7.12 Natural risk zones

Definition:

(INSPIRE, 2007) Vulnerable areas characterised according to natural hazards (all atmospheric, hydrologic, seismic, volcanic and wildfire phenomena that, because of their location, severity, and frequency, have the potential to seriously affect society), e.g. floods, landslides and subsidence, avalanches, forest fires, earthquakes, volcanic eruptions.

Description:

"Natural risk zones" are zones where natural hazards areas intersect with highly populated areas and/or areas of particular environmental/ cultural/ economic value. Risk in this context is defined as: risk = hazard x probability of its occurrence x vulnerability of the exposed populations and of the environmental, cultural and economic assets in the zone considered.

Natural hazards are natural processes or phenomena occurring in the biosphere that may constitute a damaging event. Natural hazards can be classified by origin namely: geological, hydrometeorological or biological. Hazardous events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing. An international definition on hazard is relevant in defining the theme. The internationally agreed terminology on disasters should be adopted in this document (UNISDR): Hazards is defined as a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.

Geological hazards are natural earth processes or phenomena that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Geological hazard includes internal earth processes or tectonic origin, such as earthquakes, geological fault activity, tsunamis, volcanic activity and emissions as well as external processes such as mass movements: landslides, rockslides, rock falls or avalanches, surfaces collapses, expansive soils and debris or mud flows. Geological hazards can be single, sequential or combined in their origin and effects.

Hydrometeorological hazards are natural processes or phenomena of atmospheric, hydrological or oceanographic nature, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hydrometeorological hazards include: floods, debris and mud floods; tropical cyclones, storm surges, thunder/hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wildland fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches. Hydrometeorological hazards can be single, sequential or combined in their origin and effects.

Many of the hazards are sudden in their nature. However, several categories of natural hazards with major impacts on civil security and on environmental/ cultural and economic assets are not sudden in nature. They may be permanent phenomena going unnoticed (e.g..: radon gas emanations, deficit or excess of elements in soils and water), or slow phenomena (slow ground motion). Technological hazards are commonly sudden failure of a construction or a process causing significant damage. Natural hazards have the potential to precipitate technological hazards. Usually continuous processes like pollution/emission is not classified as hazards. However, repeated emissions might be called hazards, e.g. large scale chemical, radiation or oil spills. Continuous pollution and other environmental problems may have an adverse effect also on the size and frequency of some kinds of natural hazards.

Knowledge about "Natural hazards areas" is important in the identification and delineation of risk zones. The natural hazards areas may reflect all atmospheric, meteorological, hydrologic, geological and wildfire phenomena that, because of their location, severity, and frequency, have the potential to seriously affect society, e.g. floods, landslides and subsidence, avalanches, forest fires, earthquakes, volcanic eruptions, shrinking and swelling soils, radon gas emanations, deficit or excess of trace elements in soils or water. Data and services are probably needed for both risk assessment and emergency situations Special warning services may be relevant.

Underneath is given examples of some important natural hazards, with information on occurrence: location and frequency and with some information on the datasets, coverage etc.

Areas prone to flooding by inland waters and lakes:
Areas flooded due to exceptional raise of water table in groundwater, rivers and lakes, affecting adjacent land or areas further away being at the same altitude or lower than the flooding water. Affecting housing and industrial sites, agricultural land, transport network, sewage systems, dams etc: Occurrence: Flat river plains, delta areas, valley bottoms and shorelines.

- Physical mapping of areas susceptible to flooding, line for highest recorded level, also division into zones with different susceptibility classes. Data needs: detailed elevation model and measurements in the field
- Areas with certain regulations/ restrictions for different land use/ resource use linked to flooding risk.
- Constructions for flood control
- Data set on restriction zones on land use/ building/ activities downstream reservoirs in case of reservoir brake-down
- Drainage capacity of ground and soil sealing areas with low drainage capacity

Areas prone to flooding by spring tide/ exceptional sea level rise

Areas prone to flooding due to exceptional raise of water table the sea and backwaters, affecting adjacent land or areas further away being at the same altitude or lower than the flooding water. Affecting housing and industrial sites, agricultural land, transport network, sewage systems, dams etc Occurrence: Flat coastal areas, areas lower than original sea level. Commonly harbours, trade areas etc.

Frequency: Floods, as storms, are among the most common natural disasters in Europe – with the effect of being of the most costly in terms of economy and insurance.

- Physical mapping of areas susceptible to flooding, line for highest recorded level, also division into zones with different susceptibility classes. Data needs: detailed elevation model and/or measurements in the field.
  - measures by radar satellites or air born equipment to measure water level
  - field measurement
- Constructions for flood control
- Areas with certain regulations/ restrictions for different land use/ resource use linked to flooding risk.

