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Enabling Access to Geological Information in Support of GMES

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CHANGE RECORD

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1 INTRODUCTION

This report is deliverable 3.3; ’The Product and Service Specification’ for the PanGeo product. In this report we aim to describe the PanGeo product in full. To accomplish this it is necessary to introduce the PanGeo service and what it aims to achieve. It is also important to describe what the PanGeo service will not attempt to do.

A lists of Towns for which PanGeo information will be made available within the first three years of PanGeo presented. We describe the input data to be used in the creation of the PanGeo information; the PSI data, geological data and ancillary data.

The PanGeo product is fully defined including a description of the product, the geohazard types addressed, how the information will be presented as both attributed GIS polygons and also in a detailed written report. The methodology for the creation of the PanGeo information will be given, although this is subject to change in a later version of this report once trial runs have taken place. It is important for the acceptability of the PanGeo service that data are validated. Validation plans for the PSI data and interpreted ground stability data will therefore be documented. Plans for ensuring the quality and consistency of PanGeo results are also given.

Once the information has been generated it must be disseminated, this section of the report covers the design of the PanGeo portal, its functionality, how the data will appear within the portal and how the data will link to detailed descriptions of the identified ground motions and other datasets such as the Urban Atlas.

1.1 AIMS OF PANGEO

PanGeo is aiming to take a step in developing the 'missing geological link' for GMES by initiating a pan-European geological service which will derive and standardise geohazard information across an initial subset of the Urban Atlas towns across Europe. It is hoped that eventually PanGeo will be fully incorporated into OneGeology Europe.

The objective of PanGeo is to enable free and open access to geohazard information in support of GMES. This will be achieved by the development of a validated Ground Stability Layer for 52 of the towns listed in the GMES Land Theme's Urban Atlas. The datasets will be made discoverable, accessible and useable via the distributed INSPIRE-compliant portal as built and demonstrated by OneGeology Europe (www.onegeology-europe.eu).

The key users of PanGeo are anticipated as:

- Local authority planners and regulators who are concerned with managing development risk
- National geological surveys and geoscience institutes who are obliged to collect geohazard data for public benefit,
- Policy-makers concerned with assessing and comparing European geological risk, much as the Urban Atlas data is used to compare the landcover/use status of European towns.
- The public.

PanGeo information will represent hazard and exposure components that contribute towards any future analysis of risk, thereby adding value to the Urban Atlas data. The integration and interpretation, plus a validation of key features observed, will be made by the corresponding national geological survey for the towns concerned.

1.2 OUTLINE OF THE PANGEO SERVICE

For each PanGeo town, areas of ground instability will be indicated by attributed vector polygons held within the Ground Stability Layer. The polygon will be further supported by a detailed Geohazard Summary document describing the interpretation of the geological reasons for the discovered motions. Users of the PanGeo portal will be able to navigate to the town of interest and upon clicking on a Ground Stability Polygon the Geohazard Summary information associated with that polygon will be presented. The Ground Stability Layer and Urban Atlas information will be presented in the portal in such a way that users can make informed decisions about which land use classes in their towns are affected by ground stability issues.

52 PanGeo products will be made in the first instance, 2 by each of the 27 EU national geological surveys except for Cyprus and Luxemburg who will only produce 1. The work will involve integrating and interpreting:

- Satellite Persistent Scatterer InSAR processing, providing measurements of terrain-motion.
- Geological and geohazard information already held by national Geological Surveys.
- The landcover and landuse data contained within the GMES Land Theme's Urban Atlas.

1.2.1 What PanGeo will do

PanGeo will identify areas of ground instability, interpret a reason for this instability and then relate the area of instability to the land cover classes in the Urban Atlas.

PanGeo is concerned with Geohazards and will therefore primarily address ground instability issues rather than issues associated with structures built on the ground. These geotechnical and engineering issues can be addressed if the survey feels they have the information required to address them, but they are not the focus of PanGeo.

Areas of ground instability will be identified using a combination of input datasets including existing geological data and PSI data. The PanGeo interpretation is not based on PSI data alone. The PanGeo mapping scale aims to be 1:10 000.

Areas of ground instability will be recorded as a polygon, polygons will be attributed in an INSPIRE compliant manner. Each polygon will be interpreted to provide a reason for the instability; this reason will be the geohazard.

The polygon attributes will be used in the portal to provide a summary of the geohazard, more detailed information will be given in the Geohazard Summary. The Geohazard Summary will be linked to the polygon via the attributes.

Geohazards which are identified will fall into two categories: observed and potential geohazards. Observed geohazards are those which are proven and have resulted in ground instability that has been measured. Potential geohazard areas are those which the geologist has identified as having the potential for ground instability. Areas identified as observed and potential will be clearly distinguished by the attributes.

The interpretation of each ground stability polygon will be assigned a measure of confidence within the polygon attributes and geohazard summary. This measure of confidence will be on a simple three-level scale of Low, medium and high depending on the number of datasets used in the interpretation and the confidence that the geologist feels is appropriate.

1.2.2 What PanGeo will not do

PanGeo is concerned with providing access to ground stability information; as such it is important to recognise what PanGeo will not do:

- Will not focus on geotechnical issues, or motions relating to the structure of buildings.
- Will not be producing polygons on Risk Zones (INSPIRE terminology) and therefore will not be providing an assessment of risk level.
- will not try to predict how much damage will arise from a motion
- will not comment on the severity of the motion
- Will not comment on the likelihood of occurrence – i.e. the chance of the hazard occurring
- Will not produce hazard coverage, vulnerability coverage or risk coverage (INSPIRE)

2 TOWNS TO BE PROCESSED

Count	Partner #	Survey	LUZ 1	LUZ 2
1	14	Austria	**Saltzburg**	**Vienna**
2	15	Belgium	**Brussels**	**Liege**
3	16	Bulgaria	**Sofia**	**Varna**
4	17	Cyprus	**Lefkosia**	N/A
5	18	Czech Republic	**Prague**	**Ostrava**
6	19	Denmark	**Copenhagen**	**Aalborg**
7	20	Estonia	**Tallinn**	**Tartu**
8	21	Finland	**Helsinki**	**Turku**
9	5	France	**Lyon**	**Toulouse**
10	22	Germany	**Berlin**	**Hannover**
11	23	Greece	**Athens**	**Larissa**
12	24	Hungary	**Budapest**	**Miskolc**
13	25	Ireland	**Cork**	**Dublin**
14	26	Italy	**Palermo**	**Rome**
15	27	Latvia	**Riga**	**Liepaja**
16	28	Lithuania	**Vilnius**	**Kaunas**
17	29	Luxembourg	**Luxembourg**	N/A
18	30	Malta	**Valetta**	**Gozo**
19	4	Netherlands	**Amsterdam**	**Rotterdam**
20	31	Poland	**Warsaw**	**Nowy Sacz**
21	32	Portugal	**Lisbon**	**Faro**
22	33	Romania	**Bucurest**	**Cluj-Napoca**
23	34	Slovakia	**Kosice**	**Presov**
24	35	Slovenia	**Ljubljana**	**Maribor**
25	36	Spain	**Zaragoza**	**Murcia**
26	37	Sweden	**Stockholm**	**Göteborg**
27	2	UK	**Stoke**	**London**

Existing Terrafirma results

Table 1: ***Confirmed towns for PanGeo processing. Green cells from Terrafirma. White cells indicate new PSI processing***

3 INPUT DATASETS

3.1 PANGEO COMPONENT PACK

The PanGeo Component Pack is the collection of information, supplied by the PanGeo project that the geological surveys will receive to produce the PanGeo Ground Stability Layer and Geohazard Summary. It does not include the geological data or ancillary data.

