EUROPEAN COMMISSION

Research Executive Agency

Seventh Framework Programme

Cooperation: Space Call 3

FP7-SPACE-2010-1

Grant Agreement: 262371

Enabling Access to Geological Information in Support of GMES

D3.3 Product and Service Specification Version 2.1

6th June 2012

Dissemination Level:	Public	
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Date of Issue:	6th June 2012	

CHANGE RECORD

Version 2.0 of 31/01/2012 to Version 2.1 of 06/06/2012

Section	Page	Detail of change
Executive summary	3	Executive Summary added
List of acronyms and abbreviations	4	List of acronyms and abbreviations added
5, 5.2, 5.3, 5.3.2, 5.3.3, 5.3.4, 5.4, 8, 8.3, 8.5.	15, 18, 19, 20, 28, 35, 36, 41.	User needs and requirements added prior to describing a particular specification of the product.
5 Product Definition	15	Added product tree diagram for the PanGeo Products
10 Conclusion	43	Conclusion added

Version 1.0 of 04/08/2012 to Version 2.0 of 31/01/2012

2.2 Outline of the PanGeo service	7	Updated the outline of the service
4.1 PanGeo Production Pack	10	Change of name from PanGeo Component Pack to PanGeo Production Pack
5.3 Ground Stability Layer Specifications	16	Up dated to reflect INSPIRE NRZ Specifications following discussions and ideas which have evolved during project meetings.
6 Overview of Product generation procedure	28	Updated to include procedure used by the GS to check the finished GSL
1.1 7.1 VALIDATION OF TERRAIN MOTION MEASURED BY PSI The PSI process has been extensively validated in the Terrafirma project resulting in the certification of the PSIPs involved in PanGeo. Outstanding issues, not addressed in the Terrafirma validation are addressed in PanGeo D3.6.1. Validation of geological content and format	30	Updated for automated checking tool
Appendix one: Glossary	40	Updated for grouping of Geohazards

EXECUTIVE SUMMARY

The PanGeo service has been designed with the original project aims, user requirements and technical requirements in mind. The PanGeo service will create an attributed, spatially referenced vector polygon dataset outlining all areas of ground instability for 52 European towns. INSPIRE compliant attributes will provide the reason for the instability, its area and the geologists confidence in their interpretation. The supporting Geohazard Description Document will be available as both a standalone document and the relevant section will be hyperlinked to the Ground Stability Layer polygon displayed in the portal. Along with providing a geological background to the PanGeo town the Geohazard Description will give detailed geological interpretation and evidence for the area of instability and provide information on how the instability was recognised and mapped.

The PanGeo interpretation will be carried out by the National Geological Survey for the country for which the town resides. The inputs to the interpretation are; satellite radar derived data on ground motion, ground motions observed with other surveying techniques, geological data and models and ancillary data. The satellite radar derived ground motion data will be delivered to the geological surveys by the PSIPs within in the PanGeo Production Pack.

Two types of ground instability will be recognised; observed and potential. Observed instabilities are those observed on ground motion data or through geological field campaigns. Potential instabilities are those areas that the geologist believes may be subject to instabilities given their knowledge of the area or the results of geological modelling. One of eighteen geohazards is assigned to each area of ground instability; geohazards are grouped into four categories for display on the portal.

Once the Geological Survey has completed the GSL and GHD they will be validated by the British Geological Survey before being made available to the PanGeo portal. In the first instance the GSL will be submitted to an online validating tool which will carry out automated topological data checks of the vector data and attributes. Once passed the GSL is sent to BGS who will carry out manual checks of the GSL and GHD to ensure they meet the specifications.

Once validated the Geological Survey will make the GSL and GDH available on their IT servers for harvesting by the PanGeo portal. The display of the GSL on the portal will depend on the viewing scale; at the European scale PanGeo towns will be highlighted, at the regional scale a graphic showing the number of hazards affecting an area will be displayed. At the local scale the GSL polygons will be displayed according to the geohazard category, the boundary line will distinguish potential and observed hazards. The user can also choose to integrate the GSL with the Urban Atlas; the GSL polygons will highlight those Urban Atlas land cover types affected by hazards.

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 Description.

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 Description– A summary report, for each PanGeo town, sections linked to each ground stability polygon, provides the geological interpretation for the motion.

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

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.

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.

ACRONYMS AND ABBREVIATIONS

GIS	Geographical Information System
GMES	Global Monitoring for Environment and Security
GS	Geological Survey
GSL	Ground Stability Layer
GHD	Geohazard Description
PS	Persistent Scatterer
PPM	PanGeo Production Manual
PSI	Persistent Scatterer Interferometry
PSIP	Persistent Scatterer Interferometry Providers
SLA	Service Level Agreement
QA	Quality Assessment
LOS	Line Of Sight
PGGH	PanGeo GeoHazard

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2 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 list of towns for which PanGeo information will be made available within the first three years of PanGeo is 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. 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 the PanGeo products are also outlined.

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.

Where relevant the user needs and requirements, identified from D3.2, are given at the start of a section before the corresponding product specification is given.

2.1 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.

2.2 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 Description** 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 Description 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.

The Ground Stability Layer will **map all the areas of a given town that are affected by ground instability**, which can be caused by a number of natural and anthropogenic processes or phenomena, e.g. compressible ground, shrink-swell clays, ground dissolution, collapsible ground, landslides, soil creep, tectonic movements, underground construction works, fluid extraction or injection, etc. PanGeo aims to create polygons around unambiguous geohazards. Polygons will be based on hazards and not input data types.

The areas of mapped ground instability can fall into two categories:

1. **Observed motion** includes all types of direct or indirect observation/measurement of ground motion.
2. **Potential motion** includes all areas that the geologists, using the available geological and auxiliary data, have identified as having the potential for ground motion. Observed and potential motion will be clearly distinguished by the Ground Stability Layer attributes.

Ground instability is mapped using a variety of input datasets including existing geological data and PSI (Persistent Scatterer Interferometry) data. The PanGeo interpretation is **not based on PSI data alone**.

The input datasets may differ from one PanGeo city to the other. However, four main classes of information sources are identified:

1. Motion **observed by PSI.**
2. Motion **observed with other types of deformation measurement devices** and techniques. These data are held by the Surveys.
3. Motion **observed from geology field campaigns**, e.g. refer to mass movements, measurements of active faulting and neotectonics, indirect evidences from building damage, etc. These data are held by the Geological Survey (GS).
4. **Potential motion** derived from geological & auxiliary data held by the Surveys.

There is no minimum mapping unit for PanGeo, however the PanGeo mapping scale aims to be 1:10 000. The size of the area for which PanGeo data will be produced is largely down to the geological survey responsible. The minimum area covered by the Ground Stability Layer is defined by the extent of the PSI data. The maximum possible area covered by the Ground Stability Layer is defined by the coverage of the Urban Atlas data for the town in question. It is possible that the actual area covered by the Ground Stability layer will fall somewhere between the extent of the PSI and the Urban Atlas. If so the interpreter should ensure that the area covered conforms to a logical administration boundaries; this will ensure the usefulness of the product to the local authorities.

The Ground Stability Layer polygons are attributed. Attributes are compliant with the Natural Risk Zones data specification of INSPIRE and will be used in the portal to provide a summary of the geohazard. More detailed geological information will be given in the Geohazard Description. The Geohazard Description will be linked to the polygon via the attributes, which will make it discoverable in the portal, but the Geohazard Description will also be written as a standalone document.

The interpretation of each Ground Stability polygon will be assigned a measure of confidence within the polygon attributes and Geohazard Description. This measure of confidence will be on a simple three-level scale of Low, Medium High or External depending on the number of datasets used in the interpretation and the confidence that the geologist feels is appropriate.

To see an example of how the PanGeo service will appear please see a prototype for a small area in London here: http://pangeo.brgm-rec.fr/pangeoportalOSM/viewer.jsp

2.2.1 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 spurious motions relating to the structure of buildings
- Will not be based solely on an interpretation of PSI data
- 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 vulnerability coverage or risk coverage (INSPIRE)

3 TOWNS TO BE PROCESSED

Count	Partner #	Survey	LUZ 1	LUZ 2
1	14	Austria	**Salzburg**	**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

4 INPUT DATASETS

4.1 PANGEO PRODUCTION PACK

The PanGeo Production 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 Description . It does not include the geological data or ancillary data.

The contents of the PanGeo Production Pack are as follows:

1. *The PSI Pack*.
2. *The Production Manual*.
3. *A Geohazard Description template*.
4. *A Ground Stability Layer shapefile (.shp) template*.
5. *A link to the Urban Atlas dataset*.
6. *Terrafirma User Guide*.

