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U-Geohaz – "Geohazard impact assessment for urban areas"

Deliverable D 5.1 IMPROVING THE INTEGRATION OF GEOHAZARDS INTO URBAN MANAGEMENT AND PLANNING TO INCREASE URBAN RESILIENCE

A deliverable of WP 5: Demonstration at different countries

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Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
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EXECUTIVE SUMMARY

The aim of this task is to evaluate in the European participant countries how geohazards are integrated or not into urban planning and land use management in order to increase urban resilience. For this purpose, a questionnaire has been designed and circulated among GSs in order to gather information about: a) geohazard impacts in urban aresa; b) integration of geohazards into urban management; c) integration of geohazards into policy and legislation; d) social awareness of geohazards. The results will permit to identify the gaps to be filled in order to increase urban resilience.

Geohazards, and specifically landslides, represent a major threat to human life, property, building and infrastructure in all the European countries, and they have a significant impact on the national economies. Most catastrophic landslides in Europe are associated with heavy rainfall, which are expected to increase in frequency due to global warming. Urban areas have sprawled significantly across Europe and this is projected to continue. More and more often, new constructions and infrastructures are extending onto landslide-prone areas causing widespread damage. To date, no specific policy on landslides has been implemented at EU level, as landslides are usually associated with other major natural disasters, such as floods and earthquakes, and their real impacts have been traditionally underestimated. In the present work, the Earth Observation and Geohazards Expert Group (EOEG) from EuroGeoSurveys (EGS) has carried out an enquired-based and participatory analysis to update the impact of landslide in Europe and to identify the strengths and weaknesses in the heterogeneous legislations currently in force. Twenty one national geological surveys and six regional ones have participated in the analysis. Additionally, some cases of bad and calamitous urban practices in areas of known instability have been discussed in common to determine what failed and why? Results reveal that 43% of the countries have no legal guidance at all to account landslides into the land-use and urban planning and the substantial disasters identified are related to a weak rule of law and/or absence of good governance. Furthermore, there is a wide range of laws across Europe and a large heterogeneity of mapping methods, scales and procedures. A relevant deficiency detected in many countries is the lack of landslide maps at a detailed resolution for urban planning. U-GEOHAZRD proposes a series of key actions to enhance this situation, outstanding the need of improving legislation standards for landslides at European level. A European Directive on landslides should be promoted as a common legal framework for dealing with this relevant geohazard.

REFERENCE DOCUMENTS

N°	**Title**
RD1	DOW U-Geohaz
RD2	
RD3	

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1 INTRODUCTION

Europe is highly urbanized which leads to an increase in the demand for housing as well as more transport and infrastructure. Urban sprawl (unplanned urban growth) has developed in all the European countries over the past decades and is projected to continue. Taking into account the European Environment Agency (EEA 2016) report, a total area of 77500 km^2 (almost the surface of the Czech Republic) in the European continent will be (or have been) converted to urban areas between 2000 and 2030. Local alterations over large areas to geomorphology and hydrological conditions will take place, and specifically in prone areas to landslides, such as mountainous, coastal environments as well as river basins. Land uptake for urban development will increase the landslide risk in many European countries.

Landslides in the socioeconomic framework of Europe have a high impact. A report from the European Environment Agency (EEA 2010) revealed that 70 major landslides were recorded in Europe for the period 1998-2009, causing 312 fatalities and damages and destroyed an extensive amount of infrastructures and housing. A present study (Haque et al. 2016) reveals that in 27 European countries, during the 20 year period 1995-2014, 1370 fatalities and 784 injuries were recorded from 476 deadly landslide events. Regarding economic losses caused by landslides, there is no data for Europe, only for some countries: eg. Spain reports damage costs of approximately €235M annually caused by landslides (Mateos 2017).

Climate change is expected to alter precipitation patterns in Europe and affect the stability of natural and engineered slopes having consequences on the frequency and distribution of landslides. Where the frequency and intensity of severe rainfall events is expected to increase (the primary trigger of landslides in Europe), rapid-moving landslides will be triggered and people exposed to landslide risk will rise in these areas (Gariano and Guzzetti 2016). In general, the impact of changing climate on rapid and shallow slope instabilities is forecasted to be more severe and widespread across Europe.

The EEA (2010) revealed that although landslide inventories exist in many European countries, they are very heterogeneous and, in many cases, they are not available to the public. The lack of a comprehensive database at European level have reduced the visibility of landslide events and their impact for many years. This was partially solved by the initiative of the Joint Research Centre from the European Commission in 2012 (Van De Esckhaut and Hervás 2012). The report named "Landslide inventories in Europe and policy recommendations for their interoperability and harmonization" took the first steps to compile and analyze landslide databases in 28 European countries. This report was the seed for the creation of the European Landslide Expert Group and the elaboration of the first European susceptibility map (ELSUS v1) proposed by Günther et al. (2014). In 2017, EuroGeoSurveys analyzed the landslide databases from the Geological Surveys of Europe, focusing on their interoperability and completeness (Herrera et al. 2017). A landslide density map was produced (LANDEN map) showing, for the first time, 210,544 km^2 of landslide prone-areas (almost the surface of Romania) with landslides inventoried. For the time being, we can conclude that there is a large variety of public institutions producing landslide databases at variable scales and formats and with a highly heterogeneous level of information. There is thus a need to enhance cooperation at European level for considering a common database on landslide occurrence and impacts.

Regarding how landslides are integrated into the urban legislation, the EEA (2010) already reported that methodologies and legislations including landslides were still rather heterogeneous or even absent in many European countries, as well as existing a lack of common guidelines for facing landslide hazard and risk. The enquiry developed by EuroGeoSurveys with the participation of 19 European countries in 2016 (Mateos et al. 2017 b) confirms this. There is a wide range of laws which regulate the integration of geohazards into the urban/land-use planning in Europe, and 17% of the countries have no legal guidance at all. Additionally, 77% of the countries are not satisfied with the legislations in force, since they consider them weak in the approaches and procedures.

On 1st December 2009, the European Council welcomed the Treaty of Lisbon, which provides the right for all citizens to equal civil protection from natural hazards. At a global scale, the Sendai Framework for Disaster Risk Reduction 2015-2030 (United Nations 2015a) adopted by the United Nations in 2015 clearly highlights the need for focusing actions in the following 4 priority areas: (1) understanding disaster risk; (2) strengthening disaster risk governance to manage disaster risk; (3) investing in disaster risk reduction for resilience, and (4) enhancing preparation for disaster and an effective response. The Sendai Framework also emphasizes that disaster risk reduction practices need to be multi-hazard and to develop regulatory measurements to face climate change and rapid and unplanned urbanization. Additionally, in September 2015 the Sustainable Development Goals (SDGs) were adopted by member states of the United Nations (United Nations 2015b). SDGs are an ambitious set of 17 goals and 169 targets, including the outstanding: "*make cities and human settlements inclusive, safe, resilient and sustainable*". The role of geology in this goal is unquestionable as well as the contribution that geologists can make by assessing geohazard exposure through producing hazard maps in urban developments (Gill 2017; Chaminé et al. 2016).

To date, no specific policy on landslides has been implemented at EU level, although they are one of the most widespread geohazards in Europe. In the framework of the European Soil Thematic Strategy (European Commission 2006), and the associated preparation of a directive on the protection and sustainable use of soil, landslides were recognized as a soil threat requiring specific strategies for risk assessment and management. Nevertheless, landslides cannot be simply regarded as a soil degradation process but must be considered as a threat posing risk to population, housing and infrastructures (Günther et al. 2008). Finally, on 21st May 2014 the Commission formally withdrew its proposal for the Soil Directive.