The contents of the PanGeo Production pack are as follows:

1. *The PSI Dataset*. The GS will receive three database files (.dbf) within the PSI Dataset:
    a. Average annual displacement rates

   b. Full PSI time series
   c. Reference point

Two types of PSI Datasets will be delivered depending on when the town was processed:

   a. Those emanating from the 25 new processes in PanGeo. These packs will contain the PSI results as per the Terrafirma S5 dossier. They will, where possible, include PSI datasets resulting from both ascending and descending radar data stacks.
      - PSI Dataset: average annual displacement rates, full PSI time series and reference point.
   b. The 27 PSI Datasets emanating from Terrafirma include:
      - PSI Dataset: average annual displacement rates, full PSI time series and reference point.
      - Terrafirma Service Level Agreement (SLA) deliverables: Processing Reports, Product Acceptance Reports, Exploitation Reports, Utility Reports, Interpretation report and PowerPoint.

2. *A background image*.
3. *The PSI Processing Report* (metadata).
4. *A QA sign-off*.
5. *The production Manual*. The GS will generate the PanGeo products, the “Ground Stability Layer” (GSL) and the “Geohazard Summary”, according to the Production Manual.
6. *A Geohazard Summary template*.
7. *A Ground Stability Layer shapefile template*.
8. *A link to the Urban Atlas dataset*.
9. *Terrafirma User Guide*. A document which provided much useful information about the strengths weaknesses and applications of PSI.

3.2 DESCRIPTION OF PSI DATA USED FOR THE INTERPRETATION

To be completed upon delivery of the “PSI Processing Report”

3.3 DESCRIPTION OF GEOLOGICAL DATA USED FOR THE INTERPRETATION

Geological data will be essential to enable the geological survey to both interpret ground motions discovered on the PSI data but also to identify ground motions which might not appear on the PSI dataset.

The following is a list of data you might load in to the GIS.

- Geological map: bedrock at rockhead
- Geological map: Superficial deposits type and age
- Geological map: Superficial deposits thickness (especially for Holocene deposits, particularly peat)
- Artificially modified ground (mainly worked ground, made ground or infilled ground); with thickness, if data are available
- Mass movement deposits (especially landslide deposits)
- Maps of known or suspected local geohazards, such as landslides, running sand, shrink-swell clay, compressible ground, etc.
- Geological structure
- Geological maps: subcrops and structure contours at major unconformities
- Geological models (three-dimensional)
- Geophysical maps: Bouguer anomaly, stripped to basement or other significant unconformities
- Aeromagnetic map (may be of limited extent or utility in urban areas)
- Topography (especially as a proxy for geological structure)
- Land-use, current and historical
- Location of major infrastructure projects, especially those involving tunnelling, for the period of PSI data acquisition and for about 10 years previously. Small high-amplitude domains in urban areas are likely to be caused by tunnelling or other subterranean engineering works. Research (for example in local government records) may be required to determine possible candidates for the cause of such domains.
- Subsurface utilities, particularly those in large-diameter conduits, or prone to leakage.
- Mining, including commodity, date, depth, mining method, target horizon
- Geotechnical databases/records of the properties of a rock formation or sediments
- Fieldwork data, especially field work carried out in light of the PSI data interpretation.
- Location of boreholes and borehole data
- Groundwater level in main aquifers.Changes in groundwater level in main aquifers during the period of PSI data acquisition. Care should be taken to avoid the effects of season by comparing groundwater levels from the same time of year, preferably during the winter.

3.4 DESCRIPTION OF ANCILLARY DATA USED FOR THE INTERPRETATION

These data can be thought of as ancillary data used to provide context to the PSI and geological datasets. In most cases the interpretation of a PSI dataset will be completed in conjunction with location based data. This most commonly takes the form of topographical mapping but might also be remotely sensed imagery such as aerial photography or high resolution satellite imagery. These data allow the interpreter to understand the location in which they are working and therefore make it easier to make links between datasets.

The origin, type and scale of ancillary data used in the production of the PanGeo information will vary from country to country. As a guide as to what is likely to be used the BGS will use the following:

- Urban Atlas data
- Topographical and landuse maps (Scales of 1:625 000 to 1: 10 000)
- elevation models

- Aerial photography
- Optical imagery
- Radar Imagery
- If correlations are discovered with features for which BGS do not have information, such as a new building then efforts will be made to acquire data about the feature e.g. when the building was built.
- In-situ instrumentation (Levelling benchmark, GPS etc)

Ancillary data might also be used for validation, these issues are addressed in section 5.1 ; validation component.

4 PRODUCT DEFINITION

4.1 PRODUCT DESCRIPTION

The product created by PanGeo is a web-based geoportal based on the One-Geology Europe infrastructure. Within this geoportal is a Ground Stability Layer for each of the 52 towns for which PanGeo information is to be made available (Table 1). The Ground Stability Layer is a collection of polygons representing areas of ground instability within the PanGeo town. These polygons are produced by the geological survey of the county.

Ground Stability polygons are attributed, attributes are complaint with the Natural Risk Zones data specification of INSPIRE. For each PanGeo town a Geohazard Summary document is written by the geological survey. The Geohazard Summary contains the geological interpretation for each Ground Stability Polygon. Clicking on the polygon in the portal displays the corresponding section of the Geohazard Summary thereby providing the user with the interpretation of why ground instability has occurred in that area. The Geohazard Summary is a standalone document and so can be downloaded from the portal. Key Ground Stability Polygons will be validated to ensure that the interpretation is correct.

In the geoportal the Ground Stability Layer will be automatically integrated with the Urban Atlas data. Since the Urban Atlas gives information on land cover types (exposure) and the Ground Stability Layer provides information on hazards the user can make informed decisions on risk. The portal provides the ability to both view and download the Ground Stability Layer and Geohazard Summary.

4.1.1 Definitions

PanGeo Production Pack – PSI data, other Information, templates and manuals sent to the geological survey to allow them to produce the Ground Stability Layer and Geohazard Summary.
PSI Processing Report – A report, written by the PSIPs, detailing the PSI processing
Ground Stability Layer – The polygons created by the geological surveys outlining areas of ground instability
Ground Stability Polygon – a polygon, within the Ground Stability Layer, drawn around an area of ground instability
Geohazard Summary– a summary report, for each PanGeo town, sections linked to each ground stability polygon provide the geological interpretation for the motion.

PanGeo Production Manual – The instructions for how the geological surveys should create the Ground Stability Layer and Geohazard Summary

PanGeo Portal – the INSPIRE compliant web portal through which PanGeo information will be discoverable and available free of charge

Ground stability– stability or instability of the ground and everything that is built on it.

4.2 GEOHAZARD TYPES ADDRESSED

PanGeo is concerned with geohazards which affect the stability of the ground. A list of the geohazards addressed in PanGeo is given below, a full glossary of these geohazards is provided in **Error! Reference source not found.**.

Before specifying the geohazards addressed it is important to define the following terms.

Hazard

Something with the potential to cause harm.

Natural Hazard

A natural hazard is a natural process or phenomenon that may cause loss of life, injury or other impacts, property damage, loss livelihoods and services, social and economic disruption, or environmental damage. (Council of The European Union – Commission Staff Working Paper – Risk Assessment and Mapping Guidelines for Disaster Management).

GeoHazard (Geological hazard)

A geological process with the potential to cause harm.

Risk

The likelihood that the harm from a particular hazard will be realised.