4.2 DESCRIPTION OF PSI DATA USED FOR THE INTERPRETATION

A component of the PanGeo Production Pack is the PSI Pack. A detailed guide to the PSI Pack to be delivered to the GSs can be found in D6.4 "PanGeo PSI Pack Definition". Within the PSI Pack the GS will receive three database files (.dbf) plus additional data:

a. Average annual displacement rates (.dbf)
b. Full PSI time-series (.dbf)
c. Reference point (.dbf)
d. A background reference image (.GeoTIFF)
e. The PSI Processing Report
f. A QA sign-off

For pre-existing PSI data coming from the Terrafirma project, the PSI Pack contains additional components:

a. Terrafirma Service Level Agreement (SLA) Deliverables, including:
   - Interpretation PPT
   - Interpretation Report
   - Utility Report
   - Exploitation Report

For the towns where new PS processing is taking place within the PanGeo project several issues outstanding from Terrafirma have been discussed and addressed. These are outlined below, but more information can be found in D3.6 "PanGeo PSI Pack Definition".

• The minimum number of SAR images needed to derive reliable PSI products.
In the PanGeo project it is **encouraged the use of at least 25 SAR images** to derive new PSI products. If the number is less than 25 it is fundamental to **properly document this fact** in the corresponding PSI Processing Report.
• The spatial coverage of the PSI products.
It is recommended to get a **spatial coverage between a minimum of 100 km^2 and a maximum of 600 km^2** for the new PanGeo PSI processings.
• The tilts/trends that might affect the PSI products.
The tilts/trends are removed in all the PanGeo PSI products.
• The indices used to describe the quality of the PSI results.
In the PanGeo project **the quality index to be attached to each generated PS** (Persistent Scatterer) **is the so-called temporal coherence**.
• The spatial density of PS, and its relation to the PSI quality indices.
In the PanGeo project the **decision of fixing the quality thresholds** depends on the specific processing chain at hand and it **is responsibility of each PSIP**.

4.3 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 should load in to the GIS; key datasets are highlighted in **bold**.

- **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 in-filled ground); with thickness, if data are available.
- **Mass movement deposits** (especially landslide deposits).
- **Geological structure.**
- **Mining**, including commodity, date, depth, mining method, target horizon.
- **Fieldwork data**, especially field work carried out in light of the PSI data interpretation.
- **Groundwater level** in main aquifers.
- **Maps of known or suspected local geohazards**, such as landslides, running sand, shrink-swell clay, compressible ground, etc.
- 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).
- Geotechnical databases/records of the properties of a rock formation or sediments.
- Location of boreholes and borehole data.

Results of the questionnaire sent out to all GSs confirmed that the GSs have access to such data.

4.4 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. The following are key datasets which, if possible, should be included in the interpretation GIS:

- Urban Atlas data
- In-situ instrumentation (Levelling benchmark, GPS etc)
- Topographical and landuse (current and historical) maps (Scales of 1:625 000 to 1: 10 000)
- Location of major infrastructure projects, especially those involving tunnelling, for the period of PSI data acquisition and for about 10 years previously.
- Subsurface utilities, particularly those in large-diameter conduits, or prone to leakage.
- Elevation models
- Aerial photography
- Optical imagery
- Radar Imagery
- Groundwater pumping data

Ancillary data might also be used for validation, these issues are addressed in section 7 ; validation component.

5 PRODUCT DEFINITION

5.1 PRODUCT DESCRIPTION

The product created by PanGeo is a Ground Stability Layer and Geohazard Description 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 country.

Ground Stability polygons are attributed, attributes are complaint with the Natural Risk Zones data specification of INSPIRE. For each PanGeo town a Geohazard Description document is written by the geological survey. The Geohazard Description contains the geological interpretation for each Ground Stability polygon. Clicking on the polygon in the portal displays the corresponding section of the Geohazard Description thereby providing the user with the interpretation of why ground instability has occurred in that area. The Geohazard Description 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. The PanGeo products are outlined in Figure 1.

PanGeo information is presented to the user via a web-based portal. In the portal 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, with the addition of vulnerability data, can make informed decisions on risk. The portal provides the ability to both view and download the Ground Stability Layer and Geohazard Description.

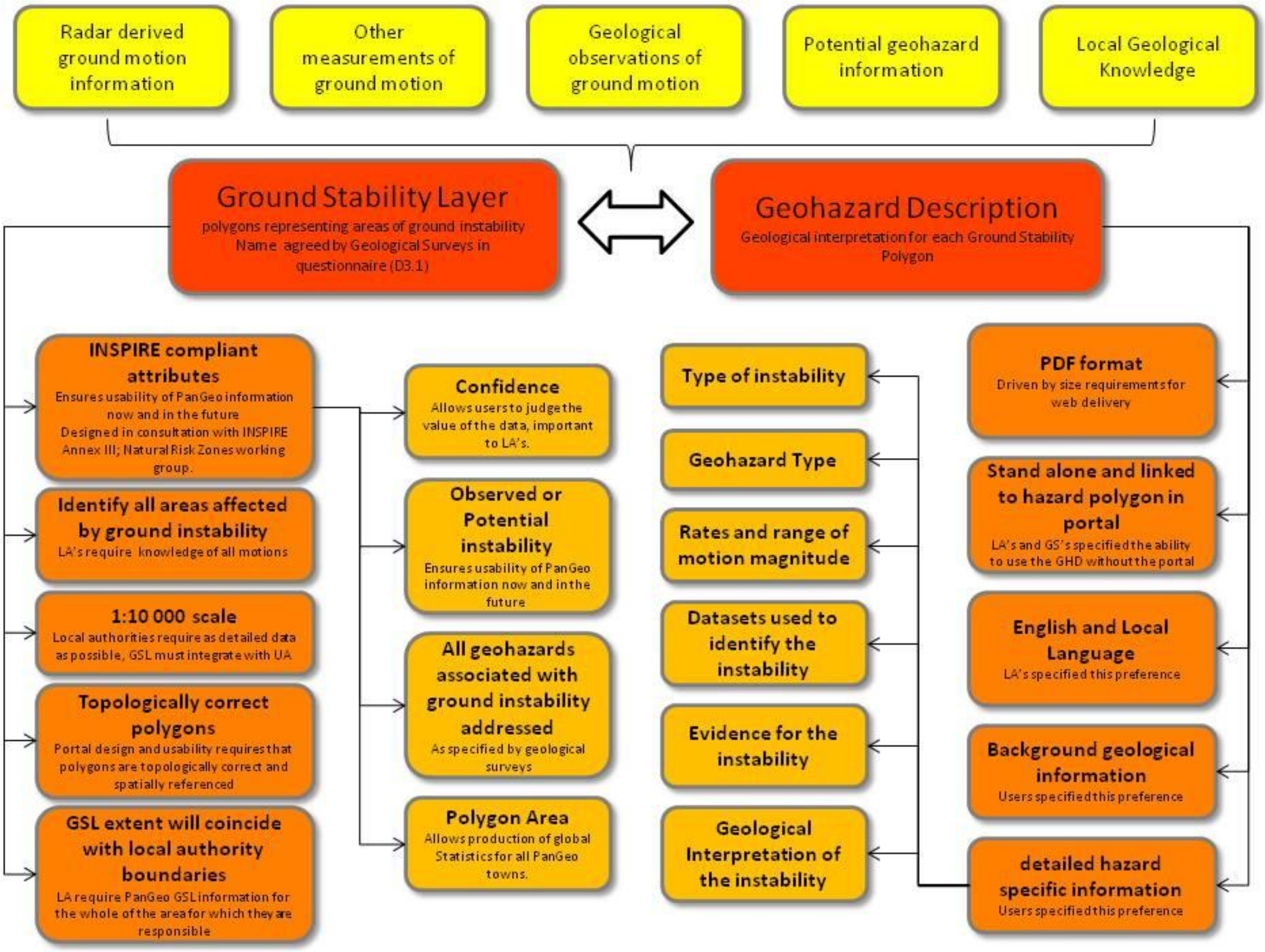


Figure 1 PanGeo Product Tree showing the PanGeo products, their specifications and the user requirements leading to the specifications.

5.2 GEOHAZARD TYPES ADDRESSED

User needs and requirements

The Geological Surveys were asked via the questionnaire (D3.1) to state the geohazards that affect their country. Figure 2 illustrates the geohazards that the surveys identified as occurring in their respective countries. While the feedback does not highlight the relative importance or impact of each geohazard, it is clear that geohazards such as landslides, anthropogenic subsidence, tectonics, dissolution and shrink swell that can be detected by InSAR within the PanGeo service are prevalent across the countries that replied to the questionnaire.

