Grant Agreement No.: 226479

SafeLand

Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies

7th Framework Programme
Cooperation Theme 6 Environment (including climate change)
Sub-Activity 6.1.3 Natural Hazards

Deliverable 2.3

Overview of European landslide databases and recommendations for interoperability and harmonisation of landslide databases

Work Package 2.1 – Harmonisation and development of procedures for quantifying landslide hazard

Deliverable/Work Package Leader: JRC Revision: 1 – Final

August, 2011

Rev.	Deliverable Responsible	Controlled by	Date
0	JRC	UPC	30 Apr 2011
1	JRC		08 Aug 2011
2			

SUMMARY

The EU-FP7 SafeLand project focuses on the different topics related to quantitative landslide risk assessment (QRA) at local to national scales. Landslide databases, usually including inventory maps and linked alphanumeric information, are the most important input data in landslide risk assessment. However, to allow quantitative landslide hazard and risk assessment they should contain information on the location of landslide phenomena, types, history, state of activity, magnitude or size, failure mechanisms, causal factors and the damage caused. Yet, it is not known which national (or regional) landslide databases contain all this information, and thus allow QRA. Therefore this study makes a detailed review of existing national landslide databases in Europe together with a number of regional databases and proposes improvements for delineating areas at risk in agreement with the EU Soil Thematic Strategy and its associated Proposal for a Soil Framework Directive, and for achieving interoperability and harmonisation in agreement with INSPIRE Directive. This report is based on the analysis of replies to a detailed questionnaire sent out to the competent persons and organisations in each country, and a review of literature, websites and main European legislation on the subject.

Note about contributors

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CONTENTS

1 INTRODUCTION

Landslide databases, or digital landslide inventories, constitute a detailed register of the distribution and characteristics of past landslides (Hervás, in press). Landslide databases are a key infrastructure for landslide susceptibility, hazard and risk assessment and management, as well as for disaster emergency management. For risk assessment, four types of data layers are required: landslide inventory data, geo-environmental factors, triggering factors, and elements at risk. Of these, the landslide database storing attributes allocated to individual landslides (Dikau et al., 1996) is the most important.

The production of landslide databases is a tedious procedure. In contrast to other natural hazards (e.g. floods, earthquakes) which affect large areas, landslides are generally isolated, localised features which individually may not be very large in size but which can occur with a high frequency in a region. They have to be mapped and described one by one, and each one may have different characteristics.

It is relatively well known that in Europe many countries have or are creating national and/or regional landslide databases. Yet, up to now only few attempts have been made to obtain an overview of such databases (Dikau et al., 1996; EEA, 2010). Dikau et al. (1996), however, only presented the situation in seven European countries as it was in the mid 1990s. An update was urgently needed, because during the last 15 years important changes have taken place. First, computer hardware and software have evolved considerably. Now it is easier to create relational databases, i.e. to link spatial and alphanumerical data. Hence, an evolution of paper document archives consisting of inventory maps and separate data sheets for each landslide to digital, relational landslide databases was expected. Secondly, new European legislation has emerged with the EU Soil Thematic Strategy and its associated Proposal for a Soil Framework Directive (EC, 2006a,b) and with INSPIRE, the European Directive establishing an Infrastructure for Spatial Information in the European Community (EC, 2007a).

To have a more up to date overview of national landslide inventories in Europe, Italy's Institute for Environmental Protection and Research (ISPRA) carried out a short enquiry consisting of eleven questions regarding landslide inventory maps with the support of the Association of Geological Surveys of Europe (EuroGeoSurveys) in 2009 (EEA, 2010). The main findings of this survey were that many European countries currently have a national landslide inventory map, but that they are highly variable with regard to resolution and level of information. The inventories were also not always available to the public.

The EU-FP7 SafeLand project focuses on the different topics related to quantitative landslide risk assessment (QRA) at local to national scales. As mentioned before, landslide databases, including not only inventory maps but also linked attribute data, are the most important input in landslide risk assessment. However, to allow quantitative landslide hazard and risk assessment they should contain information on the location of landslide phenomena, the types, date or frequency of occurrence, state of activity, magnitude or size, failure mechanisms, causal factors and the damage caused (Fell et al., 2008). Yet, it is not well known which national (or regional) landslide databases contain all this information, and thus allow QRA. Therefore the objectives of this study are to make a detailed review of existing national landslide databases in Europe and to propose improvements for delineating areas at risk in agreement with the EU Soil Thematic Strategy and its associated Proposal for a Soil Framework Directive, and for achieving interoperability and harmonisation in agreement with the INSPIRE Directive. To meet these objectives a detailed questionnaire was created and sent out to the competent persons in each European country, and a review of literature, websites and main European legislation on the subject was carried out. The analysis of the replies to the questionnaire and the above mentioned documentation is the basis of this report.

2 QUESTIONNAIRE

For analysing national and regional landslide databases in Europe, a comprehensive questionnaire was created. Inspiration was taken from previous and published questionnaires on landslide inventories (Di Mauro et al., 2003; Dikau et al., 2006; RAMSOIL, 2007-2008; Schweigl and Hervás, 2009). We also checked the content of some publically available landslide databases both in Europe and outside Europe to make our enquiry as complete as possible. For the questions related to INSPIRE, the competent persons were contacted (see section 2.7 and 5.2).

Before sending out the questionnaire, it was reviewed for completeness and clearness by Prof. J. Corominas (UPC), the leader of SafeLand's Work Package 2.1 and Dr. J.P. Malet (CNRS). The latter reviewer filled-in the questionnaire on the national landslide database of France and estimated the time needed to answer the questions to be about one hour.

The final questionnaire consists of 10 sections which are preceded by a short introduction providing background information to the persons contacted. More details can be found in the next paragraphs.

This section contains only information on the structure of the questionnaire. The questionnaire itself can be found in Annex A.

2.0 INTRODUCTION TO THE QUESTIONNAIRE

The first page of the questionnaire provides general information on the SafeLand project and more specific information on this study on landslide databases in Europe. We also briefly explain by whom persons can receive this questionnaire (by a SafeLand project partner in their country or directly by JRC) and what we would like them to do with it. The latter could be either to distribute the questionnaire to the competent person in their country or to fill it in themselves. At the end of this introduction we provide the address to which contacted persons can directly send the completed questionnaire.

2.1 CONTACT INFORMATION

The first part of the actual questionnaire deals with contact information of the institute and the person responsible for the landslide database.

2.2 DATABASE AVAILABILITY

The second part of the questionnaire collects information on the type of landslide database that is available or in preparation. Priority was given to national landslide databases. However, for countries for which no national inventory was available, attempts were made to collect information on regional landslide databases. Additional information on regional landslide databases was also collected for some countries which have a national database. In this case the regional databases are generally official documents as for example the databases used by the local Italian Basin Authorities.

2.3 GENERAL INFORMATION OF LANDSLIDE DATABASE

The third part of the questionnaire contains general information on the landslide database. Questions deal with the area covered by the database (i.e. whole country or region), the language used, the date of first creation, the recurrence time for updating, the time period of landslide events covered (e.g. all landslides from pre-Holocene to 2010 or landslides reported in historical documents after 1950), and the presence of other natural hazards (e.g. floods, snow avalanches) in the database. It further contains questions on the actual number of recorded landslides, the proportion of the country affected and the estimated completeness (i.e. percentage of existing landslides that are currently included in the database). Throughout the questionnaire four possible classes are suggested in case of questions related to the completeness of a certain feature in the database, i.e. <25%, 25-50%, 50-75%, >75%. A final question deals with the use of the landslide database for susceptibility, hazard or risk assessment by the institute responsible for the maintenance of the database or by another institute.

2.4 CONTENT OF LANDSLIDE DATABASE

The most comprehensive section of the questionnaire deals with questions related to the content of the landslide database. It contains for example questions related to the landslide inventory map (scale, reference coordinate system, representation of the landslides, mapping techniques, etc.), the landslide location, the landslide types, the type of landslide dimensions provided, the availability of triggering factors, landslide date/history and activity, and information on consequences.

2.5 FORMAT OF LANDSLIDE DATABASE

As the evolution in computer systems has allowed transition from document repository (including maps) to digital, relational databases, the fifth part of the questionnaire collects information on the format of the spatial and alphanumeric database and the software platform used. To use the collected landslide information for landslide zoning, the availability of digital landslide data is a prerequisite.

2.6 CONDITIONS TO ACCESS AND USE OF LANDSLIDE DATABASE

Interoperability of landslide databases would allow production of cross-boundary landslide susceptibility, hazard and risk assessments, and eventually, creation of a harmonised European landslide database. Therefore section 6 collects information on the access and use constraints of the landslide database.

2.7 INFORMATION RELATED TO INSPIRE

INSPIRE is an EU directive to establish an infrastructure for spatial information in Europe that will help to make spatial or geographical information more accessible and interoperable for a wide range of purposes supporting sustainable development (see section 5.2 and http://inspire.jrc.ec.europa.eu for more information). In the beginning of November 2009, a Call for Expression of Interest for participation in the development of INSPIRE data specifications for Annex II & III Data Themes was launched (http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2). One of the Annex III Data Themes considers "Natural risk zones", among which landslides. Hence, in the near future implementing rules laying down technical arrangements for interoperability and harmonisation of landslide databases will be developed. So far, only questions related to the implementation of the metadata regulations and network services could be asked. Apart from that, also the willingness of the institutes to collaborate to the development of the INSPIRE regulation is verified.

2.8 AVAILABILITY OF OTHER DATA FOR LANDSLIDE HAZARD AND RISK ASSESSMENT

As mentioned in the introduction, the landslide database is only one of the four types of data layers needed for landslide risk assessment. The other three are data layers related to controlling and triggering factors, and elements at risk. In section 8 of the questionnaire, the availability of these layers is investigated. With regard to the controlling factors, we more specifically survey the presence of digital elevation models, and lithology, soil, land cover and land use maps. For climate and seismicity, we respectively check the presence of precipitation and temperature and of magnitude, intensity or peak ground acceleration. Data on elements at risk include data on population, buildings, engineering works, economic activities, public services utilities, infrastructure and environmental features.

Contact persons are asked to provide the official name, full reference, publication date and map scale or resolution of the available datasets.

2.9 ADDITIONAL INFORMATION

At the end of the questionnaire the responsible of the landslide database was asked to provide an example of a database sheet and an excerpt of the landslide inventory map. Also additional information such as scientific publications could be provided. If necessary, the responsible could also provide additional information that according to his/her experience was necessary for our interpretation of the landslide database.

2.10 GLOSSARY

Taking into account that currently not all nations are using the same landslide terminology, a short glossary adopted in SafeLand was provided as an annex to the questionnaire (see Annex A).

3 PERSONS/ORGANISATIONS CONTACTED

The competent persons in the organisations responsible for national or regional landslide databases in EU member states, EU candidate and potential candidate countries as well as in EFTA countries could receive the questionnaire in two ways. For countries represented in SafeLand's Area 2 (quantitative risk assessment), a project partner was contacted and asked to distribute the questionnaire to the competent person in his/her country or in a neighbouring country he/she collaborates with (e.g. project partners in Norway were asked to contact institutes in Sweden, Finland and Denmark). In case contacted persons did not speak English, project partners were asked to help them filling in the questionnaire or to translate the questionnaire. In some cases the contacted project partner himself was able to complete the questionnaire (e.g. France). For the remaining countries, JRC directly contacted national and regional Geological Surveys, universities or other institutes.

In total JRC sent the questionnaire to 11 project partners, who in turn forwarded it to 20 persons responsible for a national or regional questionnaire. Additionally, JRC sent out the questionnaire to 32 persons (Fig. 3.1). Generally the competent persons worked at the Geological Survey or in a university or research institute. In some countries, finding out the competent organisation involved a long, iterative contacting process. A literature and website research also helped on this task.

The filled-in questionnaires were returned to JRC by SafeLand project members or directly by the responsible of the database. All data was collected and checked for completeness. In a second phase, some contact persons were requested to clarify certain answers or to provide complementary information.

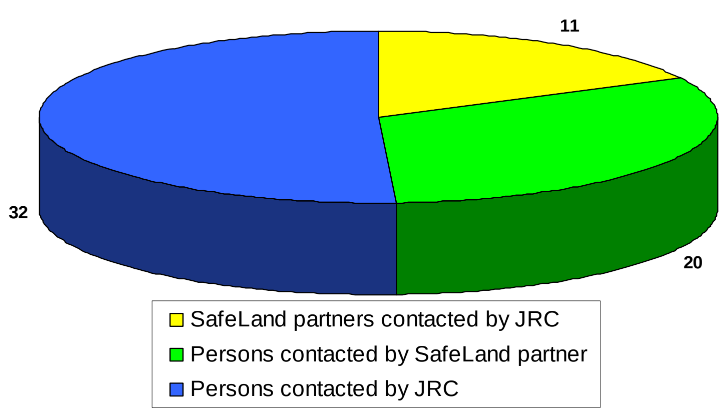


Figure 3.1: Persons contacted for distributing or filling in the questionnaire on national and regional landslide databases in Europe.

4 RESULTS

4.1 DISTRIBUTION OF NATIONAL AND REGIONAL LANDSLIDE DATABASES IN EUROPE

Thirty-three out of 37 European countries contacted replied to our survey. Moreover, for some of the countries that did not respond to our request, we probably did not find the competent persons although several attempts were made. Twenty-two out of 37 countries currently have or are constructing a national landslide database (Fig. 4.1; Table 4.1).

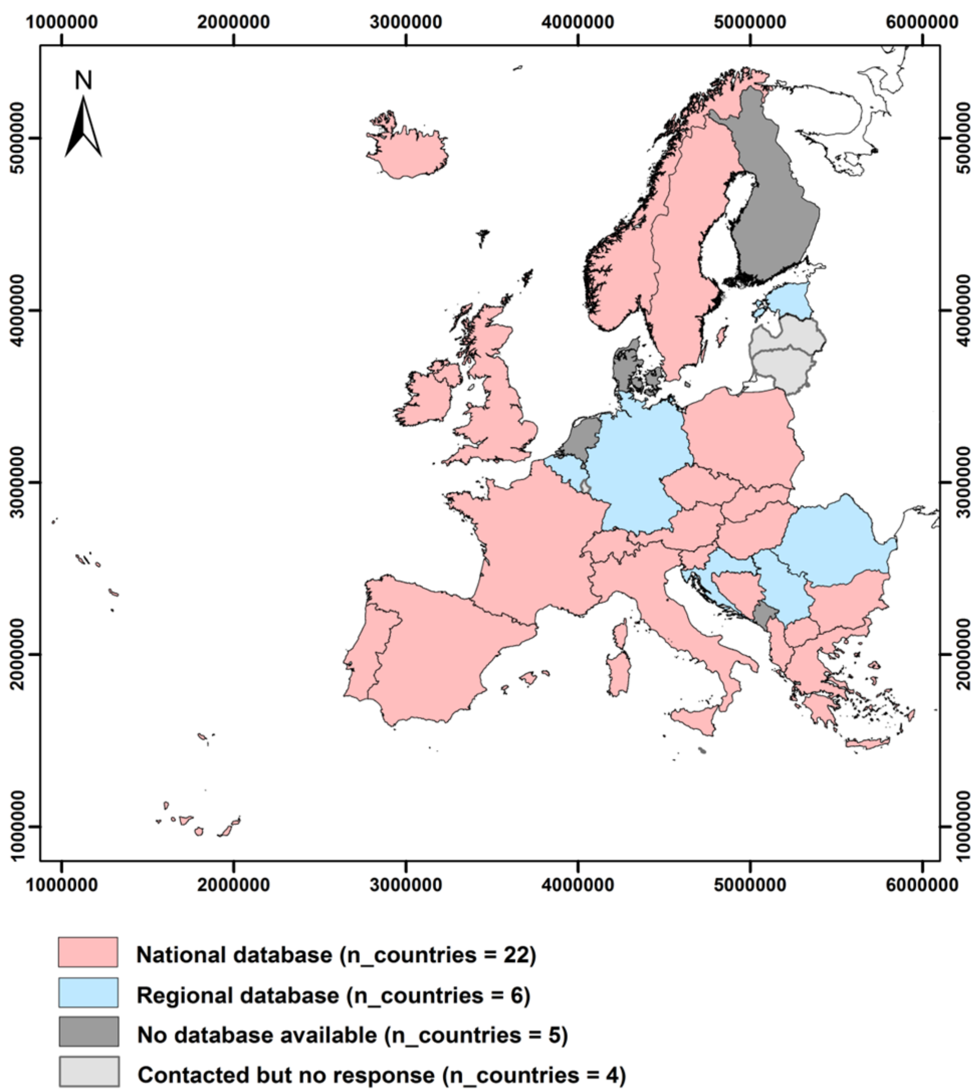


Figure 4.1: Distribution of national landslide databases in EU countries, EU official candidate and potential candidate countries and EFTA countries, and regional databases in countries where no national database exists. We refer to Figure 4.2 for location of the regional databases.

For six other countries (Belgium, Croatia, Estonia, Germany, Romania, Serbia) only information on regional landslide databases was available (Table 4.2; Fig 4.1 and 4.2). This can be due to the fact that the construction of a landslide database is a regional responsibility (e.g. Germany with regional databases for Bavaria, Rheinland-Pfalz and Saxony and Belgium with a regional database for Flanders) or that landslide databases are only constructed for the regions that are most affected by landslides (e.g. Estonia). Information on regional landslide databases was also obtained from four countries with a national database. For Austria and Portugal, we received information of one database. For Spain, we received information for two databases. For Italy, information of eight databases of which seven maintained by river basin authorities was collected (Fig. 4.2). Finally, five countries reported that they currently do not have a landslide database (Fig. 4.1). In total, the databases contain more than 636,000 landslides, of which about two thirds are located in Italy, but also Austria, Czech Republic, France, Norway, Slovakia, and UK have more than 10,000 landslides in their database (Table 4.3).

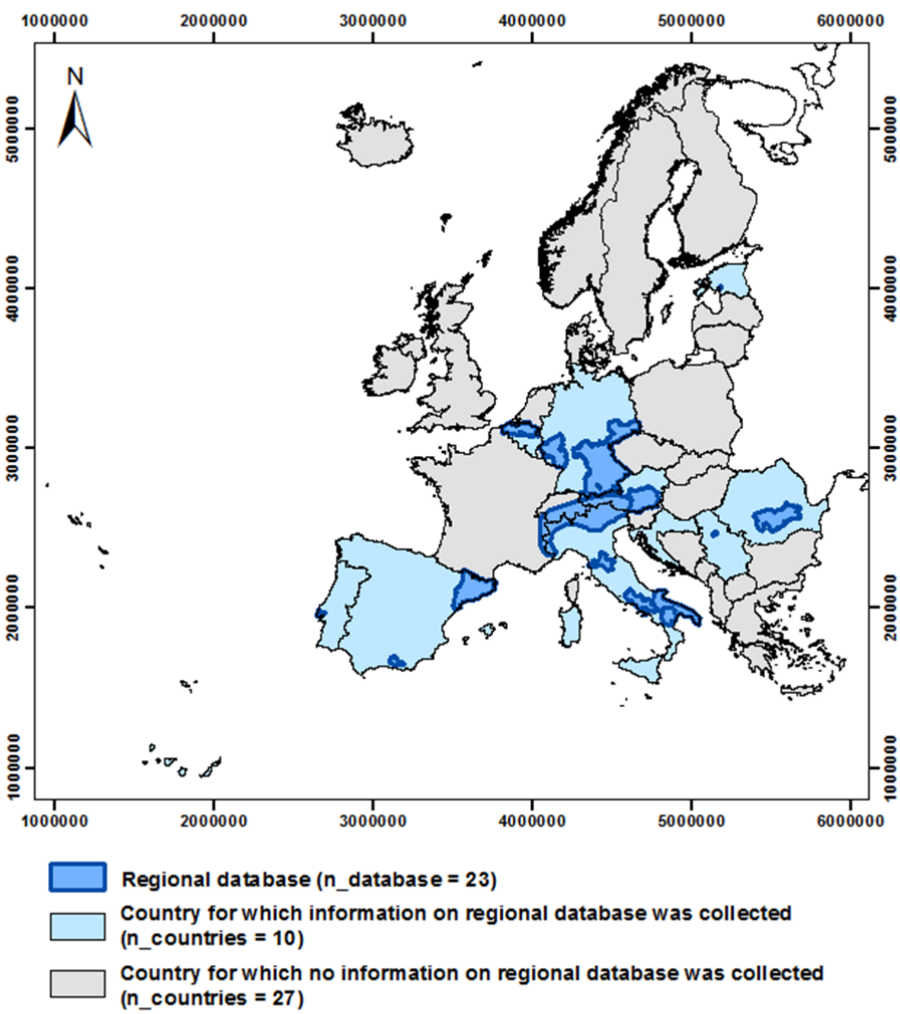


Figure 4.2: Distribution of regional landslide databases in EU countries, EU official candidate and potential candidate countries, and EFTA countries surveyed in this study.

Important to note is that not all countries have decided to create a landslide database that is as complete as possible. The database of Switzerland, for example, contains only the 317 most relevant landslide events, and the Swedish Natural Hazards Information System contains only detailed landslide information of the 17 most severe landslides. This information system not only contains landslides but is a general natural hazard database that has not the goal to encompass all landslides, storms, floods, etc., that have ever occurred in Sweden. The database focuses on those events of which lessons can be learnt with regard to management.

Table 4.1: Overview of landslide-related national databases in Europe: name, owner and weblink of database. Countries for which only regional landslide databases are available are not included as they are separately listed in Table 4.2.*
(Dept.: Department; Inst.: Institute; Min.: Ministry; Univ.: University; n.a.: reported that database was not available; /: no response)

Country	Database name	Owner (not necessarily producer)	Weblink
Albania	Landslide database	Albanian Geological Survey	n.a.
Andorra	Natural hazard database of Andorra**	Andorran Research Inst. (IAE)	http://www.cenma.ad/mbaseriscos.htm
Andorra	Terrain zonation according to geological-geotechnical problems	Andorran Government	http://www.ideandorra.ad/geoportal/framesetup.asp
Austria	GEORIOS	Geological Survey of Austria (GBA)	http://geomap.geolba.ac.at/MASS/index.cfm
Bosnia and Herzegovina	The engineering-geology map Federation of Bosnia and Herzegovina	Federal Geology Survey	n.a.
Bulgaria	Map of landslides (no real specific name)	Min. of Regional Development and Public Works	n.a.
Cyprus	n.a.	n.a.	n.a.
Czech Republic	National Landslide Register	Czech Geological Survey	http://www.geology.cz/app/dbsesuvy (intranet; not publically accessible)
Denmark	n.a.	n.a.	n.a.
Finland	n.a.	n.a.	n.a.
Former Yugoslav Rep. of Macedonia	Landslide Cadastre	Min. of Economy, sector for mineral resources	n.a.
France	National Database of Ground Movements (BDMvT)	French Geological Survey (BRGM)	http://www.bdmvt.net
Greece	Geodatabase I.G.M.E./ eng_geol/ ground_failures	Inst. of Geology and Mineral Exploration (IGME)	http://maps.igme.gr/website_ext/igme_master_ext/viewer.htm?ln=en
Hungary	National Landslides Cadastre	Hungarian Office for Mining and Geology	n.a.
Iceland	OLI	Icelandic Meteorological Office (IMO) and Icelandic Inst. of Natural History (IINH)	n.a., weblink will be available in the future

* EU countries, EU official candidate and potential candidate countries (except Turkey), and EFTA countries

Ireland	National Landslide Database	Geological Survey of Ireland	http://www.gsi.ie/mapping.htm
Italy	IFFI Project	Inst. for Environmental Protection and Research (ISPRA)	http://www.sinanet.apat.it/progettoiffi
Latvia	/	/	/
Lithuania	/	/	/
Luxembourg	/	/	/
Malta	/	/	/
Montenegro	n.a.	n.a.	n.a.
Netherlands	n.a.	n.a.	n.a.
Norway	National Landslide Database	Geological Survey of Norway (NGU)	www.skrednett.no
Poland	SOPO	Polish Geological Inst.	n.a.
Portugal	Disaster database	Centre of Geographical Studies, Univ. of Lisbon	n.a
Slovakia	Landslide Register	Geological Survey of the Slovak Republic (SGUDS)	n.a., weblink will be available in the future
Slovenia	GIS_UJME (part of larger database)	Min. of Defence	n.a.
Spain	Spanish Database of Geological Hazards	Geological and Mining Institute of Spain (IGME)	n.a.
Sweden	Swedish Natural Hazards Information System	Swedish Civil Contingencies Agency	http://ndb.msb.se/Default.aspx?l=EN
Sweden	SGI Landslide Database	Swedish Geotechnical Inst. (SGI)	n.a.
Switzerland	InfoSlide	Federal Environmental Office (OFEV)	n.a.
United Kingdom	National Landslide Database	British Geological Survey (BGS)	n.a.

** Not included in the overview of national landslide databases as it is not really a landslide database but rather a landslide hazard map with additional information of some individual landslides

Table 4.2: Overview of the regional databases included in the overview: name, owner and weblink of database.
(Dept.: Department; Inst.: Institute; Min.: Ministry; Univ.: University; n.a.: informed that database was not available; /: no response; P.A.I. Piano stralcio di bacino per l' Assetto Idrogeologico: plan regulating the more urgent aspects of the hydrogeological structure; ADB, Autorità di Bacino: River Basin Authority)

Country (Region)	**Database name**	**Owner (not necessarily producer)**	**Weblink**
Austria (Carinthia)	Landslide Event Cadastre	Geology and Soil Dept., Carinthian Provincial Government	n.a.
Belgium (Flanders)	Mapped landslides in Flanders	Dept. of Environment, Nature and Energy, Flemish Government	http://dov.vlaanderen.be
Croatia (Urbanized areas around Zagreb)	Landslide register	Croatian Geological Survey	n.a.
Estonia (Pärnu town)	Landslides near Pärnu town	Univ. of Tartu, Dept. of Geology	n.a.
Germany (Saxony)	Landslide Database of Saxony	Saxon State office for Environment, Agriculture and Geology (LfLUG)	http://www.umwelt.sachsen.de/umwelt/geologie/9605.htm (only information on the database)
Germany (Bavaria)	GEORISK	Environment Agency (LfU)	www.bis.bayern.de
Germany (Baden-Württemberg)	In progress, questionnaire was not filled in for this reason	Freiburg Regional Council, Regional Office for Geology, Raw materials and mining	n.a.
Germany (Rheinland-Pfalz)	Not specified yet	Regional Office for Geology, Raw materials and mining	n.a.
Italy (Northern Italy)	Alpine Inventory of Deep-Seated Gravitational Slope Deformations	Univ. of Milano-Bicocca	n.a.
Italy (Arno River Basin, Northern Apennines)	Landslide inventory of the Arno river basin	Dept. of Earth Sciences, Univ. Of Florence and Arno River Basin Authority	http://www.adbarno.it
Italy (Campania, ADB Sarno, Provinces of Avellino and Salerno)	P.A.I of Provinces of Avellino and Salerno	Sarno River Basin Authority	http://www.autoritabacinosarno.it/default.asp ; http://www.autoritabacinosarno.it/asp/pianostralcio/piantina.asp
Italy (Campania, ADB Sarno, Province of Napoli)	P.A.I of Province of Naples	Sarno River Basin Authority	http://www.autoritabacinosarno.it/default.asp ; http://www.autoritabacinosarno.it/asp/pianostralcio/piantina.asp
Italy (Basin of Liri-	Landslide inventory	National Basin Authority of Liri-	http://www2.autoritadibacino.it

Grarigliano and Volturno Rivers)		Garigliano and Volturno rivers	
Italy (Parts of Basilicata, Puglia and Calabria)	P.A.I. of AdB Basilicata	National Basin Authority of Basilicata	http://www.adb.basilicata.it/adb/risorseidriche.asp ; www.pcn.minambiente.it
Italy (Apulian Basin Authority territory)	1. P.A.I. of Puglia/ 2. Hydrogeomorphological map of Puglia 3. Landslide Database of Puglia	Apulian Basin Authority	www.adb.puglia.it ; www.sit.puglia.it
Portugal (North of Lisbon)	North of Lisbon Landslides	Centre of Geographical Studies	n.a.
Romania (Prahova, Arges, Dambovita, Valcea, Buzau County)	Landslide inventory	Geological Inst. of Romania (GIR)	n.a.
Serbia (Belgrade, Kragujevac)	Cadastre of landslides and unstable slopes on the territory of Serbia	Min. of Environment and Spatial Planning	n.a.
Serbia (Belgrade area)	BEOSlide	Belgrade Land Development Public Agency, Univ. of Belgrade	n.a.
Spain (Catalonia and Andorra)	LLISCAT	Technical Univ. of Catalonia (UPC)	http://www.lliscat.upc.es
Spain (Sierra Nevada, Granada)	Landslides database of the Southern Slopes of Sierra Nevada, Granada	Univ. of Granada	n.a.

Table: 4.3: Overview of landslide databases in Europe showing number of landslides included and estimated completeness. Note that the table does not provide a complete overview of all regional landslide databases. (NA: not available; NR: no response; ADB, Autorità di Bacino: River Basin Authority)*

Country: Region	**Landslide database**					
	Nation	**Region**	**NA**	**NR**	**Number of Landslides (1)**	**Complete-ness**
Albania	1				210	<25%
Andorra	2				274	
Austria	1				25000	25 - 50%
Austria: Carinthia		1			1000	>75%
Belgium: Flanders		1			291	25 - 50%
Bosnia and Herzegovina	1				1500	25 - 50%
Bulgaria	1				1107	<25%
Croatia		1			1540	50-75%
Cyprus			1			
Czech Republic	1				14178	25 - 50%
Denmark			1			
Estonia: Parnu town		1			28	>75%
Finland			1			
Former Yugoslav Rep. of Macedonia	1				150	50-75%
France	1				10000	>75%
Germany: Saxony		1			310	< 25%
Germany: Bavarian Alps		1			4236	< 25%
Germany: Rheinland-Pfalz		1			1800	>75%
Germany: Baden-Württemberg (2)		1				
Greece	1				2200	25 - 50%
Hungary	1				400	50-75%
Iceland	1				5000	< 25%
Ireland	1				422	25 - 50%
Italy	1				485004	>75%
Italy: Northern Italy		1			2216	>75%
Italy: Arno River Basin		1			27500	>75%
Italy: Campania, ADB Sarno, Provinces of Avellino and Salerno		1			3734	>75%
Italy: Campania, ADB Sarno, Province of Naples		1			465	>75%
Italy: Basin of Liri-Grarigliano and Volturno Rivers		1			32247	>75%
Italy: Parts of Basilicata, Apulia and Calabria		1			17233	25 - 50%
Italy: Apulian Basin Authority territory		1			1476	>75%
Italy: Apulia Region		1			1614	>75%
Latvia				1		

* EU countries, EU official candidate and potential candidate countries (except Turkey), and EFTA countries

Lithuania				1		
Luxembourg				1		
Malta				1		
Montenegro			1			
Netherlands			1			
Norway	1				31500 (3)	< 25%
Poland	1				1000	< 25%
Portugal	1				163	< 25%
Portugal: Region north of Lisbon		1			2500	< 25%
Romania: Prahova, Arges, Dambovita, Valcea, Buzau County		1			>2000	50-75%
Serbia: Belgrade, Kragujevac		1			1160	< 25%
Serbia: Belgrade		1			110	50-75%
Slovakia	1				21190	>75%
Slovenia	1				6602	25 - 50%
Spain	1				900	< 25%
Spain: Catalonia and Andorra		1			400	< 25%
Spain: Sierra Nevada, Granada		1			500	>75%
Sweden	2				416	50-75%
Switzerland	1				317	< 25%
United Kingdom	1				15210	
Total	24	22	5	4	636445(4)	

(1) Situation spring 2010
(2) Under construction
(3) Including snow avalanches
(4) For countries for which both information on national and regional landslide databases was collected only the number of landslides in the national landslide database is accounted here.

It might be interesting to note that the map shown in Figure 4.1 is somehow different from the map published by EEA (2010). First, the map in Figure 4.1 additionally shows countries not having a nation-wide database but having regional databases. Actually, the map by EEA (2010) incorrectly shows the presence of national scale landslide inventories in Belgium and Romania. For Belgium, a landslide database is only available for Flanders and not for Wallonia. For Romania, information on landslides that have caused damage should be gathered as paper sheets in archives by regional (county level) authorities. The available information is currently quite heterogeneous and needs ordering (in time and place) before it can be transformed in a landslide database. Second, EEA (2010) reported the existence of national landslide databases in Finland and Luxembourg. For Finland, several contacted experts informed us that no database is available. There is only a report on landslides in the country made by the Finnish Environment Institute (Ollila, 2002), which contains an overview of known landslides in the country. Third, we obtained filled in questionnaires for two national landslide databases in Sweden and one in Portugal while EEA (2010) reported the absence of a database in these countries.

Figure 4.3 provides information on the date of the first creation of the landslide databases. Older dates in the figure correspond to the creation of paper document archives consisting of inventory maps and separate data sheets. For some databases we received information on the first creation and on the transition of the paper archive into a digital database. For Bulgaria, Austria and Czech Republic, for example, already in 1963, 1965 and 1997 a paper document archive was constructed, and from 1999, 2001 and 2007 these archives were transformed into digital ones. France is one of the first countries that started with the creation of a digital landslide database. From 1994 the French Geological Survey (BRGM) together with Laboratoire Central des Ponts et Chaussées (LCPC), Institut National de l'Environnement et des Risques (INERIS) and Service de la Restauration des Terrains en Montagne (RTM) started creation of a ground movements spatial database of France called BDMvt (Table 4.1), initially combining existing landslide databases, among which ZERMOS (Zones Exposées à des Risques aux Mouvements du Sol et du sous-sol; BRGM). The latter was created in the 1970s and included both landslide susceptibility zonation and landslide outlines.

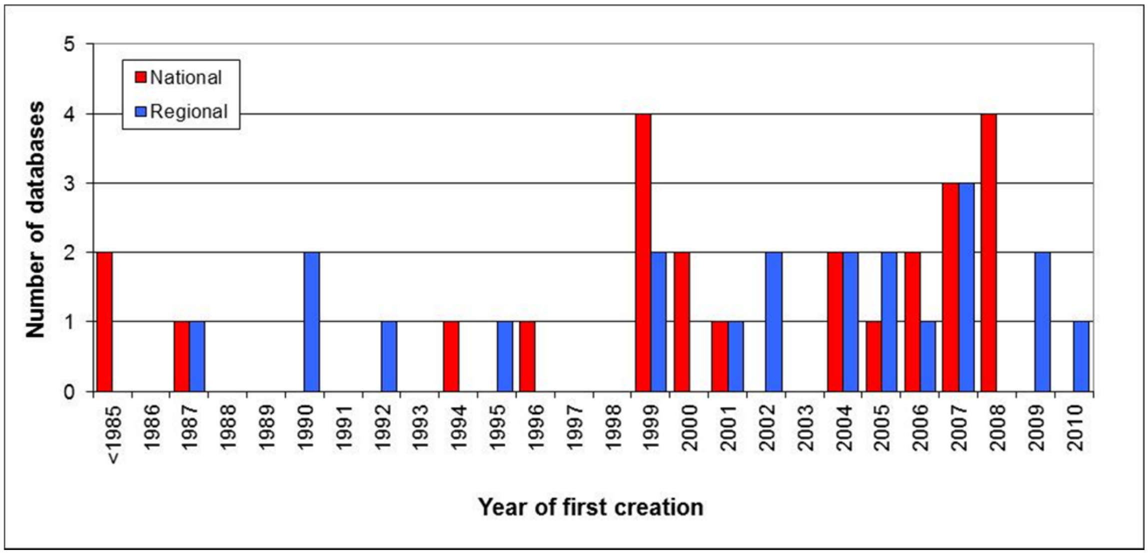


Figure 4.3: Date of first creation of the landslide databases. If dates for creation of paper archives and digital databases were provided, the latter are shown in the graph. The older dates in the graph refer to landslide databases for which only the creation date of the paper archive was provided.

4.2 ANALYSIS OF NATIONAL LANDSLIDE DATABASES

In this section the national landslide databases are discussed. It was decided to exclude the "Terrain zonation according to geological-geotechnical problems" map of Andorra as this is not really a landslide database but a landslide hazard map with additional information of some individual landslides (Table 4.1). For Sweden, we received information of two different national landslide databases. Therefore, this overview contains 23 national databases of 22 different EU countries, EU official candidate and potential candidate countries, and EFTA countries.