4.2.1 Types of Geohazard

- Earthquake (seismic hazard)
- Tectonic movements
- Salt tectonics
- Volcanic hazard

Natural Ground Instability

- Landslide
- Soil Creep
- Ground Dissolution
- Collapsible Ground
- Running Sand

Man Made (Anthropogenic) Ground Instability

- Made ground

Natural ground Movement
- Shrink-swell clays
- Compressible Ground

Man Made (Anthropogenic) Ground Movement
- Fluid extraction
- Recovery of extracted fluid
- Injection of fluid or gas.

4.3 GROUND STABILITY LAYER POLYGON PROPERTIES

PanGeo polygons must be topologically correct. They must meet the following criteria:
- Polygons have a projection specified
- Polygons are complete - the line joins back to itself
- Adjacent polygons share the same boundary

4.4 GROUND STABILITY LAYER POLYGON ATTRIBUTES (PANGEO DATA MODEL)

PanGeo is to be INSPIRE compliant, therefore the PanGeo data model has been designed in consultation with INSPIRE Annex III; Natural risk Zones.

4.4.1 INSPIRE Annex III Natural risk zones

Definition: (INSPIRE, 2007) Vulnerable areas characterized 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.

4.4.2 High level architecture of PanGeo:

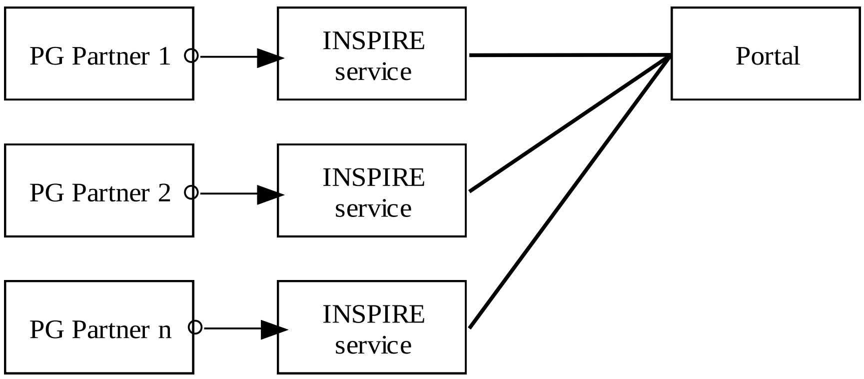


Figure 1. High level design INSPIRE (Metadata and WFS services)

The geological surveys will receive information about the following:

Spatial data content:

- Enable the geological surveys to provide their data according to the PanGeo object model through OGC compliant webservices
- Provide list (WebMapContext) of external services and/or datasets relevant to the portal
- Implement the WFS services

Metadata:

- Provide metadata for the EGS datasets (ISO19115) and services (ISO19119)
- Provide metadata for the external datasets and services
- Implement the central CSW service

A more detailed schema can be seen in Figure 2. Each geological survey will create a download server and the PanGeo Central System combines all the download services and provide these to the portal.

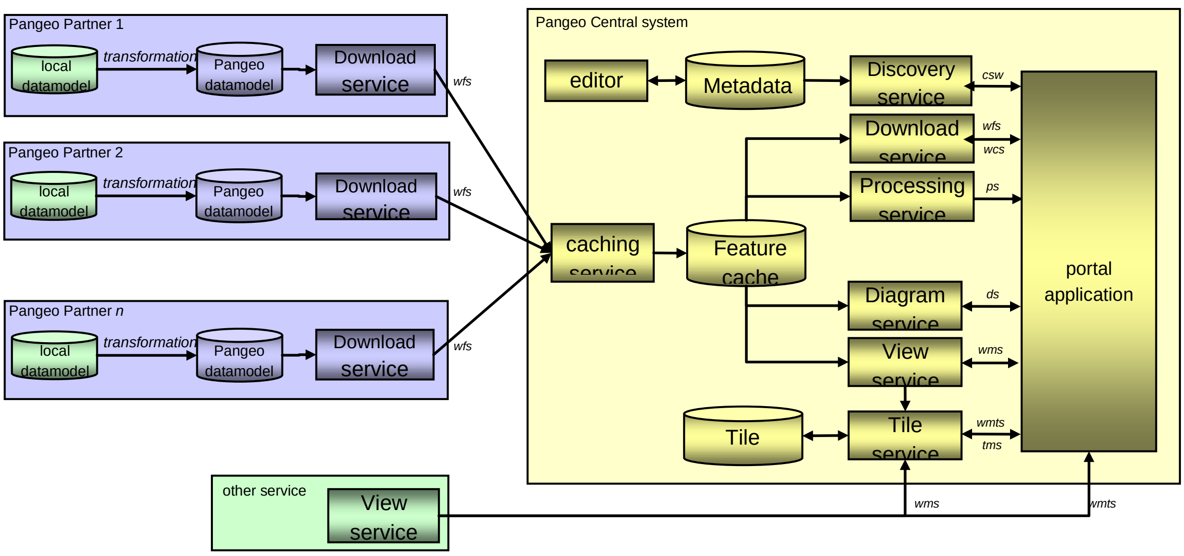


Figure 2: detailed design of the Pangeo service, including download and portal functionality

4.4.3 Database design

The following steps can be identified for creating a data model and a mapping to the INSPIRE Natural Risk Zones specification.

1. Identify the attributes needed for visualization on the portal
2. Mapping of the data model that meets the INSPIRE Natural Risk Zones specifications; this will result in a more simple UML design for implementing PanGeo.
3. Design a data model.

Only a limited set of table attributes is required for visualization on the portal.

1) User requirement data to the portal

1. Identification of a polygon
2. Polygon to be drawn
3. Category of the geohazard
4. Comment: short description
5. Link to a document that describes the geohazard

2) Inspire specification mapping:

Attribute: inspireid (HazardArea.inspireid)

Value type:

Definition: unique name that meets the INSPIRE specifications

Attribute: identification (ObservedHazard.nameOfEvent)

Value type: CharacterString

Definition: common name of the observed hazard

Attribute: geometry (RiskHazardGeometry.geometry)

Value type: GM_Object

Definition: Geometric representation of spatial extent covered by the hazard area

Attribute: category (NaturalRiskOfHazardClassification.HazardCatagoryValue)

Value type: <<codeList>>

Definition: A generic classification of types of natural risks or hazards

Attribute: Comment (separately modeled)

Value type: CharacterString

Definition: text that gives additional information

Attribute: Link (separately modeled)

Value type: CharacterString

Definition: A URL that enables to locate and get the reference document

3) Specification GeoHazard Table (Oracle specific)

Attribute: geohazard_dbk

Value type: bigdecimal

Definition: identifier that makes the element unique

Attribute: geohazard_id

Value type: Varchar(40)

Definition: logical name

Atrribute: inspireId

Value type: Varchar(20)

Definition: unique name that meets the INSPIRE specifications

Attribute: geohazard_geohazardGeometry

Value type: spatial attribute (SDO or SDE)

Definition: geometric representation of the exposed element.

Attribute: geohazard_Category_ref (should be a reference table)

Value type: <codelist>

1_biological
1_1_Epidemic
1_2_InsectInfestation
1_3_AnimalStampede
2_geophysical
2_1_Earthquake
2_2_Volcano
2_3_DryMassMovement
3_hydrological
3_1_Flood
3_2_WetMassMovement
4_meteorological
4_1_Storm
5_climatological
5_1_ExtremeTemperature
5_2_Drought
5_3_Wildfire
6_extraterrestrial
6_1_Meteorite_Asteroid

Definition: a generic classification of types of natural risk or hazards

Attribute: geohazard_Comment

Value type: CLOB

Definition: text that gives additional information

Attribute: geohazard_Link

Value type: Varchar(40) URL (hyperlink)

Definition: A URL that enables to locate and get the reference document

4.5 GEOHAZARD SUMMARY DOCUMENT

A geohazard summary will be produced for each PanGeo town. The geohazard summary is a text document containing information for each PanGeo polygon. Relevant sections of the report link to the polygon in the portal, thereby providing specific information on that particular area of ground motion.