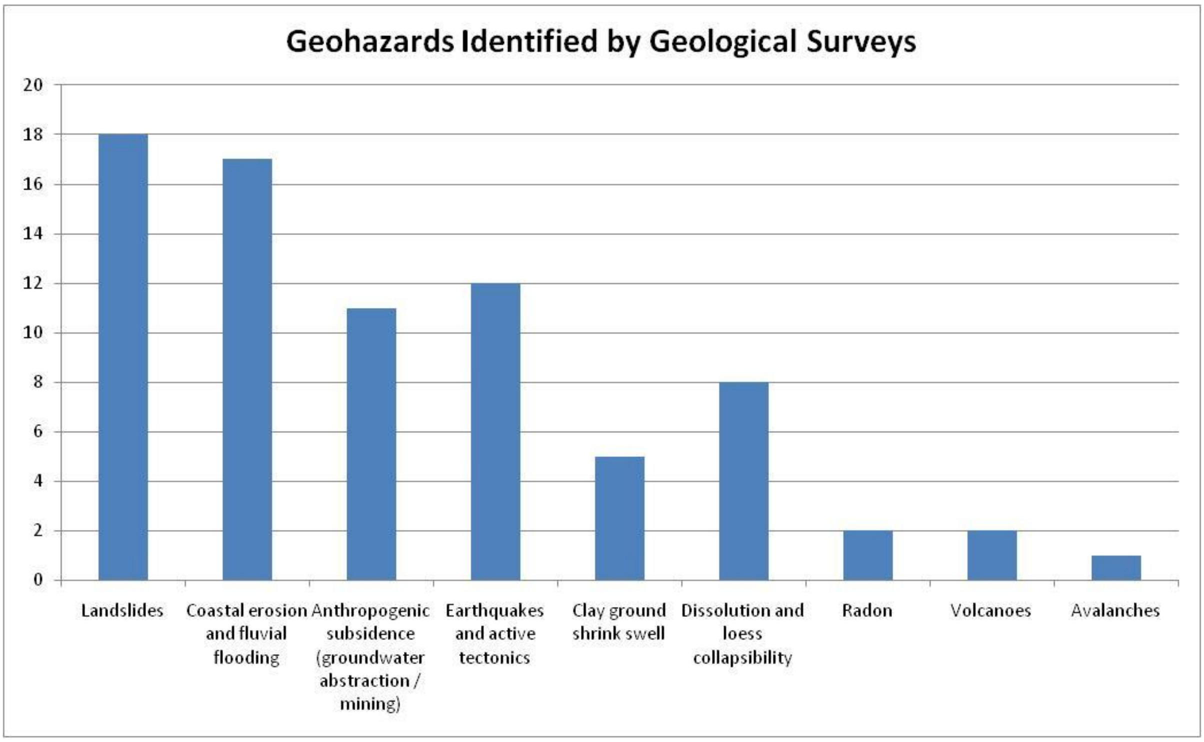


Figure 2: Geohazards identified by the Geological Surveys in their countries

5.2.1 Types of Geohazard and their groupings within PanGeo

PanGeo is concerned with geohazards which affect the stability of the ground; the project therefore addresses all geohazards listed in Figure 2 but it does not address issues of flooding or radon. A list of the geohazards addressed in PanGeo is given below, a full glossary of these geohazards is provided in Appendix one: Glossary of Terms for PanGeo.

1. <u>Deep Ground Motion</u>
   - 1.1 Earthquake (seismic hazard)
   - 1.2 Tectonic Movement
   - 1.3 Salt Tectonics
   - 1.4 Volcanic inflation/deflation

2. <u>Natural Ground Instability</u>
   - 2.1 Landslide
   - 2.2 Soil Creep
   - 2.3 Ground Dissolution
   - 2.4 Collapsible Ground
   - 2.5 Running Sand/Liquefaction

3. <u>Natural Ground Movement</u>
   - 3.1 Compressible Ground

3.2 Shrink-swell clays

4. Man Made (Anthropogenic) Ground Instability

   4.1 Groundwater Management - Shallow compaction
   4.2 Groundwater Management - Peat oxidation
   4.3 Groundwater abstraction
   4.4 Mining
   4.5 Underground construction
   4.6 Made ground
   4.7 Oil and Gas production

5. Other

6. Unknown

5.3 GROUND STABILITY LAYER SPECIFICATIONS

User needs and requirements

Fourteen GSs felt that 'Ground Stability Layer' was the more acceptable term while eleven preferred 'GeoHazard Layer'. Other suggestions included the term 'ground displacement layer'.

5.3.1 Ground Stability Layer naming convention

Each Ground Stability Layer will be named following the convention:

"<town-name>_ground_stability_layer.shp"

5.3.2 The extent of the Ground Stability Layer

User needs and requirements

The local authorities questioned within the Local Authority Feedback Group have all expressed a need to have geohazard information for the entire area for which they are responsible. This area does not always coincide with the area covered by the UA Luz.

Two Geological Surveys noted that the PSI data does not cover the Urban Atlas LUZ for the town they are going to work on.

The Toulouse local authority regards the UA LUZ as a relevant area to be covered by the GSL (See D2.1). In contrast the UA LUZ for Ljubljana in Slovenia, Gothenburg in Sweden and Rome, Italy is larger than the area for which the local authority is responsible; therefore the GSL can be restricted to this smaller area, defined by the local authority boundary.

In the PanGeo portal it will be necessary to have an indication of the limit, or boundary, of the interpreted area for each PanGeo town.

The GS will define the limit of interpretation; this boundary will be constrained with consideration given to two things:

1. The Larger Unit Zone (LUZ) of the Urban Atlas for the town will form the maximum extent of GSL coverage where the PSI coverage (or other geohazard knowledge/ancillary data) allows.
2. When the PSI coverage (or geohazard knowledge/ancillary data) does not extend to the LUZ, then a logical municipal boundary should be chosen, to define the extent of the GSL. This municipal boundary should have relevance to the responsibilities of the Local Authority to which the PanGeo service will be demonstrated and used.

Note: The use of administration boundaries as a guide to the area to be covered by the Ground Stability Layer is to make the product more useful to local authorities. Ideally the Ground Stability Layer will fully cover the spatial area that an authority is responsible for; it will be of less use to an authority if the area of responsibility is only partially covered.

5.3.3 Ground Stability Layer polygon properties

User needs and requirements

Although the following specification is mainly driven by the requirements of GIS vector data and the need to serve this over a portal the local authorities made an important point concerning the scale of the PanGeo data.

The resolution of the PanGeo data was an issue for some Local Authorities, for example the Urban Atlas data were considered insufficient for their specific purposes since they generally work with higher resolution datasets. This was especially noted by Gothenburg and Roma. On the contrary, Toulouse extensively uses Urban Atlas data for analytical purposes. Due to characteristics of the available input datasets and the Urban Atlas it is not possible to produce the GSL polygons at a scale finer than 1:10 000.

PanGeo polygons must be topologically correct. They must meet the following criteria:

1. Polygons have a projection specified; when the Ground Stability Layer is complete and made available to the portal the projection must be EPSG:4326 (Geographic Coordinates in WGS84). The working projection used whilst the interpretation takes place, may be different and is likely to be the local projection system of the country in which the PanGeo town resides.
2. Polygons are complete; the line joins back to itself to form a closed polygon.
3. All polygons will be fully attributed following the guidelines in Table 2
4. Overlapping Polygons:
    a. Polygons are able to overlap if they represent different geohazards; this enables the mapping of two geohazards for an area.
    b. Polygons are able to overlap if they represent the same geohazard **but** one polygon represents observed information and the other polygon represents information on a potential hazard. An example of this would be an area of compressible sediments which would all be considered to have the potential to become a hazard, this area of compressible sediment would then have a polygon drawn around it. A PSI result might then identify a smaller area, within the potential area, in which PSI observations confirm motion; this would be digitised as a new polygon.
    c. Polygons are not able to overlap if they relate to the same geohazard which has been **observed** in two datasets.
5. Polygons are digitised at 1: 5000 scale, and will be suitable for display at 1:10 000 scale. Efforts should be made to round off the corners of polygons to increase the aesthetics of their display.

5.3.4 Polygon attributes (PanGeo data model)

User needs and requirements

Polygon attributes need to be designed to accommodate all geohazard types identified in section 5.2.1 They also need to satisfy the requirements placed on the project by INSPIRE and portal functionality.

PanGeo is to be INSPIRE compliant, therefore the PanGeo data model has been designed in consultation with INSPIRE Annex III; Natural Risk Zones. Table 2 provides the PanGeo attributes (grey cells), their short name as used in an ArcGIS Shapefile and the values which are permitted for each attribute.

These attributes are in line with the Natural Risk Zones data specification as set out by the INSPIRE working group. It was recognised, in discussion with the leader of the INSPIRE working group, that the INSPIRE grouping of hazards unsuitable for PanGeo applications and is subject to alteration in the future. PanGeo has therefore specified a grouping of Geohazards which is suitable for PanGeo use. These can be found under **riskOrHazardCategory** in Table 2.

