Coordination with them should thus be pursued when necessary

European Landslides Working Group

Membership and operation (2)

JRC material support

- Provide financial support for travelling and lodging to group members participating in major meetings of the group, either at JRC or at a member's organisation or an international conference venue
- Create and maintain a dedicated section for the group activities and reporting within the JRC soils website (<http://eusoils.jrc.it>), with links to members' organization websites and/or personal pages
- Produce and distribute limited paper editions of the group reports
- Create a mailing list for communication between group members
- Possible additional financial support to the group operation from JRC or other organizations will be investigated