EuroGeoSurveys (EGS) is a non-for-profit organization representing 37 National Geological Surveys and some regional surveys in Europe. In the present work, the Earth Observation and Geohazards Expert Group (EOEG) from EuroGeoSurveys has developed an enquire-based and participatory analysis to determine the impact of landslides in Europe and to identify the strengths and weaknesses in the heterogeneous legislations and policies currently in force for the different countries. It is essential to understand that landslide-hazard is a widespread problem that requires collaboration and mutual understanding guided by collective EU policy. With this goal in mind, some actions are proposed by EOEG in the present work, highlighting the need for a European Directive on Landslides which encourage a best integration of landslides into national legislations as illustrated in the case of the 2007/60/EC Flood Directive and Eurocodes 7 & 8 (seismic design of buildings).

2 METHODS: THE EOEG QUESTIONNAIRE

Within the framework of the European Geological Surveys (EGS), the Earth Observation and Geohazards Expert Group (EOEG) has carried out a survey at the beginning of 2018 through a questionnaire that was circulated among its members. Twenty one National Geological Surveys have participated: Austria, Croatia, Cyprus, Czech Republic, Denmark, France, Greece, Ireland, Italy, Lithuania, Norway, Poland, Portugal, Republic of Srpska, Bosnia and Herzegovina, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden and United Kingdom, as well as six regional Geological Surveys: Baden-Württemberg, Bavaria, Hessen, Lower Saxony and Saxony Anhalt in Germany, and Catalonia in Spain (Fig. 1).

The questionnaire contains a list of 30 questions divided into 4 main sections (Anexe 1):

(1) The impact of landslides in the country. This section includes 7 questions to evaluate the importance of landslides in the country: the average annual damage caused (economic losses and fatalities); the most frequent landslide typologies (slides, rockfalls, flows, complex landslides); where the landslides are mainly concentrated (coastal fringe, mountainous regions, river basins); where the major damage takes place (infrastructures, urban areas, landscape); a very short description of the most significant landslide event that has occurred in the country during the past 10 years and, if any Multiple Occurrence Regional Landslide Event (MORLEs, defined by Crozier, 2005) was registered during the last decade. Additionally, information from damaging landslides occurred in 2015 and reported by another questionnaire from EOEG-EuroGeoSurveys has been incorporated into this section.

(2) Landslides in the Geological Surveys (GSs) of Europe. This section includes 6 questions to size up the strength of EuroGeoSurveys in the field of landslides: how many people are working on landslides; if there is a landslide mapping plan in the GS, and which kind of maps they elaborate (inventory, susceptibility, hazard, risk); if the landslide maps are later used for urban and land-use planning; if the landslide scientific-technical literature produced by the GS is known by the urban/land-use planners; how the GS is involved in the elaboration of technical reports in urban/infrastructures affected by landslides, and the current experience in landslide monitoring by applying different techniques (DInSAR, ground tools and others).

(3) Landslides in the legislation. This section aims to identify the national/regional legal singularities and to detect the common deficiencies for the different countries. 10 questions have been raised to analyze how landslides are integrated into urban and land-use planning (legislation and procedures): if the national/regional Land Bill contemplate landslide hazard; the authorities responsible for urban and land-use planning; what kind of landslide maps are officially required; how are the official methodological guides to draw up landslide maps; and some additional peculiarities about mapping.

(4) Landslide awareness and preparedness. 7 questions to analyze how landslides are perceived by the society and public managers and which protection, prevention and mitigation measures are contemplated. Finally, the questionnaire analyses the need for a landslide European Directive and the Geological Survey´s support to defend this initiative.

In a fifth stage, a participatory exercise was developed to analyze in detail cases of bad urban practices on landslide prone zones across Europe. Nine countries have reported calamitous examples: Spain, Cyprus, Greece, Italy, Serbia, Slovenia, Slovakia, Poland and Romania. Every case was discussed to determine what failed and why?

Results for each section will be exposed and the main conclusions deliberated and discussed. Actions will be proposed bearing in mind a European overview and strongly recommending common EU Policy instruments.

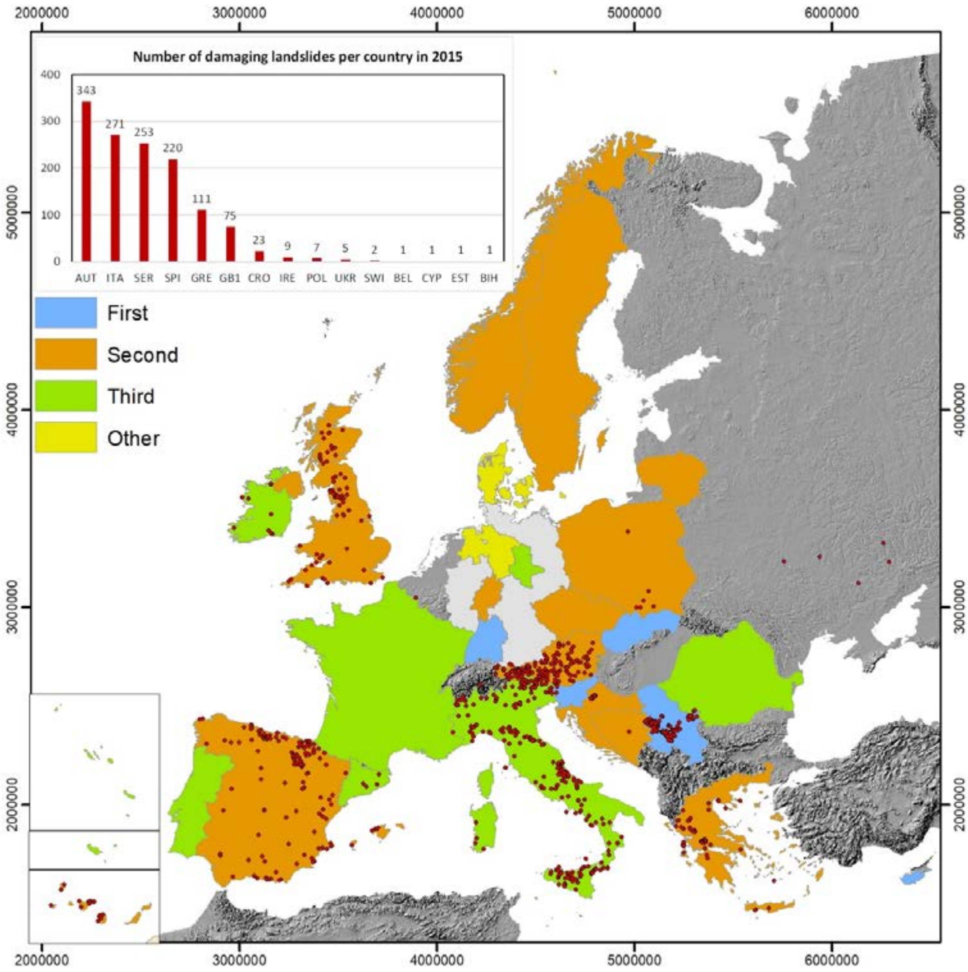

Figure 1 The participant countries and regions and the importance of landslides for them (Landslides is: "the first, second, third, etc." most important geohazard in the country). The EOEG inventory from 17 European countries has been incorporated, with a record of 1323 damaging landslides occurred in 2015.