Attribute	Description	Short Attribute Name (as used in shapefile)	Value Type	Permitted Values
ID	The default ID, as automatically completed by ArcGIS	FID		1,2,3,4 etc
geometry	The geometry of the feature	Shape	GM_Object	Polygon
inspireID	Unique polygon identifier for INSPIRE	inspireID	CharacterString	PGGH_<town name>_xxx The ID shall be composed by: • PGGH_ • The town name (without blank or special characters) • A character string of three characters unique for the town. For instance "001", "002", etc
type Of Hazard	The INSPIRE specific category (NaturalRiskOrHazardClassification).			This attribute is composed by two values. The first one is the INSPIRE category, the second one is specific to PANGEO.
	riskOrHazardCategory	HazCat	CharacterString	• 1_DeepGroundMotions • 2_NaturalGroundInstability • 3_NaturalGroundMotion • 4_AnthropogenicGroundInstability • 5_Other • 6_Unknown
	specificRiskOrHazardType	HazType	CharacterString	All Geohazard types in the PanGeo Glossary: • 1_1Earthquake • 1_2TectonicMovements • 1_3SaltTectonics • 1_4VolcanicInflationDeflation • 2_1Landslide • 2_2SoilCreep • 2_3GroundDissolution • 2_4CollapsibleGround • 2_5RunningSandLiquifaction

				• 3_1CompressibleGround • 3_2ShrinkSwellClays • 4_1GWMShallowCompaction • 4_2GWMPeatOxidation • 4_3GroundwaterAbstraction • 4_4Mining • 4_5UndergroundConstruction • 4_6MadeGround • 4_7OilGasProduction • 5_Other • 6_Unknown
determinationMethod	*Not included in the INSPIRE data model,* this attribute identifies the type of PanGeo polygon; **Observed or Potential** and indicates which category of dataset it was identified on.	Determine	CharacterString	• 1_ObservedPSI • 2_ObservedOtherDefMeasurement • 3_ObservedGeologyFieldCampaigns • 4_PotentialInstability
confidenceLevel	*Not included in the INSPIRE data model,* this attribute is the level of confidence that the interpreter has in the polygon. A value of 'External' means that the polygon has been copied from an external source. For example it may have been copied from a Landslide inventory. In such as case information on the source will be provided in the Geohazard Description document.	Confidence	CharacterString	• Low • Medium • High • External
Area	*Not included in the INSPIRE data model,* it's the area covered by polygon in km^2	Area	Number (float)	Any numerical value of area (in km^2) with a scale of 3 (3 digits to the right of the decimal point)
range date of observed instability	*Not included in the INSPIRE data model, the start and end dates of the observed instability. If the instability is observed on the average annual instability of the PSI data the dates of observed instability will be the same as the dates of the PSI data*			This attribute is represented by a range of two dates
	ObservedInstabilityStartDate	ObsStart	Date	Any date value in YYYY/MM/DD

				for example: 2003/11/02
	ObservedInstabilityEndDate	ObsEnd	Date	Any date value in YYYY/MM/DD for example: 2008/09/05
	The following attributes are required to be INSPIRE compliant, however PanGeo is not concerned with them. **The values will be as specified below for all polygons.**			
beginLifespanVersion		beginLife	Datetime	Null
levelOfHazard		levelOfHaz	CharacterString	Null
likelihoodOfOccurence		likelihood	CharacterString	Null
determinationMethod		determin_1	CharacterString	indirectDetermination

Table 2: The PanGeo Ground Stability Layer attributes and the permitted values which can be entered.

5.3.5 Ground Stability Layer Style Set.

The 'display style' of the PanGeo Ground Stability layer will follow the PanGeo brand colours; yellows, oranges and reds. It has been decided that on the portal the GSL polygons will be colour coded according to the six categories of geohazards as defined in section 5.2.1. It has also been decided that when the user is 'zoomed out' to a regional/city wide level a different display type will be applied to the GSL. More details are provided below.

The Ground Stability Layer will be visualised at two levels:

5.3.5.1 Summarised Ground Stability Layer for viewing at city/regional level

- Data Description
  - 250m grid, count of number of Ground Stability Layer features within each grid cell. Overlain on top of Google Maps (Figure 3).
- Purpose
  - Provides easy overview of geohazard distribution at city/regional level. No complicated GSL geometries to render/view at small map scales. Furthermore, at small scales boundaries of complicated geometries become difficult to distinguish and create a poor image.

Specification

Colour	Colour ramp from yellow to orange
Transparency	50%
Feature Boundary	Colour ramp from yellow to orange
Base Mapping	Open Street Mapping (for the portal), other base maps can be used in the interpretation GIS and to illustrate the Geohazard Description

Table 3: Summary of design specifications

Geohazard Count	**Feature Fill Colour**			**Feature Line Colour & Specification**			
	Red	**Green**	**Blue**	**Red**	**Green**	**Blue**	**Line Width**
0	250	255	149	250	255	149	0pt
1	255	207	11	255	207	11	0pt
2	255	170	0	255	170	0	0pt
3	255	85	0	255	85	0	0pt
4	228	16	0	228	16	0	0pt

Table 4: Detailed feature fill and boundary line specification. Please note; these specifications are based on the London demo which had a maximum intersecting geohazard count of 4. At the time of publication the maximum number of intersecting geohazards within each contributing PanGeo city is unknown and could be higher than 4; therefore, it is possible that the colour ramp will need extending.

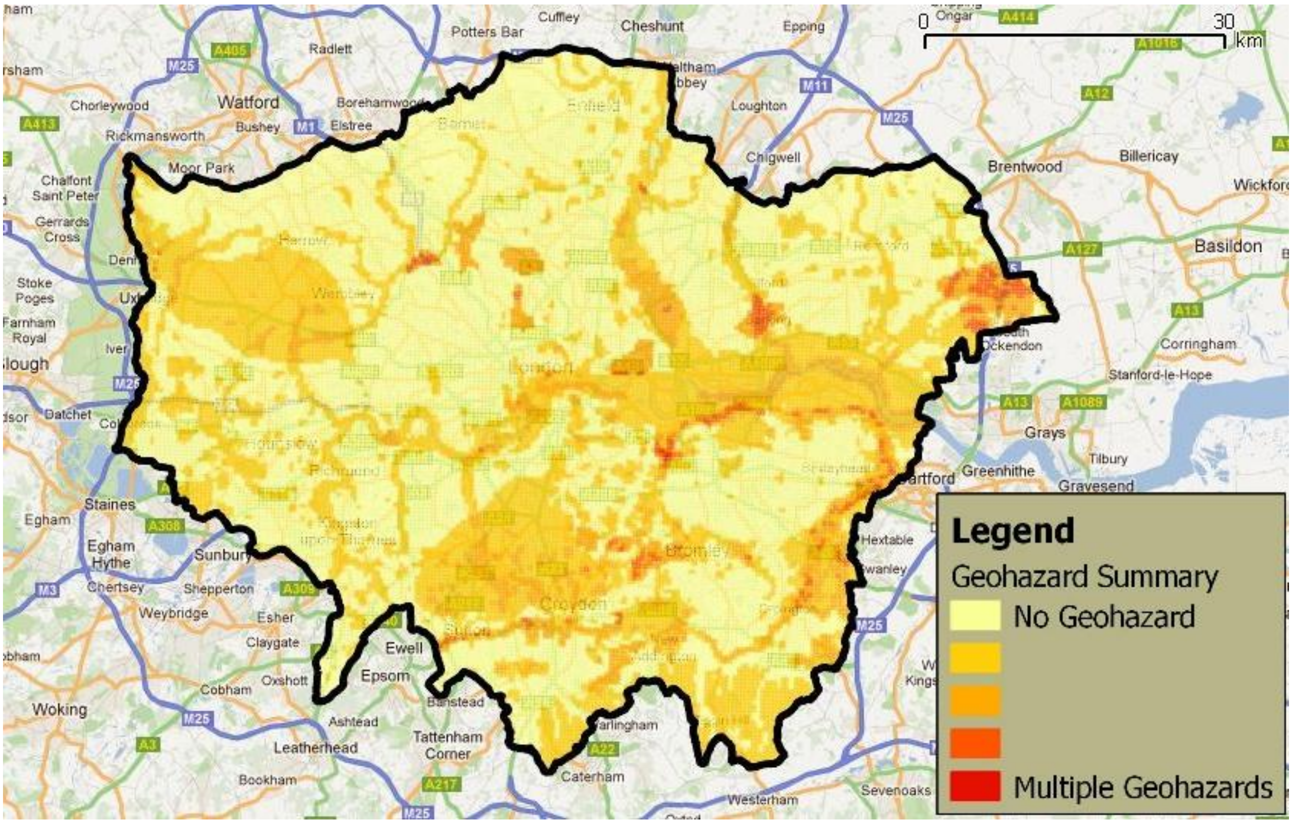


Figure 3: City level summary layer. Coloured using PanGeo colours and indicating distribution of all geohazards within the city

5.3.5.2 PanGeo Ground Stability Layer

- Data Description
  - Polygons of observed/potential geohazard. Designed for viewing at mid – high map scales and underlain by Open Street Maps (Figure 4).
- Purpose
  - To enable interrogation of PanGeo geohazard data at the local area to individual site level. Data displayed in both merged and individual ground stability layer types.