4.2.1 General information

The national databases discussed in this section are generally official documents, but most of them are not regulatory (Fig. 4.4). They are mainly produced for use within the country, so that almost all databases are only available in the official language of the country. Exceptions are Austria, Greece, Italy and Sweden, which provide at least part of the landslide information in English (Fig. 4.5, 4.6).

Thirteen of the 23 databases contain other natural hazards than landslides. These include earthquakes, floods, extreme precipitation, extreme temperatures, snow avalanches, storms, coastal erosion, subsidence and sinkholes.

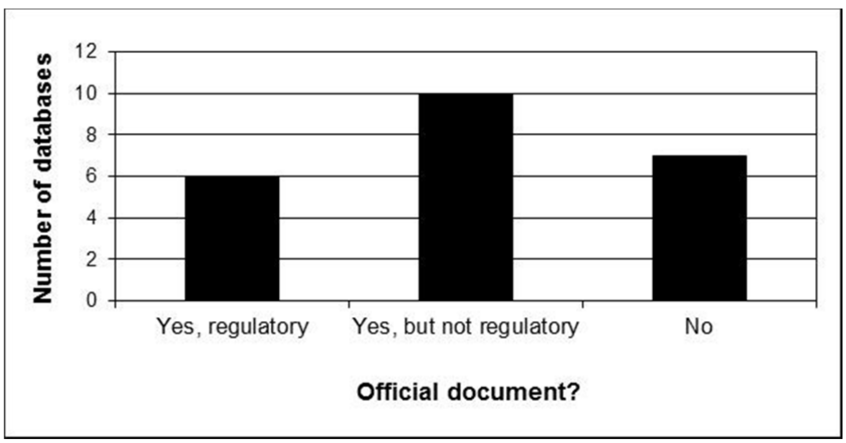


Figure 4.4: Legal value of the national landslide databases.

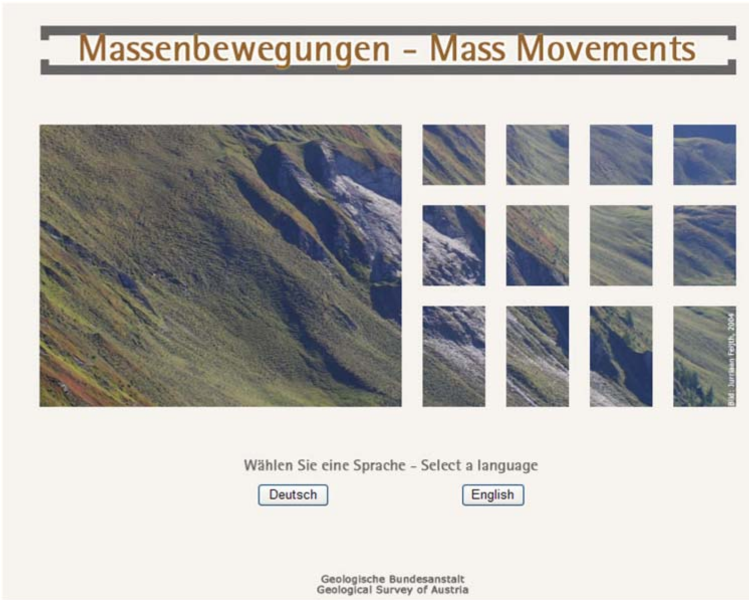


Figure 4.5: On the web interface of the published national landslide database of Austria, one can choose between German and English (http://geomap.geolba.ac.at/MASS/index.cfm; March, 2011).

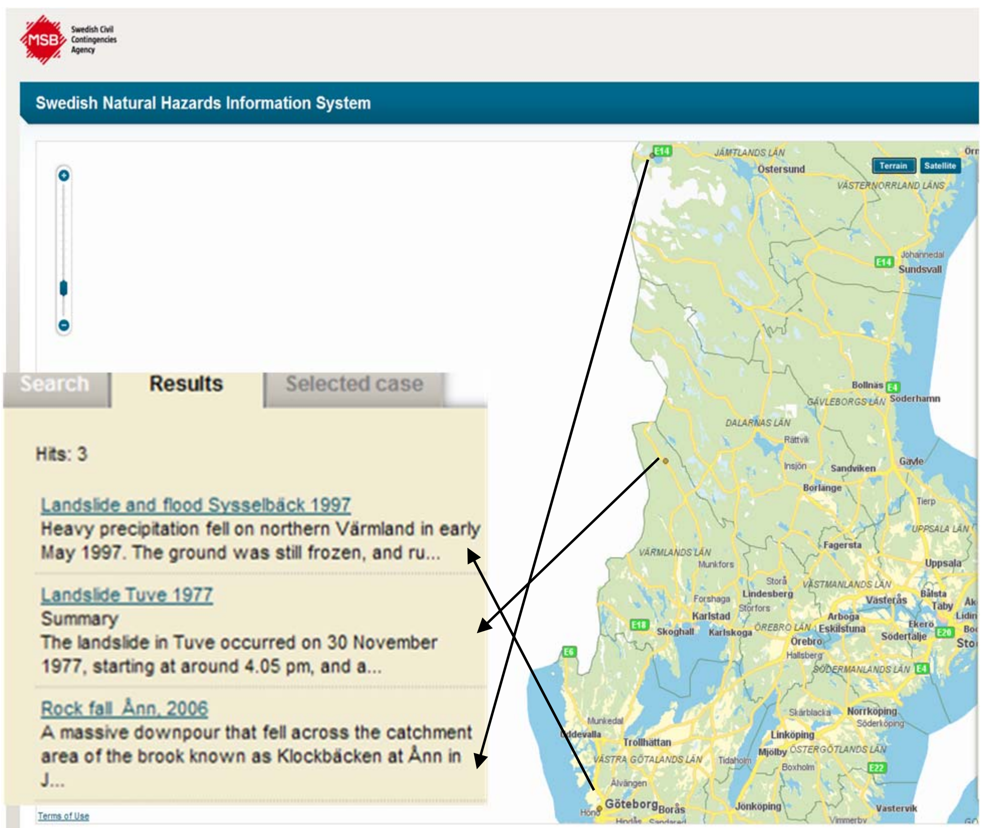


Figure 4.6: On the web interface of the national landslide database of Sweden, the information of the limited number of reported landslide events can be consulted in English (http://ndb.msb.se/Default.aspx?l=EN; March, 2011).

The collection of landslide information at the national and regional scales is an elaborate task. Although most countries try to include as many landslides as possible, the completeness of most of the databases is estimated lower than 50% of all landslides that have ever occurred in the country (Fig. 4.7, 4.8). Databases of France, Italy and Slovakia are estimated to be most complete.

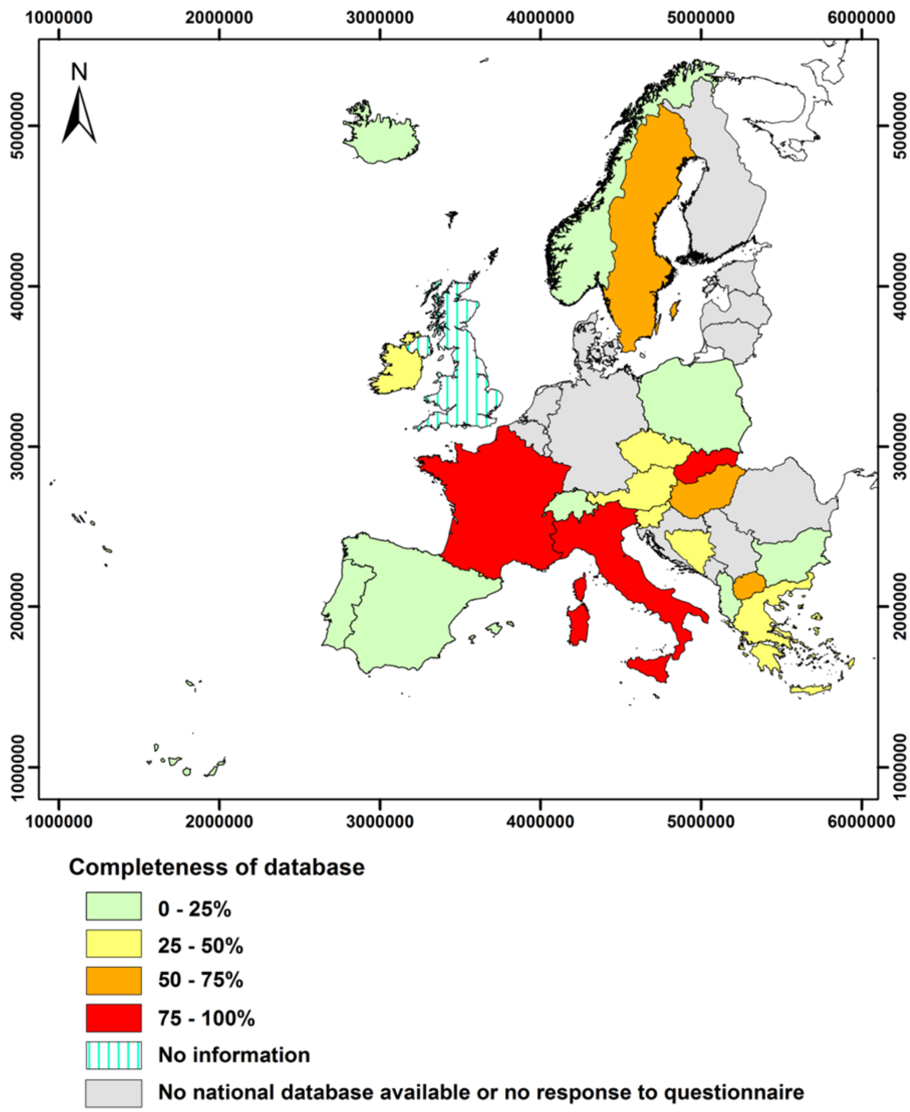


Figure 4.7: Estimated completeness of national (n=23) landslide databases in Europe.

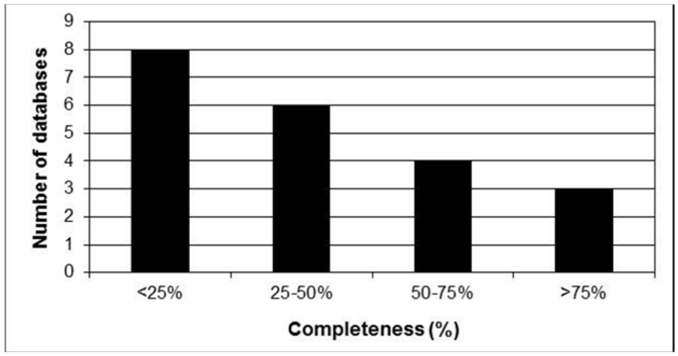


Figure 4.8: Estimate of the completeness of national landslide databases.

The completeness of a database might be related to its objectives, the time span of landslide events covered, and the methodology (see further) and resources employed. There is a large variability among the countries with databases including landslides with pre-Holocene origin to databases including only the landslides that occurred after 2000 (Table 4.4).

Table 4.4: Oldest landslides included in national landslide databases (AC: after Christ).

Period	Number of databases
Pre-Holocene – 1000 AC	2
1000 – 1800 AC	6
1800 – 1900 AC	1
1900 – 1950 AC	4
1950 – 2010 AC	8
No information	2

Figure 4.3 showed the creation date of all the national and regional landslide databases. More important than the creation date is the updating of the databases (Fig. 4.9). For only four out of 23 national landslide databases no updating of the database is foreseen. However, for some of these countries this might change if updating appears to be necessary. The other databases are generally updated at least once a year or after a major event.

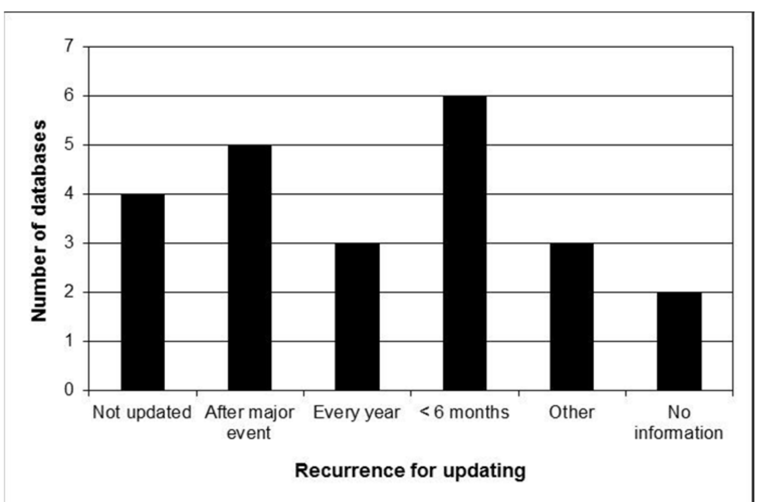


Figure 4.9: Update frequency of the national landslide databases (n = 23).

4.2.2 Content

4.2.2.1 Landslide inventory map

The landslide inventory map is one of the most important parts of a landslide database. Detailed landslide locations are for example necessary for production of landslide susceptibility and other zoning maps and for civil engineering works. Andorra, Spain and Switzerland do not have a landslide inventory map. However, the latter two countries have the landslides coordinates so it should be possible to produce a landslide map in the future. Although most national inventory maps are available in digital form (allowing zooming in and out; see further), the maps were generally created at a certain scale. Landslide inventory maps were created at a scale between 1:10,000 and 1:500,000 with six maps created at a scale of 1:10,000 (Fig. 4.10). With regard to the reference coordinate system used, generally a local coordinate system was used.

Ten of the persons that filled in the questionnaire responded that the database contained information on the spatial accuracy. However, only five of them provided extra information. For Albania, Ireland and UK accuracy is expressed in m. Where possible this is also the case for Norway, while otherwise the accuracy in this database is specified as certain or uncertain. France has three accuracy levels: the municipality, the local site or the exact location.

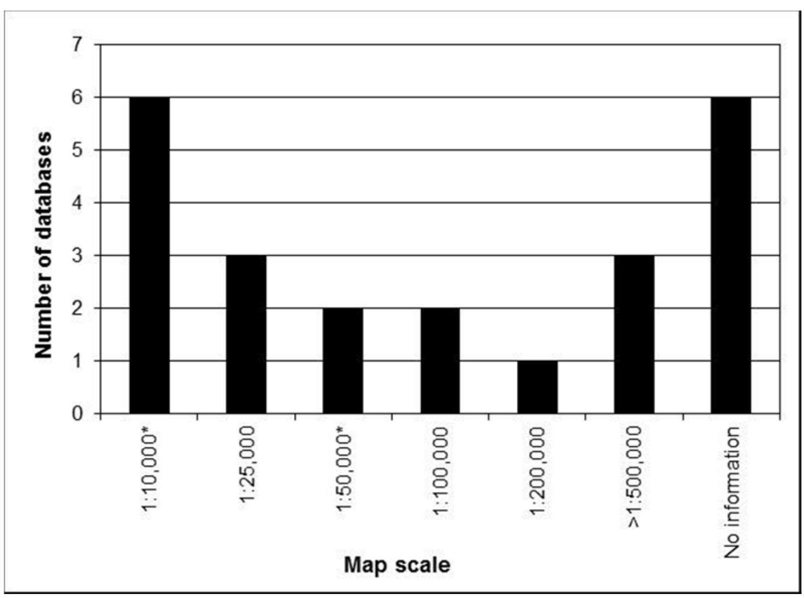


Figure 4.10: Scale of national landslide inventory maps (some of the landslide inventory maps were created at smaller scale in some parts of the country).*

Landslides are represented as points (50%) or as a combination of points, lines and polygons (50%; Fig. 4.11, 4.12, 4.13). Apart from the location on a map, also the alphanumeric part of the database contains information of the landslide location (Table 4.5). Most often these are the coordinates (82.6%) and municipality (73.9%). The database of Sweden also provides the local name given on the topographical map. Norway reports the address where the damage was reported and Slovakia the regional geomorphic and regional engineering geological division. For landslides affecting roads, Slovenia indicates the location using the kilometer indication along the road.

Table 4.5: Specific information on landslide location provided in the national landslide databases.

Landslide locator	Number	%
Coordinates	19	82.6
Municipality	17	73.9
Province/county	12	52.2
Other	7	30.4

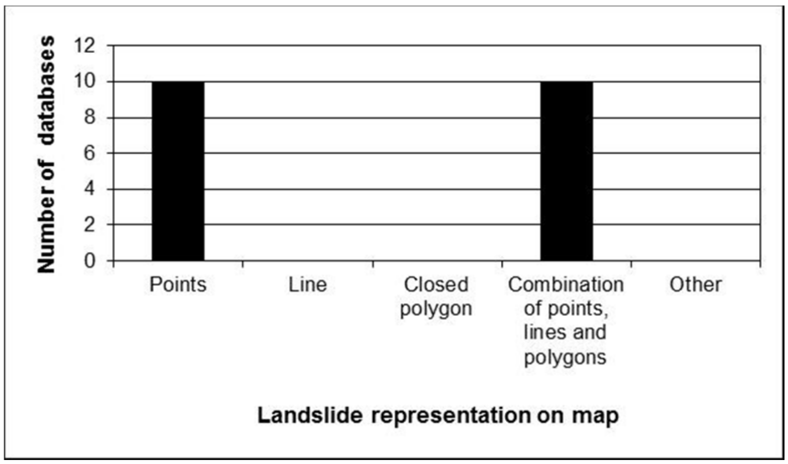


Figure 4.11: Symbol used to map landslide locations in national landslide databases.

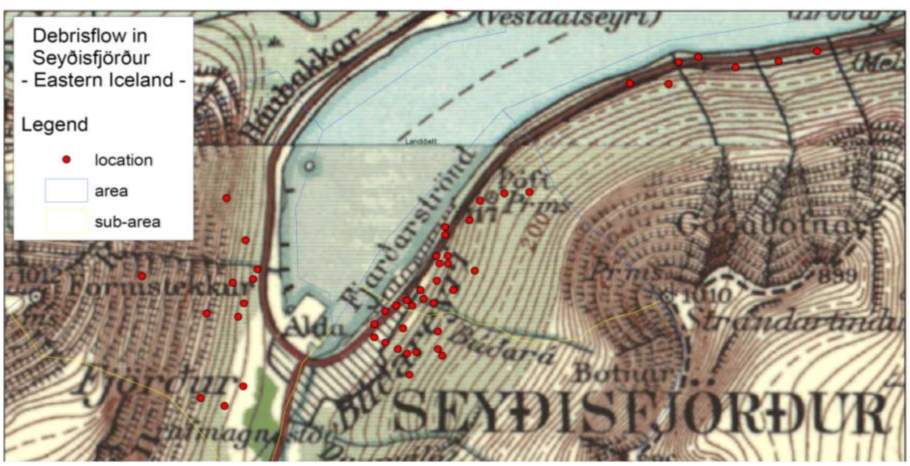


Figure 4.12: Landslides are represented as points on the landslide inventory map of Iceland (Icelandic Meteorological Office).

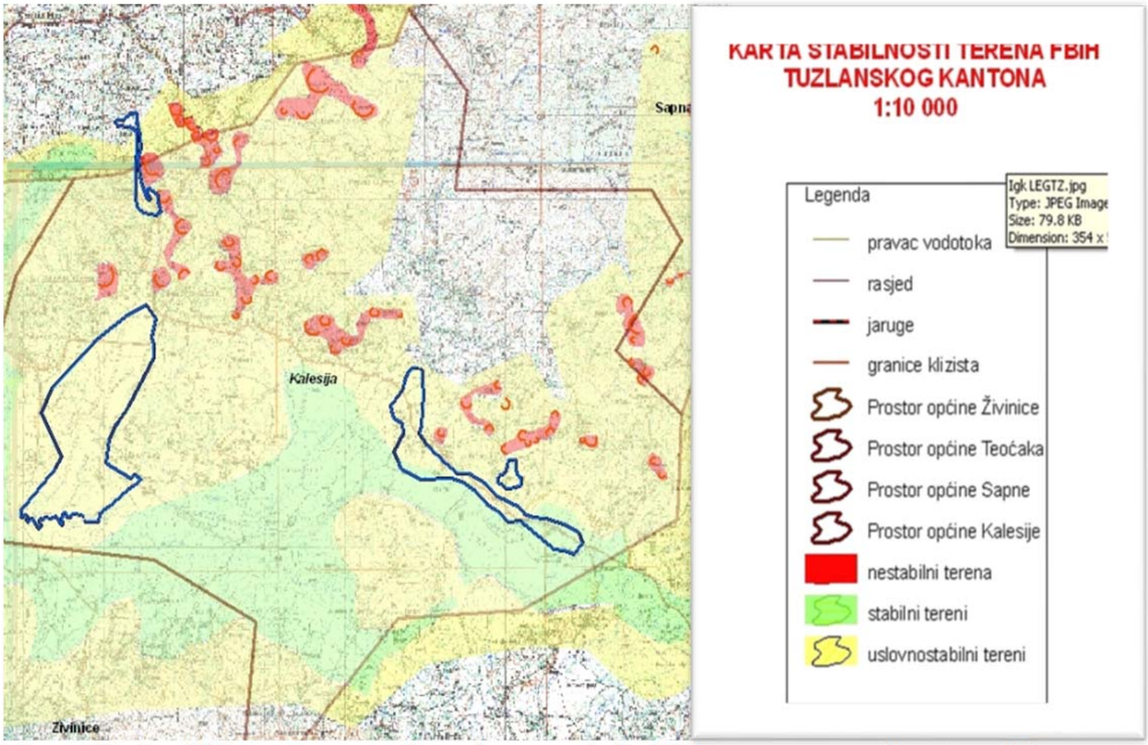


Figure 4.13: Landslides are represented as polygons on the landslide inventory map of Bosnia and Herzegovina (Federal Geological Survey).

Landslide locations are generally obtained through a combination of different techniques (Fig 4.14). Most commonly used are field surveys (16 or 70% of the databases), historical documents (17 or 74% of the databases) and aerial photograph analysis (9 or 39% of the databases). Airborne (other than aerial photographs) and satellite remote sensing are only occasionally used. Alternative methods for obtaining landslide locations are collecting local and regional inventories (Italy and Austria) or observations by road authorities and railroad companies (Norway), or geotechnical studies (Czech Republic).

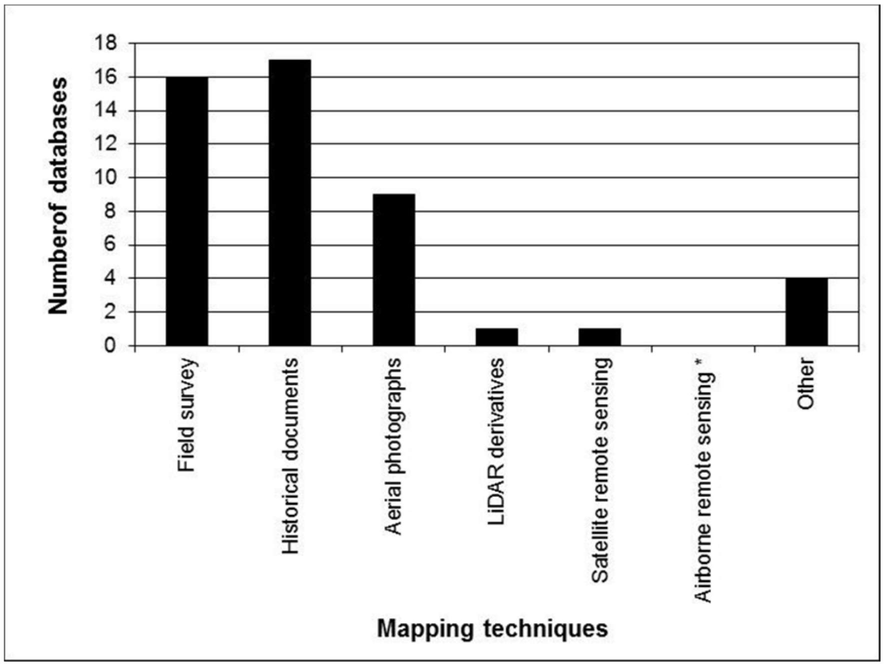


Figure 4.14: Techniques used to collect landslide locations.
** Other than aerial photographs and LiDAR*

4.2.2.2 Landslide classification

A landslide database should include information on the type of landslides reported. Twenty of the 23 landslide databases provide this information (e.g. Fig. 4.15). This information is for example necessary for creation of separate susceptibility and hazard maps for different landslide types. Information on landslide type is not available in the two databases of Sweden and the one of Portugal. However, different classification systems and number of landslide types are reported in the national databases, thus posing constraints for harmonisation of European-wide policy making and legislation on landslides. With regard to the classification system, 14 countries or regions use a system that is similar to the one suggested by Cruden and Varnes (1996). The seven other countries use a local classification system.

The number of landslide classes ranges from three to five. These are mainly types included in the Varnes (1978) or Cruden and Varnes (1996) classification (rock fall, translational and rotational slides, flows and complex slides). Italy (n=12), Slovenia (n=15) and Greece (n=24) are exceptions. The database of Italy contains 12 types, i.e. fall, topple, rotational slide, translational slide, lateral spread, slow earth flow, rapid debris flow, sinkhole, complex landslide, deep-seated gravitational slope deformation, area affected by numerous rockfalls/topples, area affected by numerous sinkholes, and area affected by numerous shallow landslides.

The landslide database of Greece is really remarkable as it distinguishes between 24 classes (translational (sheet), earth flow, mud flow, debris flow, sand liquefaction, sand outwash, sagging of strata, scree, creep, soil topples, soil falls, subaqueous slides, rotational, squeezing of soft rocks, block slides, lateral spreads, planar, wedge, rock topples, rock falls, composite, failure controlled by two surfaces in rocks, sliding and toppling in rocks, failures and inductive stresses in rocks, and block sliding on composite surfaces in rocks).

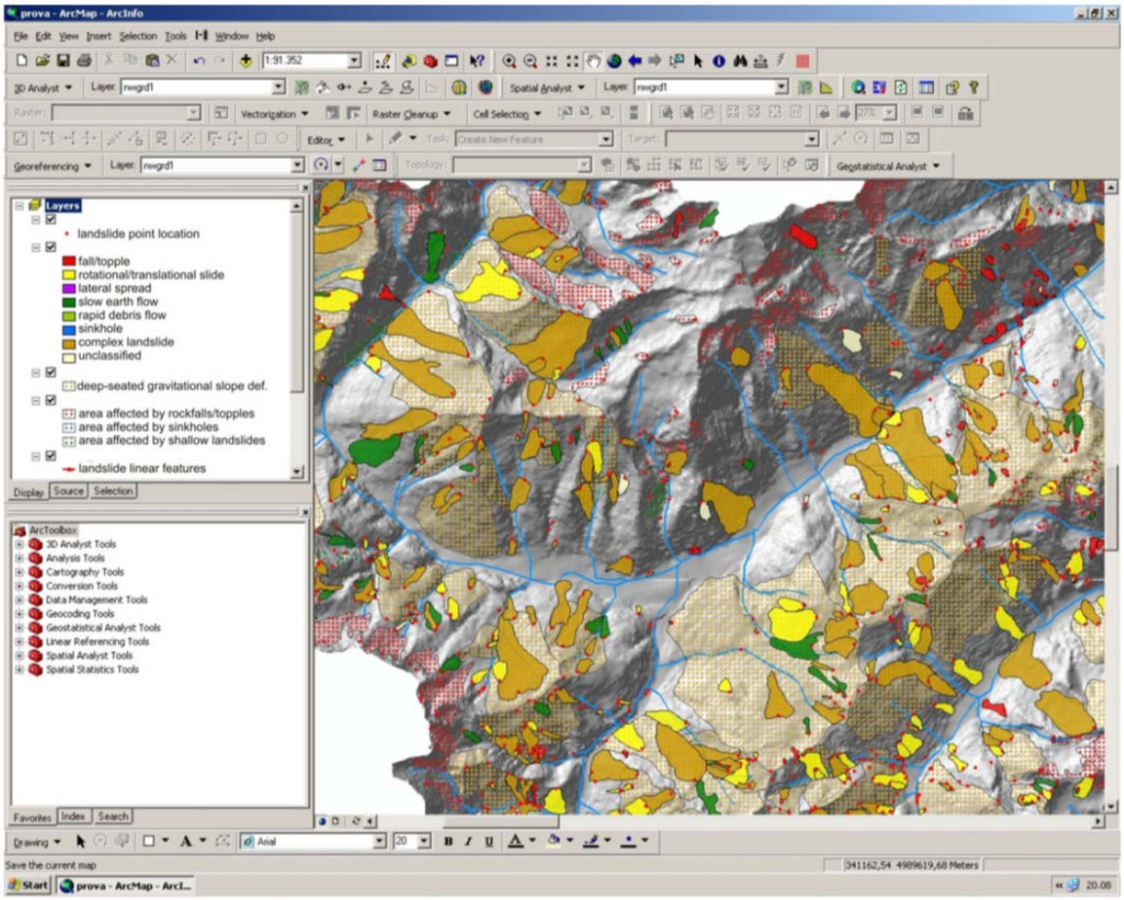


Figure 4.15: Representation of different landslide types in IFFI landslide database (Italy; Trigila et al., 2010).

4.2.2.3 Landslide dimensions

Information on the dimensions of existing landslides is important for the production of landslide hazard maps as for this information on the possible magnitude of the landslide is needed. Landslide magnitude has been represented by the displaced volume or affected area (e.g. Malamud et al., 2004; Van Den Eeckhaut et al., 2007). Calculation of the angle of reach, needed for runout modelling, requires information on height and length of the landslide (Corominas, 1996). These two examples show that landslide dimensions should be included in a landslide database.

Figure 4.16 illustrating the landslide morphological characteristics stored in the database shows that almost all databases contain information on the landslide length and width and on the area affected by the landslide. As landslide volume is more difficult to assess than the affected area, the number of databases containing this information is somewhat lower. The latter databases generally also contain information on the depth of the surface of rupture. Other information included is the height of the top and the toe.

Landslide databases of Bosnia and Herzegovina, France, Iceland and Poland include all seven morphological characteristics listed in the questionnaire. Hungary, Italy, Former Yugoslav Republic of Macedonia and Spain include six of them. Of course, these characteristics are not always available for all landslides in the database. On the other side of the ranking, there are the databases of Portugal including no information on morphological characteristics and of Andorra reporting only the area affected by the landslide. Other countries reporting only two of the morphological characteristics in the landslide database are Norway (displaced volume and height) and UK (length and width).

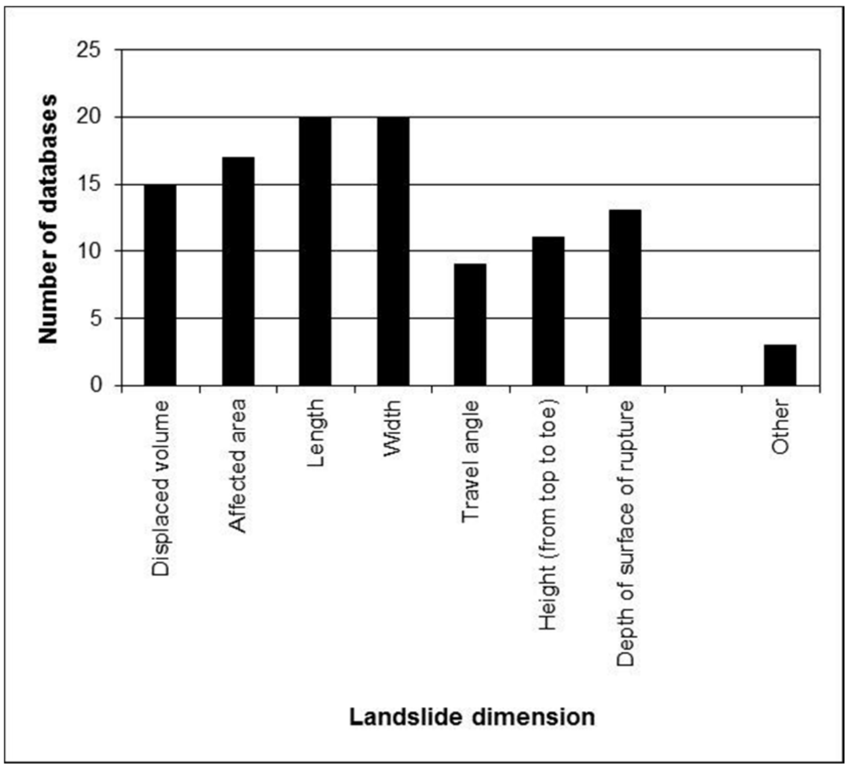


Figure 4.16: Morphological characteristics of landslides reported in national landslide databases (total number of databases=23).

4.2.2.4 Geo-environmental characteristics at landslide site

Most landslide databases contain additional information on the geo-environmental characteristics at the landslide site, especially on lithology, hydrogeology and slope gradient (Fig. 4.17). About half of the databases also provide information on the orientation of the slope and the land use on the affected site.

Bosnia and Herzegovina, Iceland, and UK include all six geo-environmental characteristics listed in the questionnaire in their database. Five of the characteristics are reported in the databases of Greece, Ireland, Italy, Poland and Slovakia. Of course, these characteristics are not always available for all landslides in the database. The landslide databases of Andorra and Portugal did not contain any of the characteristics.

Specific geo-environmental characteristics of the landslide site are important for local landslide hazard and risk studies. For national and regional analysis, the information can also be derived from e.g. DEMs and geological and land use maps.

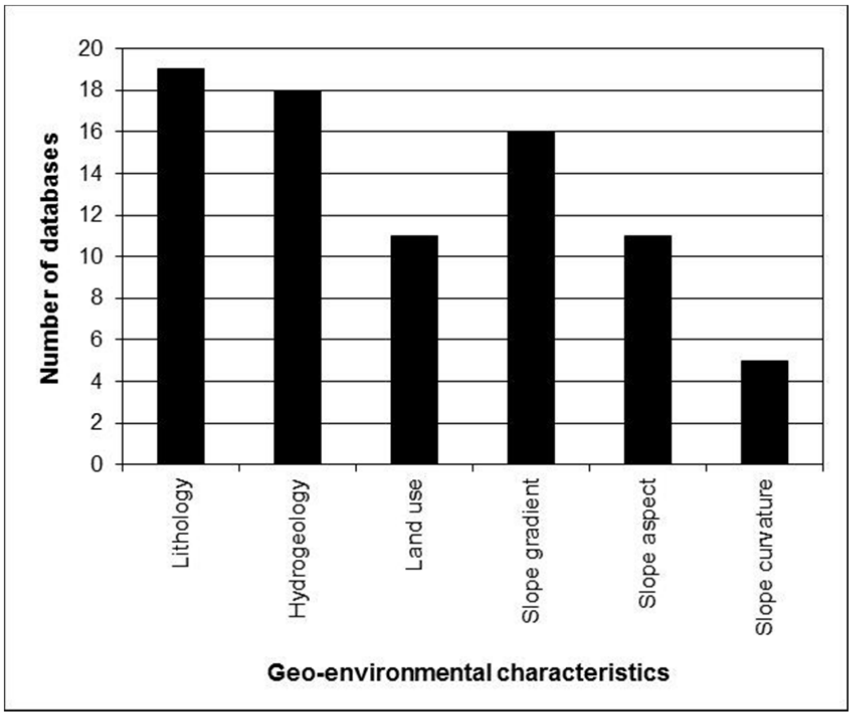


Figure 4.17: Geo-environmental characteristics at the landslide site reported in national landslide databases (total number of databases=23).

4.2.2.5 Landslide history and activity

Landslide history is important as it provides an idea of the temporal frequency of landsliding. If the date of the landslide event is known, analysis of rainfall and earthquake records may also allow determining possible landslide triggers (see section 4.2.2.6). Twenty-two out of 23 landslide databases include information on the initiation or reactivation date (i.e. history) of the landslide for the landslides for which this information is known, but for two no further information was provided. Seven databases only provide the date of the first occurrence of the landslide, while the other 13 databases provide information on the initiation and (eventual) reactivation dates. The percentage of the landslides in the database for which the date of initiation or reactivation is available, however, is generally smaller than 25% (Fig. 4.18). The objective of the database, however, largely influences this percentage. One of the databases of

Sweden, for example, contains only landslides collected from historical documents. Therefore, this database contains information on the history for more than 75% of the landslides. Databases that are, on the other hand, constructed through analysis of one (or a few) set(s) of aerial photographs generally have little information on landslide history.