3 RESULTS

3.1 Impact of landslides in Europe

For Cyprus, Slovakia, Slovenia, and Serbia (19% of the countries), as well as for the region of Baden-Wütemberg (Germany), landslide is the most important geohazard in the country. For 55% of the countries: Austria, Croatia, Czech Republic, Greece, Lithuania, Norway, Poland, Republic of Srpska, Bosnia and Herzegovina, Spain, Sweden and United Kingdom and the region of Hesse (Germany), landslide is the second most important geohazard. For the rest of the countries and regions, landslide is the third most important geohazard (24%) or even minor positions only in the case of Denmark (Fig. 1). In general, after flooding, landslide is the most relevant geohazard for most European countries.

The most frequent landslide typology is slide (for 50% of the countries), followed by rockfall and flow (20% respectively), being complex landslide the less frequent typology (Fig. 2A).

Nevertheless, if we consider damage, slides cause major damage in 65% of the countries and flows in 30% of them; rockfalls have less damage impact than their frequency (Fig. 2B), and they are the most damaging events in Austria and Slovakia. For 50% of the countries, landslide damage is mainly concentrated in infrastructures located in mountainous regions, although 30% of them (France, Slovenia, Lithuania, Sweden and Norway) refer major damages related to landslide activity in the river basins. Denmark, Spain and UK indicate the coastal fringe as the most landslide hazardous areas (Fig. 2C).

All the countries and several regions report damaging landslides events during the past 10 years. Table I summarizes the information for the most important landslides affecting urban areas, infrastructures and cultural heritage. Most of them were related to extreme rainfall episodes. That is the case of the island of Madeira (Portugal) catastrophe on 20th February 2010. The island was hit by torrential rainfall (up to 333.8 mm/24 h) that triggered tragic floods and many earthflows and mudflows. The event accounting for a death toll of 45 and 6 missing people. The economic damage costs were estimated to be €1.53 billion (Fragoso et al. 2012). Fig. 3 shows some photos of the most significant landslides reported in Table I.

During 2015, 1323 damaging landslides were reported by 17 European countries (see location in Fig. 1) affecting the road and railway network as well as urban areas. 80% of them were triggered by intense rainfall episodes. Austria, Italy and Serbia were the countries with more events; Serbia suffering the greatest impact in urban areas (69 events). Landslides in 2015 have also caused human losses and injuries: 56 fatal landslides caused 21 fatalities and 37 injured people, being Italy the most affected country with 12 deaths and 25 injured people (Fig. 9).

Multiple-Occurrence of Regional Landslide Events or MORLEs is a special type of landslide phenomenon (Crozier 2005). One event alone can involve hundreds to thousands of individual landslides occurring almost simultaneously over large extending areas (up to 20,000 km^2). Several extreme rainfall episodes -and even earthquake in Greece-have been identified during the past 10 years producing widespread landslide activity in some European regions. Table II collects the information regarding MORLEs data reported by the affected countries. An outstanding event was the very intense rainfall episode in Serbia during the third week of May 2014. The heavy rainfall increased flow of underground waters leading to widespread landslides in the western part of the country (around Krupanj and Bajina Basta). The landslides occurred in both inhabited and uninhabited areas and generated destruction of houses, roads, bridges and other infrastructures work. The disaster resulted in 51 fatalities (including flooding effects), 32,000 people evacuated and economic losses of up to €1523.3 million (United Nations Serbia et al, 2014). The country with the highest number of MORLEs is Austria, with 4 significant events during the past 10 years. The Geological Survey of Austria has provided for the present work, the landslide inventory map for the MORLEs event in the state of Styria (SE Austria) on 24th-25th July 2016 (Fig. 4). 358 shallow landslides – mainly debris and earth flows- were mapped in a small area of 15 km^2, and they were triggered by extreme rains concentrated in a short period.

Regarding economic and social impacts of landslides, there is a complete lack of information in 57% of the countries. For the rest of the countries, average annual losses and fatalities are reported and summarized in Table III. Italy reports the biggest annual economic losses: between €1-3 billion, but also considering flooding effects, as well as the highest number of casualities every year caused by landslides (12). For regions, there is also a lack of information; only Saxony-Anhalt (Germany) reports annual average costs of €10,000 generated by landslides, and Catalonia 2 fatalities caused by rockfalls in 2014 and 2016.

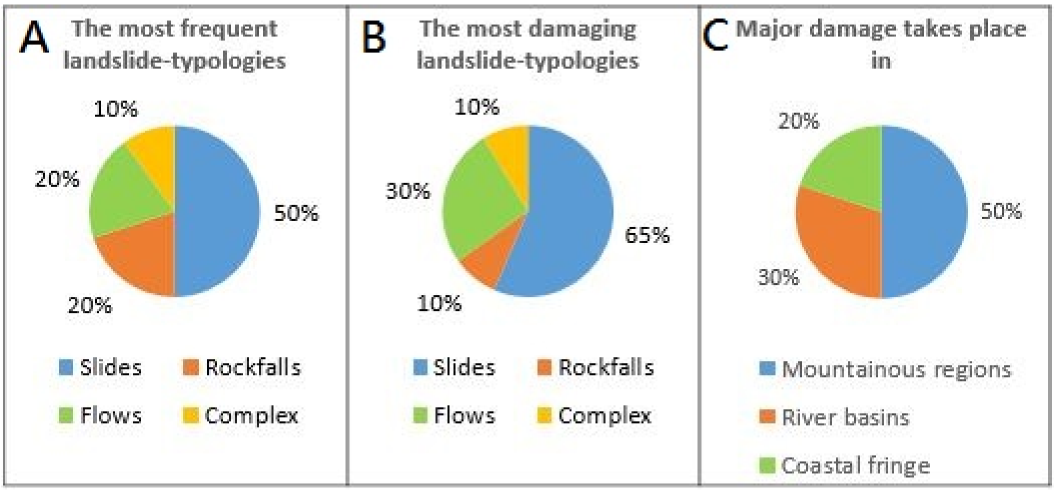

Figure 2 Statistical diagrams referring to section 1: impact of landslides in Europe: A) Frequency of landslide typologies; B) the most damaging landslide typologies and C) where major damage takes place

Figure 3 Some damaging landslides reported in Table I. A) Madeira mudflows (Portugal) on 20 February 2010 causing 45 fatalities; B) Felbertauern rockslide in Austria in May 2013; C) Prackovice landslide (Czech Republic) in July 2013; D) Hatfield landslide (UK) in February 2013; E) Gediminas Castle Hill landslides (Lithuania) in February 2016; F) Motserratrockfalls in 2008 (Catalonia, Spain); G) Kepla landslide (Greece) in February 2015; H) Vrátna Valley debris flows (Slovakia) in July 2014