Specification

Colour	Yellow-orange colours specified for ground stability categories
Transparency	40%
Observed geohazard Feature Boundary	Solid black line, 0.5pt width
Potential geohazard Feature Boundary	Dashed black line, 0.5pt width
Base Mapping	Open Street Mapping (for the portal), other base maps can be used in the interpretation GIS and to illustrate the

	Geohazard Description

Table 5: Summary of design specifications

Geohazard Category	Feature Fill Colour			Feature Line Colour & Specification			
	Red	Green	Blue	Red	Green	Blue	Line Width
Deep seated motions	255	0	0	0	0	0	0.5pt
Natural ground instability	255	64	0	0	0	0	0.5pt
Natural ground movement	255	128	0	0	0	0	0.5pt
Man made	255	191	0	0	0	0	0.5pt
Other	255	204	0	0	0	0	0.5pt
Unknown	255	255	0	0	0	0	0.5pt

Table 6: Detailed feature fill and boundary line specification for broad ground stability layer classes. Please refer to the PanGeo geohazard dictionary for full details of specific geohazards within each geohazard group.

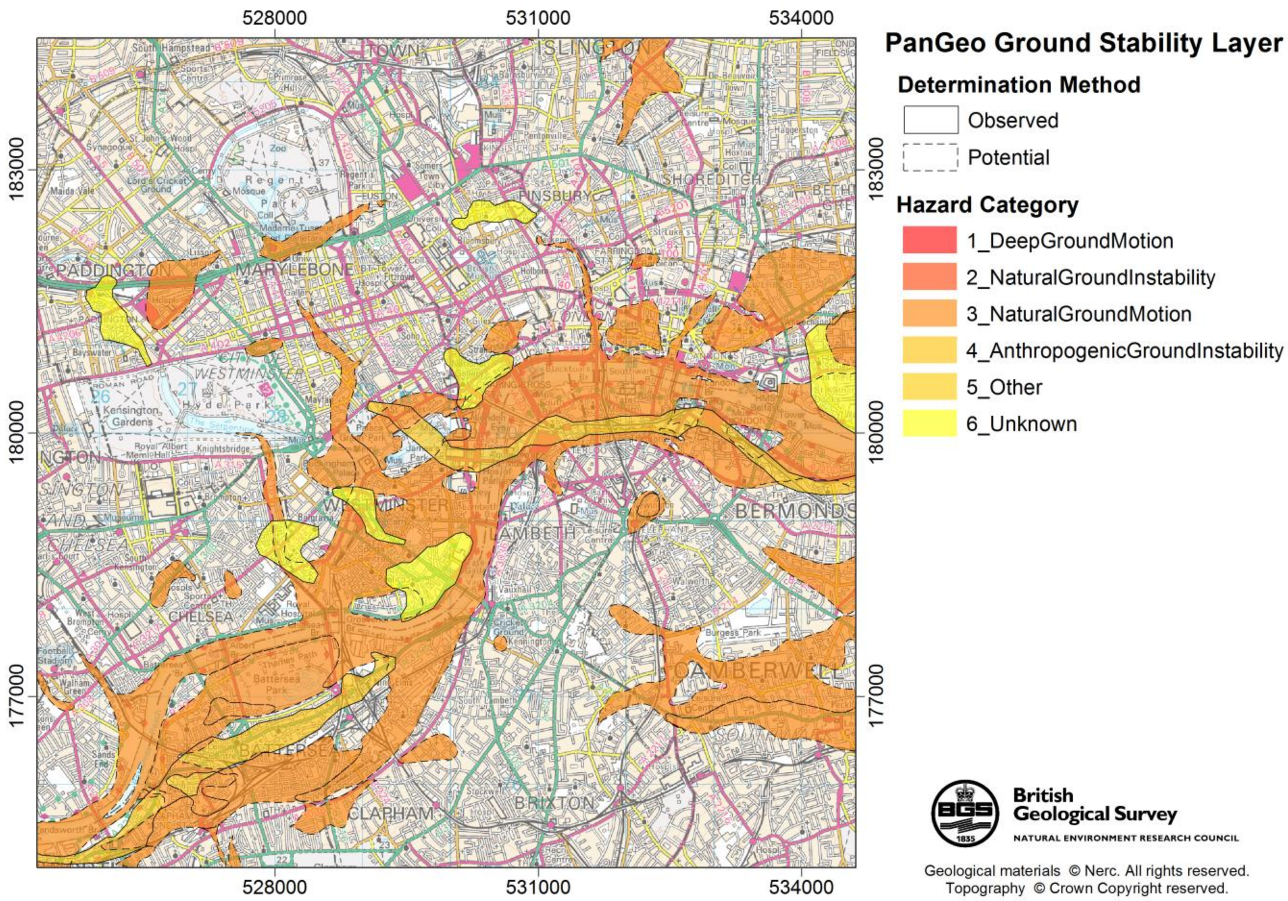


Figure 4: Ground Stability Layer displayed over Ordnance Survey topographical mapping and coloured by broad geohazard classes. Colour classification aids identification of geohazard types within user's area of interest.

5.4 GEOHAZARD DESCRIPTION DOCUMENT

User needs and requirements

The Local Authorities were keen to see the Summary Document as a stand-alone document. This view was reinforced by the Geological Surveys with twenty-five stating that they would find it valuable in that format as well as an online document linked to the hazard polygons in the portal. Local authorities expressed an interest in having the GHD available in both English and the local language. Regarding the contents of the GHD all options proposed in the meetings are regarded as valuable to be collected in the Summary, from the type of geo-hazard to the type, nature, and rate of motion, from the primary dataset used for the interpretation to the datasets used for validation including, wherever possible, even further information (though not specified).

Language was an issue raised by the Geological Surveys primarily in relation to the Description Document, with three of the surveys requesting that the document should be supplied in English while the remainder provided the following request list of preferred languages: Finnish, Swedish, Slovenian, French, Slovak, Maltese, German, Polish, Latvian, Greek, Hungarian, Lithuanian, Bulgarian and Portuguese. Eighteen of the surveys stated that they would be willing to carry out a small amount of translation to ensure that the information could be presented in their local language.

As users of the data, the Geological Surveys were asked to nominate which hazard areas identified in PanGeo should be captured in the Summary Document. Figure 5 illustrates the Surveys belief that a wide range of information should be contained within the document, including type of geohazard, description of geohazard, human activities, rate of motion, range of motion, type of motion, description of the nature of the motion, primary dataset identifying the motion, data used in the interpretation and validation of the geohazard.

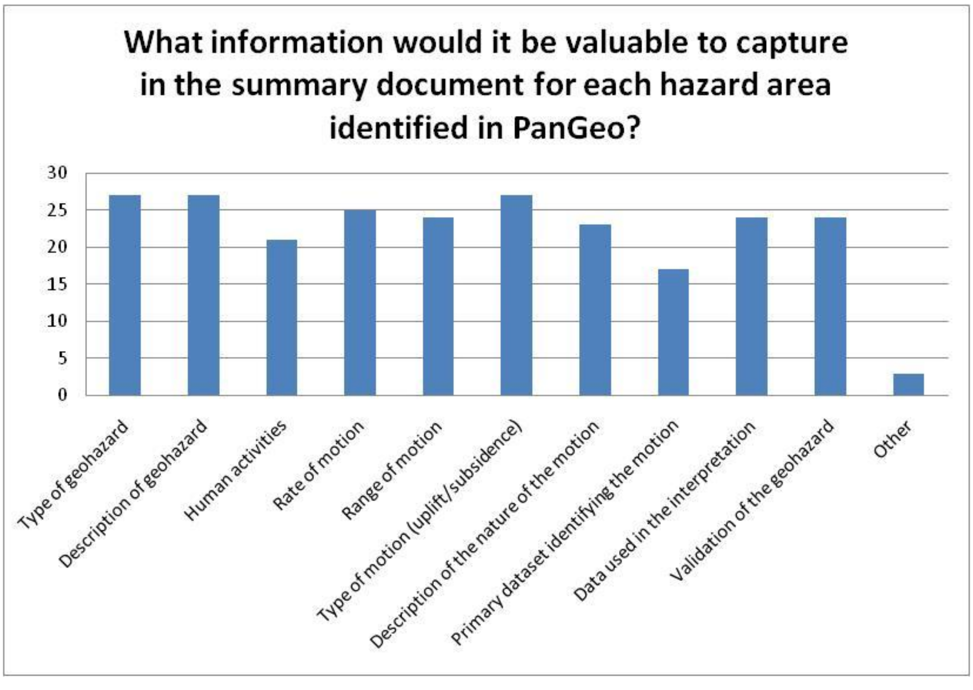


Figure 5 Valuable information to capture in the summary document for each hazard area

A Geohazard Description will be produced for each PanGeo town. The Geohazard Description 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 Geohazard Description 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 Description will be a multilingual document; typically it will be available in English and local language.