About half of the landslide databases (n=13) also contain a qualitative estimate of the activity of the landslides. In most of these cases, four or more activity states of the classification of Cruden and Varnes (1996) are distinguished. These include active, suspended, reactivated, inactive, dormant, abandoned, stabilized and relict landslides.

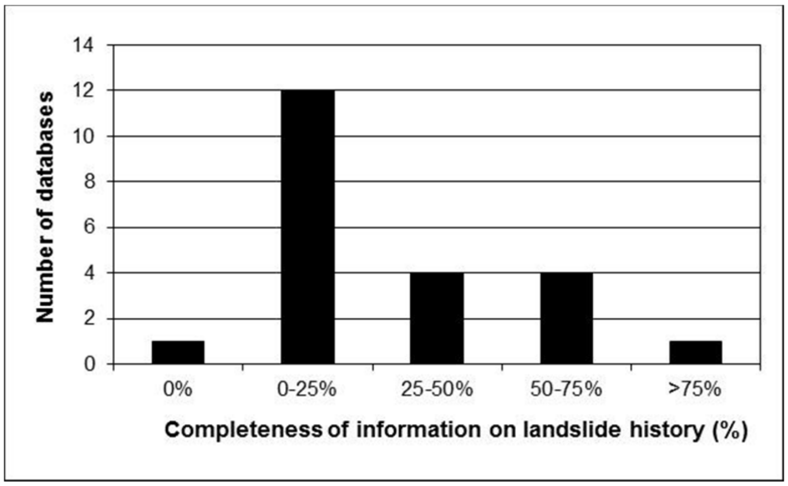


Figure 4.18: Estimated completeness of information on the landslide history (initiation and/or reactivation date) in national landslide databases (total number of databases=23).

4.2.2.6 Landslide trigger

Many landslide studies start from the hypothesis that the past and present landslides are the key to the prediction of future landslides. Hence, for prediction of the timing and frequency of future landslide events, information of the triggering factors of past events needs to be analyzed. Currently 18 of the 23 landslide databases provide this information, if it is available, because, as Figure 4.19 shows, in 52% of the databases the triggering factor is only reported for less than 25% of the documented landslides. As the percentages in the figure are estimates, they have to be considered with care.

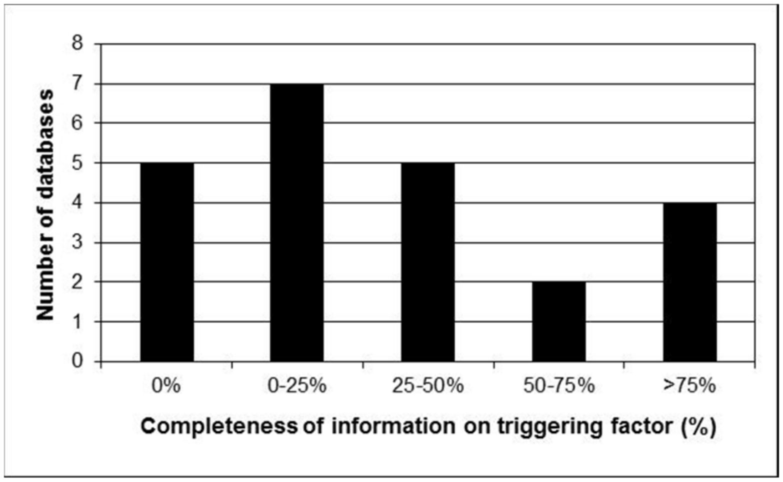


Figure 4.19: Estimated completeness of information on the triggering factor in national landslide databases (total number of databases=23).

4.2.2.7 Consequences

For estimating the damage caused by future landslides of a certain magnitude, information is needed on the damage caused by previous landslides of the same magnitude. If this information is available, it is reported in 20 of the 23 landslide databases. However, as for the triggering factor, the percentage of landslides in the databases with documented information on damage and victims caused is generally limited. For about half of the inventories the information is available for less than 25% of the recorded landslides (Fig. 4.20). Generally, only a qualitative description of the reported or observed casualties and damage is given. Damage can include building damages, road closures, losses of arable land, forest or cattle, and in a limited number of cases it also includes secondary effects such as tsunami or landslide dams. An estimate of the monetary value of damage and reparation costs is only given when available. In the landslide database of UK, this is for example the case for five landslides. The database of Sweden (Swedish Natural Hazards Information System; Table 4.1), containing the 17 most severe landslides that occurred in the country provides a very detailed description of the casualties, damage and remediation. Apart from that, also the Portuguese landslide database provides information on the damage caused by most of the 163 landslides,

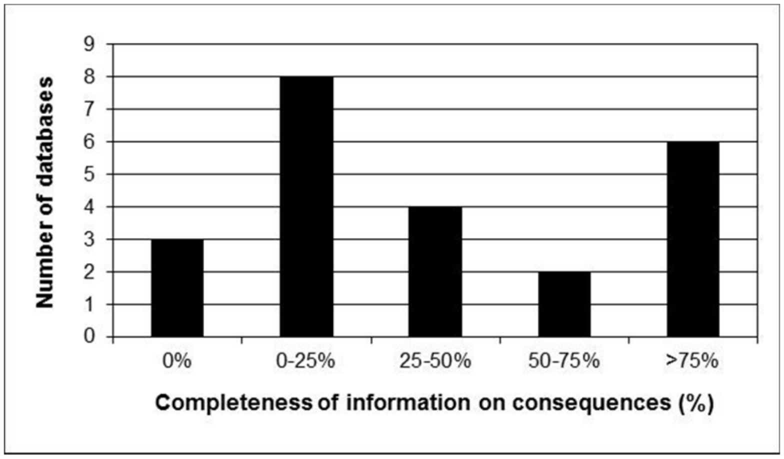


Figure 4.20: Estimated completeness of information on consequences in national landslide databases (total number of databases=23).

4.2.2.8 Other information

All 23 databases provide at least one of the additional types of information listed in Table 4.6. The class “Other” includes detailed descriptions of the landslide event and videos.

Table 4.6: Additional information included in national landslide databases.

	Number of databases
Photographs	13
Monitoring data or physical properties	11
Bibliographic references	21
Other	4

4.2.3 Format and access

Landslide data can only be directly used for landslide susceptibility, hazard or risk assessments if easily accessible and available in digital format. Ideally the alphanumeric and spatial databases are linked. Currently, this is the case for about 55% of the European countries (Fig. 4.21). Fifteen countries use ArcGIS to store the spatial data. Other spatial databases are created in ArcSD or Mapinfo. In combination with the GIS, 13 countries use Access or Oracle to store the alphanumeric data.

With regard to the accessibility, 12 countries allow the general public access to the data (Table 4.7). However, accessibility for general public is restricted to consultation for eight of these landslide databases (Table 4.8). In some cases (e.g. Greece) only limited information is available, and more specific arrangements have to be made if more detailed information is required. In the absence of a web interface a few (e.g. OLI, Iceland) of these eight databases can also only be consulted in the database owner’s office. As mentioned before, although many countries have a web interface (see Table 4.1 and Annex C for examples), they only have it in the local language, hampering consultation to most foreigners. Four databases allow free use of the data. These are Andorra, Ireland, Slovakia and Sweden (the latter only 17 landslides). Other countries eventually provide the data, but only under special conditions. In the latter case, only administrations (and sometimes scientists) have direct access to all data. Hence, currently use of landslide data from national databases for landslide zoning is generally restricted to database owners.

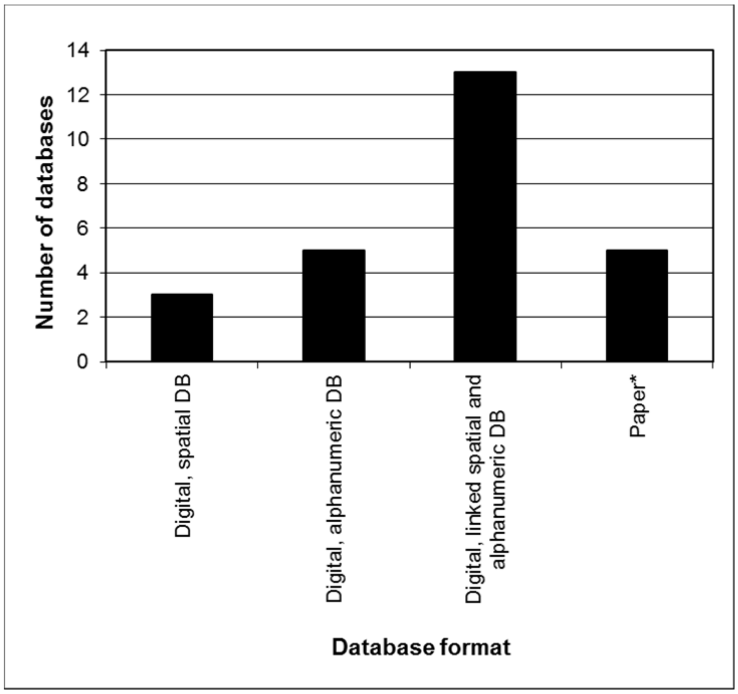


Figure 4.21: Format in which the spatial and alphanumeric data of national landslide databases (DB) are available.
** 4 countries have also a digital database*

Table 4.7: Accessibility of national landslide databases. Accessibility is generally restricted to consultation (Table 4.8).

Accessibility	Number of databases
General public*	12
Administration	19
Scientific purposes	20
Other (companies)	1

* All databases accessible for general public are assumed to be accessible to administration and for scientific purposes

Table 4.8: Possibilities for further use of accessible data in national landslide databases.

Possibilities for use	Number of databases
Use for consultation only	8
Use free of charge under any condition	4
Use after payment	1
Use without special conditions	5
Use under special conditions	7
Not known	4

4.2.4 INSPIRE Directive compliance

A detailed section on INSPIRE comes later in the report (Section 5.2). Here, only the outcomes of the questionnaires are shown. Figure 4.22 shows that currently only for a few national databases the metadata is complying with INSPIRE metadata regulations (http://inspire.jrc.ec.europa.eu/index.cfm/pageid/101). According to INSPIRE regulation, digital data of European countries should be implemented in a network service (as specified in http://inspire.jrc.ec.europa.eu/index.cfm/pageid/5) to enable interoperability. This is currently only the case for three national databases. Also formulation of the metadata is only rarely (n=5) complying with INSPIRE regulation.

Important is that Figure 4.22 suggests that the persons responsible for the database do not seem to be well-informed about the INSPIRE regulations on metadata and network services. Most of them also do not know whether their metadata and network service are complying with INSPIRE regulation. They also do not know whether their institute is registered as Spatial Data Interest Communities (SDICs) or Legally Mandated Organisation (LMOs). Therefore, we checked ourselves whether the institutes were registered, and this showed that almost half of the institutes responsible for national landslide databases are currently a LMO (n=12) or SDIC (n=2). Hence, it seems that an important proportion of the contacted persons does not know who is following up INSPIRE in their institute.

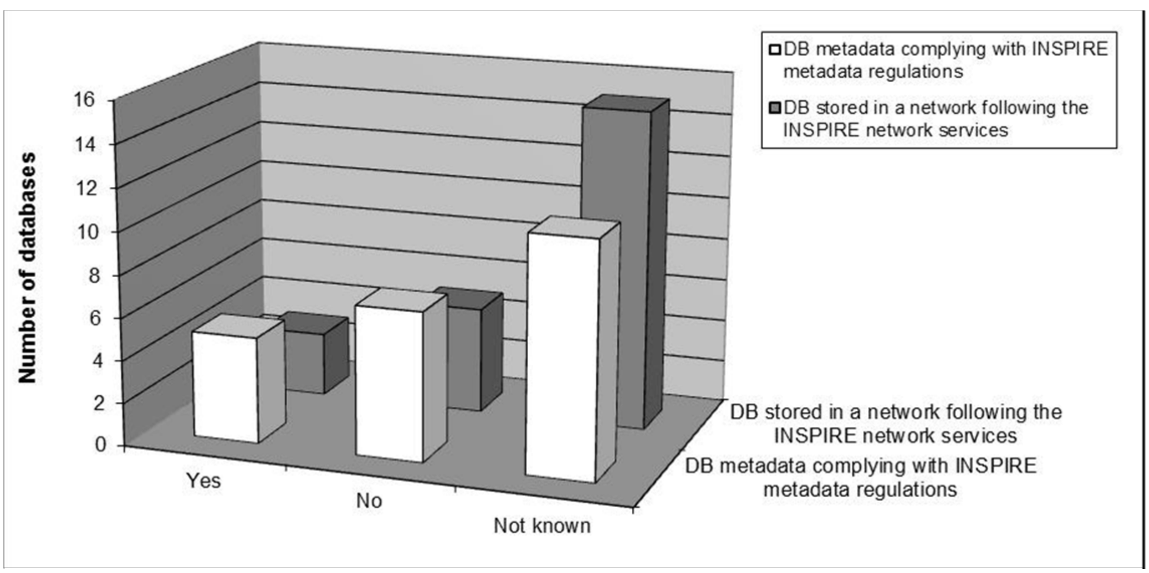


Figure 4.22: Compliance of national landslide databases (DB) with INSPIRE regulations on metadata and network services.

4.2.5 Availability of ancillary data for landslide hazard and risk assessment

Since the landslide inventory is only one of the thematic layers necessary for landslide hazard and risk assessment, the questionnaire also included questions regarding the availability of data layers related to controlling and triggering factors, and elements at risk (i.e. section 8 of questionnaire).

The results obtained are listed in Table 4.9 and provide an overview of which data are generally present at relative high quality (i.e. up to date, high to moderate resolution and digitally available), and of which data are more problematic to collect and eventually hampering landslide risk assessment at national scale. Of course, care should be taken when analysing the data. For each country we have the response of one contact person only. Generally this person only provided information for which he/she was certain.

With regard to data on controlling factors, it can be concluded that most countries have a DEM (1:10,000 to 1:200,000) and digital lithological map (1:10,000 to 1:500,000). Soil maps, especially digital versions, have a lower availability. About 30% of the contact persons which responded to have land cover data referred to the Corine land cover map.

Contact persons could not always provide information on available databases of landslide triggering factors (precipitation and seismicity) and elements at risk (buildings, infrastructure and population). It seems that population data is generally available up to the municipality level.

Table 4.9: Availability of ancillary thematic data for landslide hazard and risk assessment (max no. of responses 22).

		Available	Digital*
Controlling factor	Topography	22	18
	Lithology	20	16
	Soil properties	14	13
	Land cover**	16	14
	Land use**	13	12
Triggering factor	Climate		
	Precipitation	16	11
	Temperature	15	10
	Seismicity		
	Magnitude	10	7
	Intensity	8	4
	Peak ground acceleration	8	3
Elements at risk	Physical elements and human activities (buildings, engineering works, economic activities, public services, utilities, infrastructure and environmental features)	10	10
	Population (country, municipality)	10	10

* Digital map is available or the map can be produced by linking the data to a location
** There might be some confusion on difference among some of the contact persons

4.3 ANALYSIS OF REGIONAL LANDSLIDE DATABASES

In this section 22 regional landslide databases are analyzed (Fig. 4.2; Table 4.2). Information on regional databases was provided by:

- Regional authorities (i.e. landslide database of Flanders (Belgium), Bavaria, Rheinland-Pfalz and Saxony (Germany), Carinthia (Austria));
- National Geological Surveys (i.e. Landslide register of urbanized areas of the city of Zagreb (Croatia), Valcea-Arges-Dambovita-Prahova-Buzau (Romania), Cadastre of landslides and unstable slopes on the territory of Serbia);
- Universities (i.e. Landslides near Pärnu town (Estonia), Alpine Inventory of Deep-Seated Gravitational Slope Deformations (Northern Italy), North of Lisbon Landslides (Portugal), BEOSlide (Serbia), LLISCAT (Spain and Andorra), Landslides Database of the Southern Slopes of Sierra Nevada, Granada (Spain)); and
- Eight Italian Basin Authorities.

Although some differences with national landslide databases can be observed, one has to be aware that the collection of regional databases is not representative for the complete collection of regional landslide databases in Europe, and that the four groups of contacted institutes listed above have various reasons for creation and maintenance of a landslide database (e.g. responsible by law, scientific interest, landslide management). The results shown are for example also influenced by the high number (i.e. 8) of regional landslide databases maintained by Italian Basin Authorities. We will focus in this section on the differences observed compared to the national landslide databases discussed in the previous section. Therefore most graphs will show the results obtained from both the national and regional databases.

4.3.1 General information

The regional landslide databases included are generally official documents, i.e. they are made by a government entity (such as a ministry or a mapping agency), but they are not regulatory (Fig. 4.23).

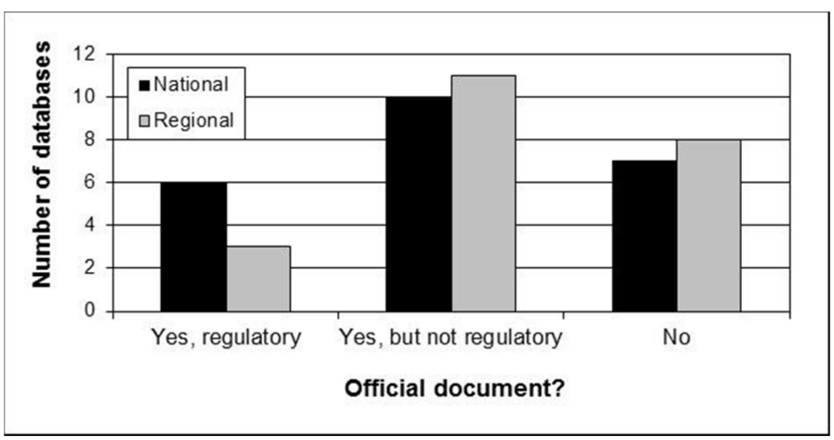


Figure 4.23: Legal value of the national and regional landslide databases.

The number of reported landslides is generally between 400 and 4000 (Table 4.3). Exceptions are three regional Italian landslide databases having more than 15,000 landslides. A first important observation is that regional databases seem to be more complete compared to national inventories (Fig 4.24; 4.25). This could be related to the fact that generally more attention can be paid for data collection of smaller regions. Similar to most national databases, regional landslide databases are also frequently updated (Fig. 4.26).

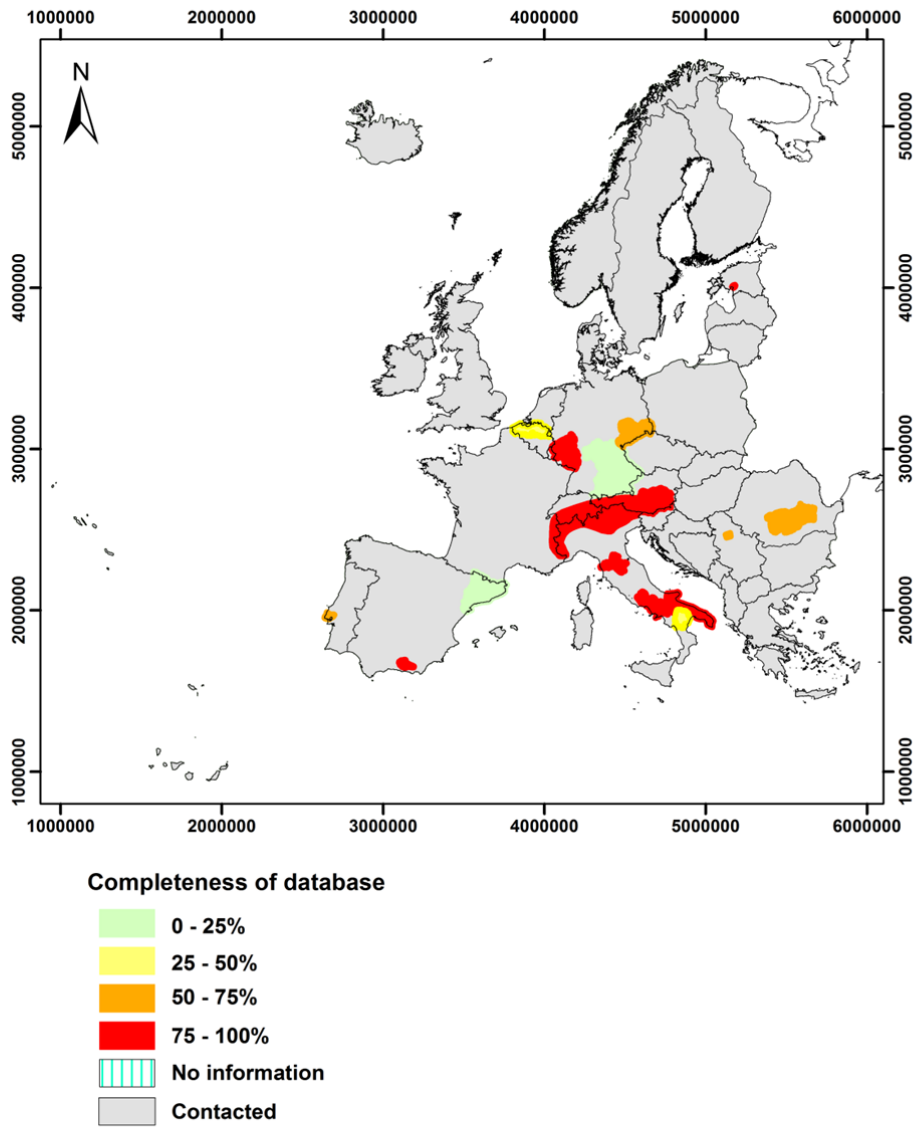


Figure 4.24: Estimated completeness of the regional landslide databases.

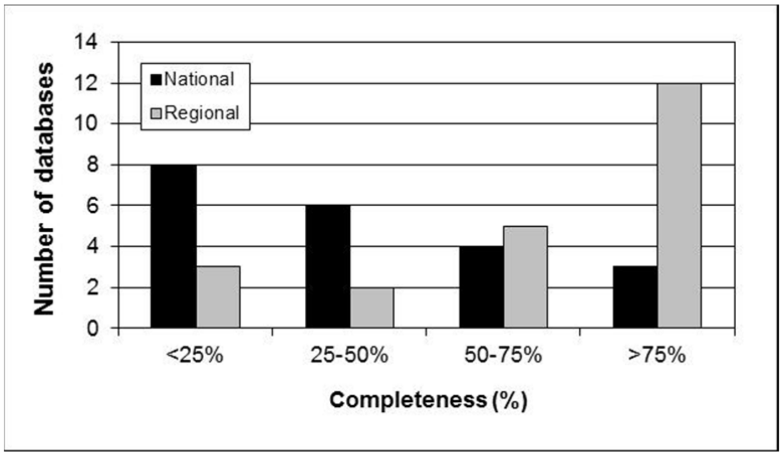


Figure 4.25: Estimated completeness of the national and regional landslide databases.

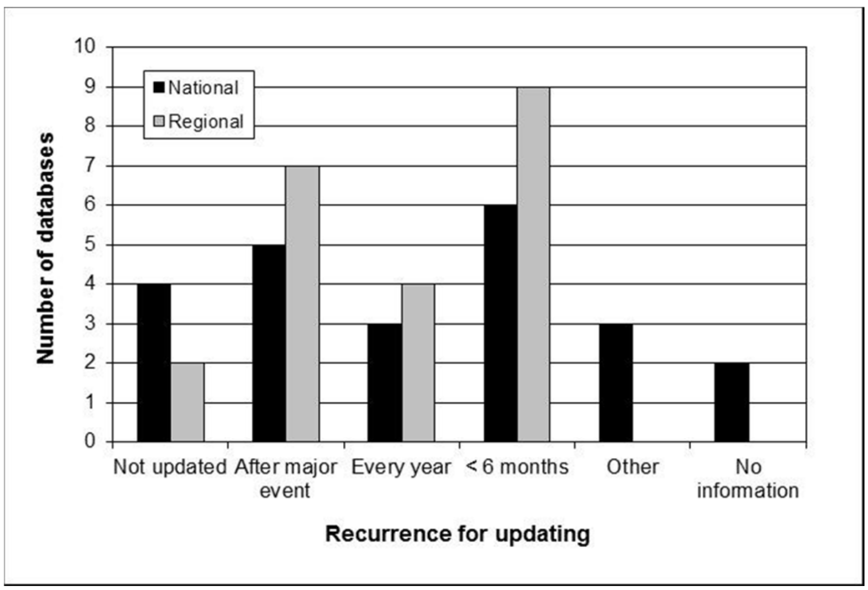


Figure 4.26: Comparison of update frequency of the national and regional landslide databases.

4.3.2 Content

4.3.2.1 Landslide inventory map

Generally covering smaller areas, regional landslide inventory maps are often produced at more detailed scale than national inventory maps (Fig. 4.27). Given the more detailed scale, landslides are most often indicated as lines or closed polygons and not as points (Fig. 4.28). For individual landslides, coordinates and municipality are separately listed in the alphanumeric database of more than half of the regional databases (Table 4.10).

With regards to the techniques used to acquire the landslide locations, Figure 4.29 shows that, similarly to the national inventories, the regional inventories are mainly created using field surveys, historical documents and analysis of aerial photographs. However, for databases produced for scientific purposes these traditional methods are used in combination with more innovative satellite and airborne remote sensing techniques. Also Google Earth provides opportunities for the production of landslide databases. This virtual globe, map and geographical information program was for example used for production of the "Alpine Inventory of Deep-Seated Gravitational Slope Deformations" (Northern, Italy; University of Milano-Bicocca, Italy).

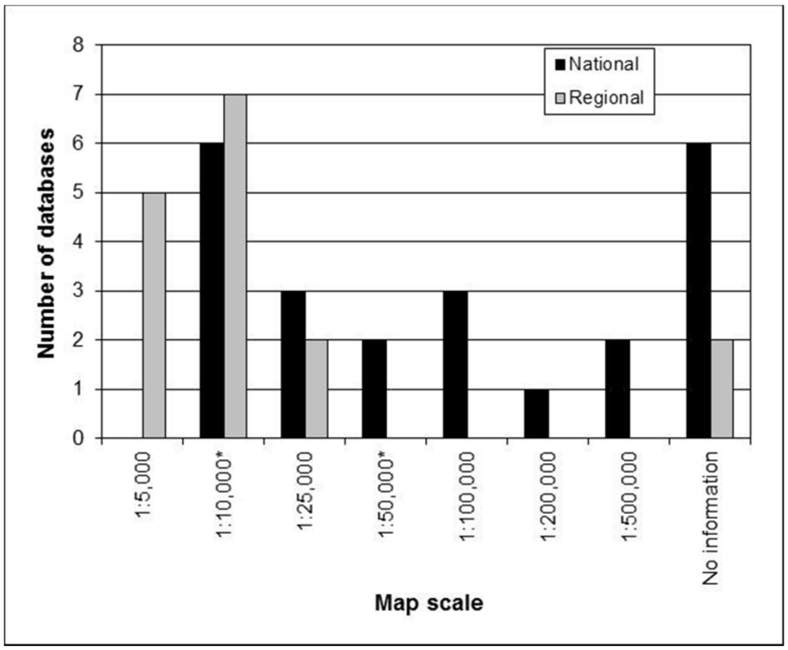


Figure 4.27: Scale of national and regional landslide inventory maps.
(some of the landslide inventory maps were created at smaller scale in some parts of the country).*

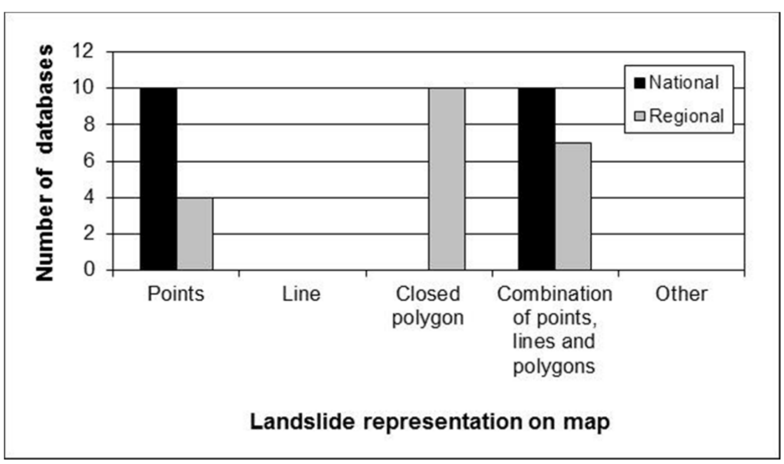


Figure 4.28: Symbol used for landslides in national and regional landslide databases.

Table 4.10: Specific information on landslide location provided in the regional landslide databases.

Landslide locator	Number	%
Coordinates	16	72.7
Municipality	13	59.1
Province/county	10	45.5
Other (hydrographic basin)	1	4.5

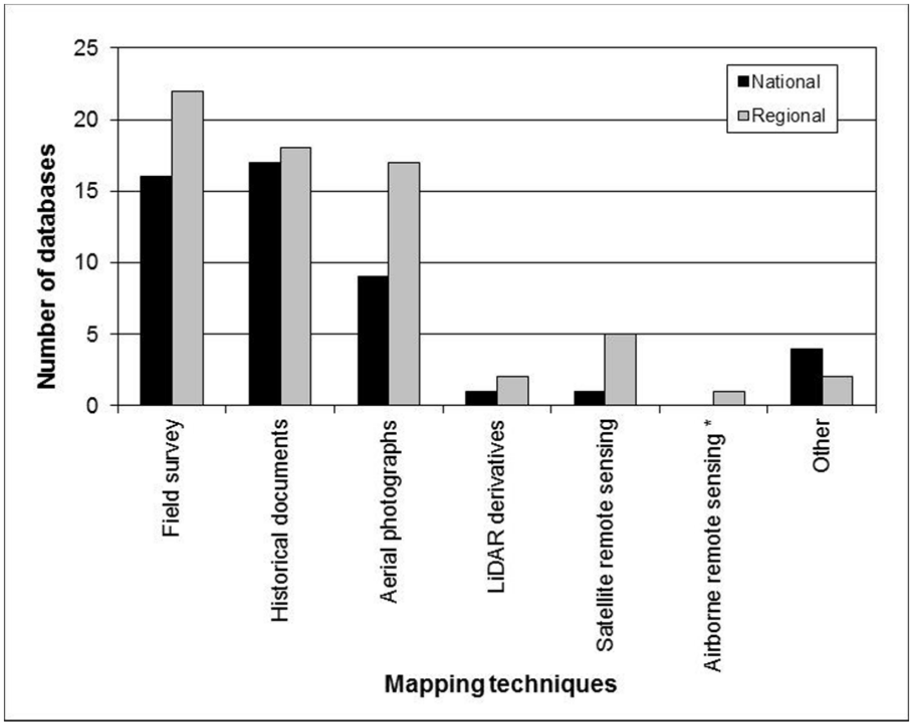


Figure 4.29: Techniques used to collect landslide locations.
** Other than aerial photographs and LiDAR.*

4.3.2.2 Landslide classification

Landslides recorded in the landslide database of State of Rheinland-Pfalz (Germany) and BEOslide (Serbia) are not further classified. Only two out of the remaining 20 databases use a classification system not derived from Cruden and Varnes (1996). Fifteen of the 22 regional databases only contain landslides. The other seven databases also contain information on e.g. floods, sinkholes, badlands, active faults, sediment fans, and large slope deposits.

4.3.2.3 Landslide dimensions

Morphological landslide characteristics were reported in 19 of the 22 regional landslide databases (Fig. 4.30). The results do not show remarkable differences with national landslide inventories, with exception of the displaced volume which is not so frequently available in the regional databases.

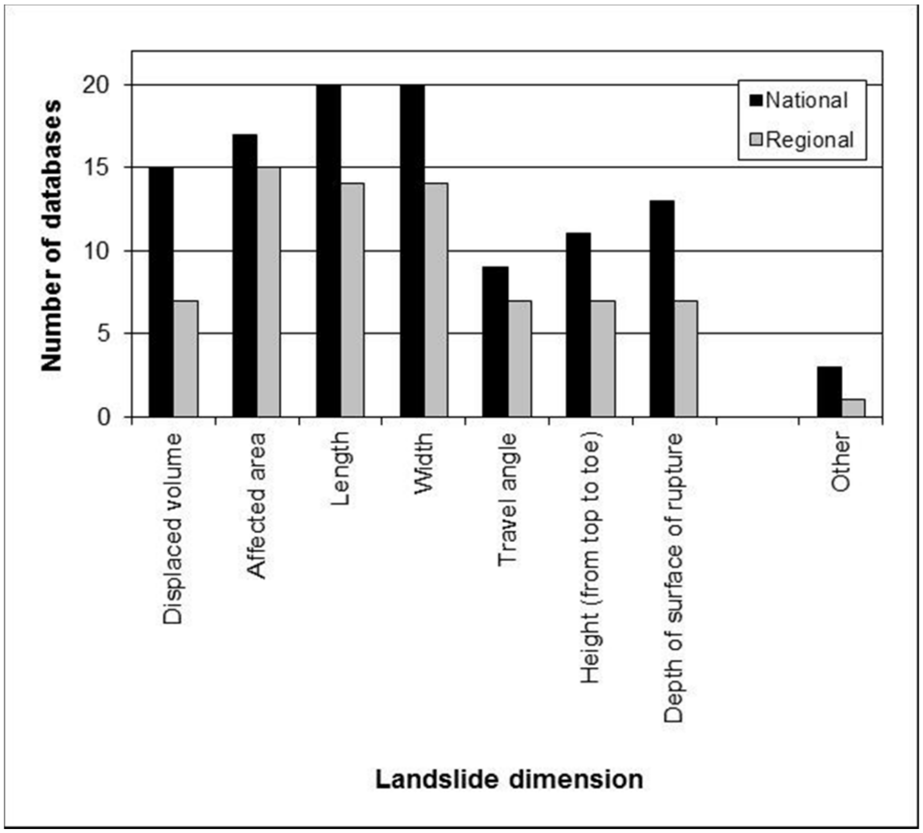


Figure 4.30: Morphological characteristics of landslides reported in national and regional landslide databases.

4.3.2.4 Geo-environmental characteristics at landslide site

Geo-environmental characteristics at the landslide site were reported in 18 of the 22 regional landslide databases (Fig. 4.31). The results do not show remarkable differences with national landslide inventories. Information on lithology and slope gradient is almost always included in the database.

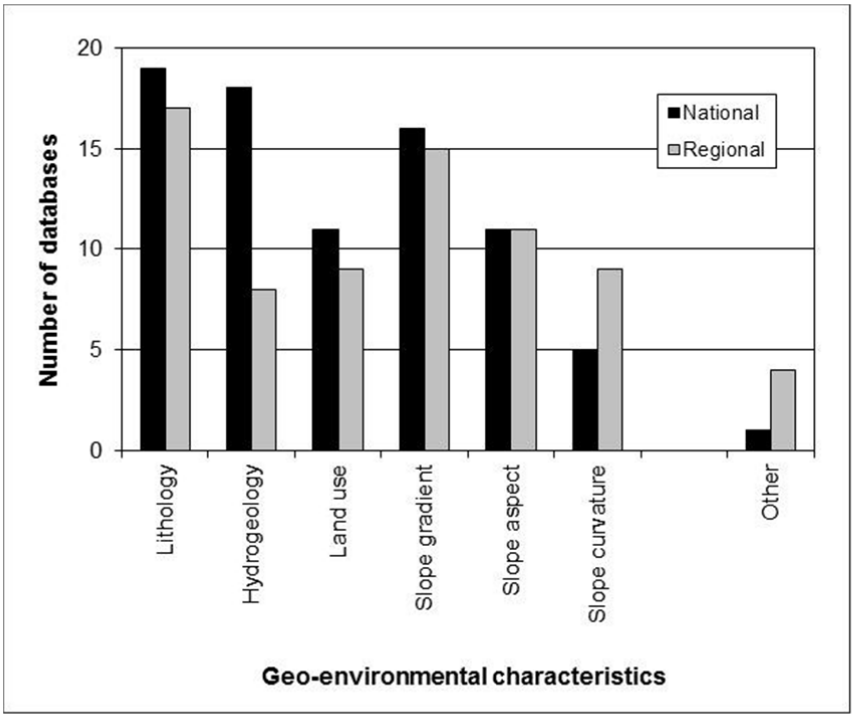


Figure 4.31: Geo-environmental characteristics at the landslide site reported in national and regional landslide databases.