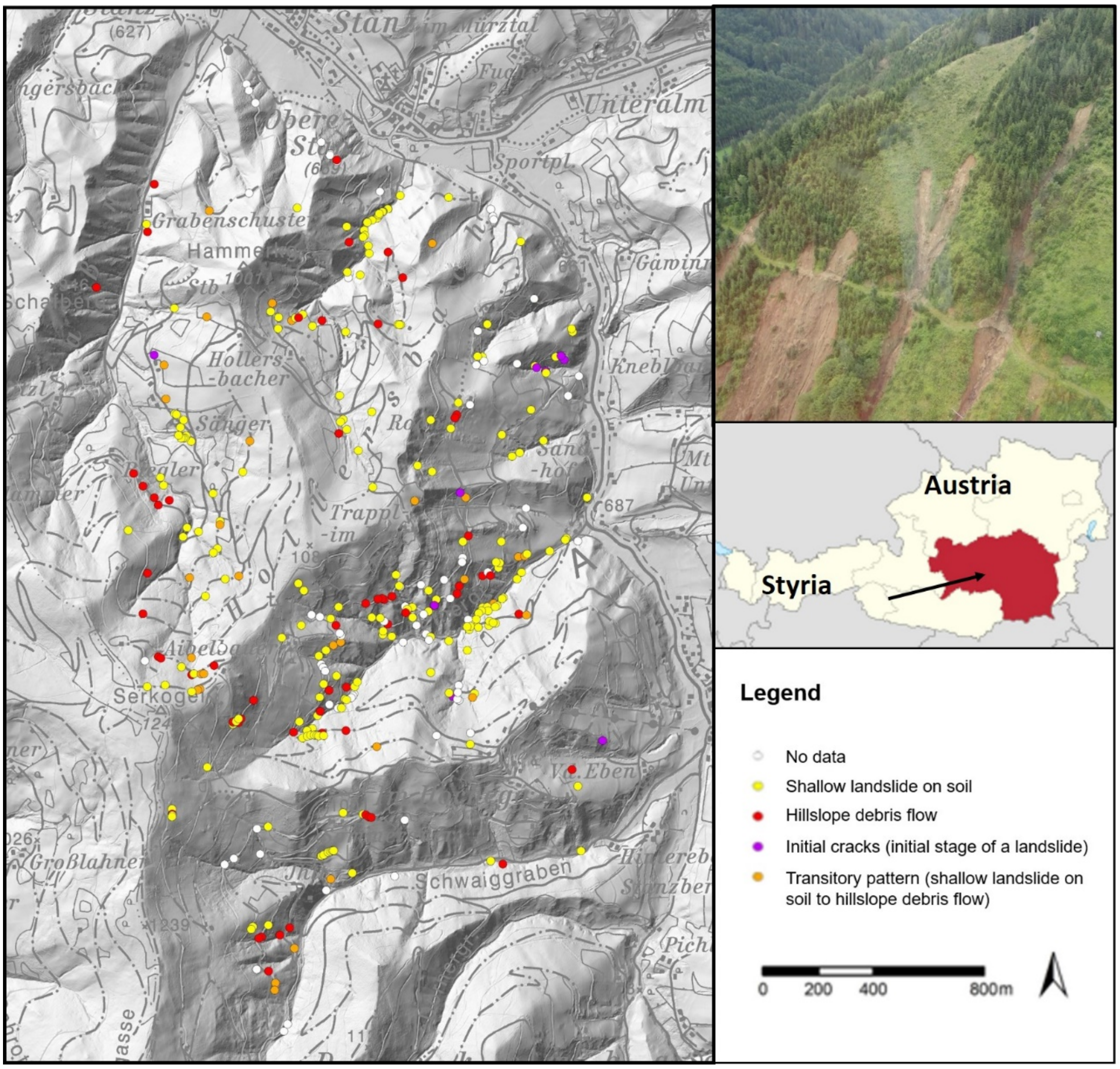

Figure 4 The MORLES event in the state of Styria (SE Austria) on 24th-25th July 2016. The inventory of 358 shallow landslides in the region is shown, as well as a representative photo of the soil slips which were triggered by the extreme rains event

Country/ region	Landslide data and references	Damage	Cost (Euro)
Austria	Felbertauern rockslide. Tyrol. On 14th May 2013. Volume: 35,000 m^3	3,5 km of a very significant road	30 million
Croatia	Kostanjek landslide (Zagreb). Firstly activated in 1963. $32x10^6$ m^3. (Stanic and Nonveiller 1996)	250 buildings, 50 of them during the last 10 years	No data
Cyprus	Armou Village (Pafos) in 2012. 65,000 m^3 in volume	6 houses and official eviction for all the residents	3 million
Czech Republic	Prackovice landslide in July 2013. 450 m in length and 60 m in width.	Destroyed the D-8 Highway	385,000
Denmark	Some slides along the coast.	One fatality in 1994	No data
France	La Clapière landslide (Tinée Valley). Active since 1952. 60 million m^3 moving at 1-3 cm/year (Palis et al. 2017)	Residential areas and road infrastructures	No data
Greece	Kepla landslide (central Greece) in February 2015. 250,000 m^3 in volume	7 buildings completed ruined, 30 buildings damaged and a road collapsed	3,41 million
Ireland	Ballincolling Hill landslide (Kerry). August 2008	Building damaged, watercourse contamination, infrastructure damage	500,000
Italy	Motagunto earthflow in March 2010. Volume: 0.006 km^3. (Ferrigno et al. 2017; Giordan et al. 2013)	The state road 90 and the Rome-Bari railway	620,000 Euro/week
Lithuania	Gediminas Castle Hill in February 2016 (Mikulėnas et al. 2017)	Gediminas Castle	15 million
Norway	Kvam debris flow (2013). Volume: 150,000 m^3 (Kalsnes et al. 2016)	Damage to a lot of buildings and infrastructures. 200 people evacuated	Several million NOK
Poland	Lanckorona landslide in May 2010	Damage to 26 houses and 25 agricultural infrastructures	17.5 million
Portugal	Funchal and Ribera Brava (Madeira) earth/mudflows on 20th February 2010 (Fragoso et al. 2012; Lira et al. 2013)	45 deaths, 6 missing and 68 injured	1.53 billion
Republic of Srpska,B&H	Landslide Boškovići (Zvornik) in May 2014	Damaged 33 households	No data
Romania	Alunu Valley landslide on 9th May 2017	8 houses demolished and 20 people evacuated. Road damage.	No data
Serbia	The Umka-Duboko landslide in 2010. Area: 1.8 km^2. (Sesov and Zugic 2010)	Motorway affected and the Sava river bank	No data
Slovakia	Vrátna Valley debris flows on 21st July 2014. Vol:100,000 m^3 (Holec et al. 2017)	Cable line terminal	10 million (+ floodings)

Slovenia	Čemšenik landslide in 2010. Volume: 3 million m^3	200 houses endangered	8 million
Spain	Landslides and rockfalls in Majorca (2008-2010). (Mateos et al. 2012; Mateos et al. 2013)	Several houses, barns and the road network	11 million
Sweden	Småröd landslide. December 2006	Collapsed motorway and railway	50 million
UK	Hatfield landslide in February 2013. Volume: 200, 000 m^3	distorted a large section of train line	No data
Baden Württemberg	Mössingen-Öschingen landslide in June 2013. Vol: 500.000 m^3	several houses	3.5 million
Hessen	Villmarrock and debris slide (Lahn-Valley) in June 2016. Volume: 100 m^3	road cut	30,000
Catalonia	Montserrat rockfalls in 2008. Volume: 900 m^3.(Janeras et al. 2013) Portainé landslide, active since 1982 (Pinyol et al. 2017) Barberà de la Conca landslide in 2010.	A hotel, roads and facilities Ski resort Buildings affected	6,8 million