5.4.1 Format of the Geohazard Description

- The Geohazard Description will untimely be saved as a PDF document
- The file name will not have any spaces instead these will be replaced by underscores ("_")
- The format of the filename will be *<town-name>_Geohazard_Description.pdf"*

5.4.2 Content of the Geohazard Description report

The following outlines the content of the Geohazard Description. A detailed guide to the content can be found in PanGeo D3.5 Production Manual.

5.4.2.1 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 Description.

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 Appendix one: Glossary of Terms for PanGeo, will be included in each Geohazard Description.

5.4.2.2 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 (for example "PGGH_London_001")*

The polygon ID (as entered into the polygon attributes) needs to be provided as the section heading for all information about that particular polygon. The polygon ID is the same value as entered as an attribute for the polygon. Having the polygon attribute and bookmarked section ID the same will allow the relevant sections of the Geohazard Description to be linked to the polygon in the portal.

The PanGeo Ground Stability Layer polygon ID will take the format of "*PGGH_<townname>_001".* Each ID is unique and numbered sequentially. PGGH stands for **P**an**G**eo **G**eo**H**azard.

Using London as an example the first polygon digitised will be "PGGH_London_001", the second polygon to be digitised will be "PGGH_London_002" etc. The polygon ID **will not** contain any spaces.

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

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. Evidence of the motion

Results of searches for evidence of the areas of instability identified in PanGeo are most likely to arise from field verification and include photographs of resulting damage.

6 OVERVIEW OF PRODUCT GENERATION PROCEDURE

A detailed methodology for generating the PanGeo products is given in the Production Manual (PanGeo Deliverable D 3.5).

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 Production Pack from PSIP
2. Checks content of PanGeo Production Pack
3. Checks various aspects of the PSI Pack as specified in D3.5
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 Description document
11. Submit draft Ground Stability Layer and Geohazard Description to on-line validation tool
12. Prepare deliverables in accordance with INSPIRE

7 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.

7.1 VALIDATION OF TERRAIN MOTION MEASURED BY PSI

The PSI process has been extensively validated in the Terrafirma project resulting in the certification of the PSIPs involved in PanGeo. Outstanding issues, not addressed in the Terrafirma validation are addressed in PanGeo D3.6.1.

7.2 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 Validation.* 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 Description 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.

7.2.1 Outline procedure for the Content Validation

Although a check list will exist it has been agreed that several characteristics of the GSL shapefile can be automatically checked via a "Validating Tool" on the PanGeo website. This tool will check the basics such as completeness of polygons, correct naming convention, and application of correct PanGeo Style Set, etc.

The outline procedure is:

1. The Survey will log onto www.pangeoproject.eu/validate-shp (using the username and password sent out for the initial questionnaire)
2. After logging on a "Validating Tool" link will be visible above the "logout" link on the top left corner of the web page.
3. Clicking on this link allows the Survey to up load a zip file containing the GSL shapefile.
4. The zip file and shapefile names should contain no spaces or special characters & be lowercase.
5. The server performs the automated data-validation checks.

6. If it passes it will be sent on to BGS with an email stating who uploaded it and when. The up-loader is also copied in on the email so they know it has passed.
7. If it does not pass then the reasons for not passing are displayed on the web page. No email is sent to BGS.
8. The user then rectifies any problems until the GSL passes the checks.
9. BGS takes further steps as necessary to complete the compliancy-checking, including checking the Geohazard Description Document.
10. BGS emails Survey with the results of the further checks and grants them permission to go ahead and make the products accessible to the portal.
11. In no event should the Survey make the GSL and GS accessible to the portal until BGS has provided the confirmation.

7.3 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.

8 PRODUCT DISSEMINATION; PANGEO PORTAL

User needs and requirements

While the geological surveys are happy to use geospatial data there appears to be a contrasting ability to deal with geospatial data at the Local Authorities. Those dealing with territorial planning have a capacity to handle geospatial data including aerial or satellite imagery via a Geographical Information System (GIS) interface whereas those responsible for civil protection and emergencies seem more prone to rely on other departments (generally the ones responsible for Information Technologies). Nevertheless, the members of the LAFG stated that they could all deal with the PanGeo service and portal as currently envisioned by the consortium, whether directly, or with the support of their local IT department.

8.1 PRODUCT APPEARANCE

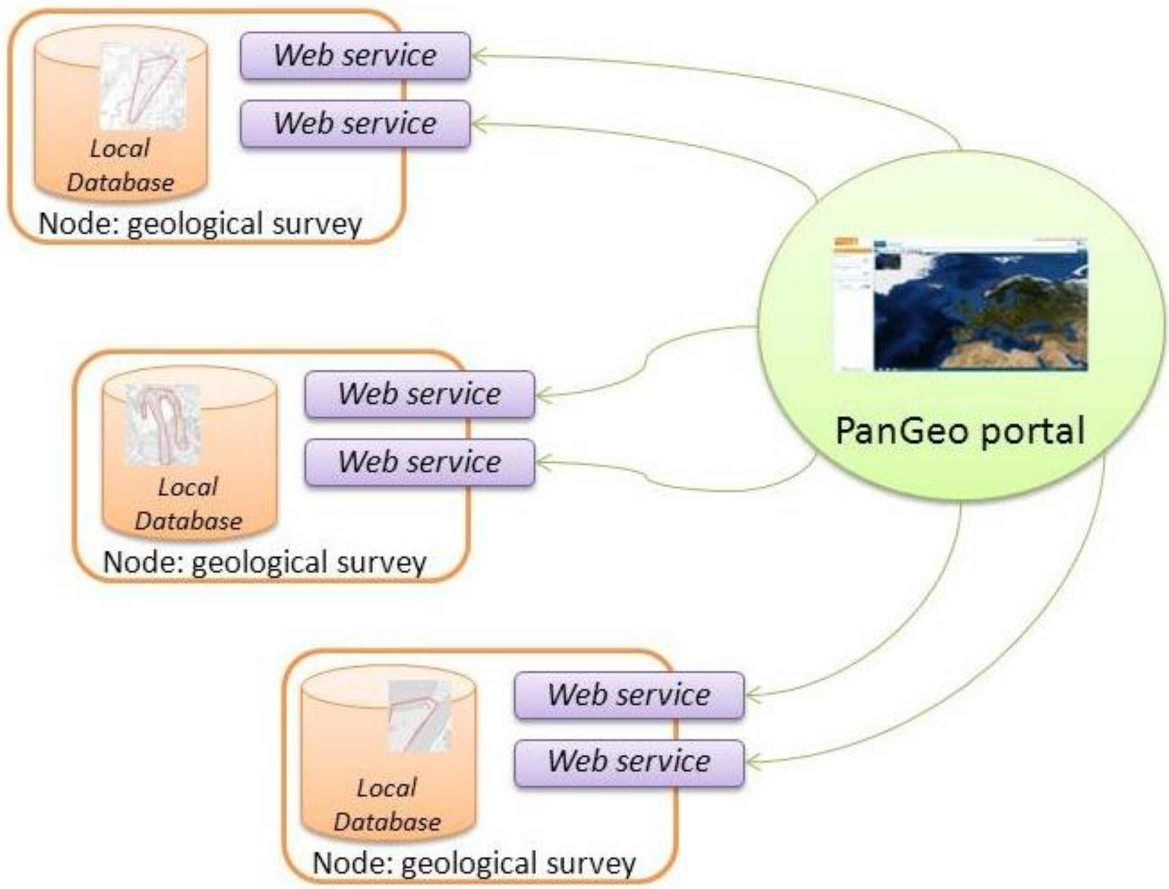
The appearance of the product is driven by the user requirements whilst paying attention to what is technically possible. In order to understand what is technically possible a working group consisting of BRGM, LIG, TNO and SIRS will look at the data model, portal, visualisation and integration of the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