The ground stability report will be written as both a standalone document and a document that can be linked to the PanGeo Ground Stability polygons. There is therefore the requirement to include an introductory section describing the geology of the PanGeo town. It will also be necessary to provide figures to illustrate both the location of the ground stability polygons and the relationship of these to geological datasets. The Geohazard Summary will be a multilingual document; typically it will be available in English and local language.

4.5.1 Content of the Geohazard Summary report

The following outlines the content of the Geohazard Summary. A detailed guide to the content can be found in PanGeo D3.4 Service Template.

4.5.1.1 General sections

These sections of the report give background information about each PanGeo town.

1. Authorship and contact details

The name(s) and contact details for the authors of the Geohazard Summary.

2. Introduction

An overall introduction for each city/town processed, covering the following:

1. The location of the town including maps.
2. A basic introduction to the geology of the area.
3. A summary of the number of areas of ground motion identified along with the main reasons for and styles of ground motions will be given.
4. Brief description of all datasets used during the interpretation.
5. Description of the PSI data used in the interpretation **(to be taken from the PSI report delivered with the data)**

3. Glossary of geohazard types

The glossary of all geohazard types, as in **Error! Reference source not found.**, will be included in each Geohazard Summary.

4.5.1.2 Detailed sections

These sections of the report offer detailed information about the hazards identified during the production of the PanGeo information. **As such they will be repeated for each PanGeo ground stability polygon**.

1. PanGeo polygon ID

The polygon ID (as entered into the polygon attributes) needs to be provided. This will allow the relevant sections of the Geohazard Summary to be linked to the Polygon in the portal.

THIS POLYGON ID MUST BE BOOKMARKED WHEN THE REPORT IS TURNED INTO A PDF. The bookmarked ID forms the link between portal and summary.

2. Type of motion

Uplift or Subsidence

3. Geohazard type

A statement of the type of geohazard interpreted for the polygon. No explanation is required since the details are in the PanGeo Glossary of Geohazards.

4. Observed or Potential motion

Has the motion been observed in a dataset or has it been identified as an area with the potential for motion.

5. Confidence in the interpretation

A confidence rating of Low, medium or high confidence will be assigned to each polygon. This will represent the geologist's confidence in the interpretation. Low confidence might represent a 'hunch' by the geologist, medium confidence assigned to those interpretations based on a single dataset. A high confidence value will be assigned to those polygons where the interpretation is supported by more than one ancillary dataset.

6. Rates of motion

The average rate of motion of the PSI points within the polygon will be given if possible.

7. Range of motion

The range of motion magnitudes will be given (e.g. from -12mm/yr to -2mm/yr), and standard deviation (or distribution) of the motion rates will also be provided if possible.

8. Datasets used to identify the motion

A statement of the dataset that the ground stability area was identified on. This will either be the PSI data or a geological dataset held by the geological survey.

9. General properties of the motion area

This general description will include:

- The location of the ground stability polygon (including figures)
    - Location with respect to geology
    - Location with respect to landuse/topography
- Polygon area in square kilometres
- Places of interest within the influence of the polygon

10. Geological interpretation of the motion

What are the reasons for the identified motion? This section will be detailed and include the geologists interpretation for the motion and the mechanisms that are at play including the relationships between the interpreted ground stability areas and the geological and ancillary datasets.

11. Validation of the motion

Results of the validation of the areas of motion identified in PanGeo will take two forms;

1. Comparison with benchmark datasets
2. Field verification

5 OVERVIEW OF PRODUCT GENERATION PROCEDURE

A detailed methodology for generating the PanGeo products is given in the Service Manual (PanGeo Deliverable D 3.4).

An overview of the steps the geological survey will take to produce the PanGeo deliverables is given below:

1. Geological Survey (GS) receives the PanGeo Component Pack from PSIP
2. Checks content of PanGeo Component Pack
3. Check various aspects of the PSI Dataset as specified in D3.4.
4. Creates a GIS containing PSI, Geological and ancillary data ready for interpretation
5. Identify areas of ground instability either **using the PSI data or existing geological information**
6. Digitise a polygon around the area of motion
7. Identify the reasons for the motion – the geohazard
8. Assign attributes to the polygon
9. Validate the motion and reasons for motion
10. Record relevant information for each polygon in the Geohazard Summary document
11. Prepare deliverables in accordance with INSPIRE

5.1 VALIDATION COMPONENT

Validation*:* In PanGeo validation is applicable to three areas.

1. The terrain-motion measured by PSI.
2. The geological content, format and consistency of the products from the Survey Team which will be made accessible via the PanGeo portal.
3. That the metadata and hosting specification have been applied correctly by the Surveys allowing the harvesting and correct display of product from the main PanGeo portal.

5.1.1 Validation of terrain-motion

Validation of terrain-motion is undertaken using either *a priori* knowledge (e.g. a Surveys own geohazard information which besides basic geology may contain other groundtruth from GPS or levelling campaigns), or going on the ground to have a look. Surveys will validate (using either their own information, or by personal visit) only significant clusters of points indicating the main motion features. Exactly what constitutes the "main motion features" to be validated is to be left to the inherent expertise and judgment of the Surveys personnel, but choices for validation should be prioritized by the exposure and vulnerability content of the corresponding Urban Atlas data, i.e. if there is significant motion in industrialized areas it might be investigated. On the other hand, if there is motion observed over agricultural land, it may be discounted. The validation work undertaken by the Surveys is to be documented in their Geohazard Summaries.

5.1.2 Validation of geological content and format

Validation of geological content and format is to be undertaken by BGS and the results recorded dossier *D3.7: Geological Content Validatio.* This dossier will list and detail the criteria with which Survey output must conform. An understanding of the criteria will develop as the PanGeo Production Manual is developed. Anticipated design and validation criteria include: symbols, legends, scale bars, map grids, colours used, Geohazard Summary format, etc. D3.7 will then act as a 'check list' to enable BGS to validate and accept the input from the geological surveys.

It should be recognised that BGS will not be responsible for validating the geological interpretations of each geological survey. This would be insulting to the survey and BGS do not have the required knowledge to do this. Instead this validation will act as a 'conformance check' to ensure that the deliverables received from each survey meet the criteria specified in D3.7.

5.1.3 Validation of service access

Access to each individual Surveys work, via the PanGeo portal, must be ensured if all the hard work and whole point of the project is not to be wasted. BRGM will be responsible for this aspect of the work by formally following, supporting and documenting the progress of each Survey in reaching the required specifications for successfully hosting their output and making accessible via the main portal. BRGM already have experience in this field by needing to support Surveys in terms of metadata and hosting to make their geological datasets accessible in OneGeology Europe. A new dossier *D4.4.1: Service Access Validation* under *WP04: Service Access* will be initiated by KO+12m, and then maintained as an ongoing and up-to-date record of the progress of each of the 27 Surveys in enabling correct access to their output.