4.3.2.5 Landslide history and activity

Information on the landslide history, available for 17 of the 22 regional databases, is relatively incomplete and for most databases below 50% (Fig. 4.32). For 12 databases qualitative information of the activity was given. Similar to national landslide databases, four or more activity states of the classification of Cruden and Varnes (1996) are distinguished. These include active, suspended, reactivated, inactive, dormant, abandoned, stabilized and relict landslides.

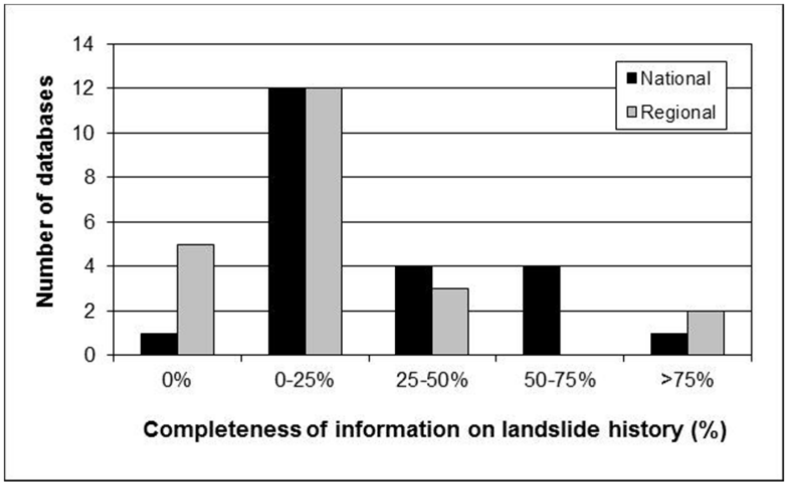


Figure 4.32: Estimated completeness of information on the landslide history (initiation and/or reactivation date) in national and regional landslide databases.

4.3.2.6 Landslide trigger

Information of the landslide trigger is included in about half of the regional landslide databases (Fig. 4.33). In contrast with an increase in overall completeness compared to national landslide databases, regional databases are not more complete with regard to the triggering factors.

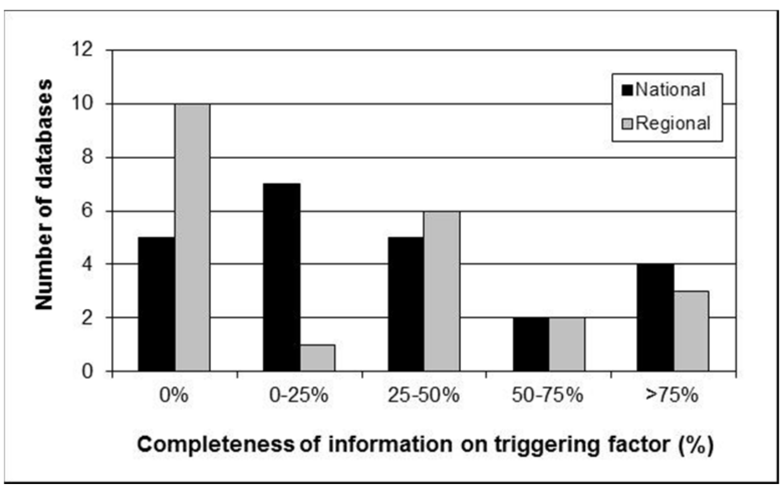


Figure 4.33: Estimated completeness of information on the triggering factor in national and regional landslide databases.

4.3.2.7 Consequences

Information on the landslide consequences (i.e. victims and estimates of damage) is included in 14 of the regional landslide databases (Fig. 4.34). In contrast with an increase in overall completeness compared to national landslide databases, regional databases are also not more complete with regard to the consequences.

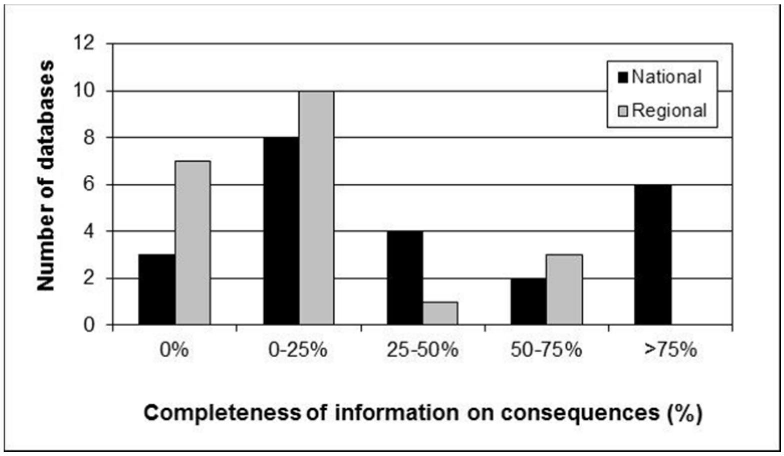


Figure 4.34: Estimated completeness of information on the consequences in national and regional landslide databases.

4.3.2.8 Other information

Seventeen regional databases include additional information such as photographs, monitoring data or bibliographic references (Table 4.11).

Table 4.11: Additional information included in regional landslide databases.

	Number of databases
Photographs	13
Monitoring data or physical properties	13
Bibliographic references	12
Other	1

4.3.3 Format and access

Similar to the national landslide databases, regional databases are generally linked databases where spatial and alphanumeric data are connected (Fig. 4.35). For nine databases, data is stored in a spatial database. They consist of a map with an attribute table and are most often produced in ArcGIS or Mapinfo. When alphanumeric-only databases are present they are generally produced in Microsoft Access or SQL server.

About 50% of the databases are accessible for general public (Table 4.12), but generally only for consultation (Table 4.13). This is, for example, the case for the databases maintained by Flemish Region, the German Länder and the Italian Basin Authorities which sometimes have a web interface (Table 4.2; Annex C). Generally, data can only be used under special conditions for further processing such as landslide zoning (Table 4.13).

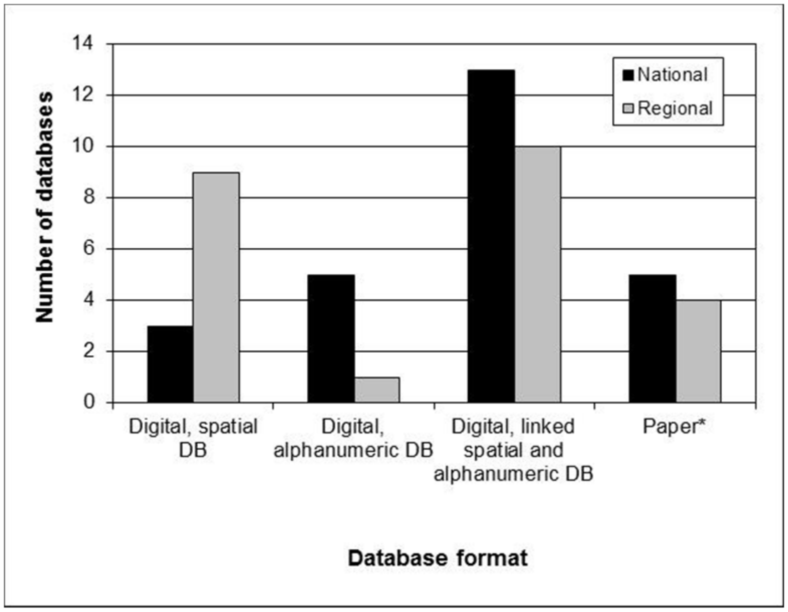


Figure 4.35: Format in which the spatial an alphanumeric data are available.

Table 4.12: Accessibility of regional landslide databases.

Accessibility	Number of databases
General public*	10
Administration	17
Scientific purposes	15
Other (internal, companies)	4

* All databases accessible for general public are assumed to be also accessible to administration and for scientific purposes

Table 4.13: Possibilities for further use of accessible data of regional landslide databases.

Possibilities for use	Number of databases
Use for consultation only	9
Use free of charge under any condition	3
Use after payment	0
Use without special conditions	4
Use under special conditions	10
Not known	4

4.3.4 INSPIRE Directive compliance

The regional databases included in this overview generally do not take into account the INSPIRE regulations (Fig. 4.36). The contact persons most often did not know whether their institute was able/willing to collaborate to INSPIRE regulations. As mentioned before, a more detailed discussion on landslide databases and INSPIRE regulation will follow in section 5.2.

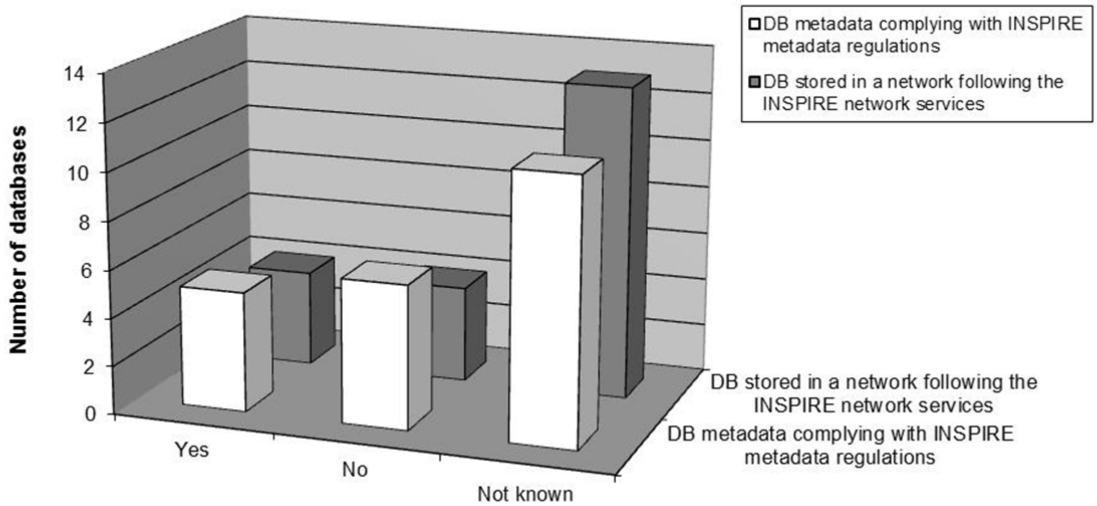


Figure 4.36: Compliance of regional landslide databases (DB) with INSPIRE regulations on metadata and network services.

5 POLICY-RELATED SUGGESTIONS FOR HARMONISATION AND INTEROPERABILITY

In the previous section we provided an overview of the information that is available in national and regional landslide databases. In this section we introduce the proposed Soil Framework Directive and the INSPIRE Directive, and give suggestions on the content and structure landslide databases should have to meet both the proposal for a Soil Framework Directive and current version of the INSPIRE data specifications for Natural Risk Zones.

5.1 PROPOSED SOIL FRAMEWORK DIRECTIVE

Landslides constitute one of the eight soil threats considered in the EU Thematic Strategy for Soil Protection, adopted by the European Commission on 22 September 2006. The legislative package included a communication on the mentioned Strategy (EC, 2006a), a proposal for a Soil Framework Directive (EC, 2006b) and the impact assessment of the Strategy (EC, 2006c). However, to date, the Soil Framework Directive is still under discussion and is not yet adopted. Therefore, only limited suggestions for harmonisation of landslide databases in agreement with the proposed Soil Framework Directive can be given.

In the proposed Soil Framework Directive it is required, among other actions, to identify risk areas for several soil threats including landslides. The Soil Information Working Group (SIWG) of the European Soil Bureau Network (ESBN) developed a set of “common criteria” (i.e. for landslides, occurrence/density of existing ones along with a set of conditioning and triggering factors) to identify these risk areas (Eckelmann et al., 2006). The SIWG suggested a nested geographical approach based on “Tiers” and exploiting thematic data of different type, quality and resolution, outlining a variety of methodological and technological approaches. Basically, the Tier 1 assessment is aimed at the general identification of areas potentially subject to landslide risk, providing a low-resolution evaluation of soil threats including landslides using existing thematic data. The Tier 2 assessment is intended to perform detailed analyses in the areas identified as potentially at risk by the Tier 1 assessment, and should provide results at a higher spatial resolution using existing and new data currently not available. The Tier approach has been further elaborated specifically for landslide risk area delineation in Europe by the European Landslide Expert Group[*] (Hervás et al., 2007; Günther et al., 2008; Hervás et al., 2010).

In the proposal for a Soil Framework Directive, risk areas are understood as areas where one or more of the soil degradation processes have occurred or are likely to occur in the near future. Hence, identification of so-called landslide risk areas could in principle be accomplished by one or more of the following maps:

- Landslide inventory maps (and landslide density maps as a by-product), which show at least the geographical distribution of past landslides, and associated databases of landslide and terrain properties;
- Landslide susceptibility maps, which show the proneness or the probability of occurrence of landslides of certain type in a given area;

[*] http://eusoils.jrc.ec.europa.eu/library/themes/Landslides/

- Landslide hazard maps, which show the probability of occurrence of landslides of certain type and magnitude in a particular area within a given period of time; or
- Landslide risk maps, which show potential damage or losses caused by landslides to individuals, infrastructure and property.

As shown in previous sections, systematic landslide databases (including e.g. maps showing the location, type of known landslides in an area and landslide history) are not available and/or accessible for all European countries. Consequently, only a continent-wide assessment of landslide susceptibility is feasible. Therefore, the European Landslide Expert Group recommended:

> "carrying out a pan-European landslide inventory, reviewing the data already available (…). The minimum requirements for such an inventory are location and type of historical landslides. The landslide type classification should follow the one proposed by Varnes (1978). Additionally, the inventory should include date of occurrence, soil/bedrock material involved, surface extent and direct impact of landslide events." (Hervás et al., 2007)

These recommendations are in line with INSPIRE regulation on data specifications of natural hazards (see next section).

5.2 INSPIRE DIRECTIVE

5.2.1 General information on INSPIRE

INSPIRE is a Directive adopted by the European Parliament and the Council of the European Union on 14 March 2007, setting the legal framework for the establishment of the Infrastructure for Spatial Information in the European Community, for the purposes of Community environmental policies and policies or activities which may have an impact on the environment (EC, 2007a). INSPIRE should be based on the infrastructures for spatial information that are created and maintained by the Member States. The components of those infrastructures include: metadata, spatial data themes (as described in Annexes I, II, III of the Directive), spatial data services; network services and technologies; agreements on data and service sharing, access and use; coordination and monitoring mechanisms, processes and procedures.

The guiding principles of INSPIRE are:

> "that the infrastructures for spatial information in the Member States will be designed to ensure that spatial data are stored, made available and maintained at the most appropriate level; that it is possible to combine spatial data and services from different sources across the Community in a consistent way and share them between several users and applications; that it is possible for spatial data collected at one level of public authority to be shared between all the different levels of public authorities; that spatial data and services are made available under conditions that do not restrict their extensive use; that it is easy to discover available spatial data, to evaluate their fitness for purpose and to know the conditions applicable to their use." (http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/D2.5_v3.2.pdf)

The text of the INSPIRE Directive 2007/2/EC (EC, 2007a) is available from the INSPIRE website (http://inspire.jrc.ec.europa.eu). The Directive identifies what needs to be achieved by the Member States.

To facilitate the implementation of INSPIRE, all stakeholders have the opportunity to participate in its specification and development. For this reason, the Commission has put in place a consensus building process involving data users and providers together with representatives of industry, research and government. These stakeholders are organised in Spatial Data Interest Communities (SDIC) and Legally Mandated Organisations (LMO). SDICs typically are networks of data producers, transformers and users, whereas LMOs are responsible in the Member States for one or more components of the INSPIRE Directive. SDICs and LMOs have provided reference materials, participated in the user requirement and technical surveys, proposed experts for the Data Specification Drafting Team and Thematic Working Groups (TWG), expressed their views on the drafts of the technical documents of the data specification development framework, and are invited to comment the draft Implementing Rule on Interoperability of Spatial Data Sets and Services.

As the objective of INSPIRE is to create a service that combines spatial data and services from different sources across the Community in a consistent way in order to share them between several users and applications, an important document is the "Regulation on INSPIRE Data and Service Sharing (29.03.2010)" (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:083:0008:0009:EN:PDF).

In short, EU countries have to share their spatial data. There can be special conditions or charges linked to the accessibility and use of the data, but these should be transparent. Charges could be for example related to costs related to updating and maintenance of the database.

5.2.2 Definition of interoperability in INSPIRE

One of the main tasks of the INSPIRE programme is:

> "to enable *interoperability* and, where practicable, *harmonisation* of spatial data sets and services within Europe. Interoperability in INSPIRE means the possibility to combine spatial data and services from different sources across the European Community in a consistent way without involving specific efforts of humans or machines."

It is important to note that interoperability is understood as providing access to spatial data sets through network services, typically via Internet. Interoperability may be achieved by either changing (harmonising) and storing existing data sets or transforming them via services for publication in the INSPIRE infrastructure.

To make the concepts of interoperability and harmonisation more tangible, a set of interoperability components were defined (Fig. 5.1). For each of the components, a separate clause specifies how this component is addressed in the Generic Conceptual Model, the model applicable for all INSPIRE thematic data specifications (e.g. natural risk zones, soil, …). We refer to http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/D2.5_v3.2.pdf (p.26 –

32) for a complete overview of these components, while in this document only the components that are most relevant for landslide databases will be highlighted. These are:

- *The multi-lingual text and cultural adaptability* (F): All feature catalogues and the feature concept dictionary are multilingual, as well as the definition and names of all spatial object types, their attributes/associations and their attribute values provided by enumerations/code lists. However, the conceptual model (e.g. Fig. 5.3) will be normally developed in English only. In principle, also cultural differences have to be taken into account, as not all terms may be translatable from one language to another. Furthermore, it is also recognized that cultural differences can exist between communities working in the same language.
- *The coordinate referencing and units model* (G): The focus is put on reference systems that are valid across Europe.
- *The identifier management* (K): Each object in the database should have a unique object identifier (K). This will be a combination of the identifier of the object on a national level with a prefix referring to its location in the INSPIRE structure. To ensure object uniqueness throughout Europe, not the form of identifier, but the identifier management mechanisms (e.g. registers) in use at national level will need to be synchronised/mapped to ensure pan-European integration.

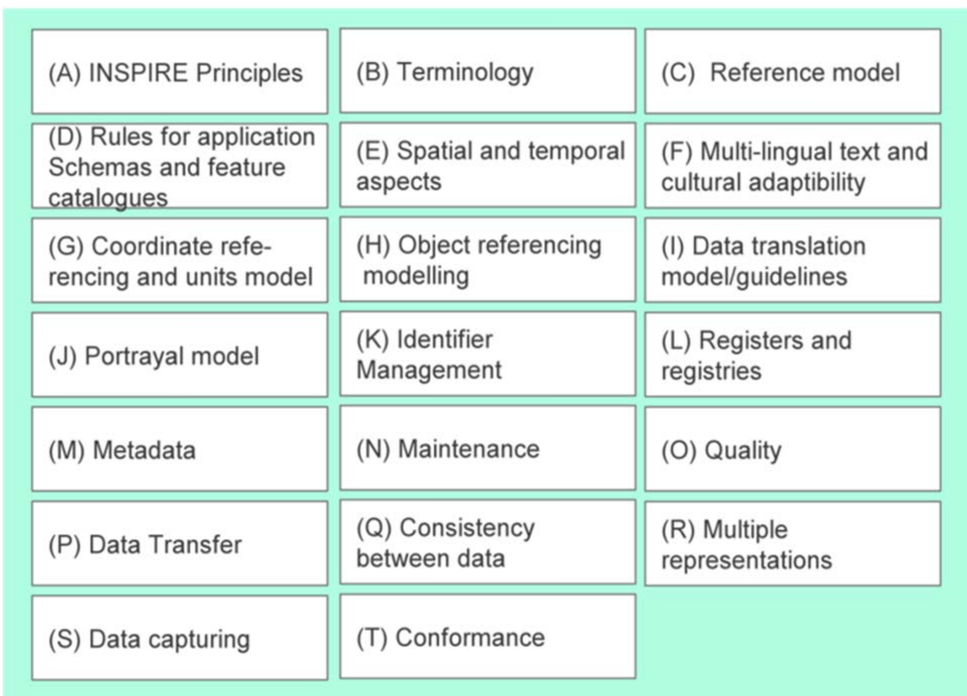


Figure 5.1: Overview of data interoperability components as defined in INSPIRE.
*(*http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/D2.5_v3.2.pdf*)*

5.2.3 Data specifications for Natural Risk Zones and implications for landslide databases

The INSPIRE Directive addresses 34 spatial data themes for environmental applications. These themes are subdivided in the three annexes of the directive. The complete list can be found on http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2/list/7. Landslides are part of the theme Natural Risk Zones (Annex III theme 12) and not of the theme soil as in the Soil Thematic Strategy. Natural Risk Zones are defined as vulnerable areas characterised according to natural hazards (all atmospheric, hydrologic, seismic, volcanic and wildfire phenomena that, because of their location, severity, and frequency, have the potential to seriously affect society), e.g. floods, landslides, earthquakes and volcanic eruptions (http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/DataSpecifications/D2.3_Definition_of_Annex_Themes_and_scope_v3.0.pdf).

For each of the 34 themes, a Thematic Working Group (TWG) is currently creating INSPIRE data specifications. The data specifications follow the structure of "ISO 19131 Geographic information - Data product specifications" standard. They include the technical documentation of the application schema, the spatial object types with their properties, and other specifics of the spatial data themes using natural language as well as a formal conceptual schema language (INSPIRE Thematic Working Group Natural Risk Zones, 2011). The specification is the work of the Natural Risk Zones TWG, a multinational team of experts from the community of SDICs and LMOs. The current version 2.0 (22/06/2011; http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2/list/1) has been compiled using reference material submitted by SDICs and LMOs and the responses to a user requirements survey. The team themselves had to draw on their own expertise and that of their organisations and other groups to develop agreed use cases in a selection of areas pertinent to Natural Risk Zones. While creating the data specifications for Natural Risk Zones, the team also had to take into account links with other thematic areas from INSPIRE (e.g. geology).

Important is that the TWG recognizes that among different natural hazards, differences in definitions of risk, hazard, vulnerability and exposure exist. Finally, it was decided to use the definitions listed in Table 5.1. Figure 5.2 illustrates the relation between these concepts, and thus the overall definition of Natural Risk Zones as zones where natural hazards areas intersect with highly populated areas and/or areas of particular environmental/ cultural/ economic value.

The production of data specifications of Natural Risk Zones is an on-going process. After launching the Call for Expression of Interest for participation in development of INSPIRE data specifications for Annex II & III Data Themes in November 2009, the TWG produced the first version of the data specification in September 2010. This version has been substantially improved. Version 1.9 (29/04/2011) was an internal report that was internally revised by the TWG, before making version 2.0 publically available on the INSPIRE webpage on June 22th, 2011 (http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2/list/1). Until October 20th, 2011 there is time for an external quality check. Persons are invited to test the model for landslide databases or susceptibility, hazard and risk assessments (for which a digital map is available). However, for this they needed to be registered as SDIC or LMO before May 15th, 2011. Eventual comments sent to the TWG will be discussed in a meeting in December 2011.

The third and final version is then planned to be published by March 2012. The information provided in this report is based on the version 2.0. Given that the model is not finalised, the TWG advised us not to provide the current version of the Natural Risk Zones application scheme, but to invite the reader to check the model in version 2 of the draft guidelines that is available on the INSPIRE webpage. Therefore, only a schematic version of the model will be presented. Until the more "stable" version of the data specifications (i.e. the one planned by March 2012) is available, no specific recommendations on landslide databases in agreement with INSPIRE can be drawn, but only general ones.

Table 5.1: Definitions used by the Thematic Working Group of Natural Risk Zones (INSPIRE Thematic Working Group Natural Risk Zones, 2011).

Risk
The term risk refers to the combination of the consequences of an event (hazard) and the associated likelihood/probability of its occurrence. The word "risk" has two distinctive connotations. The emphasis is either placed on the concept of chance or possibility, or on the consequences, in terms of "potential losses" for some particular cause, place and period (UNISDR 2009). .
Hazard
A dangerous phenomenon, substance, human activity or condition 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. In technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis (UNISDR, 2009).
Vulnerability
The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (UNISDR 2009).
Exposure
People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses (UNISDR 2009).

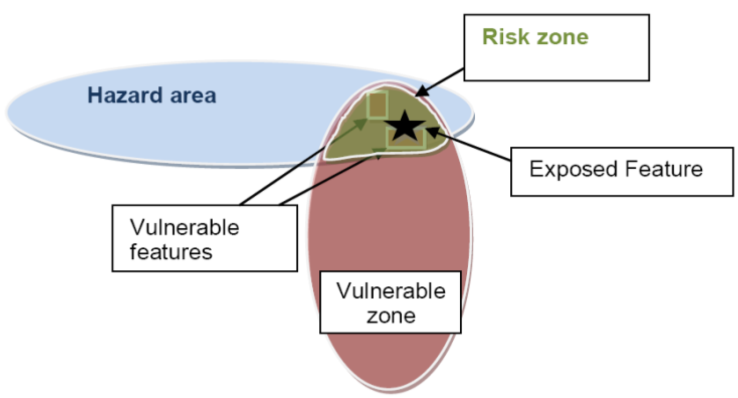


Figure 5.2: Relationships between main concepts in Natural Risk Zones model (INSPIRE Thematic Working Group Natural Risk Zones, 2011).

Figure 5.3 shows a schematic overview of the Natural Risk Zones application scheme with indication of the part that is most important in this study on landslide databases. The common scheme covers elements seen as necessary by the TWG to describe Natural Risk Zones, and thus consists of the four components shown in Figure 5.2, i.e. hazard areas, exposed elements, vulnerability of exposed elements, and risk zones. However, it is possible that for each specific natural hazard additional extensions to this general model are needed. This general model is mainly language neutral.

For this study on landslide databases only the ‘hazard area’ and the ‘observed hazard’, which is generated from the hazard area feature (Fig. 5.3), are relevant. A ‘hazard area**’** has a certain surface geometry (e.g. map with points or polygons representing landslides) to which two mandatory attributes are allocated, the INSPIRE Identifier and the type of hazard. With regard to the latter, currently no standardized natural hazards classification exists. The TWG therefore had to suggest a classification (Annex A of INSPIRE Thematic Working Group Natural Risk Zones, 2011 and Table 5.2). The challenge was to create an interoperable list of hazards that allowed the provision of more specific information about the type of hazard. All spatial objects (hazard areas, but also risk zones, and exposed elements; Fig. 5.3) need a unique identifier. This identifier needs to be maintained by the national or regional authority in the Member States. It should consist of two parts: the namespace (identifier of national database) and a local identifier (original identifier used in the national/regional database). Hence, the approach to make identifiers internationally unique is to add a prefix to the original local identifier.

Apart from the limited mandatory attributes, there is a list of attributes that should be provided if available. First, there are two attributes that describe its life cycle (i.e. “validFrom” and “validTo”). Secondly, information on the determination method used for hazard assessment, which can be either through modelling or through indirect determination (observation of evidence), can be provided. A third attribute is the level of hazard, which can be expressed either qualitatively or quantitatively. As hazard level values are not useful if the method (modelling or proxy-methods) is not indicated, also this information should be provided. A fourth attribute is the likelihood of occurrence, which can be expressed either qualitatively or quantitatively (probability or return period). Similar to the hazard level, it is also for the likelihood of occurrence requested to introduce information on the assessment method.

The ‘observed hazard’ is generated from the hazard area feature class. An observed hazard represents a feature of the real world that had or that still has an existence: the observed hazard feature has therefore two attributes that describe the life cycle of the real feature: “Valid From” and “valid To”. Also the name of observed hazard can be included.

Table 5.2: Classification of landslides as suggested by the TWG (situation 28/04/2011). When completing the type of hazard in the Natural Risk Zones application schema (see Fig. 5.3) one of the landslide types listed below should be selected. (taken from Annex A of INSPIRE Thematic Working Group of Natural Risk Zones, 2011).*

General definition	(Highland and Bobrowsky, 2008)
Landslide	A sudden gravity-driven down-slope movement of slide mass composed of soil, rock and vegetation. Landslide is a general term used to describe the downslope movement of soil, rock, and organic materials under the effects of gravity and also the landform that results from such movement.
Landslide types	(Highland and Bobrowsky, 2008)
Debris Flow	Debris flows are essentially large, extremely rapid, often open-slope flows formed when an unstable slope collapses and the resulting fragmented debris is rapidly transported away from the slope.
Karstic or Pseudo Karstic Collapse	Steep-sided sink formed by collapse into a subterranean cavity. An underground cavern forms. Eventually the overlying rock is longer collapses.
Mudflow	When a slope is so heavily saturated with water that it rushes downhill as a muddy river, carrying down debris and spreading out at the base of the slope; the fastest, wettest flow of weathered material down a hillside. A general term for a mass-movement landform and process characterized by a flowing mass of predominately fine-grained earth material possessing a high degree of fluidity during movement. The water content may range up to 60 percent.
Rockfall	Falls are abrupt movements of masses of geologic materials, such as rocks and boulders, that become detached from steep slopes or cliffs. The falling mass may break on impact, may begin rolling on steeper slopes, and may continue until the terrain flattens.
Sand Dune Movement	Large body of sand that moves under the action of wind or gravity.
Shore Line and Cliff Recession	Continuing landward movement of the shoreline or cliff due to erosion and slope failure; a net landward movement of the cliff or shoreline over a specified period.
Slide	A slide is a downslope movement of a soil or rock mass occurring on surfaces of rupture or on relatively thin zones of intense shear strain. Movement does not initially occur simultaneously over the whole of what eventually becomes the surface of rupture; the volume of displacing material enlarges from an area of local failure.
Soil Creep (slow earthflow)	Creep is the informal name for a slow earthflow and consists of the imperceptibly slow, steady downward movement of slope-forming soil or rock. Movement is caused by internal shear stress sufficient to cause deformation but insufficient to cause failure. Generally, the three types of creep are: (1) seasonal, (2) continuous, and (3) progressive.
Spreads	An extension of a cohesive soil or rock mass combined with the general subsidence of the fractured mass of cohesive material into softer underlying material. Spreads may result from liquefaction or flow (and extrusion) of the softer underlying material. Types of spreads include block spreads, liquefaction spreads, and lateral spread.
Subsidence	Sinking or downward settling of the Earth's surface, not restricted in rate, magnitude, or area involved. Subsidence may be caused by natural geologic processes, such as solution, compaction, or withdrawal of fluid lava from beneath a solid crust or by human activity such as subsurface mining or the pumping of oil or ground water.
Toppling	A topple is recognized as the forward rotation out of a slope of a mass of soil or rock around a point or axis below the center of gravity of the displaced mass. Toppling is sometimes driven by gravity exerted by the weight of material upslope from the displaced mass. Sometimes toppling is due to water or ice in cracks in the mass. Topples can consist of rock, debris (coarse material), or earth materials (fine-grained material). Topples can be complex and composite.
Snow Avalanche	A snow mass with typically a volume greater than 100 m3 and a minimum length of 50 meters that slides rapidly downhill (EEA, 2010).

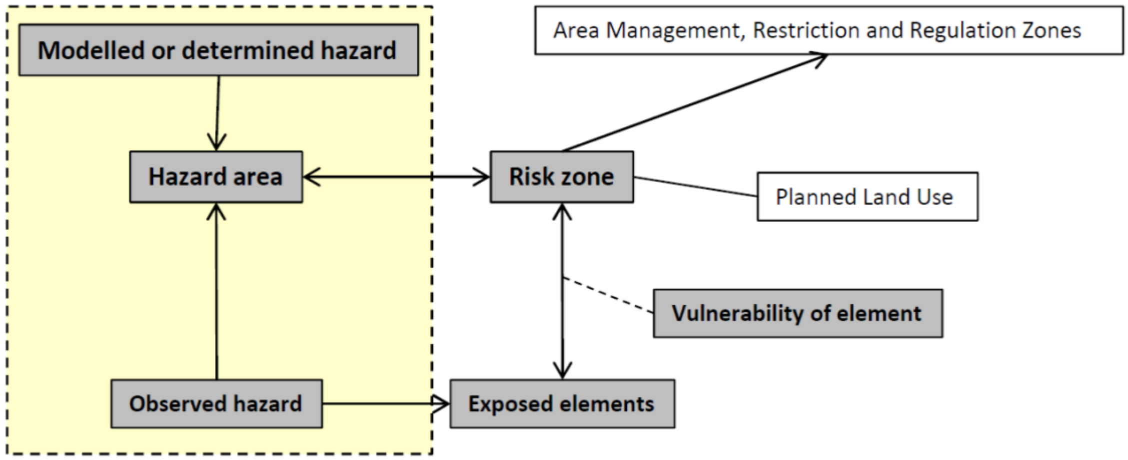


Figure 5.3: Simplified structure of the preliminary version of the Natural Risk Zones application scheme / general model (version 2.0, 22/06/2011; after INSPIRE Thematic Working Group Natural Risk Zones, 2011). We were asked not to put the preliminary model itself in this report and advise readers to check the most up to date version of the Guidelines on Natural Risk Zones Data Specifications on the INSPIRE webpage.

With regard to national landslide databases (with a digital landslide inventory map) in EU Member States, both the hazard area and the observed hazard need to be completed. The landslide inventory map and its attributes are part of the hazard area. This is the area including the surface geometry of the landslide (i.e. the digital map). The coordinate reference system to be used for the map needs to have the European Terrestrial Reference System 1989 (ETRS89) as datum in areas within its geographical scope, and the International Terrestrial Reference System (ITRS) datum in areas that are outside the geographical scope of ETRS89.

The hazard area will include the INSPIRE identifier and the type of hazard, in this case the type of landslide (Table 5.2). Probably there will also be possibility to fill in the original identifier of the landslide as present in the national database. The life cycle to be filled in is the date of first creation of the database ("validFrom") and the date until which the current database is valid ("validTo"). Information on the materials and methods used for creation of the database should be included.

To this single hazard area, a lot of observed hazards will be associated, all representing individual landslides for which, as mentioned above, a name and information on the history can be included. Up to here only attributes present in the preliminary version of the application scheme are discussed. Apart from these attributes, Member States can decide to include other information available in their national database too.

Overall, the description of Natural Risk Zones application scheme is relatively abstract. It emphasises the need for testing, and therefore the landslide community is invited to test the application scheme (end of June – October 2011; see above for details). It should be tested for both landslide inventory maps and landslide susceptibility, hazard and risk maps. Hereby, it is important to mention that it will not be possible to complete the entire scheme as schematised in Figure 5.3 in most cases. As mentioned before, landslide databases only focus on the hazard area. The risk zone, exposed elements and vulnerability features will remain blank. To help persons testing the model, the annexes of the Natural Risk Zones guidelines contain some use cases of landslides and other natural hazards. As flood risk is significantly better and more precisely defined than other hazards, due to the development of the Floods Directive (2007/60/EC; EC, 2007b), the model will be demonstrated/illustrated by providing an application schema (i.e. user case) specifically targeted at floods. This case description is not legally binding as it can be different from country to country. It illustrates how different hazard types might require different extensions to the application scheme. For the natural hazards other than floods, user cases only make suggestions that can provide ideas for construction of the general scheme.

The Natural Risk Zones guideline (version 2) further contains detailed information on the data quality requirements and on the metadata description. It is mentioned that data conformant to the INSPIRE data specification shall be made available through an INSPIRE network service so that it can be accessed and exchanged easily. Application of this common scheme will be legally binding. In the future, every national digital database on natural hazards should be interoperable with the data specifications model through INSPIRE network services. For the moment INSPIRE can not force Member States to include new data.

Our overview suggests that Member States will normally not have problems to fill in the mandatory information. Currently only Andorra, Spain and Switzerland do not have a digital landslide inventory map. However, as mentioned before, Spain and Switzerland should be able to produce one as the landslide coordinates are listed in the database, though as mentioned above INSPIRE can not force them to do so. More problematic, at least at present, is the fact that the data should be available in an INSPIRE network service so that it is easily accessible and exchangeable. Our analysis shows that currently only three landslide databases are available through such services (Fig. 4.22).