8.2 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.**

8.3 PORTAL APPEARANCE AND FUNCTIONALITY

User needs and requirements

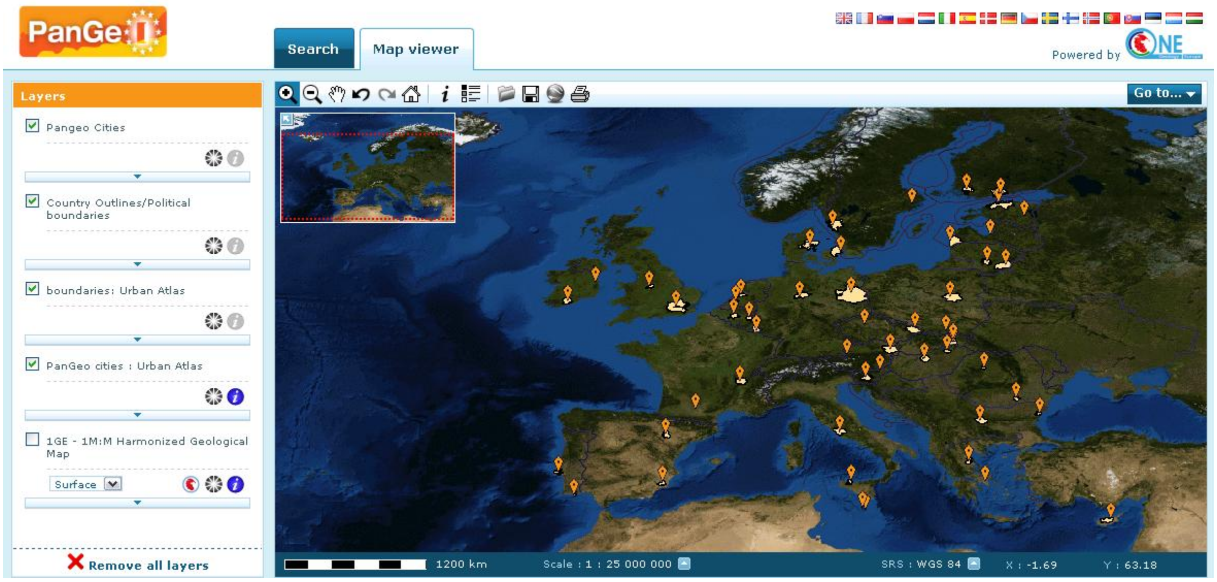
When asked about what should appear on the portal the unanimous response from the Geological Surveys was that polygons outlining terrain motion should be displayed, while twenty-four surveys also asked for the ability to display polygons according to the type of hazard. Twenty-three requested an overview of PanGeo town locations and called for the Urban Atlas polygons to be related to PanGeo hazards/motions.

Additional portal functionality requested by the Geological Surveys includes the ability to turn layers on/off and to identify/query attributes of the polygons. The ability to download and upload data and to change the properties of polygons is also high on the list of functionality requested by the Geological Survey users. Fifteen surveys also requested the functionality to derive statistics such as the percentage of a town affected by hazards. Much of the requested functionality is readily achievable for a portal.

The Local Authorities were also interested in the portals supporting functionality even though they view it principally as a tool for downloading the geohazard data prior to its use in their own GIS. The Local Authorities expressed more interest in downloading the PanGeo product (Ground Stability Layer & the Summary) rather than having it available online i.e. working with it over the Internet.

The Local Authorities agreed that English seems suitable as the (only) language on the portal however it was noted that FR or DE speaking countries may have some concerns.

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 , in this case Open Street Maps
- 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 Description (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 to a 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 "zoom 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).

8.3.1 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 towns, 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 Geological Surveys have completed their interpretations). The statistics can then be displayed on the portal and website.

Examples of the type of statistics that might be provided are:

- General spatial distribution of geohazards by type
- Proportion of the largest towns affected by geohazard type
- Populations affected by geohazard type
- Exposure, by landcover/use class, to geohazards by type
- Communications affected by geohazard type
- The proportion of brown-field sites affected by geohazards, therefore requiring special building controls
- The proportion of critical infrastructure influenced by geohazards
- Landuse classes affected by changes in water table

8.4 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, was completed in mid 2011 when all selected European towns were 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.

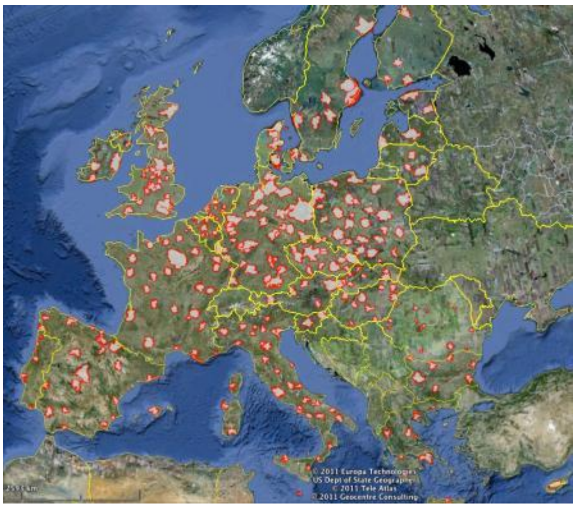


Figure 6: The respective locations of the 305 Urban Atlas LUZs (Larger Unit Zone) selected in the EU-27 member states.

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

The effort is publically 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.

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**).

8.4.1 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/

8.5 INTEGRATION OF THE GROUND STABILITY LAYER WITH THE URBAN ATLAS

User needs and requirements

Local authorities such as Faro and especially Toulouse, who make good use of UA data already, saw an advantage in the integration and display of the UA and GSL on the portal.

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. The current favoured options are provided below, however these may change as completed GSLs become available and more in depth testing is possible. It is possible to change the integration style later in the project as it will be applied to the data on the portal and therefore after the GS have completed their work.

- Description
  - Visualisation of how geohazards identified by PanGeo interact with land use classifications provided by the Urban Atlas (UA) when viewed in the PanGeo portal.
- Purpose
  - Enable users to understand the distribution of land use affected by geohazards contained within the Ground Stability Layer.

Specification

	Inside GSL feature	*Outside GSL Feature*
Colour	Urban atlas colour scheme	Urban atlas colour scheme
Transparency	20%	65%
Feature Boundary	Black	None
Line weight	0.25pt	None
Base Mapping	Google Maps	Google Maps

Table 7*: Summary of design specifications*

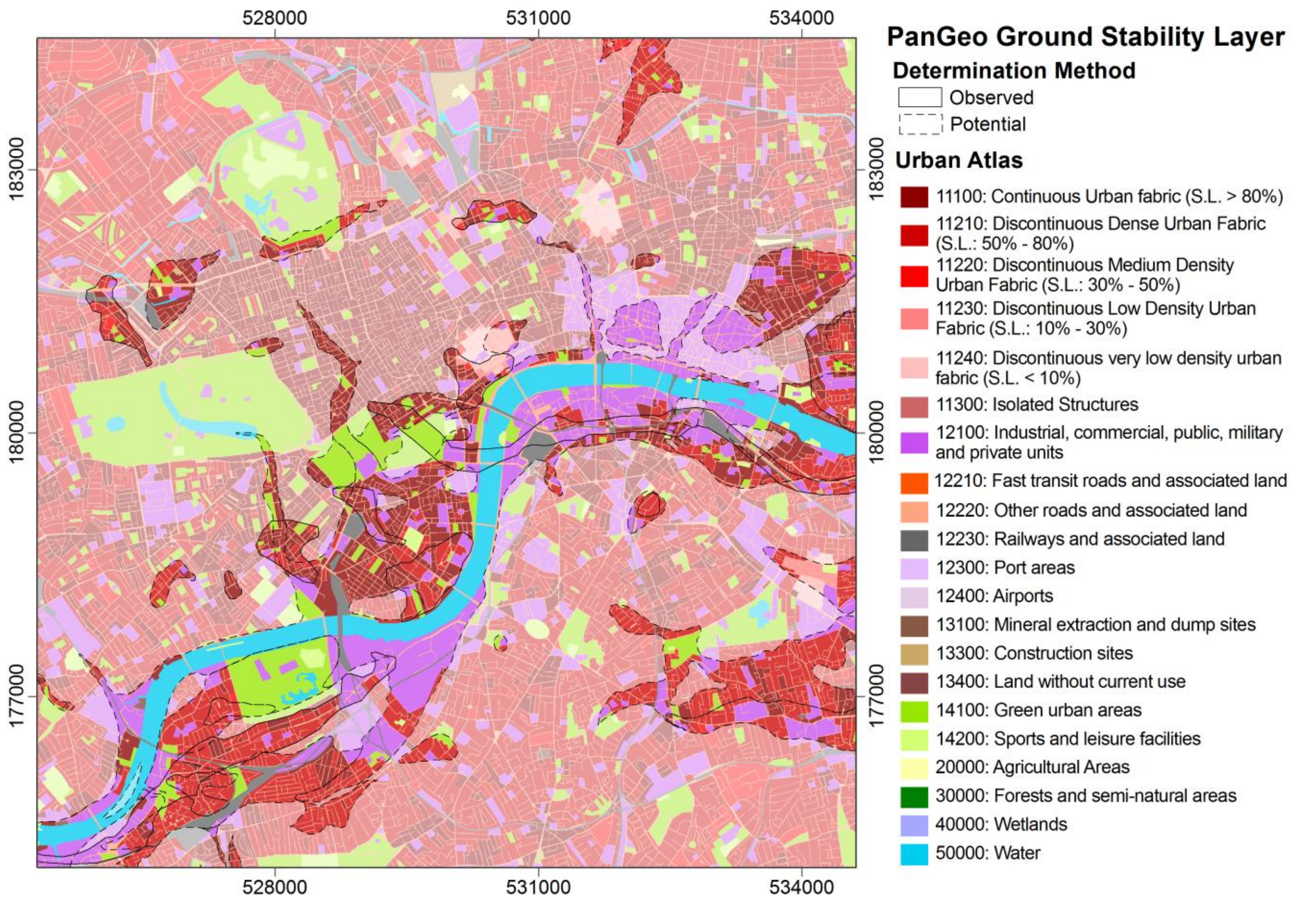


Figure 7: ***Display of Urban Atlas land use classifications, different levels of transparency are used to distinguish between areas inside and outside of identified geohazard areas.***

9 LEGAL NOTICES

See PanGeo Deliverable D3.8

10 PANGEO WEBSITE

See PanGeo dossier D4.2

11 CONCLUSION

This document sets out the specification for the PanGeo service, the detailed instructions that each geological survey will follow to produce a product meeting these specifications are given in D3.5 the Production Manual.