Table 1- A selection of damaging landslides during the past 10 years in Europe

Country	MORLEs event	Landslides/damage
Austria	-District of Feldbach, Styria. On 22th-24th June 2009 -Taxenbach (Salzburg). On 1st-2nd July 2013 -Stanzim Mürztal (Styria). On 24th-25th July 2016 -Ober-Wölz (Styria). On 4th-5th August 2017	-465 shallow landslides in an area of 12 km^2 -108 shallow landslides in an area of 60 km^2 -358 shallow landslides and flows in an area of 15 km^2 -328 shallow landslides and flows
Greece	-Western Greece. January 31st to February 2nd 2015 intense and prolonged rainfall -Lesbos. On 12nd June 2017 occurred an earthquake of 6.1 Mw	-Numerous landslide events -Simultaneous occurrence of many falls and landslides
Italy	- Giampilieri (NE Sicily) on1st October 2009. Very intense rainfall event. Triglia et al. 2015; Aronica et al. 2012. - NE Sicily, on 22nd Novembre 2011. Extreme rainfall event. Fiorillo et al. 2016. -Cinque Terre (Liguria). 25th October 2011. Very intense rainfall event. Cevasco et al. 2013.	->1000 landslides. Several small villages were hit with 38 fatalities, 6 missing persons and damage to buildings and transportation infrastructures valued up to €550 Million - Thousands of landslides -300 landslides in Vernazza and more than 170 in Monterosso. 7 people died.

Poland	Flysch Carpathians. Summer 2010. Mrozek and Laskowicz 2014.	1000 reported landslides on urban areas. Costs around €960million
Serbia	Widespread landslides around Krupanj and Bajina Basta in May 2014.	51 fatalities (including landslides and flooding). 32,000 people evacuated and economic losses up to €1,523 million
Slovakia	In May 2010 extremely high rainfall in the eastern regions. Liščák et al. 2010.	551 landslides were registered. Emergency declared.
Slovenia	On 9th-14th September 2014. Heavy rainfalls.	800 slope failures around Slovenia. Large material damage
Spain (Catalonia)	-Val d'Aran, on 17th and 18th June 2013. Catastrophic rainfall event. Pinyol et al. 2017. - Berguedá (Eastern Pyrenees), May/June 2008. Intense rains. Portilla Gamboa et al. 2009.	Numerous debris flows. Important damages in different infrastructures. >100 shallow failures. Infrastructures affected.

Table 2- MORLEs events registered in some European countries during the past 10 years

Country	Average annual economic losses (Euro)	Average annual fatalities	Fatalities in 2015
Austria	592 million (including all natural hazards)	3	3
Cyprus	Aprox. 5 million		0
France	Between 100-200 million	Few	
Greece	No data	1.2	3
Ireland	0.5 million	0.1	
Italy	1-3 billion (including floods)	12	12
Poland	No data	0-1	1
Serbia	100 Million	1	
Spain	235 million	2	1
Sweden	20 million		
UK	89.3 million (2015)	0.8	

Table 3- Economic and social impact of landslides

3.2 Landslides in the Geological Surveys (GSs) of Europe

The participant countries and regions account for 180 experts on landslides, outstanding Poland (30 experts), France (20 experts), Norway (14 experts) and Slovakia (12 experts). This represents a great strength in EuroGeoSurveys. Most of the GSs (81%) have a National landslide mapping plan, but it is usually reduced to an inventory map or a susceptibility one (in 57% of the countries and 50% of the regions). Only Ireland, Italy, Norway and Catalonia (Spain) elaborate hazard maps, being Italy the only country in contemplating landslide risk at the national level (Fig. 5). Additionally, 43% of the GSs use to elaborate technical reports in urban and infrastructures areas affected by landslides; 38% of the GSs indicate that these reports are occasional in their tasks, and the rest (19%) never elaborate them (Fig. 6A). Another strength of the EuroGeoSurveys is that 67% of the GSs are involved in landslide monitoring by exploiting a wide range of techniques: DInSAR in 47.5% of the cases and ground tools in 62% of them (FIG. 6B).

The key question is whether the maps and technic/scientific literature produced by the EGs are later used for urban and land-use planning. Regarding maps, the answer is positive only for 28.5% of the countries (Cyprus, Italy, Portugal, Serbia, Slovakia and Norway); 47.5% of them refer that their maps are used occasionally and 24% that “never” (Fig. 6C). Results are worst for the technic and scientific literature on landslides: 40% of the GSs claims that it is not known at all by the urban and land-use planners; 45% refer that it is “sometimes” known, and only 15% of the countries (Italy, Lithuania and Serbia) have a positive experience, being their products well known by the end-users (Fig. 6D).

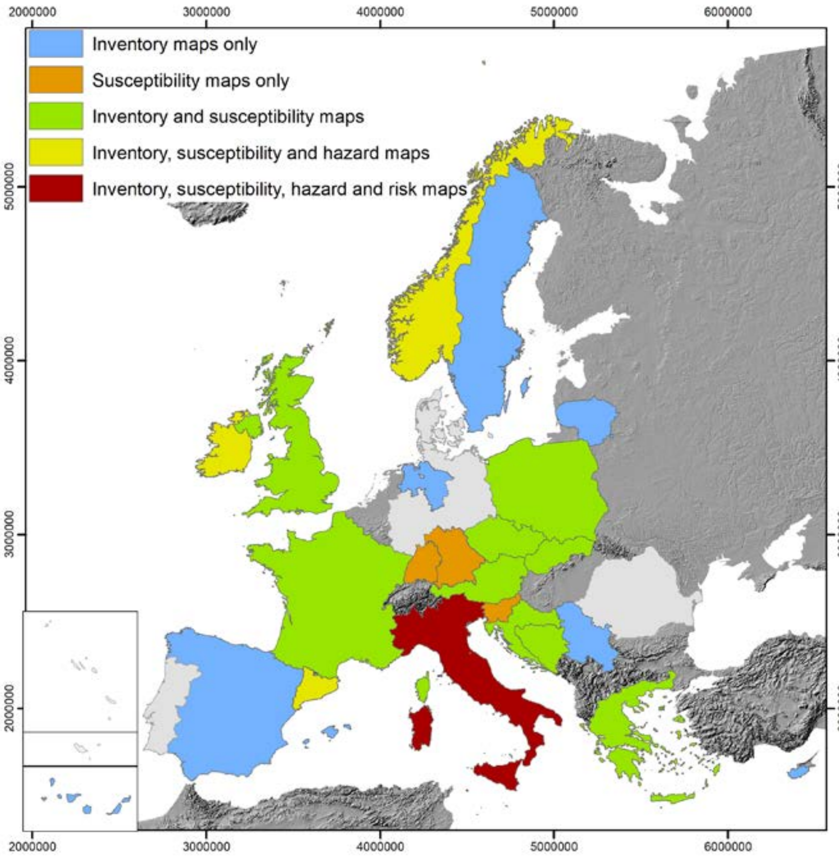

Figure 5 Types of landslide maps produced by the participant National and regional Geological Surveys