6 PRODUCT DISSEMINATION (PORTAL)

6.1 PRODUCT APPEARANCE

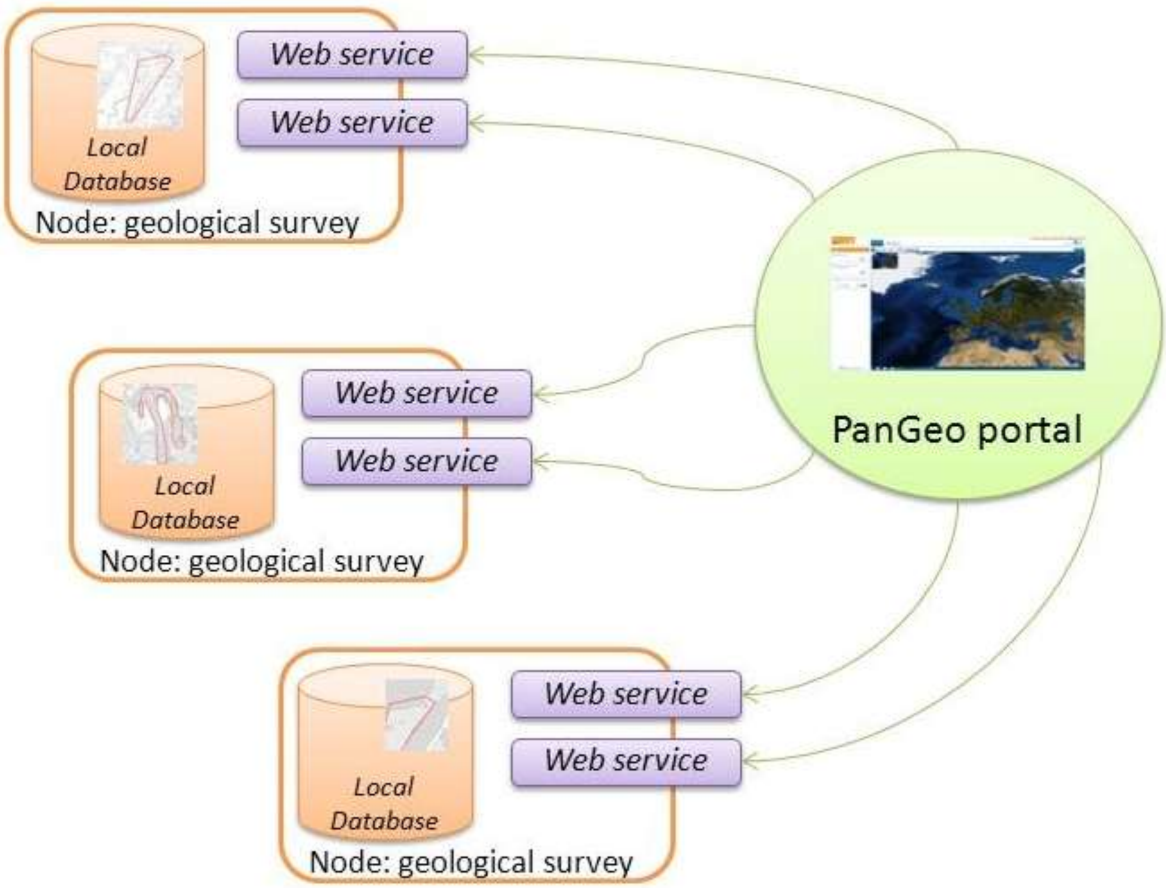
The appearance of the product is driven by what is technically possible. In order to understand what is technically possible a working group consisting of BRGM, LIG, TNO and SIRS will look at the data model, portal, visualisation and integration of the Ground Stability Layer and Urban Atlas.

6.2 DATA SPECIFICATIONS FOR PORTAL

The architecture implemented for the PanGeo project is based on the infrastructure of the OneGeology-Europe project. Main requirements are to follow existing standards (OGC web services) and to be compliant to INSPIRE (view and download services). Three main requirements are handled:

- Standards: the layers shall be implemented according to OGC standard. This will allow the PanGeo layers to be used in any OGC WMS compliant software, such as several GIS tools, and portals.
- INSPIRE: The INSPIRE view service is technically implemented by an OGC WMS 1.3, this specification requires the layers to be implemented accordingly. Other INSPIRE rules (common data model, INSPIRE tags, multilingualism) that are not yet implemented by standard OGC WMS software won't be required this year. Nevertheless, a solution is proposed for the partners willing to implement the INSPIRE approach this year.
- OneGeology-Europe: the infrastructure and Service-Oriented Architecture implemented by the project OneGeology-Europe (1G-E) shall be reused. The specification described here is very similar to the one applied in the 1G-E project.

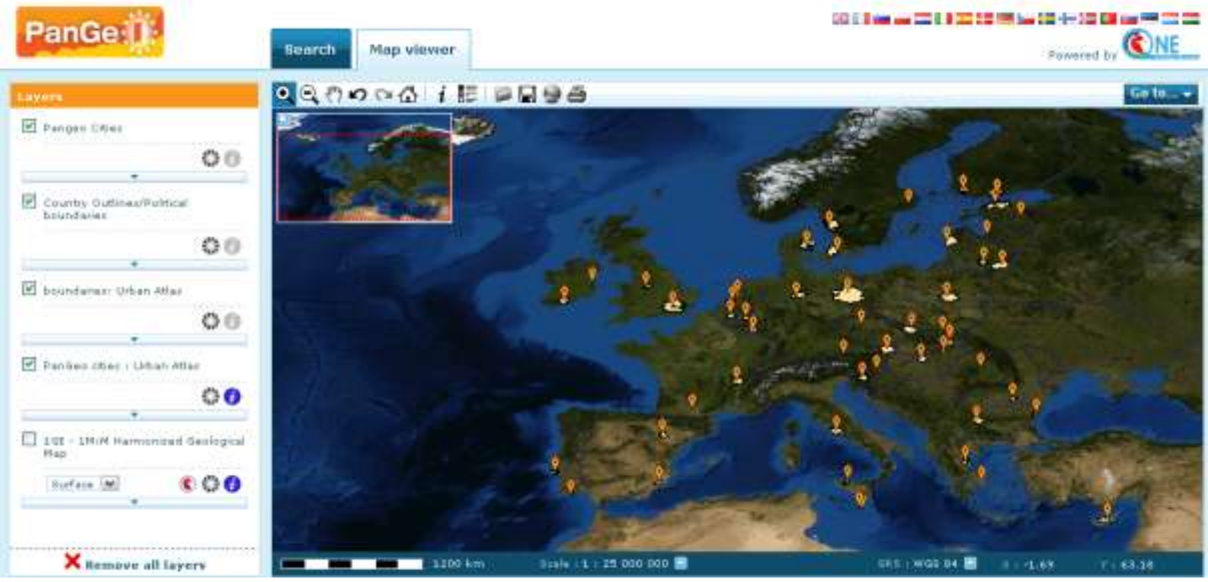
The datasets will be compiled by the geological surveys, and hosted locally on their own servers. This is the basis of a distributed architecture: the PanGeo project is not compiling a central database. A Service-Oriented Architecture (SOA) is a network of web services, allowing each partner to implement and host their own web services delivering their own data. The PanGeo portal then consumes those web services.



More information can be found in WP4 deliverable: **D4.2 PanGeo Metadata and hosting requirement specification.**

6.3 PORTAL APPEARANCE AND FUNCTIONALITY

The first version of the PanGeo portal is based on the OneGeology-Europe portal.



url: http://pangeo.brgm-rec.fr/pangeoportal/viewer.jsp

The PanGEO map viewer always presents:

- The background layer
- The Urban Atlas layer
- The Onegeology-Europe (1M:M) geological map, hidden (a simple click will allow the user to display it)
- Markers on the map, representing the 52 towns. Different colours of markers help the user to know if the dataset is already implemented, or not.
    - A click on a marker opens a window that allows the user to focus on the town and load the corresponding layer, or to open the geohazard summary (if it exists as a standalone document).