Earthquakes

Earthquakes are widespread in the EU and other European Countries. The most destructive events have occurred in the Mediterranean countries, particularly Greece and Italy, which are in the collision zone between the Eurasian and African crustal plates. Through the last three decades several thousand persons have died and injured, several hundred thousand became homeless in events in Greece and Italy. Data needed for getting overview and handling the hazard:

- date and time of occurence; - epicenter location, depth, with a liability index - Magnitude and type of magnitude used - Observations (local intensity (MSK 1964 standard) with a liability index) - Triggered effects - Fault
- Data needed for emergency/ rescue operations

Volcano eruptions:

A few active volcanoes exist in the EU and other European Countries. The activity is low and generally the threats are minimal compared to other natural hazards. Some destructive events have occurred in the Mediterranean countries, such as Italy over the past decades. Actions are usually coped with at the local level.

- It is difficult to outline important spatial data sets linked to volcano activities. There might exist maps on expected lava flow channels and restriction areas for certain activities.

Mud slides, land slides and quick (saline leached) clay soils slides:

- clay rich shrinking and swelling soils
- areas of unstable terrain, slide area divided into zones of different susceptibility classes
- borehole locations with further information on the salt content etc
- affected area if area is subject to slumping and landslip
- Areas with activity restrictions – which kinds of operations are allowed in order to prevent slides and which areas are not to be built on. Different countries have different threshold levels e.g. concerning slope degree on land used for buildings, the values depending on the ground condition (soil, clay, bedrock)

Areas prone to mountain blocks slides and stone slides:

Occurrence: Mountain block slides mostly in alpine environment with "young landscapes" where frost and water erosion is active, stone slides areas with steep slopes and loose material. Problems occur where land use includes settlements, infrastructure etc.

- Physical mapping of areas susceptible to land block slides divided into zones with different susceptibility classes. Based on mapping of bedrock structures.
- Physical mapping of areas susceptible to stone slides divided into zones with different susceptibility classes. Further info on kind of material. A rough assessment can be based on analysis of slope angle, slope length and rock stability.
- Anticipated affected areas followed by a land block slide; the stone masses themselves and following flooded areas.
- Areas with certain regulations/ restrictions for different land use/ resource use linked to land block slide risk and stone slide risk.
- Constructions for directing stone slides

Areas prone to snow slides - avalanches:

Occurrence: In areas with significant snow cover combined with steep slopes. Wind will affect the creation of snowdrifts.

- Physical mapping of areas susceptible to snow slides divided into zones with different susceptibility classes
- Areas with certain regulations/ restrictions for different land use/ resource use linked to snow slide risk.
- Constructions for directing slides

Areas susceptible to forest, bush and grassland fires

Areas susceptible to forest, bush and grassland fires can be analysed by using

- Satellite images
- Vegetation cover, composition and strata
- Elevation data
- Meteorological data, Precipitation, temperature, winds,

Areas of installations prone to storms/ wind damage

Occurrence: Unclear picture; seas, coastal areas and narrow valleys, but also other areas within the continent. In addition storms, as floods, are among the most common natural disasters in Europe – thus also being the most costly in terms of economy and insurance.

- Data sets. Areas with recorded extreme wind

Coastal erosion

Coastal erosion is an important and costly category of natural hazard of growing significance in a climate change context

Radon areas

Natural radiation from bedrocks and unconsolidated rocks are considered as natural risk zones due to a possible high radon concentration in indoor air.

Scope, use examples:

Recent local and trans-national disasters have demonstrated to the European Commission and the Member States of the European Union that data and services about natural hazards and risk zones are of paramount importance of efficient risk management. Every year European citizens experience the negative consequences of natural disasters caused by flooding, forest fires etc. This was one of the reasons why "Safety of the Citizen" has been selected as one of the main topics for future EU research and development activities within the JRC during the Fifth Framework Program. The enhanced 'risk and hazard' monitoring and coordination responsibilities of EU services Environment DG and Research DG underpin this trend. In addition European policies covering different thematic domains, planned or already in place are directly linked to Natural Hazards problems e.g. Agriculture and Forestry domain - Agriculture DG, Spatial planning domain - Regional Policy DG. Concerning technological hazards, the Seveso Directive is of major importance in regulating management of risk.

It is an aim to minimise risks by making the society more resistant to hazards, either by minimising threats or by regulation of land use and production activities susceptible to the hazards. Some areas are more prone to natural hazards than others. It is important to identify these areas and build up regulations for long term land and production management. Maps, spatial databases and online spatial services are being used actively to carry out such management. Risk analysis is the basis for all work on planning and living with natural and technological hazards. All areas may in some way or other be affected by natural hazards, and areas with certain kinds of human activity may be hit by technological hazards.

The different kinds of users for handling hazards may be grouped into four:

- reporting, trends and overall policy development , commonly at national and international level
- assessment of natural and technological risks – mapping of areas prone to be hit by hazards
- planning phase for securing public safety- long term regulation and management of land and activities
- disaster response and emergency operations

In order to perform these activities certain kinds of data and services are needed. It is essential with a well organised supply system. The different kinds of data and services to be used and handled in these kinds of actions can be

- satellite images and air photographs as orthophotos
- vector data sets with polygons and lines
- simple point information tables
- address information system handled in GIS data bases
- online and web services of different kinds offered to specific user communities or the public, from organisations such as meteorological or hydrological offices.