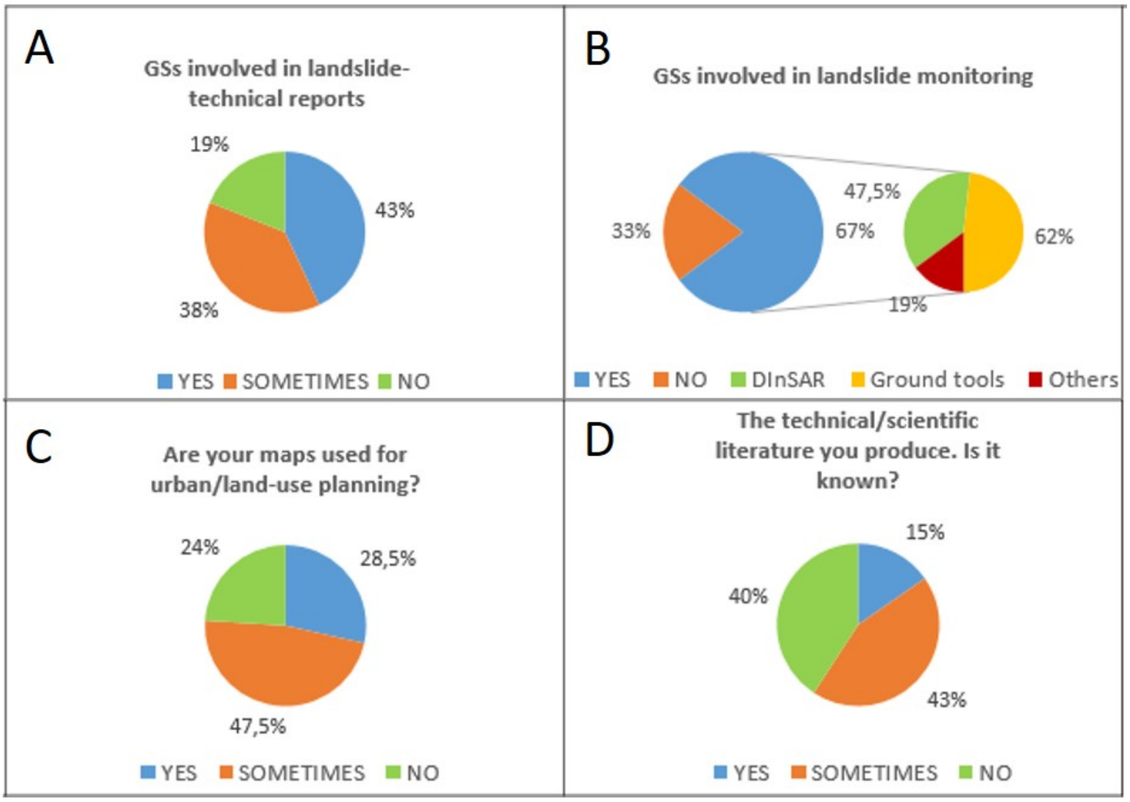

Figure 6 Statistical diagrams referring to section 2: landslides in the EGs: A) percentage of GSs involved in the elaboration of technical reports; B) percentage of GSs involved in landslide monitoring (types); C) the use of the maps elaborated by GSs for urban/land-use planning and D) the social knowledge of the technical/scientific literature generates by the GSs

3.3 Landslides in the legislations

In most of the countries (72%), urban planning is carried out within the ambit of local Governments, which are the responsible to require the landslide maps for the procedure which lead to the final acceptance of the areas subject to urban development. Surprisingly, 43% of the countries currently have no legal measures at all to account for landslides during urban and land-use planning: Denmark, Cyprus, Czech Republic, Slovenia, Slovakia, Ireland, Lithuania, Portugal and the Republic of Srpska, Bosnia and Herzegovina. The rest of the countries contemplate landslides (as natural risks) in the National Land Bill, or even in the regional laws, as occur in Germany, Austria, Croatia, Serbia and Spain (Fig. 7).

Regarding landslide maps officially required they use to be susceptibility maps in 40% of the countries with regulations, and slope/inventory maps in 35% of them. Cyprus, Italy, Norway, as well as Hessen (Germany) and Catalonia (Spain) appeal for hazard maps, and only Italy contemplates in the legislation the need to build risk maps (Fig. 8). 62% of the countries and 100% of the regions have developed official methodological guides to draw up the landslide maps. Nevertheless, there is a large heterogeneity of mapping methods, scales and procedures for the different countries. In many cases, even in the same country, landslide zoning in an area cannot be compared on a similar basis with zoning of adjacent areas. Taking into account the scales, we have elaborated the Table IV, which shows the variability in the recommended scale by the official guides for both, territorial and urban planning. Taking into account the criteria indicated by the International Association of Engineering Geology (IAEG) through the Technical Committee on Landslides and Engineered Slopes (Fell et al. 2008) on the recommended scales for landslides zoning purpose at regional, local and site-specific zoning, we observe that most of the countries regulates map scales useful for regional analysis (scales 1:25.000 to 1:250.000). For local zoning (scales 1:5000 to 1: 25.000) as well as for site-specific zoning (scales 1:5000 to 1:1000), which are recommended for urban planning, the number of countries is lower, and only 5 countries and one region (Catalonia) recommend the elaboration of hazard and risk maps at the right scales for urban purposes.

The experts from GSs participate in the elaboration of the official landslide guides and maps in 62% of the countries, but they are not involved in the supervision and final acceptance of the urban/land-use plans. The supervision is only mandatory in France, Greece and Serbia and carried out by geoexperts from other public administrations.

To illustrate the heterogeneity in legislations related to geohazards and urban development, we have selected Greece and Spain as significant examples of central and decentralized management, respectively. Within Spain, the case of Catalonia has been developed as an example of regional legal procedures.

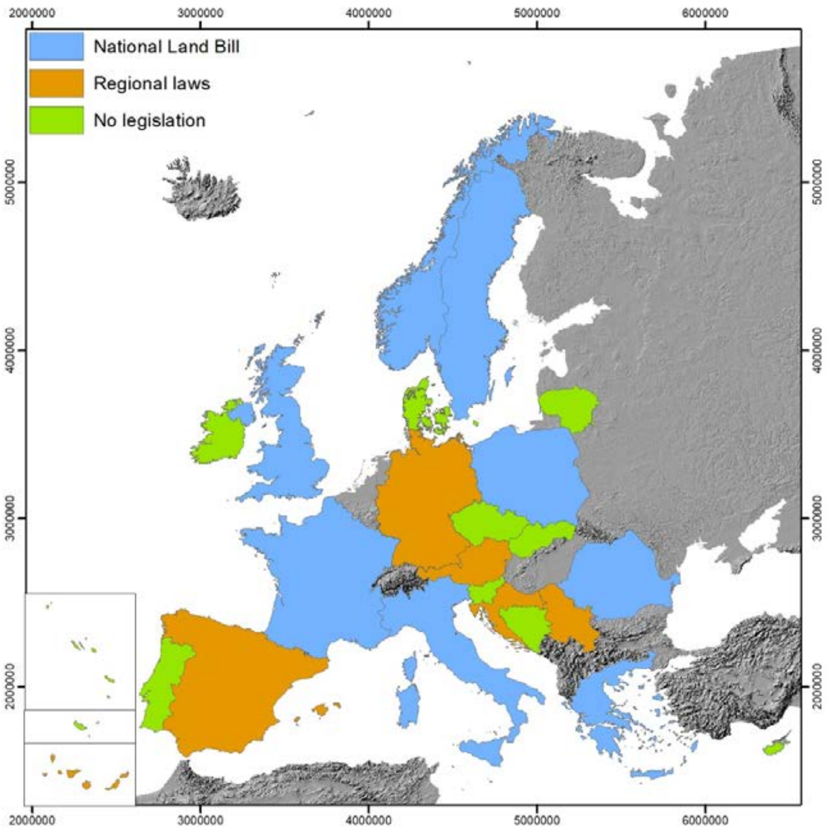

Figure 7 Legislation: how landslides are integrated into urban/land-use planning. 43% of the countries currently have no legal measures at all