The PanGeo portal initially displays the markers for each city handled by the project, together with the boundaries of the cities according to Urban Atlas. It is then possible to zoom in a to city, either by clicking on the marker, or by using the “go to” functionality which also lists the available cities. Then, the detailed Urban Atlas map is displayed, with the PanGeo polygons (when they are already implemented).

Main options like “zoon in, zoom out, print, export to view in Google Earth”, allow the user to view the map and save it (export, print). A “search” tab presents some others dataset coming from other projects: OneGeology-Europe, ProMines, Emodnet.

The portal is available in 18 languages (translations done for the OneGeology-Europe project). More information can be found in **WP4 deliverable: D4.1 PanGeo website specification** (that includes portal specification i.e. appearance and functionality).

6.3.1 Global Statistics

Global statistics for the PanGeo service will be provided on the Portal. These statistics will present information on the types of geohazards across all 52 town, the proportion of all PanGeo coverage affected by geohazards.

These statistics will be automatically computed off-line once we have a harmonized WFS dataset in place (once the GSO's have completed their interpretations). The statistics can then be displayed on the portal and website.

6.4 DESCRIPTION OF URBAN ATLAS

The Urban Atlas is an operational activity offering highly detailed urban land use maps for the 305 most populated towns in Europe (EU 27).
The activity is a European-wide effort funded by European Commission as local component of the GMES initiative (Global Monitoring for Environment and Security).
The first edition of the Urban Atlas, effort started in 2008, should be completed by mid 2011 when all selected European towns would be mapped. All EU capitals are included in the effort plus a large sample of large and medium-sized cities participating in the European Urban Audit.

The main goals of Urban Atlas should be helping urban planners for better assessing risks and opportunities, ranging from threat of flooding and impact of climate change, to identifying new infrastructure and public transport needs.
The Urban Atlas can also provide a pan-European classification of city zones, allowing for easily comparison of information on density of residential areas, commercial and industrial zones, extend of green areas, exposure to flood risks and monitoring of urban sprawl which is important for public transport planning in suburban areas.

The Urban Atlas offers those leading with land management (Urban administrations, policy makers, environmentalists, and other public stakeholders) the opportunity to build additional detail on top of these maps in order to monitor the status of urban development and trends, indicating, for instance, average distance to services, sizes of green areas and their environmental status, assess adequate response to rising percentages of sealed areas, support flood prevention due to increased surface run-off, etc.

Figure 3: The respective locations of the 305 Urban Atlas LUZs (Larger Unit Zone) selected in the EU-27 member states.

Urban Atlas maps are currently produced by the French company SIRS under a contract with the European Commission.

The effort is public funded with the main financial support coming from the European Regional Development Fund (ERDF).

To be noticed that future editions of the Urban Atlas are planned in 3-5 year intervals in order to contribute to the legal requirements related to the Urban Audit exercise.

6.4.1 MAIN CHARACTERISTICS OF THE PRODUCT

Urban Atlas main features are to:

- Provide harmonised land cover/land use maps at scale **1:10,000** and according to a common classification,
- Designed to measure urban land use at high resolution and at high/low levels of soil sealing
- Covers **305 major European agglomerations**, based on Urban Audit's Larger Urban Zones
- Thematic classes based on CORINE LC nomenclature and GUS Legend.
- Imagery reference year: **2006** (+/- 1 year)
- Project duration: 2009-2011

Areas of Interest for Urban Atlas Mapping are determined by E. Commission (**DG REGIO**).

6.4.2 INPUT DATA SOURCES

Urban Atlas maps are derived mainly from Earth Observation (EO) satellite images with **2.5 m** spatial resolution, multispectral or pan-sharpened (multispectral merged with panchromatic). To be noticed that all multispectral datasets included near-infrared spectral information.

The type of VHR (Very High Resolution) satellite imagery used are:

- SPOT 5 (Pansharpened, 2.5m Ground Sample Distance)
- ALOS (Panchromatic 2.5m + multispectral 10m GSD)

- QUICK BIRD (multispectral, 2.6m GSD)
- RAPIDEYE (multispectral, 5m GSD)

About 2 TB of satellite imagery have been processed and analysed.

In addition to the satellite imagery, other spatial data has been utilised to derive the maps, such as:

- Topographic and cartographic maps at different scales
- Commercial off the shelf (COTS) **navigation data** for the road network.
- The GMES FTS (Fast Track Service) Soil Sealing Layer specifications to determine the different degrees of sealing for classes 11s
- Other aancillary data (local digital/paper maps, Google Earth, Bing, etc.)

All input data were described by metadata according to the INSPIRE metadata profile specifications and guidelines.

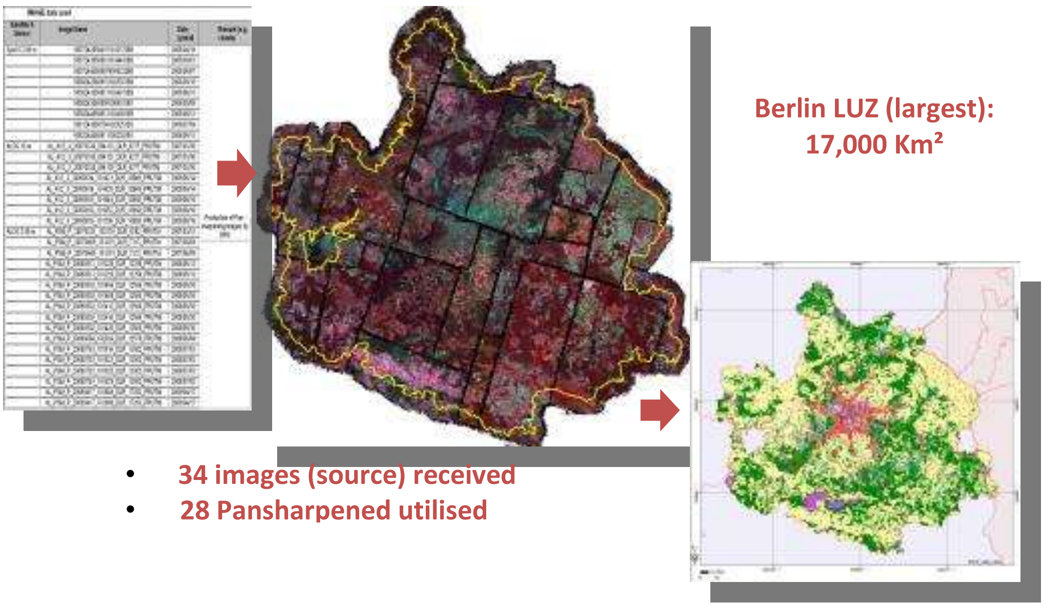


Figure 4: Example of UA production for Berlin

6.4.3 ADOPTED METHODOLOGY

The minimum mapping unit (MMU) used for producing all the maps was 0.25 ha (2,500 m²) in the core urban environments while 1ha was considered more opportune for the more rural/peripheral areas (see details below in classification scheme paragraph).