6 CONCLUSIONS AND RECOMMENDATIONS

To have a first detailed overview of the availability and content of national landslide inventories in Europe, a questionnaire was sent to the competent persons in the institutes responsible for compilation and maintenance of the landslide databases in EU member states, EU official candidate and potential candidate countries (except Turkey), and EFTA countries. As we received responses from 33 out of 37 European countries our approach proved very successful. Currently already 22 countries have a national database (Fig. 4.1 and Table 4.1). Six other countries (i.e. Belgium, Croatia, Germany, Estonia, Romania and Serbia; Figs. 4.1 and 4.2 and Table 4.2) only have one or more regional databases. This can be due to the fact that creation and maintenance of landslide databases or landslide management (requiring a landslide database) is a regional responsibility, or to the fact that currently attention was paid to the most landslide affected areas only. We finally also collected and analysed information of representative regional databases in landslide-prone countries such as Italy, Austria, Portugal and Spain to compare with nation-wide databases.

Analysis of the returned questionnaires on 23 national databases demonstrated that European databases contained more than 636,000 landslides in Spring 2010. Two thirds are located in Italy, but also Austria, Czech Republic, France, Norway, Slovakia, and UK have more than 10,000 landslides in their databases. However, the total amount of landslides that have occurred in Europe is assumed to be more than twice this number as the completeness of most of the national databases is estimated to be lower than 50%. This incompleteness is mainly due to the fact that it is difficult, and perhaps not the objective, to recognize all historical (inactive, dormant, abandoned, stabilized and relict) landslides. Apart from that, also the lack of resources and time, the surveyors' experience and the site characteristics influence the completeness of the database. A positive observation, on the other hand, is that 82% of the investigated databases are updated at least once a year or after a major event, and that the remaining countries do not exclude updating their database if this appears necessary.

Several publications have mentioned that national landslide databases have various content, scale, language, format, structure and accessibility. However, this was never really proven in detail.

The variability in map scale and used symbology is true. Three countries with a national database, Andorra, Spain and Switzerland currently do not have a landslide inventory map. However, for the latter two countries landslide coordinates are available in the database, which suggest that production of a (perhaps simplified) inventory map should be possible. All other countries produced a map at a scale ranging between 1:10,000 and 1:500,000 and showing landslides either as point features or closed polygons. Both symbols enable landslide zoning at regional and national scale. However, for more local analysis, accurate polygons are required.

The databases generally contain information on the landslide type, and on a limited or larger number of landslide morphological characteristics and geo-environmental factors. There is indeed a large variety on the landslide types included in the databases, but we observed that for most databases it should be possible to classify the landslides in a limited number of types from the classification of Cruden and Varnes (1996; e.g. fall, flow and slide).

With regard to the landslide characteristics national landslide databases generally contain information on the length and width of the landslide and on its affected area. Information on landslide volume, necessary for magnitude-frequency relationships and hence for landslide hazard analysis is also available for 65% of the databases. The remaining countries could envisage the possibility of including information on landslide volume too.

For landslide susceptibility analysis on a regional, national or continental scale, landslide databases should not necessaritly include detailed geo-environmental information of the landslide site, as this is generally extracted from thematic maps with a scale appropriate for that for which the analysis is being carried out. For more detailed local and site analysis, site-specific information, especially on topography, lithology and hydrology becomes more important.

Information on landslide history and activity, triggering factors and consequences, on the other hand, is low in most of the databases (i.e. completeness generally less than 25%), and this causes problems for hazard and risk studies. It could be advised to include also a qualitative estimate of landslide activity. Again it is suggested to use some of the classes defined by Cruden and Varnes (1996; e.g. active, reactivated, dormant, and relict).

In the near future, INSPIRE might help in overcoming the problem of variability in language, format, structure and accessibility of landslide databases. INSPIRE regulation and the preliminary data specifications of Natural Risk Zones, including landslides (as defined in INSPIRE Thematic Working Group Natural Risk Zones, 2011), were presented in section 5.2. Since physical combination of all landslides in one harmonised European database is currently impossible, and probably not recommended, the procedure followed by the INSPIRE regulation seems feasible. INSPIRE focuses on designing a framework or infrastructure to ensure that spatial data are stored, made available and maintained at the most appropriate level; that it is possible to combine spatial data and services from different sources across the Community in a consistent way and share them between several users and applications; that it is possible for spatial data collected at one level of public authority to be shared between all the different levels of public authorities; that spatial data and services are made available under conditions that do not restrict their extensive use; and that it is easy to discover available spatial data, to evaluate their fitness for purpose and to know the conditions applicable to their use. Each Member State transposing the directive should create and maintain this infrastructure, including detailed general schemes (Fig 5.3) on natural risk zones such as landslides, and share it with other public authorities in EU Member States. This should increase interoperability and accessibility of spatial landslide information, including a limited set of features (i.e. mandatory are a digital landslide inventory map, a landslide INSPIRE identifier and the hazard type, while landslide history can be included if available) among Member States. The general scheme or conceptual model itself will be in English, but feature catalogues are envisaged to be multilingual, so it should be possible to translate the limited set of features in a national landslide database from one language into another one. It can be concluded that the limited information to be included in the general model as defined by INSPIRE regulation will probably allow quantitative landslide susceptibility modelling at a European scale. For landslide hazard and risk modelling, however, more datasets regarding landslides are needed.

In contrast to INSPIRE regulation that will soon have some specifications for digital landslide databases, the EU Thematic Strategy for Soil Protection currently does not have legally binding regulations for landslide databases, because its associated legislative proposal for a Soil Framework Directive is still not approved. According to the current proposal, identification of risk zones will be required. For this landslide information from the EU countries will be necessary. Therefore, the Soil Information Working Group (SIWG) of the European Soil Bureau Network (ESBN) developed a set of “common criteria” (i.e. occurrence/density of existing landslides along with a set of conditioning and triggering factors) to identify these risk areas (Eckelmann et al., 2006) and they suggested using a nested geographical approach based on “Tiers”. As currently no harmonised landslide databases are available throughout Europe, the European Landslide Expert Group recommended carrying out a pan-European landslide inventory by reviewing the data already available and including at least information on the location and type of historical landslides, but if possible also on date of occurrence, surface extent and direct impact (Hervás et al., 2007). The minimum suggested information would then allow creation of a European landslide susceptibility map.

Hence, these preliminary recommendations of INSPIRE and the recommendation proposed by the European Landslide Expert Group are more or less in agreement. In both cases, a limited mandatory set of information to be included in the database is defined, while other information can be provided too. In both cases the minimum set of information allows assessment of landslide susceptibility, but not of hazard and risk.

7 ACKNOWLEDGEMENTS

The authors would like to thank all the respondents to the questionnaire and their organisations (see Annex B for a detailed list) for their valuable contribution to this study as well as all the SafeLand partners who distributed the questionnaire in their country or helped identifying the responsible person in each country or region investigated. More specifically, we wish to thank the SafeLand partners T. Oppikofer and R. Hermanns (NGI/ICG), V. Tofani (UNIFI), F. Agliardi and G.B. Crosta (UNIMIB), L. Cascini, D. Peduto and S. Ferlisi (UNISA), C. van Westen (ITC), C. Michoud and M. Jaboyedoff (UNIL), R. Supper (GBA), R.M. Maftei (GIR), and M. Čarman and S. Kumeli (GeoZS).

We further thank V. Kalm and J. Kivisilla (Geological Survey of Estonia), K. Soini (Finnish Environment Institute), K. Verbruggen (Irish Landslide Working Group), A. Pasuto (CNR-IRPI), D. Balteanu and M. Micu (Geomorphology and Natural Hazards Dept., Institute of Geography, Romanian Academy), M. Tatu (Institute of Geodynamics Sabba S. Stefanescu, Romanian Academy), R. Jélinek (JRC, Ispra, Italy), and L. Laín (Geological and Mining Institute of Spain) for helping us finding the contact person in their country.

We, finally, wish to thank the SafeLand partners J. Corominas (UPC, Barcelona) and J.P. Malet (CNRS, Strasbourg) for reviewing the questionnaire, and R. Tomas, V. Lima and M. Van Liedekerke (all of JRC, Ispra, Italy) for providing information on the INSPIRE regulation status.

8 REFERENCES

Corominas, J., 1996. The angle of reach as a mobility index for small and large landslides. Canadian Geotechnical Journal 33, 260-271.

Cruden, D.M., Varnes, D.J., 1996. Landslide Types and Processes. In A.K. Turner, and R.L., Schuster (Eds.), Special Report 247: Landslides, Investigation and Mitigation, Transportation Research Board. National Research Council, National Academy Press, Washington, DC, pp. 36-71.

Dikau, R., Cavallin, A., Jager, S., 1996. Databases and GIS for landslide research in Europe. Geomorphology 15, 227-239.

Di Mauro, C., Vetere Arellano, A.L., Ranguelov, B., Hervás, J., Peckham, R., Christou, M.D., Duffield, J.S., Wood, M., Nordvik, J.P. and Lucia, A.C., 2003. Questionnaire: Risk Mapping - Natural and Technological Risk and Contaminated lands. Special Publication No. I.03.222, JRC, Ispra, Italy, pp. 108.

EEA, 2010. Mapping the impacts of natural hazards and technological accidents in Europe: an overview of the last decade. European Environmental Agency Technical report 13. Office for Official Publications of the European Communities, Luxembourg.

EC, 2006a. Thematic Strategy for Soil Protection. COM(2006)231 final, Brussels 22.9.2006, pp. 12.

EC, 2006b. Proposal for a Directive of the European Parliament and of the Council establishing a framework for the protection of soil and amending Directive 2004/35/EC. COM(2006)232 final, Brussels 22.9.2006, pp. 30.

EC, 2006c. Impact assessment of the Thematic Strategy on Soil Protection. SEC(2006)620, Brussels, 22.9.2006, pp. 130.

EC, 2007a. Directive 200/7/2/EC of the European Parliament and the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE). Official Journal of the European Union, 25.4.2007, L108/1-14, Luxembourg. http://inspire.jrc.ec.europa.eu

EC, 2007b. Directive 2007/60/EC of the European Parliament and the Council of 6 November 2007 on the assessment and management of flood risks. Official Journal of the European Union, 6.11.2007, L288, 1-27, Luxembourg. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0060:EN:NOT

Eckelmann, W., Baritz, R., Bialousz, S., Bielek, P., Carre, F., Houskova, B., Jones, R.J.A., Kibblewhite, M.G., Kozak, J., Le Bas, C., Toth, G., Varallyay, G., Yli Halla, M., Zupan, M., 2006. Common criteria for risk area identification ac-cording to soil threats. European Soil Bureau Research Report n. 20, EUR 22185 EN. Office for Official Publications of the European Communities, Luxembourg.

Fell, R., Corominas, J., Bonnard, C., Cascini, L., Leroi, E., Savage, W.Z. on behalf of the JTC-1 Joint Technical Committee on Landslides and Engineered Slopes, 2008. Guidelines for landslide susceptibility, hazard and risk zoning for land use planning. Engineering Geology 102, 85-98.

Glade, T, Anderson, M.G. and Crozier, M.J., 2005. Landslide Hazard and Risk. Wiley, Chichester.

Günther, A., Reichenbach, P., Hervás, J., 2008. Approaches for Delineating Areas Susceptible to Landslides in the Framework of the European Soil Thematic Strategy. Proceedings of the First World Landslide Forum, Tokyo , 18-21 November 2008, pp. 235-238.

Hervás J., in press. Landslide inventory. In: Bobrowky, P.T. (Ed.), Encyclopedia of Natural Hazards. Springer, Heidelberg. DOI 10.10071978-14020-43994.

Hervás, J., Günther, A., Reichenbach, P., Chacón, J., Pasuto, A., Malet, J.-P., Trigila, A., Hobbs, P., Maquaire, O., Tagliavini, F., Poyiadji, E., Guerrieri, L., Montanarella, L. 2007. Recommendations on a common approach for mapping areas at risk of landslides in Europe. In: Hervás, J (Ed.), Guidelines for Mapping Areas at Risk of Landslides in Europe. Proceedings Experts Meeting, JRC Ispra, Italy, 23-24 October 2007.JRC Report EUR 23093 EN, Office for Official Publications of the European Communities, Luxembourg, pp. 45-49.

Hervás, J., Günther, A., Reichenbach, P., Malet, J.P., Van Den Eeckhaut, M., 2010. Harmonised approaches for landslide susceptibility mapping in Europe. In: Malet, J.P., Glade, T., Casagli, N. (Eds.), Proceedings International Conference Mountain Risks: Bringing Science to Society, Florence, Italy, 24-26 November 2010. CERG Editions, Strasbourg, pp. 501-505.

Highland, L.M., Bobrowsky, P., 2008. The Landslide Handbook - A Guide to Understanding Landslides. Circular 1325, U.S. Geological Survey, Reston, Virginia.

INSPIRE Thematic Working Group Natural Risk Zones, 2011. D2.8.III.12 Data Specification on Natural Risk Zones – Draft Guidelines, version 2.0 (22/06/2011). INSPIRE Thematic Working Group Natural Risk Zones.

Malamud, B.D., Turcotte, D.L., Guzzetti, F., Reichenbach, P., 2004. Landslide inventories and their statistical properties. Earth Surface Processes and Landforms 29, 687-711

Ollila, M., 2002. Ylimmät vedenkorkeudet ja sortumariskit ranta-alueille rakennettaessa Suositus alimmista rakentamiskorkeuksista. Suomenympäristökeskus Ympäristoministeriö Maa Jametsätalousministeriö, Helsinki, Finland.

RAMSOIL, 2007-2008. http://eusoils.jrc.ec.europa.eu/projects/Ramsoil/data.html

Schweigl, J., Hervás, J., 2009. Landslide Mapping in Austria. JRC Report EUR 23785 EN, Office for Official Publications of the European Communities, Luxembourg, pp. 61.

Trigila, A., Iadanza, C., Spizzichino, D., 2010. Quality assessment of the Italian Landslide Inventory using GIS processing. Landslides 7, 455-470.

UNISDR, 2009. Terminology on Disaster Risk Reduction. United Nations International Strategy for Disaster Reduction Secretariat, Geneva, Switzerland.

Van Den Eeckhaut, M., Poesen, J., Govers, G., Verstraeten, G., Demoulin, A., 2007. Characteristics of the size distribution of recent and historical landslides in a populated hilly region. Earth and Planetary Science Letters 256, 588-603.

Varnes D.J., 1978. Slope movements. Types and processes. In: Schuster, R.L. Krizek, R.J. (Eds.), Landslides: analysis and control. Natural Academy of Sciences Press, NRC-Transportation Research Board, Washington, Special Report 176, pp. 11-35.

9 ANNEX A: QUESTIONNAIRE

The SafeLand project

SafeLand is a Large-scale integrating Collaborative research project funded by The Seventh Framework Programme for research and technological development (FP7) of the European Commission. The project team is composed of 25 institutions from 13 European countries. More information can be found on http://www.safeland-fp7.eu/Introduction.html.

SafeLand will develop generic quantitative risk assessment and management tools and strategies for landslides at local, regional and European scales and establish the baseline for the risk associated with landslides in Europe, to improve the ability to forecast landslide hazard and detect hazard and risk zones. Part of the research focuses on reviewing existing landslide databases and proposing improvements for delineating areas at risk in agreement with the EU Soil Thematic Strategy and its associated Proposal for a Soil Framework Directive, and for achieving interoperability and harmonization in agreement with the INSPIRE European Directive.

What we would like to know from you

This questionnaire has been sent to you to survey the current situation of landslide databases in your country. Given that the SafeLand project focuses on landslide risk assessment, there is a need to know which landslide databases currently contain the information required for quantitative landslide hazard and risk assessment (i.e. type, location, timing of landslide and, if possible, impact / damage). Based on the results of this questionnaire, options for harmonization of landslide databases for quantitative landslide hazard and risk assessment in the EU will be suggested. Hence, it is very important to have a representative coverage of Europe.

For each country we contact SafeLand project partners of that country and we ask them to fill the questionnaire themselves (if they are able to do it) and/or to distribute the questionnaire to the competent persons in their country or in a neighbouring country they collaborate with. In case contacted persons do not speak English, we ask the project partners to help them filling in the questionnaire or to translate the questionnaire.

This questionnaire

The questionnaire consists of 10 short sections and it will take approximately 45 minutes to complete it. A short glossary can be found at the end of this document. We ask you to <u>return this questionnaire to the SafeLand project partner from your country from whom you received it or to us if we directly sent it to you</u>. If, for any reason, you are unable to send it to the project partner of your country, please send the questionnaire back to us via E-mail or via postal mail (see below). We kindly request you to return the questionnaire <u>before May 15, 2010</u>. For questions regarding this questionnaire please send an E-mail to miet.van-den-eeckhaut@jrc.ec.europa.eu with contact details.

Contact persons and contact address

Javier Hervás (javier.hervas@jrc.ec.europa.eu) and Miet Van Den Eeckhaut (miet.van-den-eeckhaut@jrc.ec.europa.eu)

Land Management and Natural Hazards Unit, Institute for Environment and Sustainability
Joint Research Centre (JRC) - European Commission
21027 Ispra (VA), Italy
Tel +39 0332786289

1. Contact information

Your Name:

Telephone number:

E-mail address:

Institute / Governmental body / company:

Address:

Country:

2. Database availability

Is there a landslide database available for your country?

☐ Yes, we have / are preparing a national landslide database. *Please continue answering the questionnaire.*

☐ Yes, we have / are preparing (a) regional landslide database(s). *Please continue answering the questionnaire.*

☐ No, we do not have / are not preparing a national or regional landslide database. *In this case, you are not able to fill in the questionnaire. We thank you for your collaboration.*

Note: If you can provide information or are responsible for more than one landslide database, please fill in this questionnaire for each of the databases.

3. General information of landslide database

Name of the country / region for which the database is prepared	
Official name of the database	
Approximate area covered by the database (km^2)	
Which institute owns the database? Who is the contact person?	
Which institute produced the database?	
Is the landslide database an official * document?	☐ Yes, it is a regulatory/compulsory document indicated by force in a law? ☐ Yes, but it is not a regulatory/compulsory document indicated by force in a law? ☐ No
Which language is used in the database?	
When was the database first created?	
When was the database last updated?	
What is the recurrence for updating the database?	☐ Original database is not updated ☐ Database is updated after a major landslide triggering event ☐ Database is updated each year ☐ Other:
What is the time period of landslide events covered by the database?	
Does the database contains features other than landslides? (e.g.** floods, sinkholes, avalanches)	☐ Yes, please specify ☐ No
How many landslides (active, dormant and relict) are currently included in the database?	
What is the completeness of the database (estimate in %)?	☐ < 25% of the existing landslides ☐ 25 - 50 % of the landslides ☐ 50 - 75% of the landslides ☐ > 75% of the landslides

* Official: document made by a government entity, such as a ministry, a mapping agency, the army or other, regardless of their possible availability to the public or their possible use only for internal purposes

** e.g.: example given

What is the proportion of Finland that is affected by the landslides included in the database?	
Could you please estimate the proportion of Finland that is affected by landslides (i.e. not only the area affected by the landslides currently included in database, but the total area in Finland that is estimated to be affected by landslides)?	
Is the database used for landslide susceptibility, hazard or risk mapping or other applications by your institute of by another institute? If yes, please specify the application and the responsible institute.	☐ Susceptibility ☐ Hazard ☐ Risk ☐ Other, (please specify)

4. Content of landslide database

What type of information is available? (1/2) *(For each type of information, the second column can only be filled in if information in first column is available)*	
☐ Landslide inventory map	What is the scale? What is the reference coordinate system? Is there information on the positional accuracy? ☐ yes / ☐ no / ☐ I don't know If yes, please explain How are landslides represented on the map? ☐ Point ☐ Line ☐ Closed polygon ☐ Combination of points, lines and polygons (depending on landslide size and mapping/visualisation scale) ☐ Other: How was this map produced? (Please indicate all techniques used) ☐ Field survey ☐ Historical documents (e.g. newspapers, technical reports, scientific papers, parish chronicles) ☐ Aerial photograph interpretation ☐ LiDAR (Light Detection and Ranging) derived images ☐ Satellite remote sensing ☐ Airborne remote sensing, other than aerial photos and LiDAR ☐ Other:
☐ Landslide location	How is landslide location reported in the database? (More than one category can be selected) ☐ Coordinates ☐ Municipality ☐ Province / County ☐ Other:
☐ Type of landslide	Which landslide classification is used? (e.g. Cruden and Varnes, 1996) Which landslide types are distinguished?
☐ Landslide dimension	☐ Displaced volume ☐ Affected area ☐ Length ☐ Width ☐ Travel angle (i.e. Length / Height) ☐ Height (from top to toe) ☐ Depth of surface of rupture ☐ Other:

<table>
<tr><th colspan="2">What type of information is available? (2/2)
(For each type of information, the second column can only be filled in if information in first column is available)</th></tr>
<tr><td>☐ Geo-environmental characteristics at landslide site</td><td>☐ Lithology and / or structure
☐ Hydrogeology (e.g. presence of springs and/or ponds)
☐ Land use
☐ Slope gradient
☐ Slope aspect
☐ Slope curvature
☐ Other:</td></tr>
<tr><td>☐ Triggering event or cause of landslide</td><td>Triggering factor is included for
☐ None of the inventoried landslides
☐ < 25% of the landslides
☐ 25 - 50 % of the landslides
☐ 50 - 75% of the landslides
☐ > 75% of the landslides</td></tr>
<tr><td>☐ Landslide date / history</td><td>☐ Information on initiation date
☐ Information on reactivation date(s) (e.g. for old landslides)
☐ Information on initiation and reactivation dates (Multi-temporal information)

Landslide history is available for
☐ None of the inventoried landslides
☐ < 25% of the landslides
☐ 25 - 50 % of the landslides
☐ 50 - 75% of the landslides
☐ > 75% of the landslides</td></tr>
<tr><td>☐ Landslide activity</td><td>Which activity classes are distinguished (e.g. active, reactivated, suspended, dormant, relict, inactive)?</td></tr>
<tr><td>☐ Consequences
(i.e. victims and estimate of damage)</td><td>Consequences are included for
☐ None of the inventoried landslides
☐ < 25% of the landslides
☐ 25 - 50 % of the landslides
☐ 50 - 75% of the landslides
☐ > 75% of the landslides
If included, please specify how landslide damage is described (e.g. very detailed description with monetary value of damage and/or reparation cost)</td></tr>
<tr><td>☐ Other:</td><td>☐ Photographs
☐ Monitoring data or physical properties from field and/or laboratory tests (even if locally for a limited number of landslides only). Please specify :
☐ Bibliographic references (e.g. historical documents, reports or scientific papers)
☐ Other:</td></tr>
</table>

5. Format of landslide database

In which format is the database currently available?	☐ Digital, a spatial database in a GIS ☐ Digital, an alphanumeric database ☐ Digital, a spatial database in a GIS linked to an alphanumeric database (i.e. relational database) ☐ Other digital: ☐ Paper
If digital, which spatial software is used?	☐ ArcGIS ☐ Other GIS:
If digital, which alphanumeric software is used?	☐ Oracle ☐ Microsoft Access ☐ Other software:
If paper, which type of document is available?	☐ Datasheets ☐ Maps

6. Conditions to access and use of landslide database

The landslide database is accessible to?	☐ General public ☐ Administration ☐ Scientific purposes ☐ Other:
The landslide database (It is possible to indicate two boxes; i.e. one for accessibility and one for use	☐ Is accessible for consultation only (not downloadable) ☐ Is downloadable free of charge under any condition ☐ Is downloadable by paying ☐ Can be used without specials conditions ☐ Can be used under certain conditions only ☐ I don’t know
Please (if existing) list the weblink to the landslide database.	

7. Information related to INSPIRE

INSPIRE is an EU directive to establish an infrastructure for spatial information in Europe that will help to make spatial or geographical information more accessible and interoperable for a wide range of purposes supporting sustainable development (http://inspire.jrc.ec.europa.eu).

In the beginning of November 2009, a call for Expression of Interest for participation in the development of INSPIRE data specifications for Annex II & III Data Themes was launched (http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2). One of Annex III Data Themes considers "Natural risk zones", among which landslides. Hence, in the near future implementing rules laying down technical arrangements for interoperability and harmonisation of landslide databases will be developed.

(If this is the responsibility of somebody else in your institute or organisation, please contact him/her for helping you answer these questions.)

Is the metadata of the landslide database complying with INSPIRE metadata regulations? (http://inspire.jrc.ec.europa.eu/index.cfm/pageid/101)	☐ Yes ☐ I don't know ☐ No
Is the landslide database provided through / stored in a network following the INSPIRE network services (e.g. viewing, discovering, downloading)? (http://inspire.jrc.ec.europa.eu/index.cfm/pageid/5)	☐ Yes ☐ I don't know ☐ No
Is your institute currently registered as an INSPIRE stakeholder?	☐ Yes, as Legally Mandated Organisation (LMO*) ☐ Yes, as Spatial Data Interest Community (SDIC*) ☐ I don't know ☐ No
Is your institute willing to register as an INSPIRE stakeholder?	☐ Yes, as Legally Mandated Organisation (LMO*) ☐ Yes, as Spatial Data Interest Community (SDIC*) ☐ I don't know ☐ No
Is your organization willing to participate in the real testing or reviewing of a draft of the INSPIRE Data Specifications related to the spatial data theme "Natural Risk Zones" when it is developed by the Thematic Working Group?	☐ Yes ☐ I don't know ☐ No

* SDICs typically are networks of data producers, transformers and users, whereas LMOs are responsible in the Member States for one or more components of the INSPIRE Directive (http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpec_ToR_AnnexII_III.pdf)

8. Availability of other databases for landslide hazard and risk assessment

The European Commission Proposal for a Framework Directive for the protection of soil has identified several factors ('common criteria or elements') that can be used for landslide hazard assessment. Please indicate which information is available in your country.

(Please note that another element, namely the occurrence/density of existing landslides, was already the main object of previous questions).

Common Criteria Landslides	Map available	Only point data available	Map scale	Spatial resolution	Date	Official name of map/database and reference
Topography	☐ Yes, please specify: ☐ digital /☐ paper					
Lithology	☐ Yes, please specify: ☐ digital /☐ paper					
Soil properties	☐ Yes, please specify: ☐ digital /☐ paper					
Land cover	☐ Yes, please specify: ☐ digital /☐ paper					
Land use (including land management, farming systems and forestry)	☐ Yes, please specify: ☐ digital /☐ paper					
Climate						
Precipitation (liquid/solid)	☐ Yes, please specify: ☐ digital /☐ paper	☐				
Temperature	☐ Yes, please specify: ☐ digital /☐ paper	☐				
Other:	☐ Yes, please specify: ☐ digital /☐ paper	☐				
	☐ Yes, please specify: ☐ digital /☐ paper	☐				
Seismicity						
Magnitude	☐ Yes, please specify: ☐ digital /☐ paper	☐				
Intensity	☐ Yes, please specify: ☐ digital /☐ paper	☐				
Peak ground acceleration	☐ Yes, please specify: ☐ digital /☐ paper	☐				
Other:	☐ Yes, please specify: ☐ digital /☐ paper	☐				
	☐ Yes, please specify: ☐ digital /☐ paper	☐				

For landslide risk assessment additional information is necessary. Please indicate which information is available.

Common Criteria Landslides	
☐ Elements at risk (buildings, engineering works, economic activities, public services utilities, infrastructure and environmental features)	☐ Digital map is available or the map can be produced by linking the data to a location (e.g. municipality) in a GIS - Spatial resolution: - Map scale: - Date: - Official name and reference:
☐ Population data (absolute number and population density)	☐ Digital map is available or the map can be produced by linking the data to a location (e.g. individual building, municipality) in a GIS - Spatial resolution: - Map scale: - Administrative level for which data is available ☐ Country ☐ Province or County ☐ Municipality ☐ Quarters within municipalities ☐ Street ☐ Individual buildings ☐ Other: - Date: - Official name and reference:

9. Additional information

- Please send us, together with the filled-in questionnaire, an example of a database sheet or attribute table and an excerpt of the landslide inventory map (with legend).

- Please provide us additional information that, according to your experience, could be useful for the overview of European landslide databases. (e.g. Please mention if the landslide database is restricted to a specific type of landslides, to active or recent landslides, or to landslides causing significant damage, and hence pays less attention to inventorying other types of landslides)

10. Glossary

(Glade et al., 2005; Fell et al., 2008)[4]

Consequence – The outcomes or potential outcomes arising from the occurrence of a landslide expressed qualitatively or quantitatively, in terms of loss, disadvantage or gain, damage, injury or loss of life. In other words, the effects usually (but not always) negative or adverse resulting from hazard. Negative consequences may be referred to as losses or costs involving both economic and non-economic values.

Elements at risk – The population, buildings and engineering works, economic activities, public services utilities, infrastructure and environmental features in the area potentially affected by landslides.

Landslide hazard – (Not to be confused with landslide susceptibility) The probability of occurrence of a potentially damaging landslide with a certain magnitude within a specified period of time and within a given area. The description of landslide hazard should include information on the location, the period of time and the magnitude (i.e. volume or area, velocity) of the event. In other words, the probability of a landslide occurring in a unit of time. This probability varies with the magnitude of the event.

Landslide inventory – Information of the location, classification, volume, activity and date of occurrence of landslides.

Landslide risk – A measure of the probability and severity of an adverse effect (a landslide) to health, property or the environment (i.e. the elements at risk). In other words, it is the expected degree of loss due to a landslide with a certain magnitude within a specified period of time and within a given area.

[4] Fell, R., Corominas, J., Bonnard, C., Cascini, L., Leroi, E. and Savage, W.Z. on behalf of the JTC-1 Joint Technical Committee on Landslides and Engineered Slopes (2008). Guidelines for landslide susceptibility, hazard and risk zoning for land use planning. Engineering Geology 102, 85-98.

Glade, T, Anderson, M.G. and Crozier, M. J., (Eds.) Landslide Hazard and Risk. Wiley, Chichester.

10 ANNEX B: LIST OF CONTACT PERSONS AND ORGANISATIONS

Albania

Contact Person	Mimoza Jusufati,
e-mail	Jusufati2000@yahoo.com
Institute	Albanian Geological Survey
Address	Rr.Kavajes, Nr.153, Tirane, Albania
Name of database	Landslide database of Albania

Andorra

Contact Person	Montserrat Mases Coberó
e-mail	mmases.cenma@iea.ad
Institute	Andorran Research Institute
Address	Av. Rocafort, 21-23. Edifici Molí, 3 pis. AD600 Sant Julià de Lòria, Andorra
Name of database	Natural Hazard Database of Andorra
Contact Person	Xavier Planas Batlle
e-mail	xplanas@andorra.ad
Institute	Government of Andorra
Address	Ministeri d'Ordenament Territorial, Camí de la Gral s/n, Andorra
Name of database	Geotechnical and Geological Hazard Map of Andorra

Austria

Contact Person	Arben Kociu
e-mail	arben.kociu@geologie.ac.at
Institute	Geological Survey of Austria
Address	Neulinggasse 38, 1030 Vienna, Austria
Name of database	GEORIOS
Contact Person	Franz Goldschmidt
e-mail	Franz.Goldschmidt@ktn.gv.at
Institute	Geology and Soil Department Carinthian Provincial Government
Address	FlatschacherStraße 70, 9021 Klagenfurt
Name of database	Landslide Event Cadastre (Carinthia)

Belgium

Contact Person	Liesbeth Vandekerckhove
e-mail	liesbeth.vandekerckhove@lne.vlaanderen.be
Institute	Environment, Nature and Energy, Flemish Government, Belgium
Address	Koning Albert II-laan 20, bus 20, Brussel
Name of database	Mapped landslides in Flanders

Bosnia and Herzegovina

Contact Person	Hazim Hrvatović
e-mail	zgeobih@bih.net.ba (hazim.hrvatovic@yahoo.com, geologijabih@yahoo.com)
Institute	Federal Geology Survey
Address	Ustanička 11, 71210 Ilidža, Bosnia and Erzegovina
Name of database	The engineering-geology map Federation of Bosnia and Herzegovina

Bulgaria

Contact Person	Nikolai D. Dobrev
e-mail	ndd@geology.bas.bg
Institute	Geological Institute, Bulgarian Academy of Sciences
Address	Acad. Georgi Bonchev str., block 24, 1113 Sofia, Bulgaria
Name of database	Map of landslides
Contact Person	Kiril Anguelov
e-mail	angelov@bondys.bg; dimitar@bondys.bg
Institute	BONDYS Ltd
Address	Sofia 1700, Vitosha Residential Estate, 11 “Prof. G. Zlatarski” Str
Name of database	Map of landslides

Croatia

Contact Person	Zelko Miklin
e-mail	zeljko.miklin@hgi-cgs.hr
Institute	Croatian Geological Survey
Address	Sachsova 2, 10001 Zagreb, Croatia
Name of database	Landslide register of Urbanised areas of the city of Zagreb

Cyprus

Contact Person	Maria Efthymiou
e-mail	director@gsd.moa.gov.cy
Institute	Geological Survey Department of Cyprus
Address	1 Lefkonos, 1415 Nicosia, Cyprus
Name of database	No landslide database available

Czech Republic

Contact Person	Zuzana Krejčí
e-mail	zuzana.krejci@geology.cz
Institute	Czech Geological Survey
Address	Leitnerova 22, Brno 658 69, Czech Republic
Name of database	National Landslide Register

Estonia

Contact Person	Marko Kohv
e-mail	marko.kohv@ut.ee
Institute	University of Tartu, Department of Geology
Address	Ravila 14a, Tartu, Estonia
Name of database	Landslides near Pärnu town

Finland

Contact Person	Raimo Sutnen, Philipp Schmidt-Thomé
e-mail	raimo.sutinen@gtk.fi; philipp.schmidt-thome@gtk.fi
Institute	Geological Survey of Finland
Address	Betonimiehenkuja 4, 02150 Espoo, Finland
Name of database	No landslide database available

Former Yugoslav Rep. of Macedonia

Contact Person	Milorad Jovanovski
e-mail	jovanovski@gf.ukim.edu.mk
Institute	University Sts. Cyril and Methodius, Civil Engineering Faculty
Address	blvd Partizanski odredi 24 P.O.Box 560, 1000, Skopje, Former Yugoslav Rep. of Macedonia
Name of database	Landslide cadastre for each section of engineering geological maps in the country

France

Contact Person	Jean-Philippe Malet
e-mail	jeanphilippe.malet@eost.u-strasbg.fr (for contact person of BDMvT at BRGM: mvt@brgm.fr)
Institute	CNRS – School and Observatory of Earth Sciences
Address	5 rue Descartes, F-67084 Strasbourg Cedex
Name of database	National Database of Ground Movements (BDMvT)

Germany

Contact Person	Christoph Starke
e-mail	Christoph.Starke@smul.sachsen.de
Institute	Saxon State Office for Environment, Agriculture and Geology
Address	Pillnitzer Platz 3, 01326 Dresden, Germany
Name of database	Landslide Database of Saxony
Contact Person	Andreas v.Poschinger
e-mail	Andreas.Poschinger@lfu.bayern.de
Institute	Bavarian Environment Agency (LfU)
Address	Lazarettstr. 67, 80636 München, Germany
Name of database	GEORISK (Bavaria)
Contact Person	Clemens Ruch
e-mail	clemens.ruch@rpf.bwl.de (Ralph.Watzel@rpf.bwl.de)
Institute	Freiburg Regional Council, Regional Office for Geology, Raw Materials and Mining
Address	Kaiserstuhlstr. 28, D-79106 Freiburg i. Br.
Name of database	In progress, questionnaire was not filled in for this reason
Contact Person	Michael Rogall
e-mail	michael.rogall@lgb-rlp.de
Institute	Regional Office for Geology, Raw Materials and Mining
Address	Emy-Roeder-Str. 5, 55129 Mainz, Germany
Name of database	Not yet specified (State of Rheinland-Pfalz)

Greece

Contact Person	Eleftheria Poyiadji
e-mail	kynpo@igme.gr
Institute	Institute of Geology and Mineral Exploration (IGME)
Address	1, Sp. Loui, GR 13677 - Acharnae, Greece
Name of database	Geodatabase I.G.M.E./ eng_geol/ ground_failures

Hungary

Contact Person	Tamas Oszvald
e-mail	tamas.oszvald@mbfh.hu
Institute	Hungarian Office for Mining and Geology
Address	H-1145 Budapest, COLUMBUS U. 17-23, Hungary
Name of database	National Landslides Cadastre

Iceland

Contact Person	Jón Kristinn Helgason
e-mail	jonkr@vedur.is
Institute	Icelandic Meteorological Office (IMO)
Address	Suðurgata 12, 400 Ísafjörður, Iceland
Name of database	OLI