The issues will be further elaborated below.

Four different forms of usage are identified below, including an outline of their spatial data needs. Based on the data, different kinds of services may be developed and used.

- **Reporting, indicators, trends, overall policy development:** The needs for spatial data by this use is limited. Usually one will need reporting units such as countries, NUTS regions, or catchment areas. There will be some use of generalised versions of data sets to be used under the other use categories. Overall trends in frequency of natural hazards is for some of the phenomena linked to the environmental situation – climate change in particular and land cover changes in particular. Data needed for analysing links and dependencies are needed.
- **Susceptibility analysis, mapping and prediction:** Data sets describing and analysing the natural phenomena causing hazards, commonly detailed data with high accuracy is needed, such as measuring stations, detailed thematic mapping through fieldwork (e.g. specific aspects of soil and land cover) , air photo interpretation or remote sensing, analysis of detailed elevation models, water flow data linked to the river and lake network, meteorological and climate data, seismic activity mapping etc. Work is seen to be carried out by both local authorities, national mapping agencies, national thematic agencies or international organisations.
- **Physical and sector disaster-prevention planning:** Making disaster-resistant communities by long term physical and sector planning, usually carried out at local and regional level. The mapping carries of by thematic agencies as described over will is used and transformed into simplified data sets and planning documents showing areas of high risk and restriction zones at or around high risk areas. The delimitation of the restriction zones would need population data, land use plans etc.
- **Emergency operations/disaster response:** The emergency operations for both natural and technological hazards needs more or less the same kinds of data. In order to make emergency management a faster and more accurate means to reduce effects, data are needed in several parts of the operation;
    - Monitoring; continuous or real time situation reports, giving information on trends, direction etc. Using GNSS linked to detailed topographic map data,
    - Overview and identification of qualities at land and sea; persons, property, production activities, infrastructure and environmental qualities that can be affected by the hazard/ disaster. It is essential to access the extensiveness of the anticipated damage caused by natural and technological hazards. There is a need to know about population information at the lowest possible level, property information making it possible to identify owners of individual properties, address register for information purposes and identification, mapping of areas/ infrastructure affected, such as roads, rail, telecommunication lines, water, gas pipe lines, oil installation at sea, storage areas for hazardous substances, resources such as important groundwater bodies, other extraction points for water or other resources, land use, location of high value environmental areas (biodiversity, recreation, cultural heritage sites etc)
    - Location of resources needed to perform the operation; Infrastructure, road and rail capacity, water supply points, depot for emergency equipment (oil spill extraction boats, vehicles etc) location and capacity of hospitals, information to see vehicle information on location, allocating resources, deploying personnel. Included here is also the administrative boundaries for responsibility areas of different bodies involved in the operation.

Links and overlaps with other themes:

The broad field of natural risks may link and overlap may other themes, mostly concerning physical environment; Land use (land use plans may reflect risk zones), Elevation, Hydrography, Land cover, Geology, Environmental protection facilities, Meteorological geographical features, Oceanographic geographical features.

Reference documents:

Balestro, Gianni; Piana, Fabrizio: GIS technology as tool to bring out the role of geological interpretation in the assessment of geological hazard

CNIG: Annexe 5 – Liste des données géographiques de référence en domaine littoral (France)

Glade, Thomas; Malcom Anderson and Michael J. Crozier (editors): Landslide Hazard and Risk

http://nedies.jrc.it/
http://www.eu-medin.org/
http://reports.eea.europa.eu/environmental_issue_report_2004_35/en/
http://reports.eea.europa.eu/environmental_assessment_report_2003_10/en/kiev_chapt_10.pdf
http://ioc.unesco.org/igospartners/Geohazards.htm
http://www.jcomm.info/
http://www.tsunamiwave.info/
http://www.geohazards.no/
http://geohazards.cr.usgs.gov/
http://www.ngu.no/kart/skrednett/?lang=English

IGOS Geohazards Theme report, 2004;(with the support of the European Space Agency) - Terminology: Basic terms of disaster risk reduction developed by the UN International Strategy for Disaster Reduction, available here: http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm

Norwegian feature catalogue. definitions and UML application schema e.g. for landslide: http://www.statkart.no/sosi/UMLfullmodell/Skred/Skred.htm.

Oosterom, Peter van; Siyka Zlatanova and Elfriede M. Fendel (editors): Geo-information for Disaster Management

POSITION COMMUNE (CE) No 33/2006 arrêtée par le Conseil le 23 novembre 2006, Chapitre III art.6

Schmidt-Thomè, P (2006): Natural and Technological Hazards and Risks Affecting the Spatial Development of European Regions. Geological Survey of Finland, Special Paper 42. (Espoo), p. 167, fig. 35, tab. 56, maps 22