The classification scheme was derived from Corine Land Cover and contained 20 different thematic classes. The first action in the production chain was the processing of the navigation data for correcting possible spatial/geometric errors of the communication networks making the relative adjustments according to the VHR satellite imagery. This processing step followed the principles established by the GSE (GMES Service Element) Land mapping guide

Then, a hybrid automated/visual interpretation classification procedure was performed, which included an automatic labelling of the polygons followed by the visual interpretation/verification performed by trained photo-interpreters.

Finally, to characterise the urban fabric classes (respective percentage of density of each urban fabric polygon) an automatic integration of the Soil Sealing layer was performed.

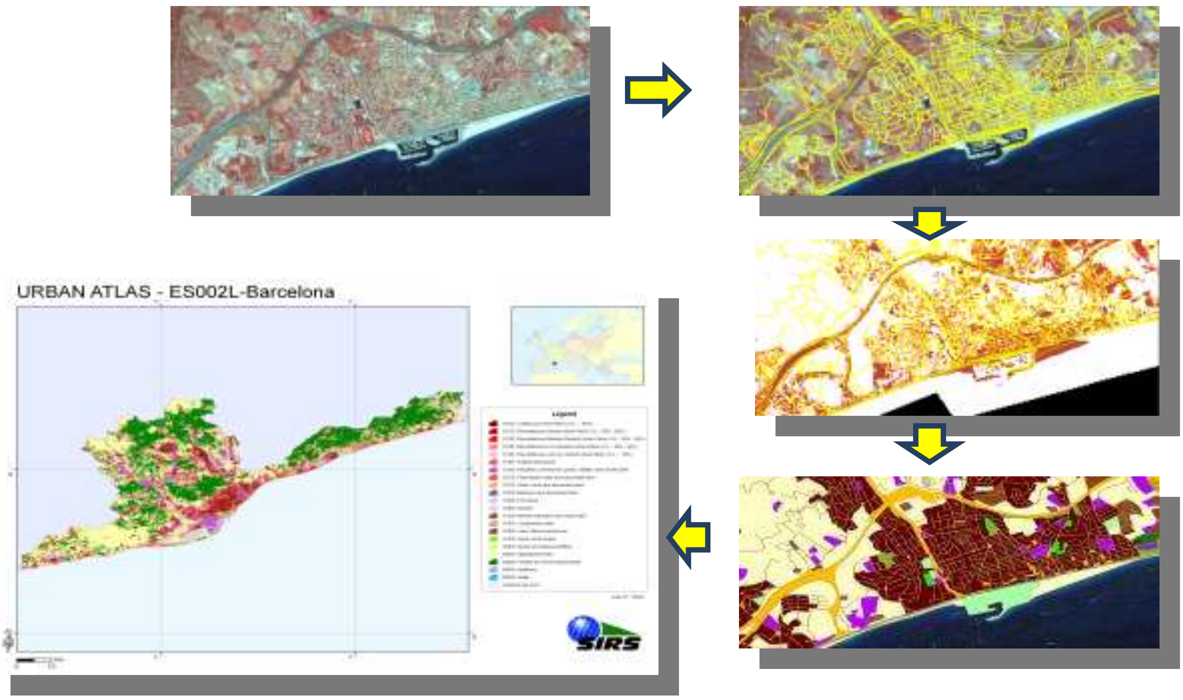


Figure 5: Example of UA production for Barcelona

6.4.4 URBAN ATLAS CLASSIFICATION SCHEME

6.4.4.1 RESIDENTIAL URBAN CLASSES

The thematic classes referring to (impervious) **residential** urban areas are shows below:

- **11100: Continuous Urban fabric (S.L. > 80%)**
- **11210: Discontinuous Dense Urban Fabric (S.L.: 50% - 80%)**
- **11220: Discontinuous Medium Density Urban Fabric (S.L.: 30% - 50%)**
- **11230: Discontinuous Low Density Urban Fabric (S.L.: 10% - 30%)**
- **11240: Discontinuous Very Low Density Urban Fabric (S.L. < 10%)**
- **11300: Isolated Structures**

To distinguish between the different density classes, the use of soil sealing was employed

6.4.4.2 NON-RESIDENTIAL URBAN CLASSES

The thematic classes referring to (impervious) **non-residential** urban areas are shown below:

- 12100: Industrial, commercial, public, military and private units
- 12210: Fast transit roads and associated land
- 12220: Other roads and associated land
- 12230: Railways and associated land
- 12300: Port areas
- 12400: Airports

To distinguish between different classes in addition to spectral and spatial info from satellite imagery, detailed transport network layer (COTS) and local maps as auxiliary were the main source of information.

6.4.4.3 OTHER URBAN/NON-URBAN CLASSES

The remaining thematic classes (all the pervious ones) are shown below:

- 13100: Mineral extraction and dump sites
- 13300: Construction sites
- 13400: Land without current use
- 14100: Green urban areas
- 14200: Sports and leisure facilities
- 20000: Agricultural Areas, semi-natural areas and wetlands
- 30000: Forests
- 50000: Water

To be noticed that less thematic details are required for agricultural, semi-natural, wetlands, forest and water areas (minimum mapping unit of 1 ha).

6.4.5 WHERE TO FIND URBAN ATLAS DATA

Urban Atlas completed geo-referenced datasets for all 305 cities are/will be freely available and downloadable from EEA site (re.: http://www.eea.europa.eu/data-and-maps/data/urban-atlas).

In addition, a Map viewer is also available on EEA site (beta):
http://dataservice.eea.europa.eu/map/UrbanAtlasbeta/

6.5 INTEGRATION WITH URBAN ATLAS

A working group has been established consisting of BRGM, LIG, TNO and SIRS. It will look at the data model, portal, visualisation and integration of the Ground Stability Layer and Urban Atlas.

6.6 LINK BETWEEN POLYGONS AND GEOHAZARD SUMMARY

There is a requirement for a dynamic link between the polygons in the Ground Stability Layer, as viewed in the portal and the information about those polygons held in the Geohazard Summary. It must be possible to select a polygon in the portal and to be presented with the geohazard information relating to that polygon which is stored in the Geohazard Summary.

This connection is established via a hyperlink to be automatically built by the portal. For the link to be built there must be a hyperlink containing the unique ID of the polygon at the start of the relevant section of the Geohazard Summary. The unique ID of the polygon is one of the polygon attributes, therefore when the user clicks on the polygon, the portal requests the OGC service to get the attributes of the polygon; this is when the hyperlink is built.

6.7 LEGAL NOTICES ETC – FNPA

Nearly ready

7 PANGEO WEBSITE

See PanGeo dossier D4.2

APPENDICES

APPENDIX ONE – PANGEO GEOHAZARD GLOSSARY

1 HAZARD

Something with the potential to cause harm.

2 NATURAL HAZARD

A natural hazard is a natural process or phenomenon that may cause loss of life, injury or other impacts, property damage, loss livelihoods and services, social and economic disruption, or environmental damage. (Council of The European Union – Commission Staff Working Paper – Risk Assessment and Mapping Guidelines for Disaster Management).

3 GEOHAZARD (GEOLOGICAL HAZARD)

A geological process with the potential to cause harm.

4 RISK

The likelihood that the harm from a particular hazard will be realised.

5 TYPES OF GEOHAZARD

5.1 EARTHQUAKE (SEISMIC HAZARD)

Earthquakes are the observable effects of vibrations (known as seismic waves) within the Earth's crust arising from relatively rapid stress release, typically along a fault zone.

Damage to buildings and other infrastructure can be caused as the ground shakes during the passage of seismic waves. Other effects include liquefaction of water-saturated soft ground, potentially leading to a loss in ground strength and the extrusion of water-saturated sediments as 'mud volcanoes' and the like. Ground shaking can also trigger secondary events such as landslides and tsunami. Some earthquakes are associated with significant permanent vertical or lateral ground movement. Changes to drainage systems can cause flooding. There is potential for injury and loss of life during earthquakes.