Ireland

Contact Person	Ronnie Creighton
e-mail	ronnie.creighton@gsi.ie
Institute	Geological Survey of Ireland
Address	Beggars Bush, Haddington Road, Dublin 4, Ireland
Name of database	National Landslides Database

Italy

Contact Person	Alessandro Trigila
e-mail	alessandro.trigila@isprambiente.it
Institute	ISPRA - Institute for Environmental Protection and Research
Address	Via Vitaliano Brancati , 48 - 00144 Roma, Italy
Name of database	IFFI Project
Contact Person	Federico Agliardi, Giovanni B. Crosta
e-mail	federico.agliardi@unimib.it
Institute	University of Milano-Bicocca
Address	Piazza della Scienza, 4 – 20126 Milano, Italy
Name of database	Alpine Inventory of Deep-Seated Gravitational Slope Deformations (Northern Italy)
Contact Person	Veronica Tofani
e-mail	veronica.tofani@unifi.it
Institute	Department of Earth Sciences, University of Firenze
Address	Via La Pira, 4, 50121 Firenze, Italy
Name of database	Landslide inventory of the Arno river basin
Contact Person	Frederico Baistrocchi
e-mail	baistrocchi.federico@autoritabacinosarno.it
Institute	Sarno River Basin Authority, Italy
Address	
Name of database	P.A.I (Provinces of Avellino and Salerno) and P.A.I (Province of Napoli)

Contact Person	Vera Corbelli
e-mail	Vera.Corbelli@autoritadibacino.it
Institute	National Basin Authority of Liri-Garigliano and Volturno rivers
Address	Viale Lincoln (ex Zona Saint Gobin) - 81100 Caserta, Italy
Name of database	Landslide inventory of basin of Liri-Grarigliano and Volturno Rivers
Contact Person	Michele Vita
e-mail	mivita@regione.basilicata.it
Institute	National Basin Authority of Basilicata
Address	Corso Umberto I, 85100 Potenza, Italy
Name of database	P.A.I. of AdB Basilicata
Contact Person	Antonio Rosario Di Santo
e-mail	segreteria@adb.puglia.it
Institute	National Basin Authority of Puglia
Address	C/o InnovaPuglia s.p.a. -S.P. per Casamassima, km 3, 70010 - Valenzano (BA), Italy
Name of database	1. P.A.I. of Puglia, 2. Hydrogeomorphological map of Puglia and 3. Landslide Database of Puglia

Montenegro

Contact Person	Zvonko Tomanović
e-mail	zvonko@ac.me
Institute	University of Crne Gore
Address	Montenegro
Name of database	No landslide database available

The Netherlands

Contact Person	Cees van Westen
e-mail	westen@itc.nl
Institute	University Twente, Faculty of Geo-Information Science and Earth Observation (ITC)
Address	PO Box 6, 75000 AA Enschede, The Netherlands
Name of database	No landslide database available

Norway

Contact Person	Thierry Oppikofer, Reginald Hermanns
e-mail	thierry.oppikofer@ngu.no, reginald.hermanns@ngu.no, kari.sletten@ngu.no
Institute	Geological Survey of Norway (NGU)
Address	Leiv Eirikssons vei 39, Postboks 6315 Sluppen, NO-7491 Trondheim, Norway
Name of database	National Landslide Database

Poland

Contact Person	Dariusz Grabowski
e-mail	dariusz.grabowski@pgi.gov.pl
Institute	Polish Geological Institute
Address	Rakowiecka 4 Street, 00-975 Warsaw, Poland
Name of database	SOPO

Portugal

Contact Person	Jose Luis Zêzere
e-mail	zezere@campus.ul.pt
Institute	Centre of Geographical Studies
Address	Alameda da Universidade, 1600-214 Lisboa, Portugal
Name of database	North of Lisbon Landslides

Romania

Contact Person	Raluca Maftei
e-mail	mafteir@yahoo.com
Institute	Geological Institute of Romania
Address	1 Caransebes, sect.1, 012271, PO 32, Bucharest
Name of database	Landslide inventory of Prahova, Arges, Dambovita, Valcea and Buzau County

Serbia

Contact Person	Djordje Trbojevic
e-mail	djtrbojevic@gis.co.rs, office@gis.co.rs
Institute	Geological Institute of Serbia
Address	Belgrade, Rovinjska 12, Serbia
Name of database	Cadastre of landslides and unstable slopes on the territory of Serbia
Contact Person	Branislav Trivić
e-mail	btrivic@rgf.bg.ac.rs
Institute	University of Belgrade, Faculty of Mining and Geology
Address	Belgrade, Djušina 7, Serbia
Name of database	BEOSlide (Belgrade area)

Slovakia

Contact Person	Pavel Liščák
e-mail	pavel.liscak@geology.sk; Liscak@fns.uniba.sk
Institute	SGUDS, Geological Survey of the Slovak Republic
Address	Mlynska dolina, 81704 Bratislava, Slovakia
Name of database	Atlas Zosunov, on the SGUDS website: Register zosunov (landslide register)

Slovenia

Contact Person	Marko Komac
e-mail	marko.komac@geo-zs.si; urszr@urszr.si
Institute	Geological Survey of Slovenia
Address	Dimičeva ulica 14, SI - 1001 Ljubljana, Slovenia
Name of database	GIS_UJME (Landslide Database is a part of a larger database)

Spain

Contact Person	Juan Carlos García López-Davalillo / Mercedes Ferrer Gijón
e-mail	jc.garcia@igme.es; m.ferrer@igme.es
Institute	Geological and Mining Institute of Spain (IGME)
Address	c/ Ciril Amorós 42 Entreplanta; 46004 Valencia, Spain
Name of database	Spanish Database of Geological Hazards

Contact Person	Jordi Corominas
e-mail	jordi.corominas@upc.edu
Institute	Department of Geotechnical Engineering and Geosciences. Technical University of Catalonia.
Address	Jordi Girona 1-3, Campus Nord UPC. D-2 Building, 08034 Barcelona, Spain
Name of database	LLISCAT (Catalonia and Andorra)
Contact Person	Jorge David Jiménez Perálvarez
e-mail	jorgejp@ugr.es
Institute	University of Granada
Address	Upper School of Civil Engineering, C/ Severo Ochoa S/N. 18071 Granada, Spain
Name of database	Landslides database of the Southern Slopes of Sierra Nevada, Granada

Sweden

Contact Person	Magnus Johansson
e-mail	magnus.johansson@msb.se
Institute	Swedish Civil Contingencies Agency, Sector for Lessons Learning
Address	MSB, 651 81 Karlstad, Sweden
Name of database	Swedish Natural Hazards Information System
Contact Person	Ann-Christine Hågeryd
e-mail	ann-christine.hageryd@swedgeo.se
Institute	Swedish geotechnical institute (SGI)
Address	Olaus Magnus väg 35, 581 93 Linköping, Sweden
Name of database	SGI Landslide Database

Switzerland

Contact Person	Hugo Raetzo / Bernard Loup
e-mail	bernard.loup@bafu.admin.ch
Institute	Federal Environmental Office (OFEV)
Address	3003 Bern, Switzerland
Name of database	Infoslide

United Kingdom

Contact Person	Claire Foster
e-mail	cfoster@bgs.ac.uk
Institute	British Geological Survey
Address	Kingsley Dunham Centre, Keyworth, Nottingham, Nottinghamshire, NG12 5GG, UK
Name of database	National Landslide Database

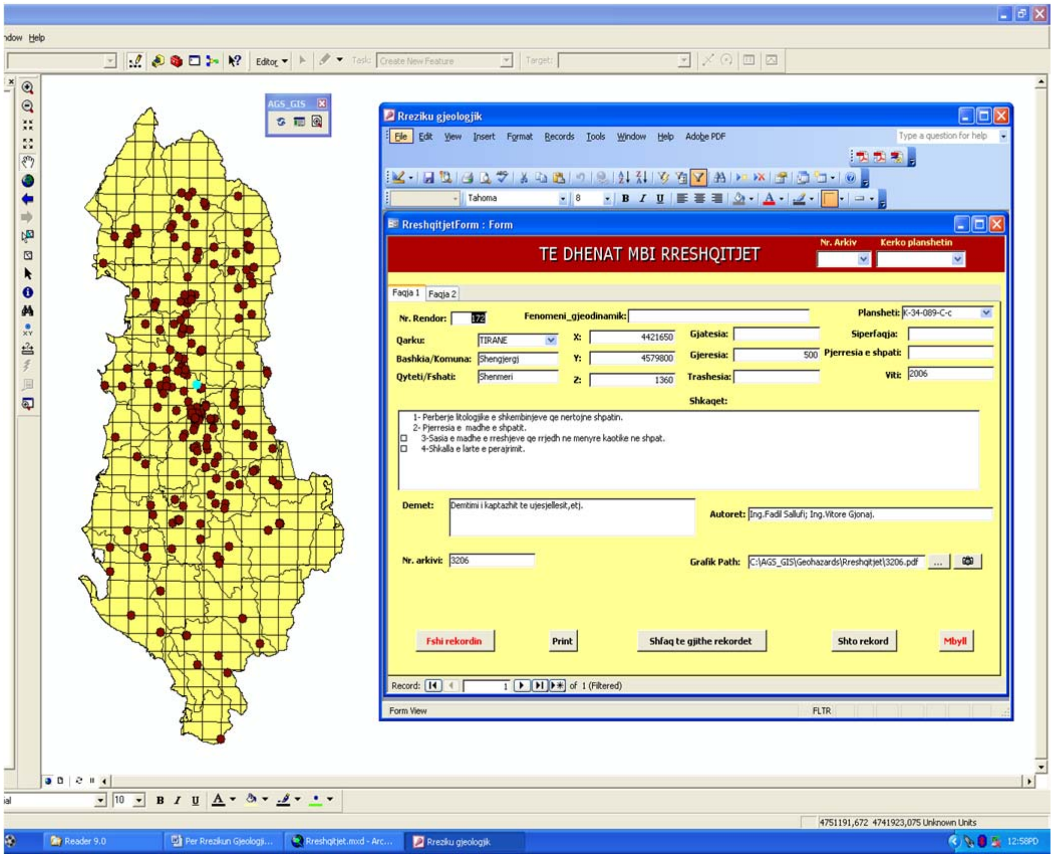
11 ANNEX C: ILLUSTRATIONS OF NATIONAL LANDSLIDE DATABASES

This annex includes examples of national landslide databases sent by the contact persons or taken from the publically accessible website.

The annex does not provide examples for all European countries. We apologise to those contact persons that have sent us some additional information that is not included in the report, and refer also to the weblinks to the national and regional landslide databases included in this overview (Tables 4.1 and 4.2).

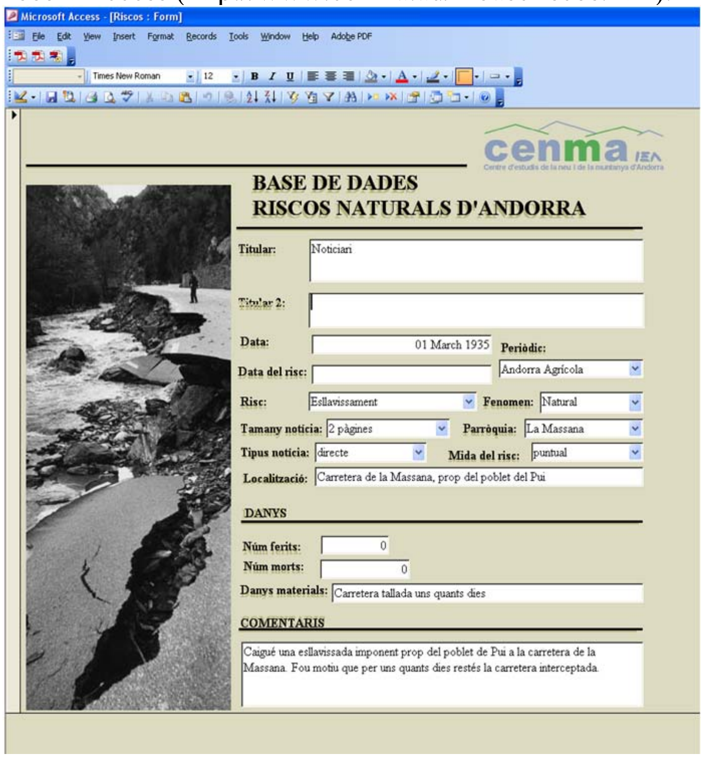
11.1 ALBANIA

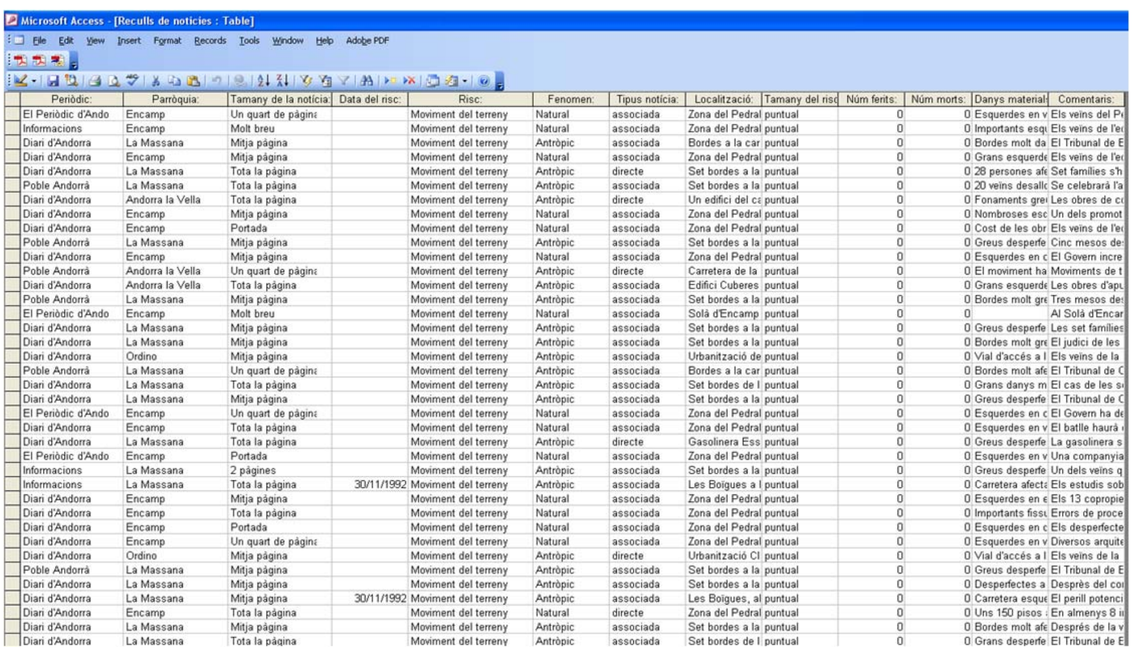
Screenshot of a landslide inventory map and linked datasheet of Albanian Geological Survey's landslide database.



11.2 ANDORRA

Excerpts of the natural hazards database of Andorra (Base de dades de riscos naturals d'Andorra) in Microsoft Access (http://www.cenma.ad/mbaseriscos.htm).

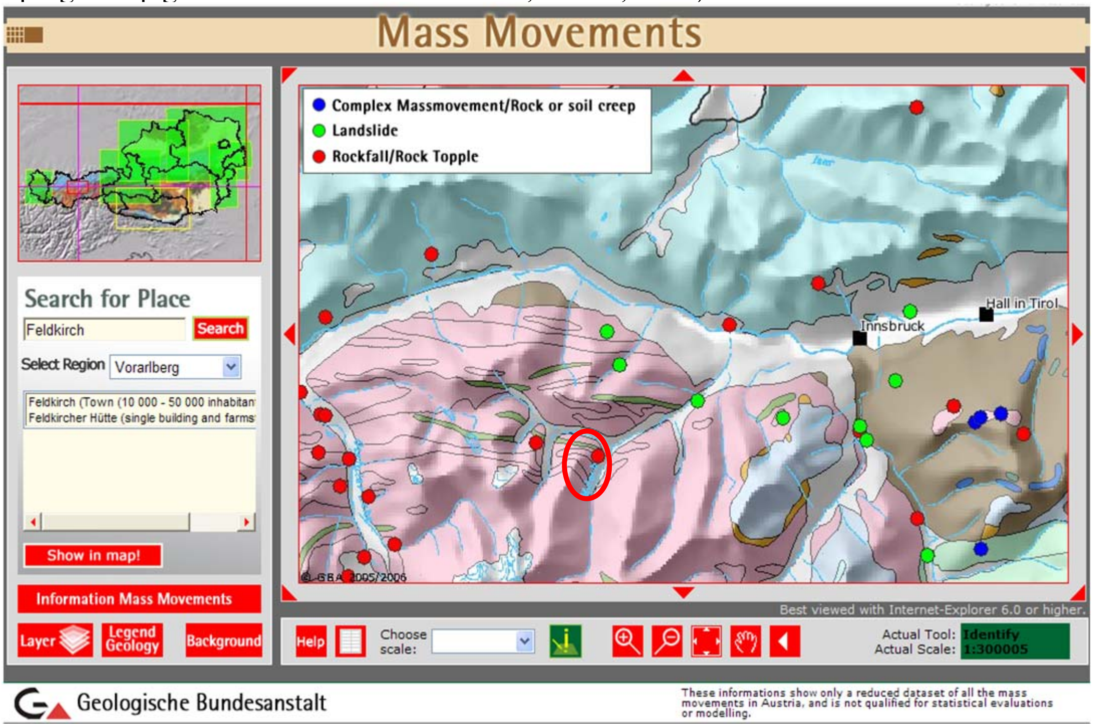


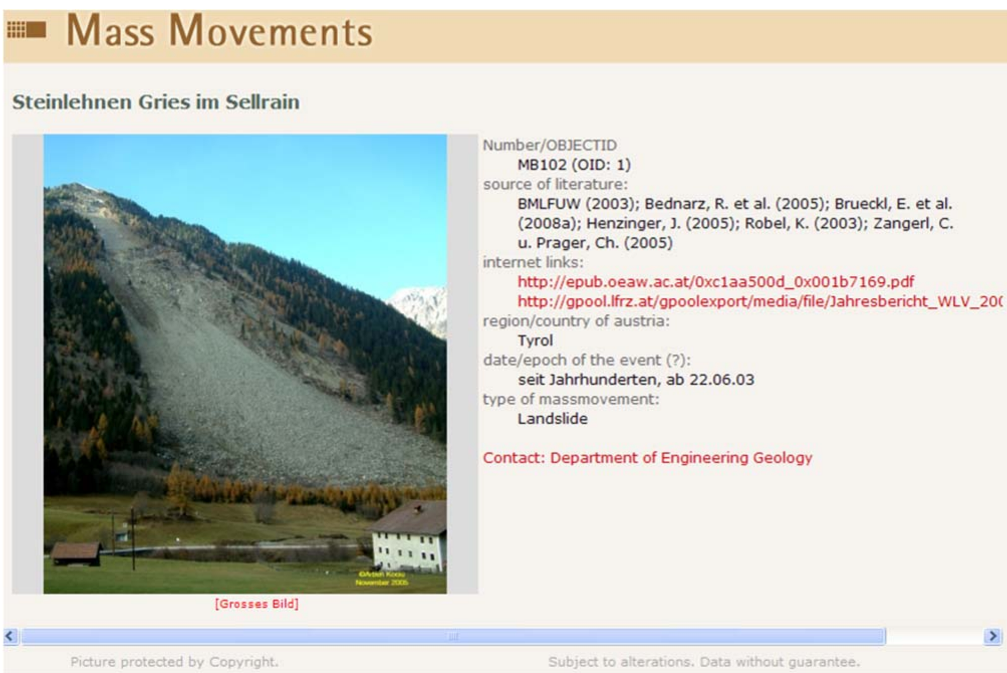


Periòdic:	Parròquia:	Tamany de la notícia:	Data del risc:	Risc:	Fenomen:	Tipus notícia:	Localització:	Tamany del risc	Núm ferits:	Núm morts:	Danys material	Comentaris:
El Periòdic d'Ando	Encamp	Un quart de pàgina		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Esquerdes en v	Els veïns del P
Informacions	Encamp	Molt breu		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Importants esq	Els veïns de l'e
Diari d'Andorra	La Massana	Mitja pàgina		Moviment del terreny	Antròpic	associada	Bordes a la car	puntual	0	0	Bordes molt da	El Tribunal de E
Diari d'Andorra	Encamp	Mitja pàgina		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Grans esquerde	Els veïns de l'e
Diari d'Andorra	La Massana	Tota la pàgina		Moviment del terreny	Antròpic	directe	Set bordes a la	puntual	0	0	28 persones afe	Set famílies s'h
Poble Andorrà	La Massana	Tota la pàgina		Moviment del terreny	Antròpic	associada	Set bordes a la	puntual	0	0	20 veïns desall	Se celebrarà l'a
Diari d'Andorra	Andorra la Vella	Tota la pàgina		Moviment del terreny	Antròpic	directe	Un edifici del ca	puntual	0	0	Fonaments gre	Les obres de co
Diari d'Andorra	Encamp	Mitja pàgina		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Nombroses esc	Un dels promot
Diari d'Andorra	Encamp	Portada		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Cost de les obr	Els veïns de l'e
Poble Andorrà	La Massana	Mitja pàgina		Moviment del terreny	Antròpic	associada	Set bordes a la	puntual	0	0	Greus desperfe	Cinc mesos de
Diari d'Andorra	Encamp	Mitja pàgina		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Esquerdes en c	El Govern incre
Poble Andorrà	Andorra la Vella	Un quart de pàgina		Moviment del terreny	Antròpic	directe	Carretera de la	puntual	0	0	El moviment ha	Moviments de t
Diari d'Andorra	Andorra la Vella	Tota la pàgina		Moviment del terreny	Antròpic	associada	Edifici Cuberes	puntual	0	0	Grans esquerde	Les obres d'apu
Poble Andorrà	La Massana	Mitja pàgina		Moviment del terreny	Antròpic	associada	Set bordes a la	puntual	0	0	Bordes molt gre	Tres mesos des
El Periòdic d'Ando	Encamp	Molt breu		Moviment del terreny	Natural	associada	Solà d'Encamp	puntual	0	0		Al Solà d'Encar
Diari d'Andorra	La Massana	Mitja pàgina		Moviment del terreny	Antròpic	associada	Set bordes a la	puntual	0	0	Greus desperfe	Les set famílies
Diari d'Andorra	La Massana	Mitja pàgina		Moviment del terreny	Antròpic	associada	Set bordes a la	puntual	0	0	Bordes molt gre	El judici de les
Diari d'Andorra	Ordino	Mitja pàgina		Moviment del terreny	Antròpic	associada	Urbanització de	puntual	0	0	Vial d'accés a l	Els veïns de la
Poble Andorrà	La Massana	Un quart de pàgina		Moviment del terreny	Antròpic	associada	Bordes a la car	puntual	0	0	Bordes molt afe	El Tribunal de C
Diari d'Andorra	La Massana	Tota la pàgina		Moviment del terreny	Antròpic	associada	Set bordes de l	puntual	0	0	Grans danys m	El cas de les s
Diari d'Andorra	La Massana	Mitja pàgina		Moviment del terreny	Antròpic	associada	Set bordes a la	puntual	0	0	Greus desperfe	El Tribunal de C
El Periòdic d'Ando	Encamp	Un quart de pàgina		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Esquerdes en c	El Govern ha de
Diari d'Andorra	Encamp	Tota la pàgina		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Esquerdes en v	El batlle haurà
Diari d'Andorra	La Massana	Tota la pàgina		Moviment del terreny	Antròpic	directe	Gasolinera Ess	puntual	0	0	Greus desperfe	La gasolinera s
El Periòdic d'Ando	Encamp	Portada		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Esquerdes en v	Una companyia
Informacions	La Massana	2 pàgines		Moviment del terreny	Antròpic	associada	Set bordes a la	puntual	0	0	Greus desperfe	Un dels veïns q
Informacions	La Massana	Tota la pàgina	30/11/1992	Moviment del terreny	Antròpic	associada	Les Boïgues a l	puntual	0	0	Carretera afecta	Els estudis sob
Diari d'Andorra	Encamp	Mitja pàgina		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Esquerdes en e	Els 13 copropie
Diari d'Andorra	Encamp	Tota la pàgina		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Importants fissu	Errors de proce
Diari d'Andorra	Encamp	Portada		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Esquerdes en c	Els desperfecte
Diari d'Andorra	Encamp	Un quart de pàgina		Moviment del terreny	Natural	associada	Zona del Pedral	puntual	0	0	Esquerdes en v	Diversos arquite
Diari d'Andorra	Ordino	Mitja pàgina		Moviment del terreny	Antròpic	directe	Urbanització Cl	puntual	0	0	Vial d'accés a l	Els veïns de la
Poble Andorrà	La Massana	Mitja pàgina		Moviment del terreny	Antròpic	associada	Set bordes a la	puntual	0	0	Greus desperfe	El Tribunal de E
Diari d'Andorra	La Massana	Mitja pàgina		Moviment del terreny	Antròpic	associada	Set bordes a la	puntual	0	0	Desperfectes a	Després del co
Diari d'Andorra	La Massana	Mitja pàgina	30/11/1992	Moviment del terreny	Antròpic	associada	Les Boïgues, al	puntual	0	0	Carretera esque	El perill potenci
Diari d'Andorra	Encamp	Tota la pàgina		Moviment del terreny	Natural	directe	Zona del Pedral	puntual	0	0	Uns 150 pisos	En almenys 8 i
Diari d'Andorra	La Massana	Mitja pàgina		Moviment del terreny	Antròpic	associada	Set bordes a la	puntual	0	0	Bordes molt afe	Després de la v
Diari d'Andorra	La Massana	Tota la pàgina		Moviment del terreny	Antròpic	associada	Set bordes de l	puntual	0	0	Grans desperfe	El Tribunal de E

11.3 AUSTRIA

Excerpts of the English version of the Geological Survey of Austria's mass movement (Massenbewegungen) database
(http://geomap.geolba.ac.at/MASS/index.cfm; March, 2011).





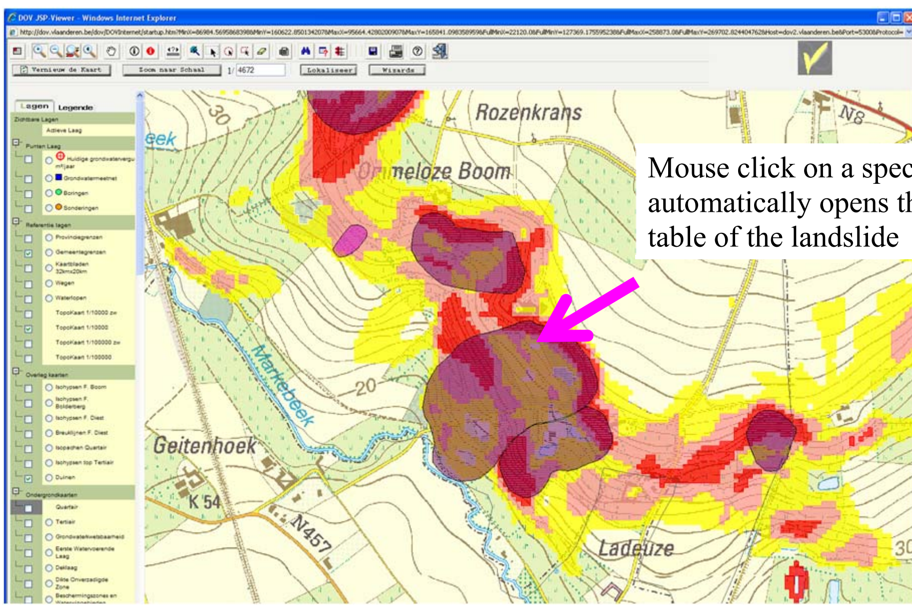
11.4 FLANDERS (BELGIUM)

As in about half of the EU countries, the landslide database (and classified landslide susceptibility map) are included in a larger database, i.e. the database for the subsoil of Flanders "Databank Ondergrond Vlaanderen; DOV" (http://dov.vlaanderen.be/dov/DOVInternet/default.htm).

Information on the database can also be found in:

- Vandekerckhove, L., Vanthournout, L., Van Den Eeckhaut, M., Poesen, J., Vanwesenbeeck, V., Van Damme, M., Boel, K., De Nil, K., De Rouck, T., Vergauwen, I., 2009. Integrating landslide information in the Flemish Subsoil Database (DOV). 6th EUREGEO European Congress on Regional GEOscientific Cartography and Information Systems, Munich (Germany), 9-12 June, 2009, pp. 4.

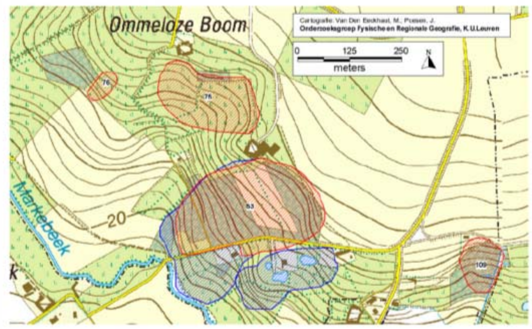
- Van Den Eeckhaut, M., Poesen, J., Vandekerckhove, L., Van Gils, M., Van Rompaey, A., 2010. Human-environment interactions in residential areas susceptible to landsliding: the Flemish Ardennes case-study. Area 42 (3), 339–358.



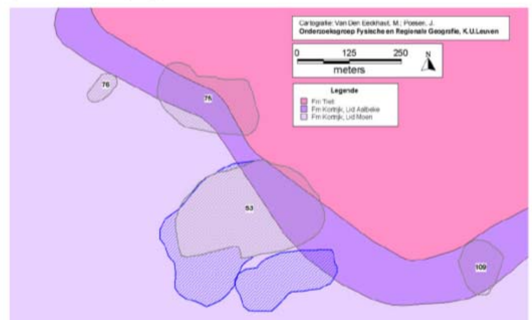
Excerpt of topographical and geological map.

Code:	53
Ligging:	Hekkebrugstraat Gemeente: Oudenaarde X = 97390 Y = 168430
Type:	Duidelijke grondverschuiving met een diep schuifvlak Rotationele verglijding type 1
Morfologische Kenmerken van de massabeweging:	Oppervlakte (ha): 6,3 Lengte (m): 350 Breedte (m): 240 Hoogte steilrand (m): 8 Diepte glijvlak (m): > 3
Topografische kenmerken van de site:	Gemiddelde helling site (m/m): 0,14 Oriëntatie: ZW Kromming in plan: Recht Kromming in profiel: Concaaf
Lithologie:	Steilrand: Tt / KoAa Grondverschuiving: KoAa / KoMo
Bodem:	Vergraven of verschoven terrein, slecht gedraineerde kleibodem
Hydrografie:	Bronniveau: Ja, tussen 60 en 65 m boven zeeniveau Waterstagnatie / poelen: Nee Ondergraving door beek: Nee Oppervlakkige afvoer van hellingopwaarts gelegen akkers? Ja
Landgebruik	Bos
Historiek:	Datum van activatie / reactivatie: 1960, januari 1966, winter 1988, februari - maart 1995, 1996, winter 1997, 1999, januari 2003 (zie opmerkingen)
Menselijke ingrepen:	Voor de reactivatie van 1995: Ophogen van wegdek en terrein rond het vroegere huis van V. Desaedeleer, verwaarlozen onderhoud grachten, oppervlakkige afvoer van ca. 10 ha groot toestroomgebied, graven van vijvers, wegnemen van materiaal aan de voet van de grondverschuiving in 2001 Na de reactivatie van 1995: In 2000 werden twee 2 m diepe afvoergrachten gegraven. Deze moeten de evacuatie van zowel het bronwater als van de oppervlakkige afvoer van de hellingopwaarts gelegen akkers doorheen de accumulatiezone van de grondverschuiving bevorderen
Locale info DOV:	Recent werden door de Afdeling Geotechniek (Ministerie van de Vlaamse Gemeenschap) 6 sonderingen en 2 boringen uitgevoerd.
Opmerkingen:	Bijkomende informatie omtrent de historiek van deze grondverschuiving: Van Den Eeckhaut et al. (2003) en Van Den Eeckhaut et al. (in voorbereiding)

Figuur 1 : Uitsnede uit de topografische kaart (Bron: OC GIS-Vlaanderen, 2001)



Figuur 2 : Uitsnede uit de geologische kaart (Bron: OC GIS-Vlaanderen, 2001)



Excerpt of soil map and photographs of the site.

Figuur 3 : Uitsnede uit de bodemkaart (Bron: OC GIS-Vlaanderen, 2001; eigen bewerking)

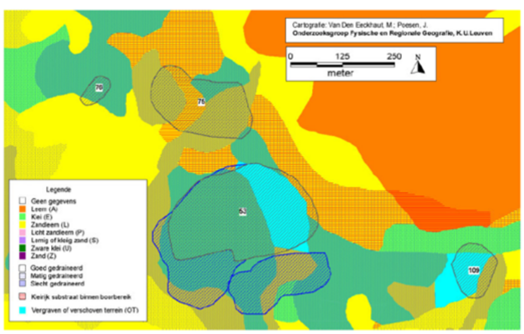


Foto 2 : Zicht op de hoofdsteilrand van GV. 53. Enkele jaren na de reactivatie van 1995 heeft deze steilrand nog een fris karakter: hij is zeer steil en onbegroeid. Op de achtergrond liggen braakliggende akkers

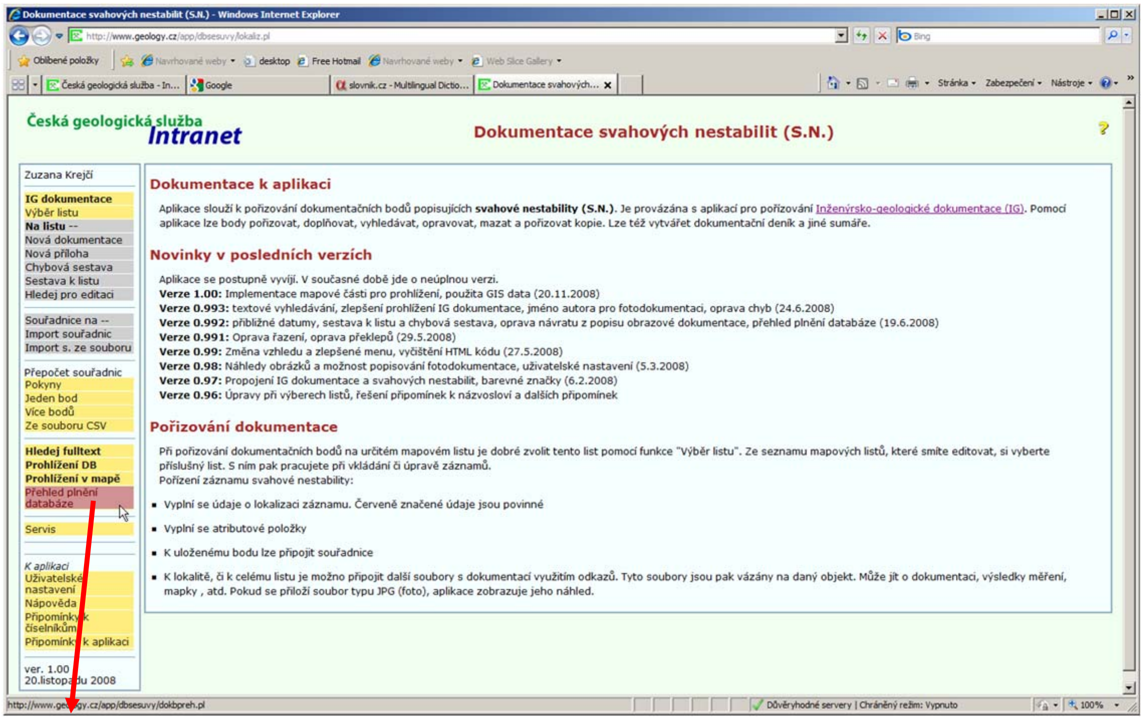
Foto 1 : Uitsnede luchtfoto (NGI, 14/04/1995) van GV. 53. Ook GV. 75, 76 en 109 zijn zichtbaar op de foto. Indien de GV. niet teruggevonden worden kan gebruik gemaakt worden van Figuur 1 om ze te lokaliseren.