APPENDICES

APPENDIX ONE: GLOSSARY OF TERMS FOR PANGEO

Sources:

- ISDR (2009) *UNISDR Terminology on Disaster Risk Reduction*, UNISDR, Geneva, Switzerland.
- EC DG Environment (2008) *Assessing the potential for a comprehensive community strategy for the prevention of natural and man-made natural disasters*, DG environment, Brussels.
- PanGeo Colleagues: Don Aldiss, Luke Bateson (BGS), David Norbury (European Federation of Geologists, Stephen Gruijters (TNO)

Acceptable risk: The level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions.

Adaptation: The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Building code: A set of ordinances or regulations and associated standards intended to control aspects of the design construction, materials, alteration and occupancy of structures that are necessary to ensure human safety and welfare, including resistance to collapse and damage.

Capacity: The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals.

Capacity development: The process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvements of knowledge, skills, systems and institutions.

Climate change:
a) The Inter-governmental Panel on Climate Change (IPCC) defines climate change as: "a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use".

b) The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".

Coping capacity: The ability of people, organisations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters.

Corrective disaster risk management: Management activities that address and seek to correct or reduce disaster risks which are already present.

Critical facilities: The primary physical structures, technical facilities and systems which are socially, economically or operationally essential to the functioning of a society or community, both in routine circumstances and in the extreme circumstances of an emergency.

Disaster: A serious disruption of the functioning of a community or society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.

Disaster risk: The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period.

Disaster risk management: The systematic process of using administrative directives, organisations and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Disaster risk reduction: The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Disaster risk reduction plan: A document prepared by an authority, sector, organization or enterprise that sets out goals and specific objectives for reducing disaster risks together with related actions to accomplish these objectives.

Emergency: Any situation which has or may have an adverse impact on people, the environment and property.

Emergency management: The organization and management of resources and responsibilities for addressing all aspects of emergencies, in particular preparedness, response and initial recovery steps.

Environmental degradation: The reduction of the capacity of the environment to meet social and ecological objectives and needs.

Environmental impact assessment: Process by which the environmental consequences of a proposed project or program are evaluated, undertaken as an integral part of planning and decision-making processes with a view to limiting or reducing the adverse impacts of the project of program.

Exposure: People, property, systems or other elements present in hazard zones that are thereby subject to potential losses.

Extensive risk: The widespread risk associated with the exposure of dispersed populations to repeated or persistent hazard conditions of low or moderate intensity, often of a highly localized nature, which can lead to debilitating cumulative disaster impacts.

Forecast: Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area.

Geological (Geo) hazard: Geological process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption or environmental damage.

Geohazard types (as used in the PanGeo Ground Stability Layer classification)**:**

DEEP SEATED MOTIONS

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.

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.

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.

Volcanic Inflation/deflation: 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. For PanGeo we are interested in hazards associated with Ground instability. Ground instability associated with Volcanoes tends to relate to inflation and deflation of the ground surface as magma volumes change. Secondary effects such as landslides should be mapped into the other relevant PanGeo geohazard classes.

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.

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 10m 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.

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.

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.

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.

Running Sand/ Liquefaction

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.

Liquefaction of water-saturated soft ground often results as an effect of earthquake activity but can also be triggered by manmade vibrations due to construction works. It can potentially lead to a loss in ground strength and the extrusion of water-saturated sediments as 'mud volcanoes' and the like. Soils vulnerable to liquefaction represent areas of potential ground instability.

NATURAL GROUND MOVEMENT

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.

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.

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.

Ground water management - Shallow compaction

Ground water management may be applied for example to ensure the exploitability of existing agricultural land in lowland coastal areas. Groundwater management can lead to higher or lower water levels of phreatic groundwater and of deeper aquifers in the shallow subsurface. Groundwater occupies pore and interstitial spaces and fractures within sediments and rocks and therefore exerts a pressure. When the water is drained the pore pressure or effective stress is reduced. This leads to consolidation of especially soft sediments, such as clay and peat. This change in the sediment volume leads to subsidence. Similarly when groundwater levels are allowed to recover, uplift may be a result of increasing pore pressure.

Ground water management - Peat oxidation

Ground water management may be applied for example to ensure the exploitability of existing agricultural land in lowland coastal areas. Groundwater management can lead to higher or lower water levels of phreatic groundwater and of deeper aquifers in the shallow subsurface. Peat oxidation is the chemical reaction where peat starts decomposing and will waste away with time. This loss of soil volume leads to subsidence. It occurs when layers of peat in the subsurface are exposed to oxygen. As long as peat is located in saturated ground layers this process does not take place. However peat oxidation does occur in unsaturated soils, for instance in areas where ground water management lowers ground water levels.

Groundwater abstraction

Groundwater also occupies pore and interstitial spaces and fractures within sediments and rocks in the deeper subsurface. When this water is removed, for instance through pumping for drinking water or lowering of water levels in mines, the pore pressure or effective stress is reduced and consolidation of the sediments causes a change in the sediment volume. This leads to subsidence. Similarly when aquifer levels are allowed to recover, uplift may be a result of increasing pore pressure. Deep geothermal energy systems should not lead to ground movement. They involve closed systems where water, which was extracted from a deep aquifer, will be pumped back into that same aquifer. However, geothermal heat pumps are used at shallower depths. Although these are also closed systems, ground movement might occur temporarily (e.g. seasonally) or even permanently.

Mining

Mining is the removal of material from the ground, in the context of PanGeo we consider mining to relate to the removal of solid minerals. The ground surface may experience motion due to readjustments in the overburden if underground mine workings fail.

Underground construction

In PanGeo we are interested in underground construction that might bring about ground instability. An example of this would be underground tunnelling; the removal of subsurface material can alter the support for the overlying material therefore leading to ground motions.

Made ground

Made ground comprises of anthropogenic deposits of all kinds such as land reclamation, site and pad preparation by sand infill, road and rail embankments, levees and landfills for waste disposal. Examples of land reclamation are artificial islands, beach restoration and artificial harbours. Reclaimed land as well as embankments and levees are generally made up of sand, which is not prone to compaction as are clay and peat. However, two ground instability processes will occur: consolidation of this artificial ground and compaction of the ground below due to the load of the artificial ground and the structure it supports, e.g. a building. Depending on its composition and mode of deposition, landfill can also be a compressible deposit.

Oil and Gas Production

Similar to abstraction of groundwater the production of oil and gas decreases the pore pressure of the reservoir rocks and therefore can cause consolidation and subsidence of the surface. Storage of material in the depleted reservoir (such as natural gas or CO2) can lead to surface uplift.

Georisk: The mix of a geohazard with levels of exposure and vulnerability that together constitute a risk.

Hazard: Something with the potential to cause harm.

Intensive risk: The risk associated with the exposure of large concentrations of people and economic activities to intense hazard events, which can lead to potentially catastrophic disaster impacts involving high mortality and asset loss.

Land use planning: The process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, including consideration of long-term economic, social and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses.

Mitigation: The lessening or limitation of the adverse impacts of hazards and related disasters.

Natural hazard: Natural processes or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Preparedness:
a) The knowledge and capacities developed by governments, professional response and recovery organisations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts likely, imminent or current hazard events or conditions.
b) A state of readiness and capacity of human and material means enabling them to ensure an effective rapid response to an emergency, obtained as a result of action taken in advance.

Prevention:
a) The outright avoidance of adverse impacts of hazards and related disasters.
b) Any action that supports Member States in preventing risks or reducing harm to people, the environment and property resulting from emergencies.

Public awareness: The extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards.

Recovery: The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.

Residual risk: The risk that remains in unmanaged form, even when effective disaster risk reduction measures are in place, and for which emergency response and recovery capacities must be maintained.

Resilience: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to, and recover from, the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Response: The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected.

Risk: 1) The combination of the probability of an event and its negative consequences. 2) The likelihood that harm will be realised. 3) In geohazard terms, a mix of a hazard, and the vulnerability and exposure to that hazard.

Risk assessment: A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend.

Risk management: The systematic approach and practice of managing uncertainty to minimise potential harm and loss.

Socio-natural hazard: The phenomenon of increased occurrence of certain geophysical and hydrometeorological hazard events, such as landslides, flooding, land subsidence and drought, that arise from the interaction of natural hazards with overexploited or degraded land and environmental resources.

Sustainable development: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Vulnerability: The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.