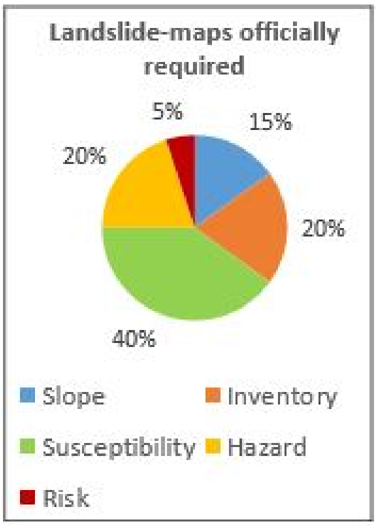

Figure 8 Landslide maps officially required by the legislations in force. 55% of the countries only required slope/susceptibility maps

Country/ Region	**Territorial planning (land-use)**				**Urban planning**			
MAPS	Inventory	Susceptibility	Hazard	Risk	Inventory	Susceptibility	Hazard	Risk
Austria		1:25.000- 1: 50.000	1:5.000- 1:10.000	< 1:5.000		1:25.000- 1: 50.000	1:5.000- 1:10.000	< 1:5.000
Czech Republic						1:10.000		
France		1:250.000				1:10.000		1:5000
Greece	1:25.000- 1:5000	1:25.000- 1:5000			1:2000 1:1000	1:2000 1:1000		1:1000 1:500
Ireland	1:50.000	1:50.000	1:50.000					
Italy	1:25.000 – 1:10,000		1:25.000 – 1:10.000	1:25.000 – 1:10.000				
Norway		1:50.000					1:10.000	
Poland	1:10.000				1:10.000			
Portugal						1:25.000- 1: 10.000 1:2000 in coastal areas		
Republic of Srpska, B&H	1:25.000	1:100.000 - 1:25.000	1:25.000	1:25.000	1:5.000	1:25.000- 1:5.000	1:25.000 -1:5.000	< 1:5.000

Romania			1:25.000					
Serbia	1:25.000	1:25.000	1:25.000	1:25.000	1:5000- 1:1000	1:5000- 1:1000	1:5000- 1:1000	1:50001: 1000
Slovakia		1:50.000						
Slovenia		1:250.000 1:25.000				1:25.000		
Sweden	1:25.000	1:25.000- 1:100.000						
Bavaria			1:25.000					
Baden Württember g			1:50.000					
Hessen			1:50.000					
Lower Saxony			1:50.000					
Saxony-Anhalt			1:25.000					
Catalonia	1:10.000	1:25.000	1:25.000	1:25.000	1:5.000	1:5.000	1:1000- 1:5.000	1:1000 1:5.000

Table 4 Recommended scale in the official methodological guides to draw up landslide maps

3.3.1 Central state management: the case of Greece

First legislation was got into force in 1998. The so called "Geological Housing Suitability Studies" (Official Journal No. 723/B/15-07-98), introduces the geological suitability studies as a necessary condition for the development of a new urban area and also gives clear instructions of how these studies should be performed (methodological guidelines), naming geologists as the only authorized persons to perform them. The geological studies include engineering geological mapping at a scale of 1:5000 and larger, concluding in suitability zones accompanied with the necessary measurements or instructions for safe construction practices. In 2007 the legislation was improved and the studies of geological suitability are being conducted within the framework of General Planning Studies regulated by the Official Journal of the Hellenic Republic 1902B/14-09-07. Currently, the Geological Suitability Studies are being carried out in two stages:

(1) A first phase where a preliminary study of geological suitability is conducted at scale 1: 25,000, which is the scale of General Planning Studies. The scope of this study is the rough assessment of geo-problems/geohazards and their relation to building environment, as well as the definition of areas that need conservation and protection. This phase ends with the delineation of areas that are suitable for urban development.

(2) A second phase where the geological suitability study is conducted at scales 1: 5,000 to 1:1,000. The geological study is elaborated with the following targets:

- Zonation of urban areas in respect to their suitability for housing.
- Specific description of the required conditions or the necessary measures for soil improvement, or other required protective measures in order to achieve safety in regions. Rough estimation of the financial requirements.
- Submission of proposals for additional studies and investigations, if required.
- Estimation of possible problems to large infrastructures and large technical works. Relevant mitigation measures to develop. Risk assessment.

The geological suitability are the last studies conducted before the finalization of the urban plan and refer strictly to a specific area, which is defined according to the results of the statements-permissions of archaeological and forestry authorities. It is mandatory that these studies are submitted to the national or regional administration and only after their approval by geoexperts employees are brought into force.

3.3.2 State decentralization management: the case of Spain

The National Land and Urban Rehabilitation Bill, approved by the Royal Decree 7/2015 of 30 October 2015, includes, for the first time, the requirement to draw up natural-risk maps within the ambit of urban and land-use planning in Spain. Nevertheless, the application of the law falls within the ambit of State decentralization and the transfer of powers to the 17 country´s autonomous communities and 2 autonomous cities. Town councils are responsible for urban planning but the final acceptance of the areas subject to urban development depends on the autonomous community decision. Yet this objective is proving difficult to accomplish because of the stagnation of public bodies, which tend to be poorly prepared for interactive policies, and the lack of detailed risk maps, which are the key elements in urban development planning. A great achievement to solve this was the initiative of the Spanish Professional Association of Geologists (ICOG) that in 2008 elaborated a methodological guideline to draw up risk maps of the natural hazards, including landslides (ICOG 2008). This guide recommends the scale of 1:2000-1:5000 for landslide maps to be used in urban planning. Nevertheless, the guide is not mandatory for the moment, since there is no agreement among all the autonomous communities for its application. Currently, only some regions have already taken a first step by including the requirement to consider landslides when authorizing urban development, since most of the regions only contemplate flooding and seismic risk, being that they are regulated by European legislations (Mateos 2017). In some regions where the price of land is very high, restrictions only include non-urban land. That is the case of the Balearic Islands whose economy depends largely on income from tourism and the urban land is scarce. Since 2003, local authorities are required to draw up 1:25000-scale landslide susceptibility maps. For any land use planned for a non-urban area with a medium or high degree of susceptibility, a binding report on the real risk must be commissioned.

This report has been prepared for a long time by experts from the National Geological Survey (IGME). Nevertheless, the urban land is not included in this procedure.

In Catalonia, the Catalan Urban Law (1/2005, 26 July 2005), and further developments, determines a mandatory report on geological risks (including landslides) prior to any urban change or planning. The Cartographic and Geological Institute of Catalonia (ICGC) validates the report regarding landslides, since the institution has the competences in this field. The aim of the report is to preserve the urbanization and construction in landslide risk areas for the safety and welfare of people, unless the works to be executed are foreseen as a prevention or mitigation of the risk. In legal terms, the ICGC report is mandatory but not binding. Ultimately, it is the Planning Commission who has the responsibility to issue informs and resolve planning procedures (Marturià et al. 2017). The ICGC support this task by means of the Geological Hazard prevention Map of Catalonia (at scale 1:25.000). This is a multi-hazard map with a prominent role in the territorial planning which provides an overview of the dangerousness of the territory integrating geohazards such as landslides (slides, rockfalls mudflows, and complex movements), torrential flows, subsidence, collapse, snow avalanches, flooding and seismicity. For urban planning, a preliminary study of risk identification (EIRG) is done at scale of 1:5000 and larger. This report try to identify the presence/absence of geohazard evidences on new urban areas, as well as supervising hazard mitigation works carried out by third parties.