Foto 3 : Materiële schade in de accumulatiezone van GV. 53

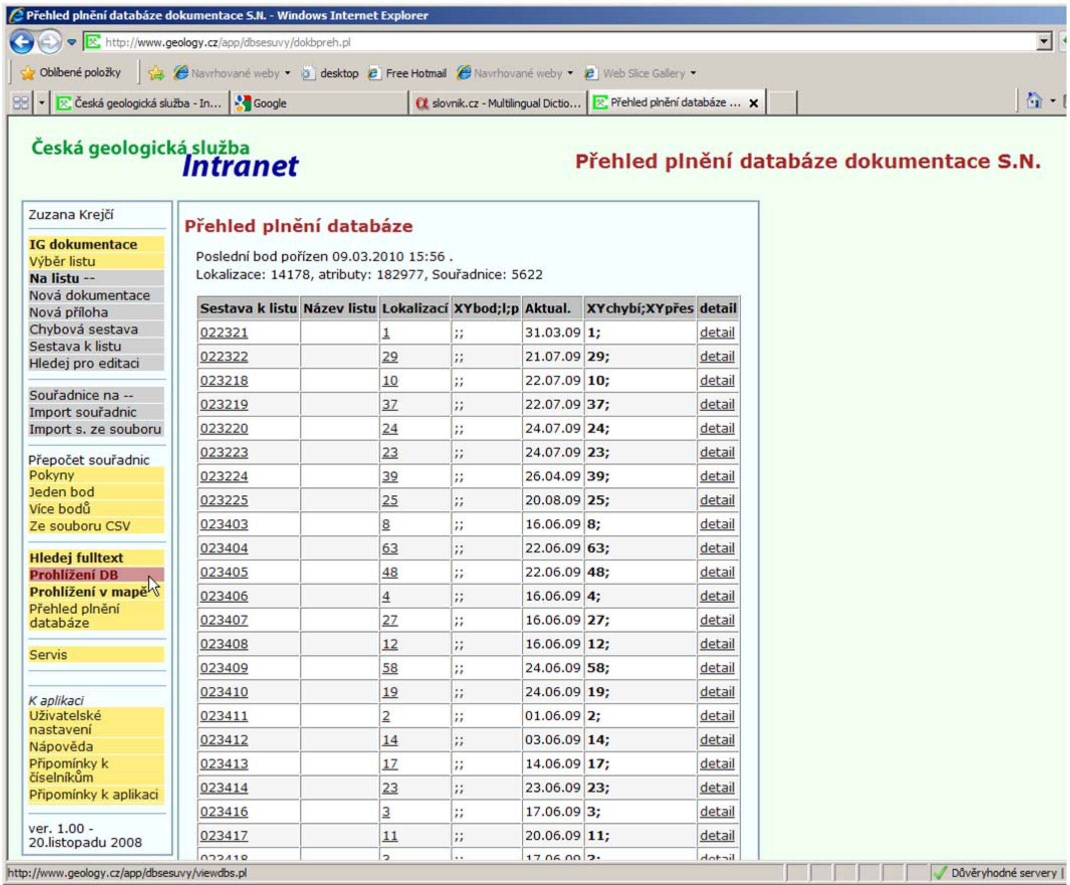
11.5 CZECH REPUBLIC

Czech Geological Survey (CGS) Information Portal – Intranet –
http://www.geology.cz/app/dbsesuvy
(no public access, and in national language).

Start page



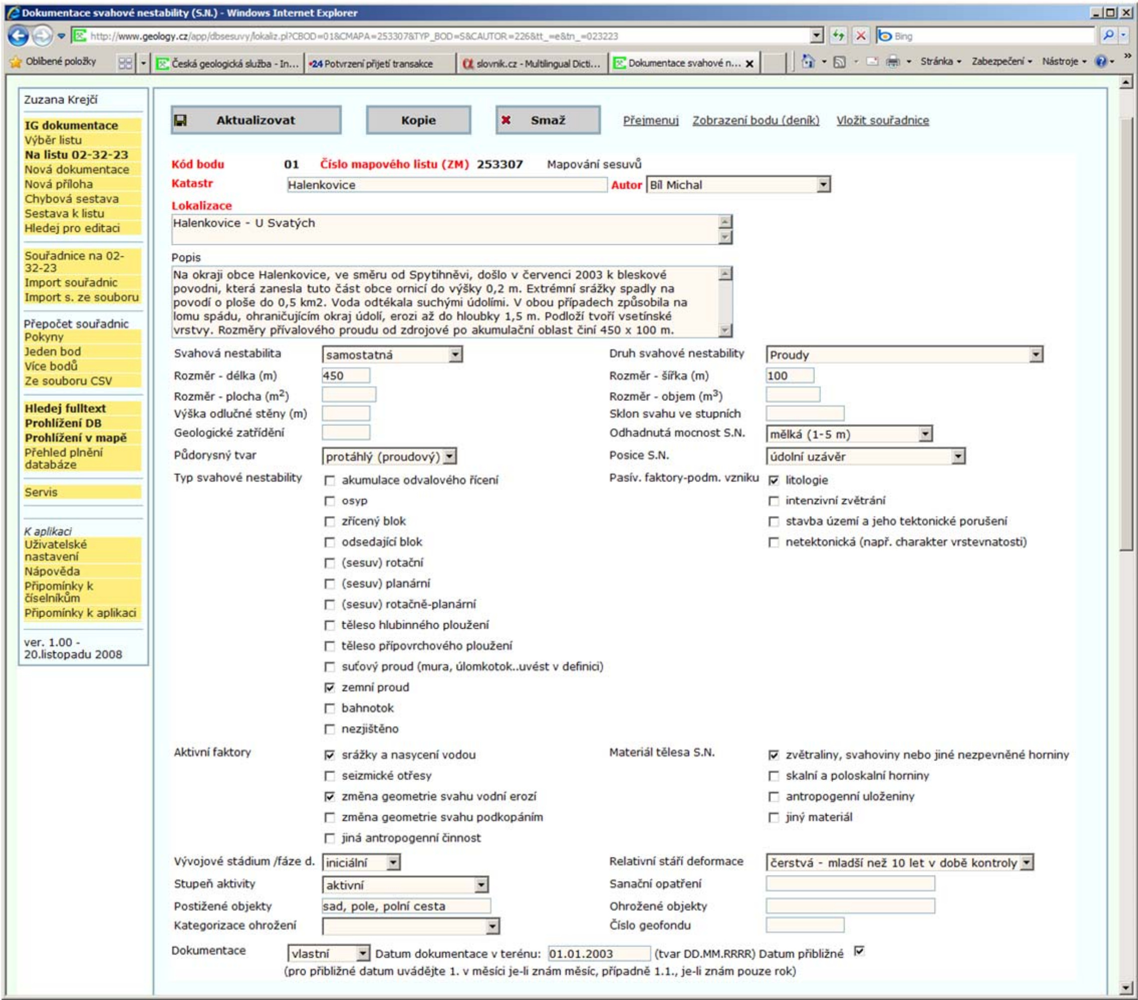
Statistic



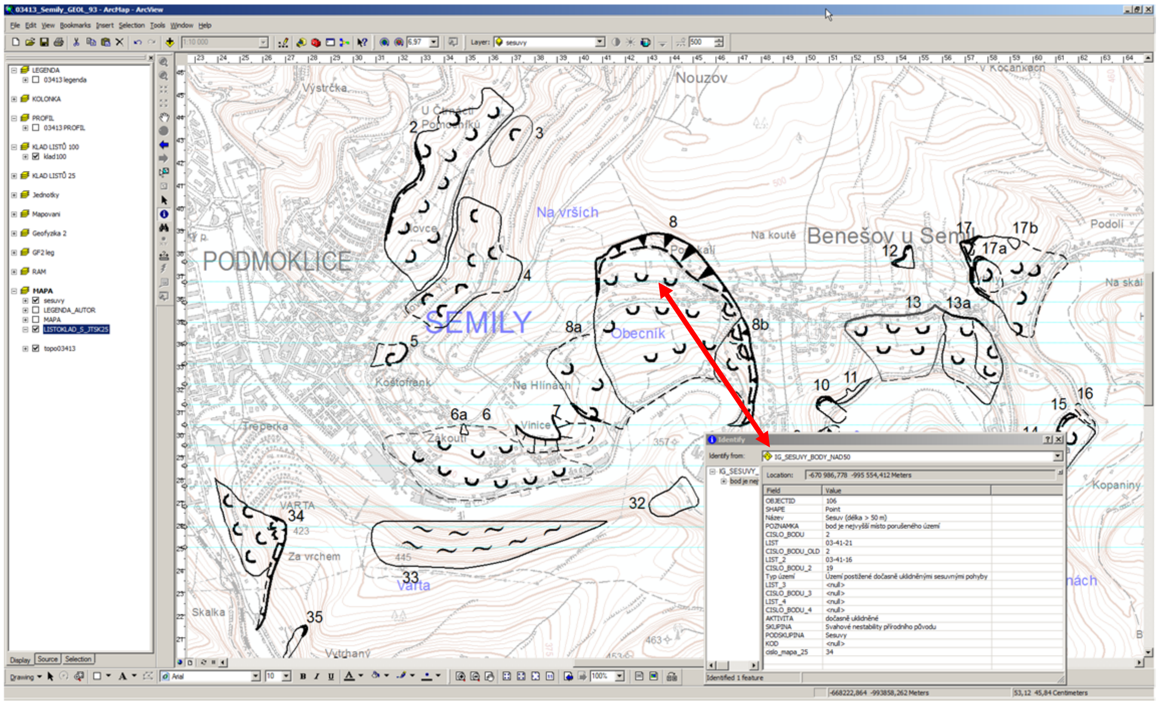
Sestava k listu	Název listu	Lokalizací	XYbod;l;p	Aktual.	XYchybí;XYpřes	detail
022321		1	;;	31.03.09	1;	detail
022322		29	;;	21.07.09	29;	detail
023218		10	;;	22.07.09	10;	detail
023219		37	;;	22.07.09	37;	detail
023220		24	;;	24.07.09	24;	detail
023223		23	;;	24.07.09	23;	detail
023224		39	;;	26.04.09	39;	detail
023225		25	;;	20.08.09	25;	detail
023403		8	;;	16.06.09	8;	detail
023404		63	;;	22.06.09	63;	detail
023405		48	;;	22.06.09	48;	detail
023406		4	;;	16.06.09	4;	detail
023407		27	;;	16.06.09	27;	detail
023408		12	;;	16.06.09	12;	detail
023409		58	;;	24.06.09	58;	detail
023410		19	;;	24.06.09	19;	detail
023411		2	;;	01.06.09	2;	detail
023412		14	;;	03.06.09	14;	detail
023413		17	;;	14.06.09	17;	detail
023414		23	;;	23.06.09	23;	detail
023416		3	;;	17.06.09	3;	detail
023417		11	;;	20.06.09	11;	detail

Table including all landslides included in the digital landslide inventory map (1:10,000).

Example of a data sheet



Excerpt of the landslide inventory map



11.6 FRANCE

Excerpts of the French Geological Survey (BRGM)'s ground movement database of France (http://www.bdmvt.net; March 2011).

11.7 GERMANY

Example of datasheet of the landslide database of Saxony provided by Saxon State Office for Environment, Agriculture and Geology (LfLUG).

Ingenieurgeologische Aufnahme von Felsböschungen

Ersteinschätzung von Felsstutz- und Steinschlagereignissen

Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie

		lfd. Nr.: xxx	**Blatt 1**

Allgemeine Angaben

Bearbeiter	xxxxx xxxxxxxxx				
Institution	xxxxxxxxxxxxxxxxx				
Veranlassung	Information durch xxxxxxxxxxxx, Herr xxxxxx, am xx.xx.xxxx (Ingenieurgeologische Landesaufnahme – Erfassung von Massenbewegungen)				
Zuständigkeit	xxxxxxxxxxxxxxxxx				
Rechtsträger	xxxxxxxxxxxxxxxxx				
TK 10 / TK 25 Nr.	xxxx-xx / xxxx	**Rechtswert**	xxxxxxx	**Hochwert**	xxxxxxx
Landkreis	xxxxxxxxxxxxxxxxx	**Gemeinde**	xxxxxxxxxxxxxxxxx		
Gemarkung	xxxxxxxxxxxxxxxxx	**Flurstück**	xx/x		
Lagebeschreibung	Felssporn unterhalb des westlichsten Punktes vom xxxxxxxxxxxxxxxxx				
Schutzwürdige Objekte	Privatgrundstück (massives Schuppengebäude)				
Schadensbild	beschädigter temporärer Bauzaun (kein Personenschaden, geringer materieller Sachschaden)				
Witterung / **am**	leicht bewölkt, trocken, 2 °C	xx.xx.xxxx	**Ereignisdatum**	xx.xx.xxxx	
Sonstiges	Das Baugerüst wurde an einer Stelle am späteren Abbruchkörper Ak1 befestigt und wenige Tage vor dem Ereignis abgebaut!				

Angaben zur Böschung

☒ **Natürl. Böschung**		☐ **Ein- / Anschnitt**		☐ **Steinbruch / Halde**		**Streichrichtung:**	NW – SE
Ausbruchhöhe:	1,2 m	**Ausbruchbreite:**	0,8 m	**Ausbruchtiefe:**	0,35 m	**Böschungswinkel:**	60° / 90°
Verlagerte Masse	ca. 0,4 m³	**Verlagerungsgefährdete Masse**	ca. 0,4 m³				
Böschungshöhe / -wand	ca. 8 – 10m	☐ eben	☒ uneben	Sonstiges:			
Böschungsschulter	☒ konvex	☐ konkav		Sonstiges:			
Böschungsfuß	☒ verschüttet	☐ nicht verschüttet		Sonstiges:			
Art der Bewegung	☐ Fallen	☐ Kippen		☒ Gleiten		☐ Driften	
Vegetation	im Ausbruchbereich sind Efeu-Wurzelreste erkennbar, oberhalb ist Efeubewuchs vorhanden						
Wasseraustritte	☐ temporär	☐ permanent		Menge/Einheit (l/s):			
Entwässerung / Dränage	nicht vorhanden						
Sicherungsbauten	nicht vorhanden						
Monitoring	☐ ja	☒ nein		**Art des Monitoring**			

Ergebnis

G e f a h r e n b e u r t e i l u n g

Handlungsbedarf	☐ sofort	☒ mittelfristig	☐ kein
Zusatzuntersuchungen	-		
Vorschläge für sofortige Sicherungsmaßnahmen	-		

Weiterer Handlungsbedarf
- Gebirgsschonende Beräumung des potentiellen Abbruchkörpers Ak2. In diesem Zusammenhang ist der Felssporn auf weiteres loses (verlagerungsgefährdetes) Material zu überprüfen, ggf. ist dieses zu beräumen. Die Maßnahme ist durch eine Fachfirma zu realisieren.
- Bis zur Durchführung der Beräumungsarbeiten ist der Ablagerungsbereich abzusperren und der Privatgrundstücksbesitzer ist zeitnah nach der Ortsbegehung zu informieren.

Datum: xx.xx.xxxx	Unterschrift:

Ingenieurgeologische Aufnahme von Felsböschungen

Ersteinschätzung von Felssturz- und Steinschlagereignissen

Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie

Ingenieurgeologische Charakteristik

lfd. Nr.: xxx | **Blatt 2**

Gebirgszustand

Gesteinsart	Metagrauwacke und Metagrauwackenpelit (feinstkörnige Metagrauwacke)
Stratigraphie	Neoproterozoikum (Tieferes Vendium; Varanger: *Weesensteiner Gruppe*); *Niederseidewitzer Folge*, kontaktmetamorph
geologische Struktur	nordöstlicher Rahmen des Maxen-Berggießhübeler Synklinoriums (Elbtalschiefergebirge)
Verwitterungsgrad	☐ unverwittert ☒ angewittert ☐ entfestigt ☐ zersetzt

Trennflächengefüge

Schichtung (Ss)	*Messwerte (EFR/EFW):*
Abstand Schichtung [cm]	☐ < 1 ☐ 1 - 5 ☐ 5 - 10 ☐ 10 - 30 ☐ 30 - 60 ☐ > 60
Sonstiges	
Schieferung (Sf)	*Messwerte (EFR/EFW):* 16° / 60°
Abstand Schieferung [cm]	☐ < 1 ☐ 1 - 5 ☐ 5 - 10 ☐ 10 - 30 ☒ 30 - 60 ☐ > 60
Sonstiges	bildet gleichzeitig die Ablösefläche für den Abbruchkörper Ak1 und Ak1a
tekton. Besonderheiten	Weesensteiner Störung ca. 240 m SW, Innerer Kontakthof (zweifach kontaktmetamorph überprägt)

Klüftung K 1 *Messwerte (EFR/EFW):*	**Klüftung K 2** *Messwerte (EFR/EFW):*	**Klüftung K 3** *Messwerte (EFR/EFW):*
266° / 8°	36° / 72°	
weitere Kluftsysteme *Messwerte (EFR/EFW):*		
Kluftabstände K 1 – K 3 [cm]		
☐ 1-5 ☐ 5-10 ☐ 10-30 ☐ 30-60 ☒ > 60	☐ 1-5 ☐ 5-10 ☐ 10-30 ☐ 30-60 ☒ > 60	☐ 1-5 ☐ 5-10 ☐ 10-30 ☐ 30-60 ☐ > 60
Sonstiges:	Sonstiges:	Sonstiges:
Kluftgröße – Trennflächenlänge K 1 – K 3 [m]		
☐ < 1 ☒ 1-10 ☐ > 10 Bem.:	☐ < 1 ☒ 1-10 ☐ > 10 Bem.:	☐ < 1 ☐ 1-10 ☐ > 10 Bem.:
Habitus der Kluftwandung K 1 – K 3		
☒ stufig ☐ wellig ☒ eben	☒ stufig ☐ wellig ☒ eben	☐ stufig ☐ wellig ☐ eben
☐ rau ☒ glatt ☒ rippelig	☐ rau ☒ glatt ☒ rippelig	☐ rau ☐ glatt ☐ rippelig
Kluftöffnungsweite K 1 – K 3 [cm]		
min.: max.: mittel:	min.: max.: mittel:	min.: max.: mittel:
Kluftfüllung K 1 – K 3		
Kluftversatz K 1 – K 3 [cm]		

Kluftkörperform ☐ säulig ☒ blockig ☐ würfelig ☐ quaderig ☒ plattig

Ingenieurgeologische Aufnahme von Felsböschungen

Ersteinschätzung von Felssturz- und Steinschlagereignissen

Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie

lfd. Nr.: xxx	Blatt 3

Skizze / Profil / Bilder

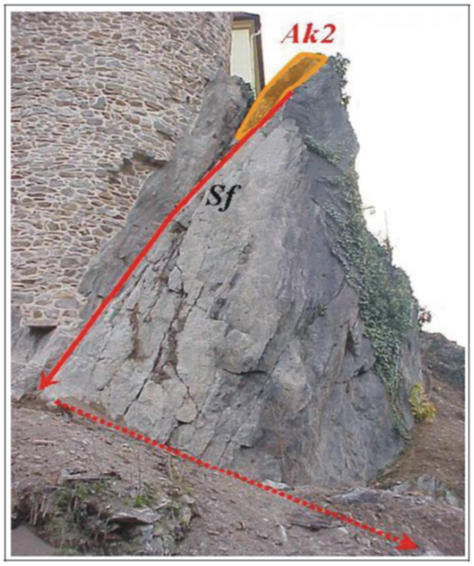


Bild 1
Abbruchbereich [Blickrichtung ± ESE, Seitenansicht] – maßgebend für den Abbruch ist die Trennflächensituation (rot gekennzeichnete Schieferungsfläche **Sf**). Im oberen Teil verlagerungsgefährdeter Abbruchkörper **Ak2** ⇨ Abmessungen ca. 1,0 x 1,0 x 0,4 m (Länge x Breite x Höhe). Im unteren Bildbereich Aufschlagbereich (Böschungsfußbereich). Der Böschungswinkel des Aufschlagbereiches beträgt zwischen 35° und 42° (rot gepunktet), so dass das Abbruchmaterial (**Ak1** und **Ak1a**) dort nicht liegen geblieben ist und sich weiter hangabwärts abgelagert hat (s. a. Bild 2).

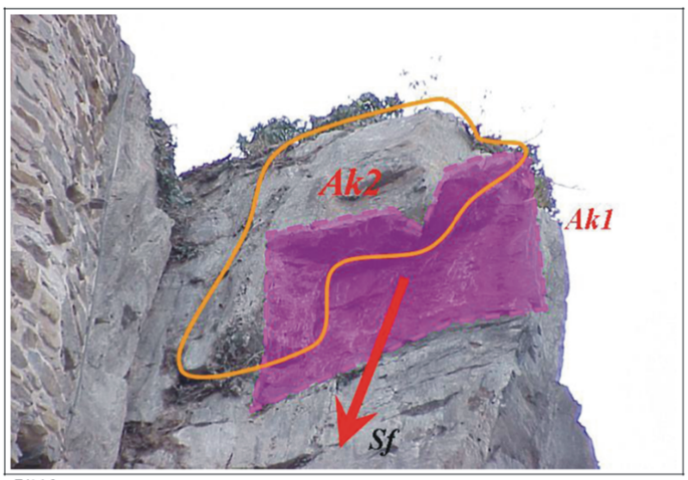
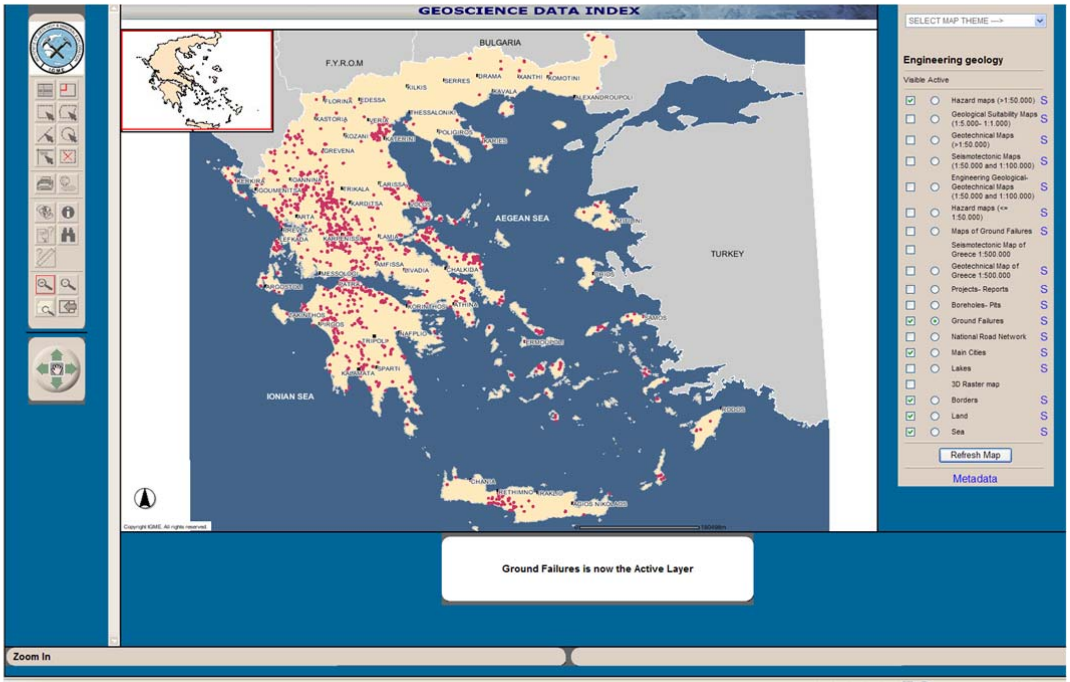
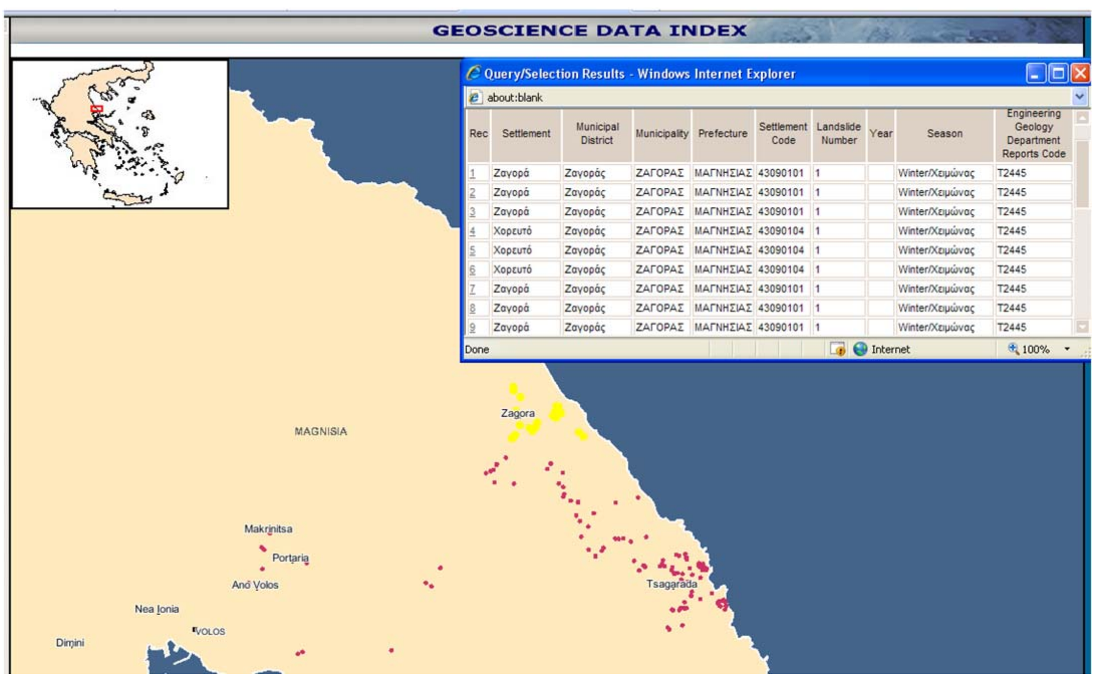


Bild 2
Im Bild 3 ist der potentielle Abbruchkörper **Ak2** aus dem Bild 1 in einer Detailaufnahme zu sehen. Der Abbruchkörper **Ak1** ist ebenfalls gekennzeichnet wie auch die Schieferungsfläche **Sf** mit der Bewegungsrichtung.

11.8 GREECE

English version of the web interface of the Greek Institute of Geology and Mineral Exploration (IGME)'s ground failure database.
(http://maps.igme.gr/website_ext/igme_master_ext/viewer.htm?ln=en; March 2011).

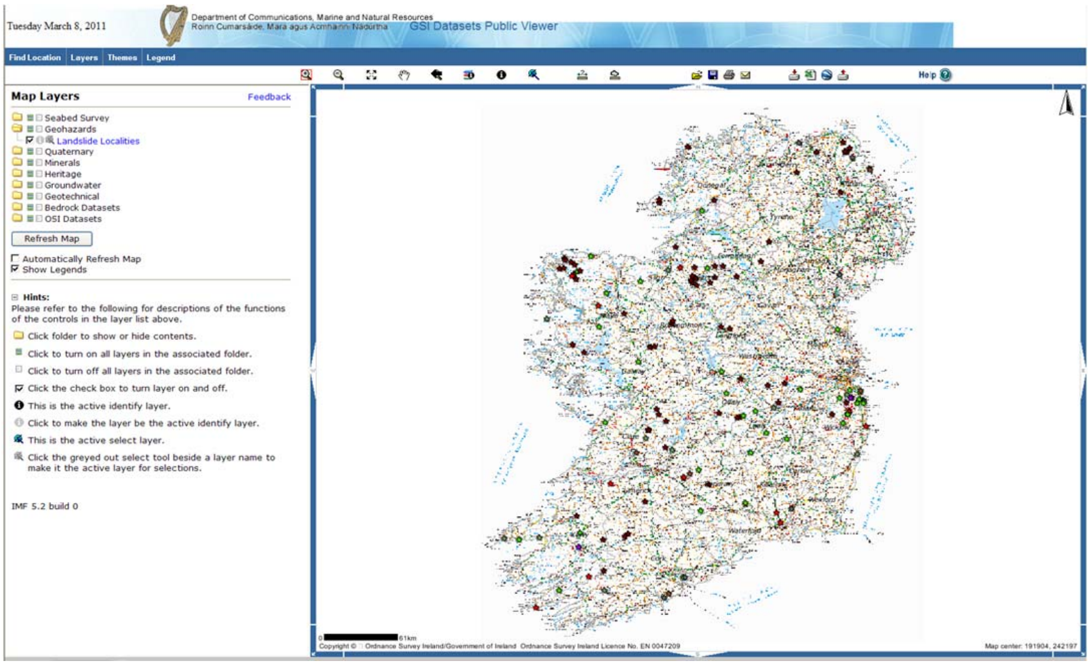


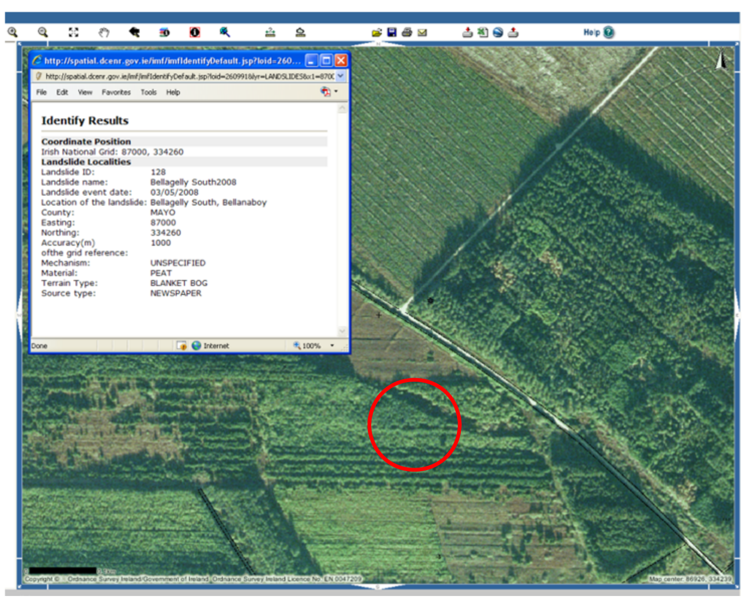


11.9 IRELAND

Some examples of the web interface of the Geological Survey of Ireland (GSI)'s landslide database are shown below.
(http://spatial.dcenr.gov.ie/imf/imf.jsp?site=GSI_Simple ; March 2011).

Information on the database can also be found in:
Creighton R, Irish Landslides Working Group, 2006. Landslides in Ireland. Geological Survey of Ireland, Dublin, Ireland.

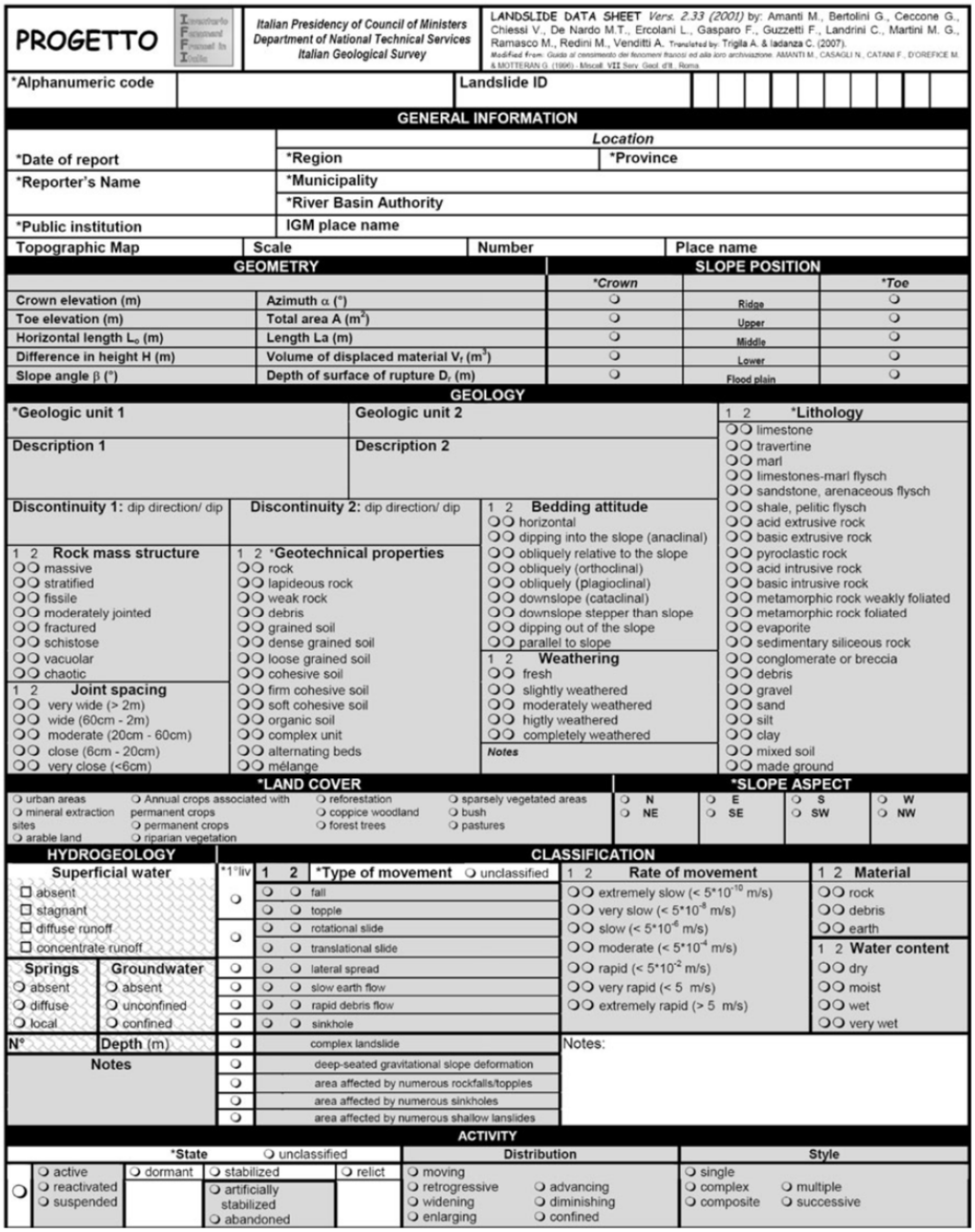




11.10 ITALY

Examples of web screenshots and datasheets of the Italian Landslide Inventory database (IFFI) by the Institute for Environmental Protection and Research (ISPRA) are given below. (http://www.sinanet.apat.it/progettoiffi; March 2011).

Information on the database can also be found in:
Trigila, A., Iadanza, C., Spizzichino, D., 2010. Quality assessment of the Italian Landslide inventory using GIS processing. Landslides 7, 455-470.