Seismic hazard can be assessed by reference to the size and frequency of recorded earthquakes, although individual earthquakes are essentially unpredictable. Individual events occur on time-scales of seconds or minutes. Modern infrastructure should be designed to withstand probable local seismic events.

5.2 TECTONIC MOVEMENTS

Tectonic movements are large scale processes that affect the earth's crust. These processes can lead to areas of the crust rising or falling. Importantly it is the neotectonic movements that area still active and may therefore produce a ground motion that can be measured by InSAR. Neotectonic movements are typically due to the stresses introduced through moments of the earth's plates. These types of motion are likely to be on a broad scale and so it may not be possible to measure them using the SAR scene relative measurements of InSAR.

5.3 SALT TECTONICS

Localised motions can be associated with the movement of evaporate deposits, these are termed Salt tectonics and can produce both uplift and subsidence depending on the exact mechanisms at play.

5.4 VOLCANIC HAZARD

Volcanic activity can lead to the creation of lava flows, ash flows, debris and ash falls, and debris flows of various kinds. It might be accompanied by release of poisonous or suffocating gases, in some instances with explosive violence, or by significant seismic activity or ground movement. Secondary effects can include landslide and flooding.

5.5 NATURAL GROUND INSTABILITY

The propensity for upward, lateral or downward movement of the ground that can be caused by a number of natural geological processes. Some movements associated with particular hazards may be gradual or occur suddenly and also may vary from millimetre to metre or tens of metres scale. Note that anthropogenic deposits can be affected by natural ground instability.

Significant natural ground instability has the potential to cause damage to buildings and structures, and weaker structures are most likely to be affected. It should be noted, however, that many buildings, particularly more modern ones, are built to such a standard that they can remain unaffected in areas of even significant ground movement. The susceptibility of built structures to damage from geohazards might also depend on local factors such as the type of nearby vegetation, or the nature of the landforms in the area.

The effects of natural ground instability often occur over a local area as opposed to the effects of natural ground movements which occur over larger areas.

5.5.1 Landslide

A landslide is a relatively rapid outward and downward movement of a mass of rock or soil on a slope, due to the force of gravity. The stability of a slope can be reduced by removing ground at the base of the slope, increasing the water content of the materials forming the slope or by placing material on the slope, especially at the top. Property damage by landslide can occur through the removal of supporting ground from under the property or by the movement of material onto the property. Large landslides in coastal areas can cause tsunami.

The assessment of landslide hazard refers to the stability of the present land surface, including existing anthropogenically-modified slopes as expressed in local topographic maps or digital terrain models. It does not encompass a consideration of the stability of new excavations.

Land prone to landslide will normally remain stable unless the topography is altered by erosion or excavation, or the land is loaded, or pore water pressure increases. Landslide might also be initiated by seismic shock, frost action, or change in atmospheric pressure.

This hazard is significant in surface deposits but may extend to more than 10 m depth.

The common consequences are damage to properties, including transportation routes and other kinds of infrastructure, and underground services.

Some landslides can be stabilised by engineering.

5.5.2 Soil Creep

Soil creep is a very slow movement of soil and rock particles down slope and is a result of expansion and contraction of the soil through cycles of freezing and thawing or wetting and drying.

5.5.3 Ground Dissolution

Some rocks and minerals are soluble in water and can be progressively removed by the flow of water through the ground. This process tends to create cavities, potentially leading to the collapse of overlying materials and possibly subsidence at the surface.
The common types of soluble rocks and minerals are limestones, gypsum and halite.

Cavities can become unstable following flooding, including flooding caused by broken service pipes. Changes in the nature of surface runoff, excavating or loading the ground, groundwater abstraction, and inappropriate installation of soakaways can also trigger subsidence in otherwise stable areas.

5.5.4 Collapsible Ground

Collapsible ground comprises materials with large spaces between solid particles. They can collapse when they become saturated by water and a building (or other structure) places too great a load on it. If the material below a building collapses it may cause the building to sink. If the collapsible ground is variable in thickness or distribution, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion.
Collapse will occur only following saturation by water and/or loading beyond criticality.
This hazard can be significant in surface deposits and possibly also in buried superficial deposits.

5.5.5 Running Sand

Running sand occurs when loosely-packed sand, saturated with water, flows into an excavation, borehole or other type of void. The pressure of the water filling the spaces between the sand grains reduces the contact between the grains and they are carried along by the flow. This can lead to subsidence of the surrounding ground.

If sand below a building runs it may remove support and the building may sink. Different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion.
The common consequences are damage to properties or underground services. This hazard tends to be self-limited by decrease in head of water.

5.6 MAN MADE (ANTHROPOGENIC) GROUND INSTABILITY

Ground motions covering a local area which have been brought about by the activity of man.
Subsidence (downward movement) of the ground can result from a number of different types of anthropogenic activity, namely mining (for a variety of commodities), or tunnelling (for transport, underground service conduits, or for underground living or storage space).
Subsidence over a regional area can result from fluid extraction (for water, brine, or hydrocarbons) Uplift or heave of the ground can occur when fluid is allowed to move back into an area from where it was previously extracted and groundwater recharge occurs. This fluid recovery may include injection of water or gas.

5.6.1 Made ground

Made ground comprises anthropogenic deposits of all kinds, including landfill for waste disposal. Depending on its composition and mode of deposition, landfill can be a compressible deposit. If it includes certain types of waste it can be a source of methane, which if uncontrolled can give rise to explosion hazard, or of leachates that have the potential to contaminate surface water or groundwater.

5.7 NATURAL GROUND MOVEMENT

5.7.1 Shrink-swell clays

A shrinking and swelling clay changes volume significantly according to how much water it contains. All clay deposits change volume as their water content varies, typically swelling in winter and shrinking in summer, but some do so to a greater extent than others. Most foundations are designed and built to withstand seasonal changes. However, in some circumstances, buildings constructed on clay that is particularly prone to swelling and shrinking behaviour may experience problems. Contributory circumstances could include drought, leaking service pipes, tree roots drying-out of the ground, or changes to local drainage such as the creation of soakaways. Shrinkage may remove support from the foundations of a building, whereas clay expansion may lead to uplift (heave) or lateral stress on part or all of a structure; any such movements may cause cracking and distortion.

The existence of this hazard depends on a change in soil moisture and on differential ground movement.

Uniform ground movement may not of itself present a hazard.

This hazard is generally significant only in the top five metres of ground.

5.7.2 Compressible Ground

Many ground materials contain water-filled pores (the spaces between solid particles). Ground is compressible if a building (or other load) can cause the water in the pore space to be squeezed out, causing the ground to decrease in thickness. If ground is extremely compressible the building may sink. If the ground is not uniformly compressible, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion.

This hazard commonly depends on differential compaction, as uniform compaction may not of itself present a hazard. Differential compaction requires that some structure that might be susceptible to subsidence damage has been built on non-uniform ground.
The common consequences are damage to existing properties that were not built to a sufficient standard, and possible damage to underground services.

5.8 MAN MADE (ANTHROPOGENIC) GROUND MOVEMENT

These motions typically cover a larger area and are the result of mans activities. Subsidence over a regional area can result from fluid extraction (for water, brine, or hydrocarbons) Uplift or heave of the ground can occur when fluid is allowed to move back into an area from where it was previously extracted and groundwater recharge occurs. This fluid recovery may include injection of water or gas.