PROGETTO IFFI | Italian Presidency of Council of Ministers, Department of National Technical Services, Italian Geological Survey | LANDSLIDE DATA SHEET Vers. 2.33 (2001) by: Amanti M., Bertolini G., Ceccone G., Chiessi V., De Nardo M.T., Ercolani L., Gasparo F., Guzzetti F., Landrini C., Martini M. G., Ramasco M., Redini M., Venditti A. Translated by: Trigila A. & Iadanza C. (2007). Modified from: Guida al censimento dei fenomeni franosi ed alla loro archiviazione. AMANTI M., CASAGLI N., CATANI F., D'OREFICE M. & MOTTERAN G. (1996) - Miscell. VII Serv. Geol. d'It., Roma

*Alphanumeric code | Landslide ID

GENERAL INFORMATION

*Date of report
*Reporter's Name
*Public institution
Location: *Region | *Province
*Municipality
*River Basin Authority
IGM place name
Topographic Map | Scale | Number | Place name

GEOMETRY

Crown elevation (m) | Azimuth α (°)
Toe elevation (m) | Total area A (m²)
Horizontal length L_o (m) | Length La (m)
Difference in height H (m) | Volume of displaced material V_f (m³)
Slope angle β (°) | Depth of surface of rupture D_r (m)

SLOPE POSITION

*Crown | | *Toe
❍ | Ridge | ❍
❍ | Upper | ❍
❍ | Middle | ❍
❍ | Lower | ❍
❍ | Flood plain | ❍

GEOLOGY

*Geologic unit 1 | Geologic unit 2
Description 1 | Description 2
Discontinuity 1: dip direction/ dip | Discontinuity 2: dip direction/ dip

1 2 Rock mass structure: massive, stratified, fissile, moderately jointed, fractured, schistose, vacuolar, chaotic

1 2 Joint spacing: very wide (> 2m), wide (60cm - 2m), moderate (20cm - 60cm), close (6cm - 20cm), very close (<6cm)

1 2 *Geotechnical properties: rock, lapideous rock, weak rock, debris, grained soil, dense grained soil, loose grained soil, cohesive soil, firm cohesive soil, soft cohesive soil, organic soil, complex unit, alternating beds, mélange

1 2 Bedding attitude: horizontal, dipping into the slope (anaclinal), obliquely relative to the slope, obliquely (orthoclinal), obliquely (plagioclinal), downslope (cataclinal), downslope stepper than slope, dipping out of the slope, parallel to slope

1 2 Weathering: fresh, slightly weathered, moderately weathered, higtly weathered, completely weathered

Notes

1 2 *Lithology: limestone, travertine, marl, limestones-marl flysch, sandstone, arenaceous flysch, shale, pelitic flysch, acid extrusive rock, basic extrusive rock, pyroclastic rock, acid intrusive rock, basic intrusive rock, metamorphic rock weakly foliated, metamorphic rock foliated, evaporite, sedimentary siliceous rock, conglomerate or breccia, debris, gravel, sand, silt, clay, mixed soil, made ground

***LAND COVER**

urban areas, mineral extraction sites, arable land, Annual crops associated with permanent crops, permanent crops, riparian vegetation, reforestation, coppice woodland, forest trees, sparsely vegetated areas, bush, pastures

***SLOPE ASPECT**

N, NE, E, SE, S, SW, W, NW

HYDROGEOLOGY

Superficial water: absent, stagnant, diffuse runoff, concentrate runoff
Springs: absent, diffuse, local
Groundwater: absent, unconfined, confined
N° | Depth (m)
Notes

CLASSIFICATION

*1°liv | 1 2 *Type of movement ❍ unclassified: fall, topple, rotational slide, translational slide, lateral spread, slow earth flow, rapid debris flow, sinkhole, complex landslide, deep-seated gravitational slope deformation, area affected by numerous rockfalls/topples, area affected by numerous sinkholes, area affected by numerous shallow lanslides

1 2 Rate of movement: extremely slow (< $5*10^{-10}$ m/s), very slow (< $5*10^{-8}$ m/s), slow (< $5*10^{-6}$ m/s), moderate (< $5*10^{-4}$ m/s), rapid (< $5*10^{-2}$ m/s), very rapid (< 5 m/s), extremely rapid (> 5 m/s)

1 2 Material: rock, debris, earth

1 2 Water content: dry, moist, wet, very wet

Notes:

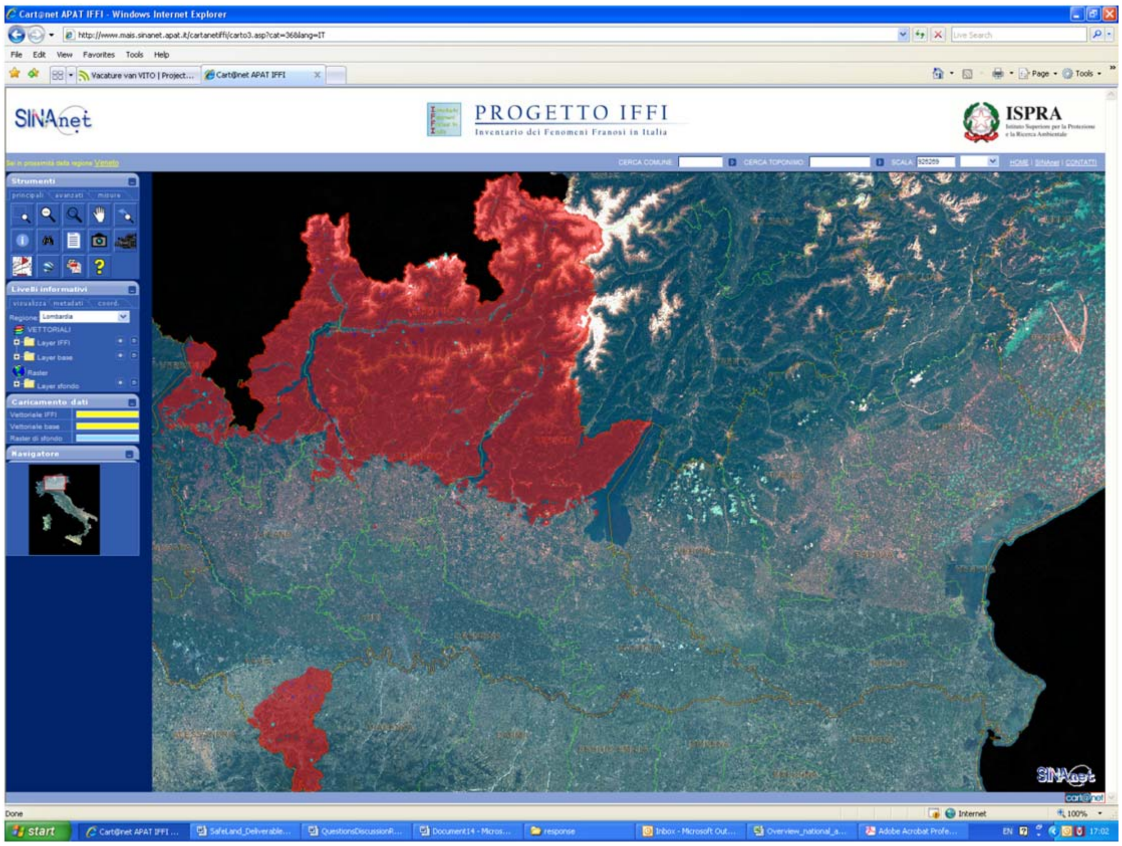
ACTIVITY

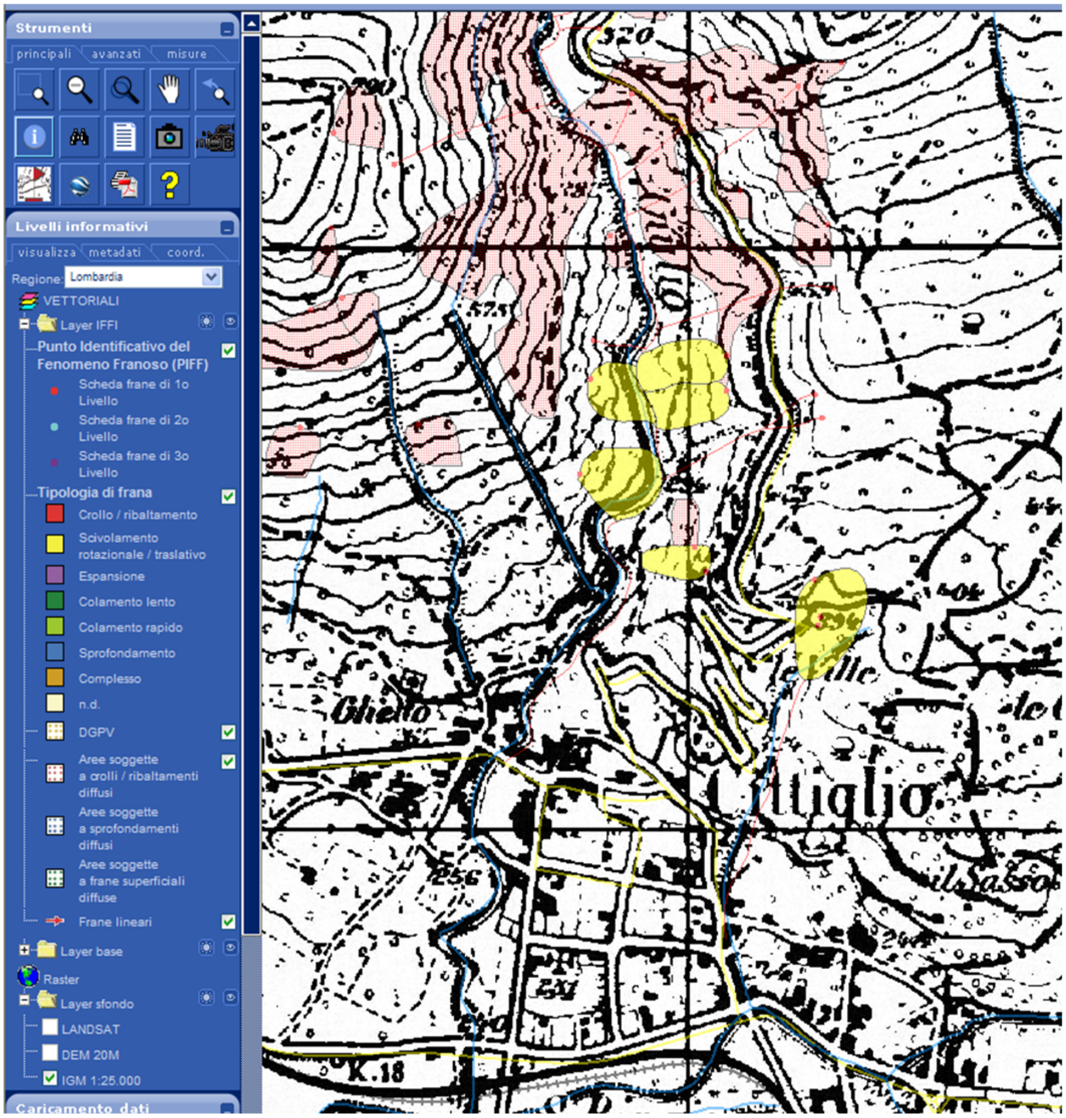
*State ❍ unclassified: active, reactivated, suspended | dormant | stabilized, artificially stabilized, abandoned | relict

Distribution: moving, retrogressive, widening, enlarging, advancing, diminishing, confined

Style: single, complex, composite, multiple, successive

An example of the database for Lombardy is shown in the two screenshots below.





DATI ALFANUMERICI DEGLI ELEMENTI RELATIVI ALLA CARTOGRAFIA IFFI

Frana 1

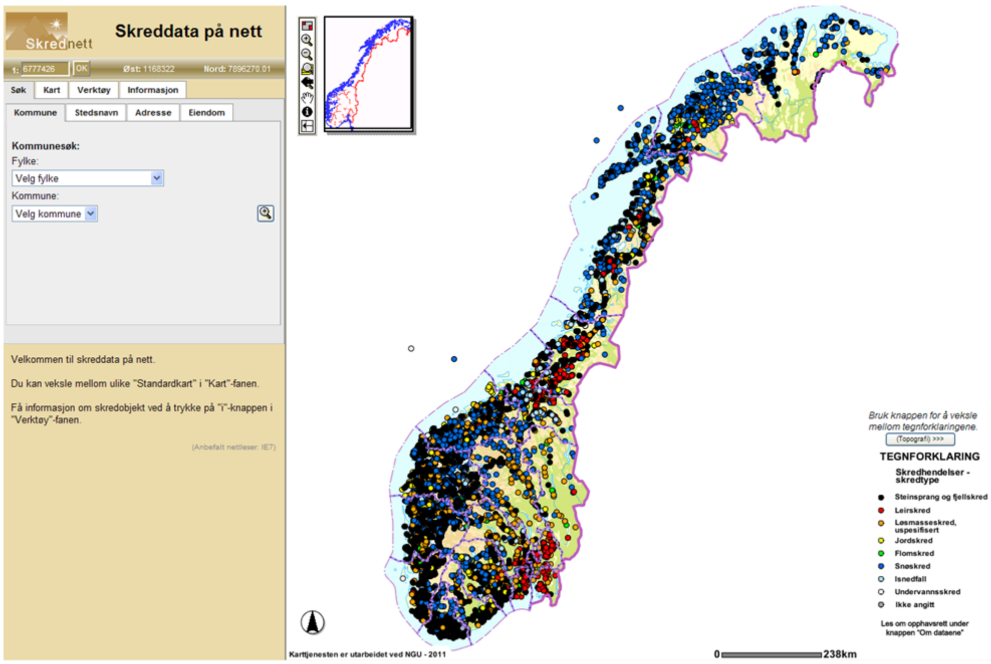
IDFrana	Regione	Provincia	Comune	Autorita' di Bacino	Tipo di movimento	Attivita	Litologia	Uso del suolo	Metodo usato per la valutazione del movimento e dell'attivita'	Danno	Area della frana (m^2)	Data evento (gg/mm/aaaa)	Causa	Interventi
0120019100	Lombardia	Varese	Cittiglio	Po	Scivolamento rotazionale/traslativo	Quiescente			Fotointerpretazione	n.d.	14136			

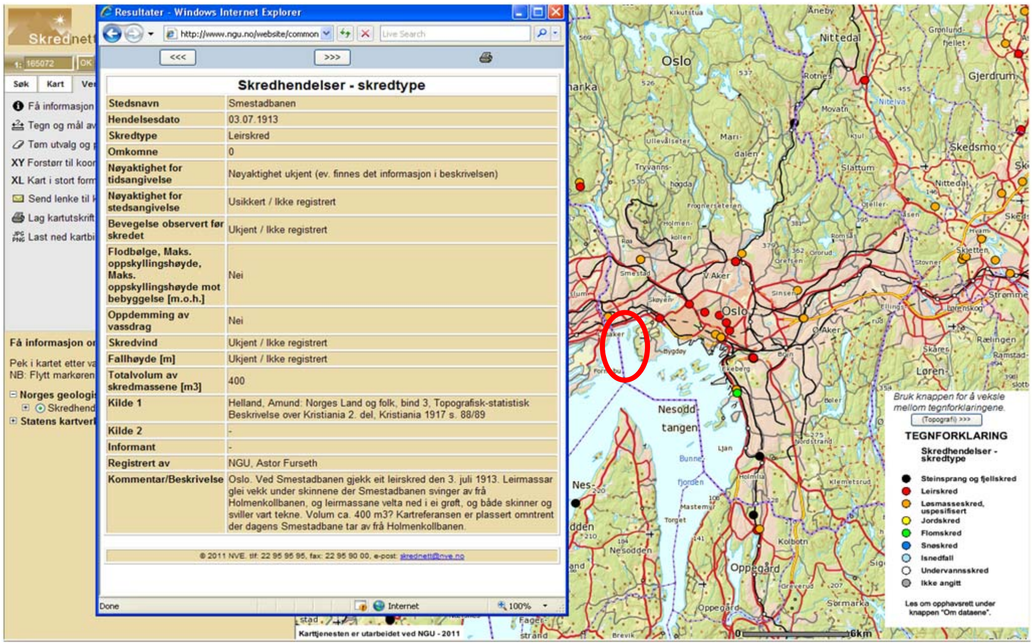
torna su

11.11 NORWAY

Examples of web screenshots of the Norwegian Landslide Database by the Geological Survey of Norway (NGU) are given below. (www.skrednett.no; March, 2011).

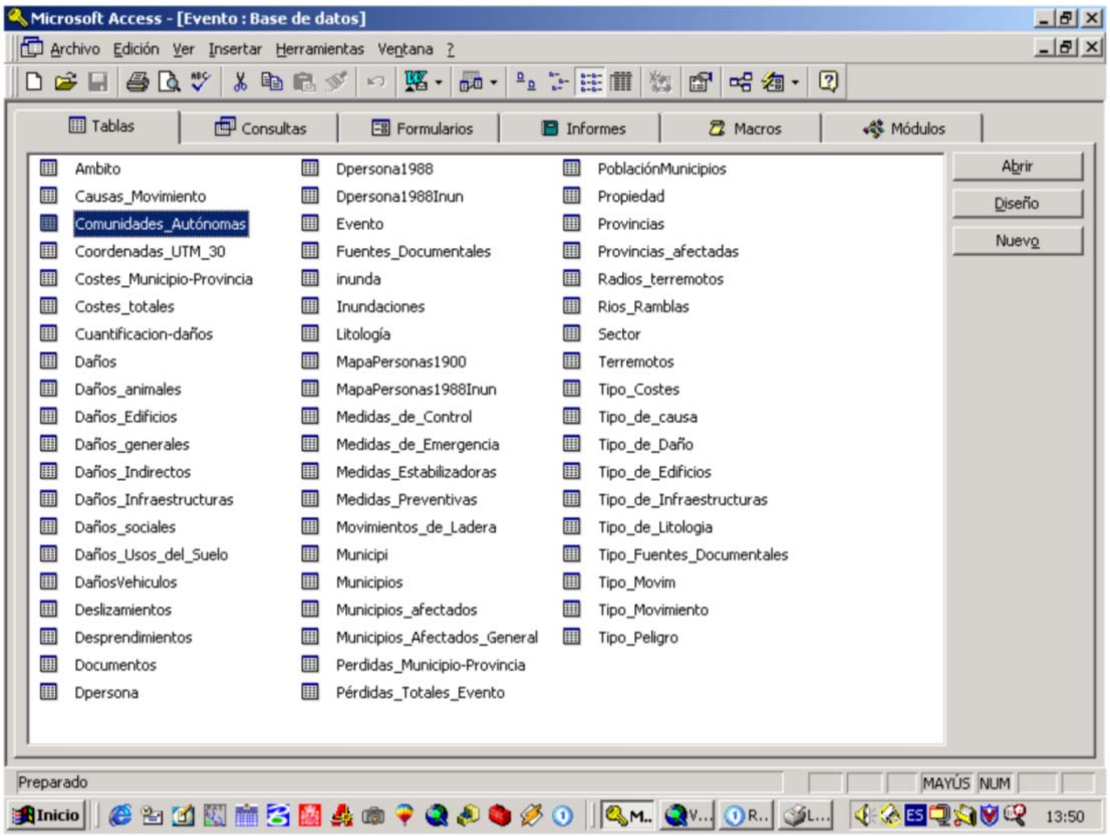
Information on the database can also be found in:
Jaedicke, C., Lied, K., Kronholm, K., 2009. Integrated database for rapid mass movements in Norway. Nat. Hazards Earth Syst. Sci. 9, 469-479.

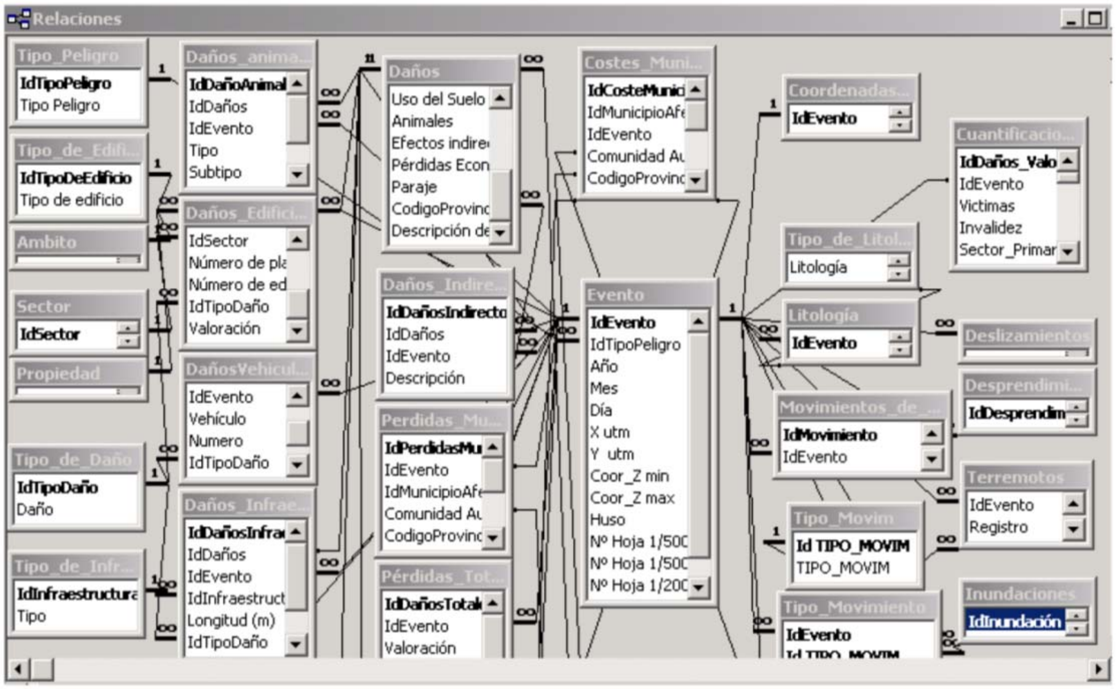


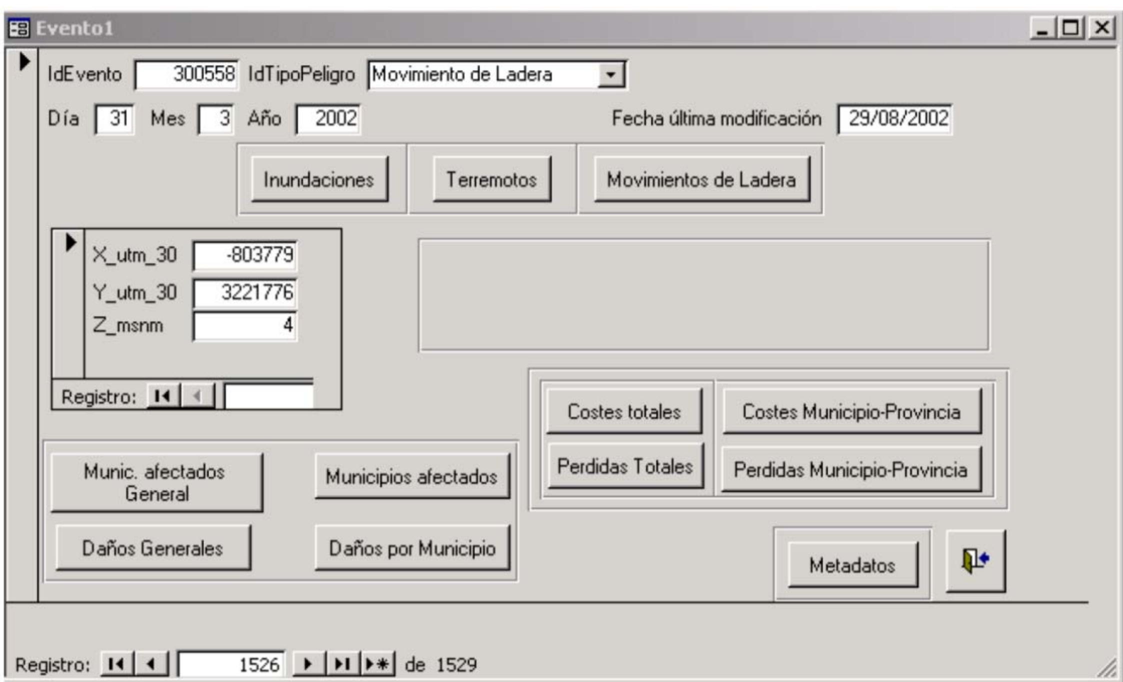

Resultater - Windows Internet Explorer
http://www.ngu.no/website/common
Skredhendelser - skredtype
Stedsnavn: Smestadbanen
Hendelsesdato: 03.07.1913
Skredtype: Leirskred
Omkomne: 0
Nøyaktighet for tidsangivelse: Nøyaktighet ukjent (ev. finnes det informasjon i beskrivelsen)
Nøyaktighet for stedsangivelse: Usikkert / Ikke registrert
Bevegelse observert før skredet: Ukjent / Ikke registrert
Flodbølge, Maks. oppskyllingshøyde, Maks. oppskyllingshøyde mot bebyggelse [m.o.h.]: Nei
Oppdemming av vassdrag: Nei
Skredvind: Ukjent / Ikke registrert
Fallhøyde [m]: Ukjent / Ikke registrert
Totalvolum av skredmassene [m3]: 400
Kilde 1: Helland, Amund: Norges Land og folk, bind 3, Topografisk-statistisk Beskrivelse over Kristiania 2. del, Kristiania 1917 s. 88/89
Kilde 2: -
Informant: -
Registrert av: NGU, Astor Furseth
Kommentar/Beskrivelse: Oslo. Ved Smestadbanen gjekk eit leirskred den 3. juli 1913. Leirmassar glei vekk under skinnene der Smestadbanen svinger av frå Holmenkollbanen, og leirmassane velta ned i ei grøft, og både skinner og sviller vart tekne. Volum ca. 400 m3? Kartreferansen er plassert omntrent der dagens Smestadbane tar av frå Holmenkollbanen.
© 2011 NVE. tlf: 22 95 95 95, fax: 22 95 90 00, e-post: skrednett@nve.no
Done
Internet
100%
Karttjenesten er utarbeidet ved NGU - 2011
Oslo
Nesodd-tangen
Bruk knappen for å veksle mellom tegnforklaringene.
(Topografi) >>>
TEGNFORKLARING
Skredhendelser - skredtype
Steinsprang og fjellskred
Leirskred
Løsmasseskred, uspesifisert
Jordskred
Flomskred
Snøskred
Isnedfall
Undervannsskred
Ikke angitt
Les om opphavsrett under knappen "Om dataene".

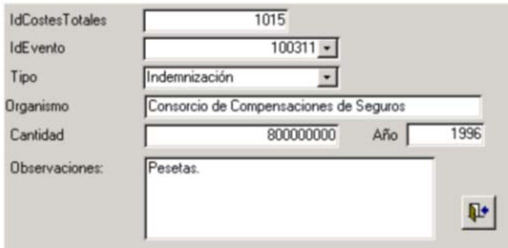
11.12 SPAIN

Excerpts of the Geological and Mining Institute of Spain (IGME)'s geohazards database (in Microsoft Access) are provided below.



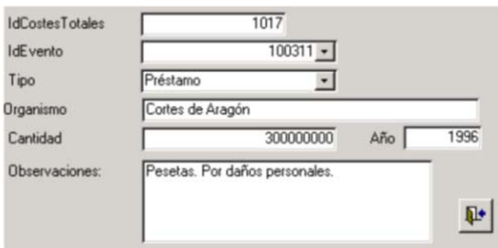

Relaciones
Tipo_Peligro
IdTipoPeligro
Tipo Peligro
Daños
Evento
IdEvento
IdTipoPeligro
Año
Mes
Día
X utm
Y utm
Coor_Z min
Coor_Z max
Huso
Coordenadas
Litología
Deslizamientos
Terremotos
Inundaciones
IdInundación


Evento1
IdEvento
300558
IdTipoPeligro
Movimiento de Ladera
Día
31
Mes
3
Año
2002
Fecha última modificación
29/08/2002
Inundaciones
Terremotos
Movimientos de Ladera
X_utm_30
-803779
Y_utm_30
3221776
Z_msnm
4
Registro:
Costes totales
Costes Municipio-Provincia
Perdidas Totales
Perdidas Municipio-Provincia
Munic. afectados General
Municipios afectados
Daños Generales
Daños por Municipio
Metadatos
Registro:
1526
de 1529

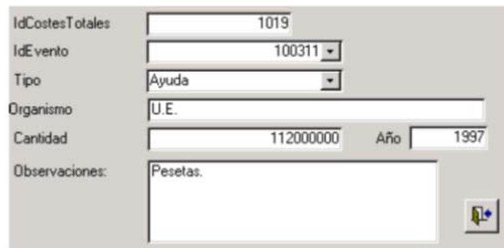


IdCostesTotales: 1015
IdEvento: 100311
Tipo: Indemnización
Organismo: Consorcio de Compensaciones de Seguros
Cantidad: 800000000 Año: 1996
Observaciones: Pesetas.

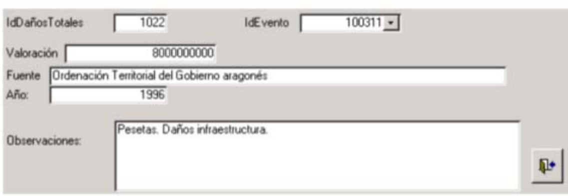
IdCostesTotales: 1016
IdEvento: 100311
Tipo: Ayuda
Organismo: Estado
Cantidad: 4700000000 Año: 1996
Observaciones: Pesetas.



IdCostesTotales: 1017
IdEvento: 100311
Tipo: Préstamo
Organismo: Cortes de Aragón
Cantidad: 300000000 Año: 1996
Observaciones: Pesetas. Por daños personales.



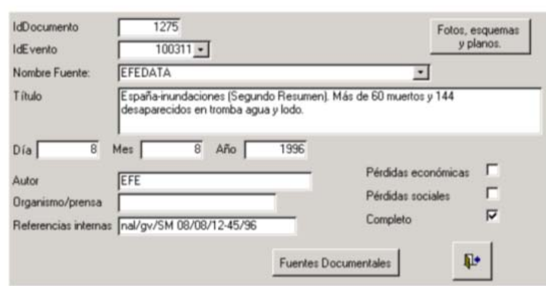
IdCostesTotales: 1019
IdEvento: 100311
Tipo: Ayuda
Organismo: U.E.
Cantidad: 112000000 Año: 1997
Observaciones: Pesetas.



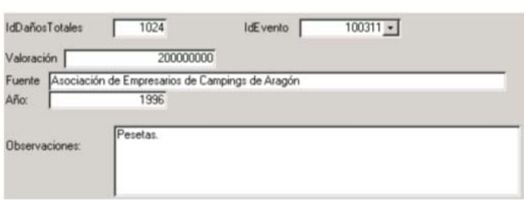
IdDañosTotales: 1022 IdEvento: 100311
Valoración: 8000000000
Fuente: Ordenación Territorial del Gobierno aragonés
Año: 1996
Observaciones: Pesetas. Daños infraestructura.

IdCosteMunicipio-Pro: 1020 IdEvento: 100311
IdMunicipioAfectado: 4581
Municipio: Biescas
Provincia: Huesca
Comunidad Autónoma: Aragón
Cantidad: 1200000000 Año:
Tipo: Préstamo
Fuente: Gobierno
Observaciones: Pesetas. Crédito extraordinario aprobado por el Gobierno y con ayudas del Fondo de Cohesión de Unión Europea.

IdDañosTotales: 1023 IdEvento: 100311
Valoración: 391000000
Fuente: Gobierno de Aragón
Año: 1996
Observaciones: Pesetas. Para las localidades de Aso, Yosa y Betés (daños Infraestructuras)



IdDocumento: 1275
IdEvento: 100311
Nombre Fuente: EFEDATA
Título: España-inundaciones (Segundo Resumen). Más de 60 muertos y 144 desaparecidos en tromba agua y lodo.
Día: 8 Mes: 8 Año: 1996
Autor: EFE
Organismo/prensa:
Referencias internas: nal/gv/SM 08/08/12-45/96
Fotos, esquemas y planos.
Pérdidas económicas
Pérdidas sociales
Completo
Fuentes Documentales



IdDañosTotales: 1024 IdEvento: 100311
Valoración: 200000000
Fuente: Asociación de Empresarios de Campings de Aragón
Año: 1996
Observaciones: Pesetas.

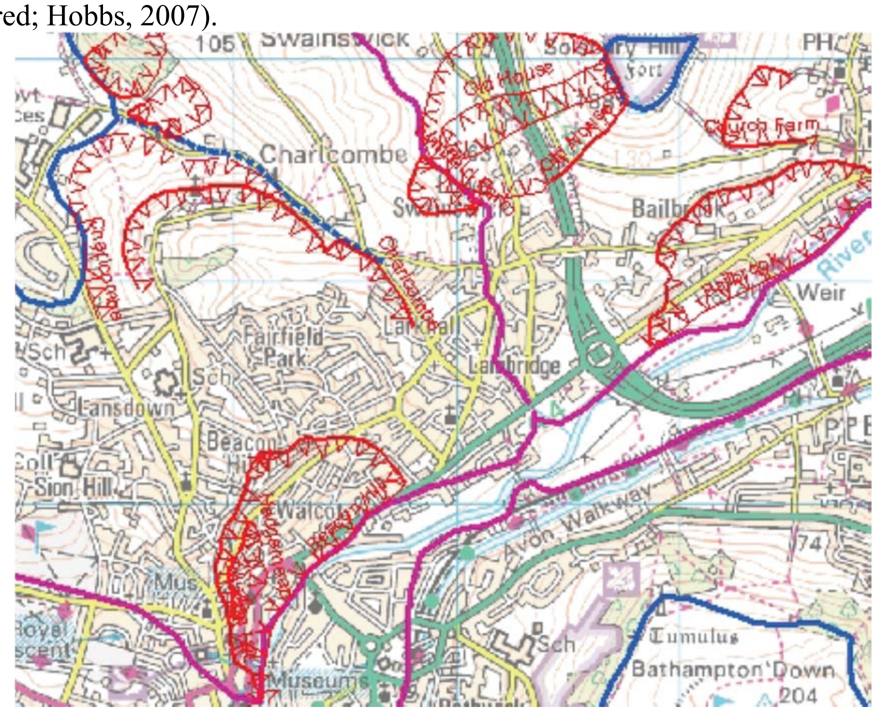
11.13 UNITED KINGDOM

Examples of the British National Landslide Database by the British Geological Survey (BGS) are given below.

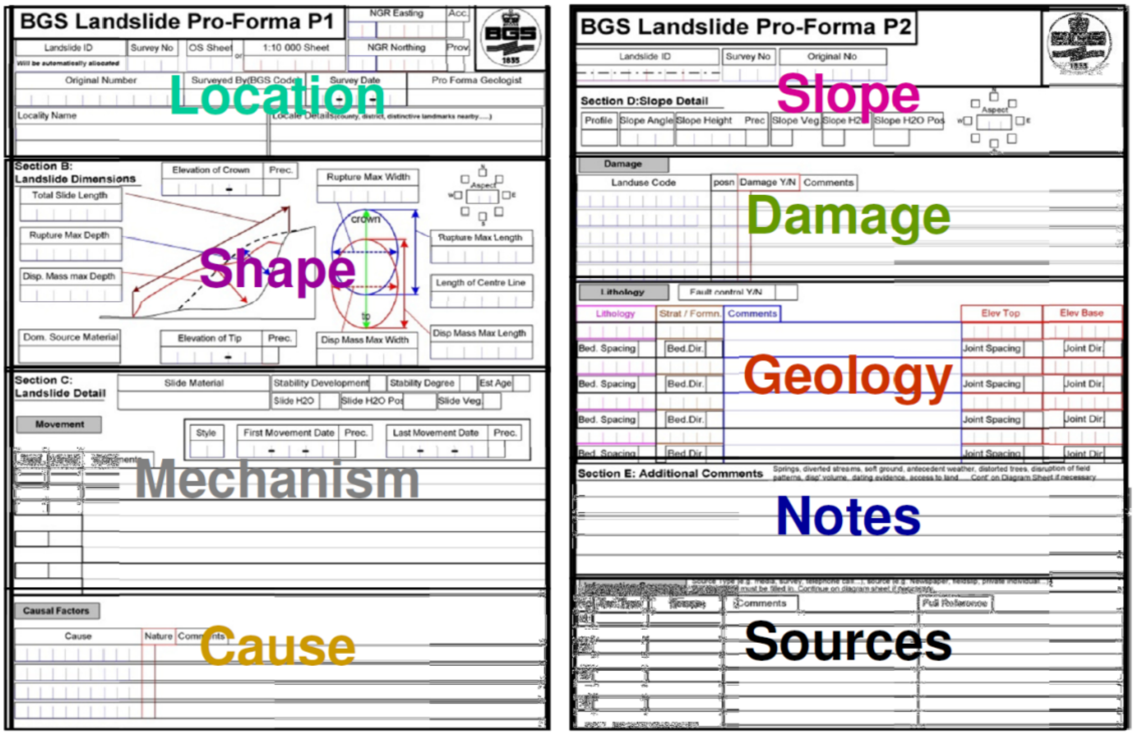
Information on the database can also be found in:
Foster, C., Gibson, A. Wildman, G., 2008. The new national landslide database and landslide hazard assessment of Great Britain. Proceedings of the First World Landslide Forum, Tokyo, 18-21 November 2008, pp. 203-206.

Hobbs, P., 2007. BGS landslide data and mapping in Britain. In: Hervás, J. (Ed.), Guidelines for Mapping Areas at Risk of Landslides in Europe. Proc. Experts Meeting, Ispra, Italy, 23-24 October 2007. JRC Report EUR 23093 EN, Office for Official Publications of the European Communities, Luxembourg, pp. 11-14.

Part of an urban landslide map of Bath, Avon. The figure shows relict landslide backscarps and toes (red; Hobbs, 2007).



Example of datasheet in landslide database (Hobbs, 2007).



“British Geological Survey © NERC. IPR/137-83C”.