3.4 Landslides awareness and preparedness

Romania, Greece, Italy, Serbia and Norway consider landslides as a National problem; for the rest of the countries this geohazard is a local problem (in 42% of the countries and 100% of the regions) or a regional one (in 32% of the countries). For 65% of the countries, people who live in hazardous areas is aware of the risk, but only after a significant event; for the rest of the countries (Austria, Romania, Greece, Italy, Sweden and Norway) population is fully aware and coexists with the risk. The perception of landslide risk in public managers increases slightly (40% of the countries) but in general, they are equally conscious only after the occurrence of an important event. Half of the participant Geological Surveys have an outreach program to strengthen geohazard awareness; in many cases, these programs include landslides. A good example is the British Geological Survey (BGS) which is actively engaged in communicating its research through a balance of peer-review scientific papers, technical reports and non-technical information. This is accessible to the public to aid awareness of landslides and the associated hazards. BGS has sought to use internet to increase the visibility of its research, improve access to knowledge and encourage dialogue across a wide audience. Data are published online under the Open Government License, which enables the free re-use of government and public sector data under a common authorization. An example of openly available data is the National Landslide Database which is available as a free online resource via the BGS online GIS, the GeoIndex (BGS 2018a). An educational resource (BGS 2018b) has also been designed that includes nomenclature, published papers, reports, products (e.g. landslide susceptibility maps), updates on current research and a suite of case studies detailing landslide field surveys, impacts, photographs, videos and links to reports. In addition, the use of social media platforms such as Twitter, Facebook, Instagram and blogging allows BGS to engage directly and regularly with people who are observing and being affected by landslides. This facilitates data collection and communication between members of the public and technical specialists.

Regarding preparedness, 35% of the countries have a continuous plan which contemplates measures of protection, prevention and mitigation against landslides. The rest of the countries, and 100% of the regions, only take actions after a significant event. Fig. 9 shows this vision, including the location of landslides with fatalities and injuries during 2015. We can observe that countries with fatal landslides (Greece, Spain, Republic of Srpska, Bosnia and Herzegovina and Uk) have not already implemented a continuous plan for landslide risk reduction.

Finally, 100% of the countries and 50% of the regions consider that a common landslide European legislation is needed for defining and mapping landslides prior to the licensing process. Authorities ensure their compliance when a legal framework exists. In this sense, all the participant countries consider that the 2007/60/EC Flood Directive is the example to follow.

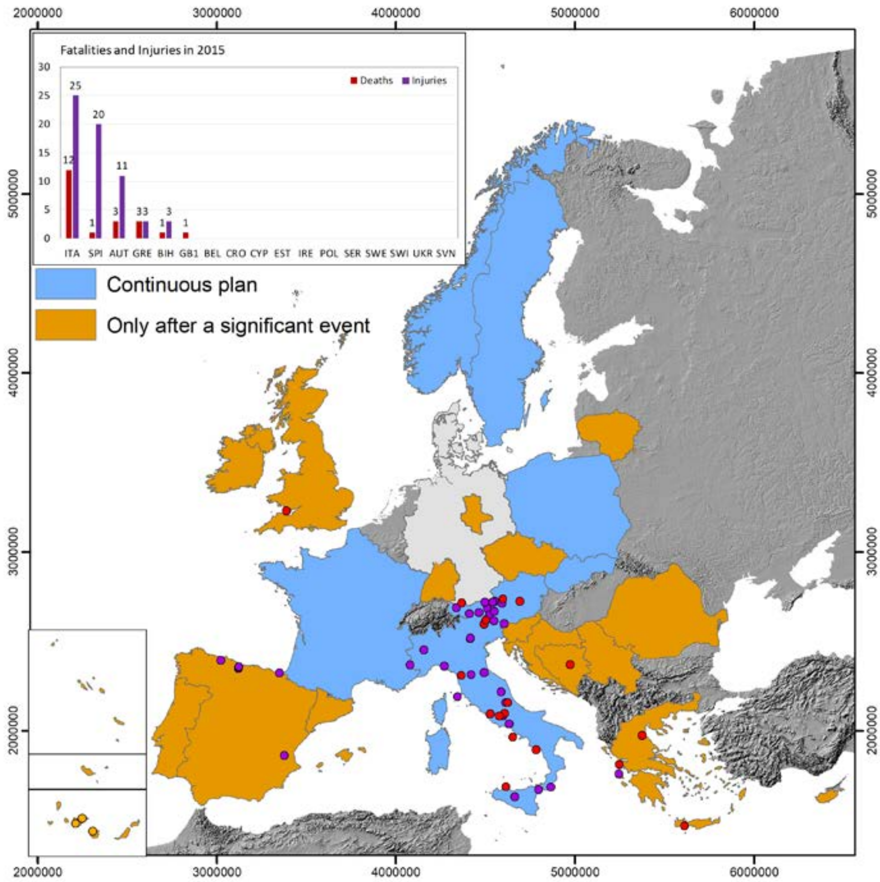

Figure 9 Preparedness against landslides in the participant European countries and regions. Austria, France, Italy, Norway, Portugal, Slovakia and Sweden have a continuous plan to implement measures to protect, prevent and mitigate landslide disasters. The landslides which caused fatalities and injuries in 2015 have been represented, outstanding Italy, Austria and Greece with more deaths

3.5 Cases of bad urban practices in areas of instability

In the present work, the participants countries have shared cases of bad urban practices on landslide prone zones across Europe to analyse and determine what failed in each case and why. Initially, the singular case in the Mediterranean coast of Spain was exposed during the EOEG meeting held in Vienna in April 2019, and the countries were invited to answer the following two questions: (1) Do you have a similar case in your country? (2) With the legislation in force in your country, it is possible a case like this nowadays?

Surprisingly, eight countries have reported similar cases than the Spanish one; they are: Cyprus, Greece, Italy, Serbia, Slovenia, Slovakia, Poland and Romania. All of them account with severe affections to buildings and infrastructures caused by landslides and refer great social impact, not only financial but also emotional problems in the population. The variety of examples has been summarized as follows.

3.5.1 The case-type: Cármenes del Mar (Spain)

Cármenes del Mar is an urbanization on the southern coast of Spain (Granada). The urban development started around 1997 and it continued until 2006. The development consists of 416 houses dominating the seafront (Fig. 10). The resort was built on a steep coastal slope and on a pre-existing large landslide (Mateos et al. 2017 a). In November 2015, the Regional Parliament of Andalusia declared a state of emergency in the resort. Up to date, 42 houses -which lie in ruins- have already been evacuated, causing great social alarm. A long judicial process was initiated in October 2013 by the affected property owners against the developers and construction companies. Finally, the High Court of Andalusia (2016), remitted a sentence in favor of the residential communities which confirmed that the legal procedure for controlling the urban license was extremely weak. Although the preliminary geotechnical assessment identified the slope stability and recommended a more in-depth geotechnical study for the whole area (Chacón et al. 2018), it was never carried out by the builders, and the administration never forced them to do it. Moreover, the administration approved the construction of the 416 dwellings when initially there were planned to be about 100 (Granadadigital 2017). Currently, the landslide is still active and no homeowner has been indemnified.

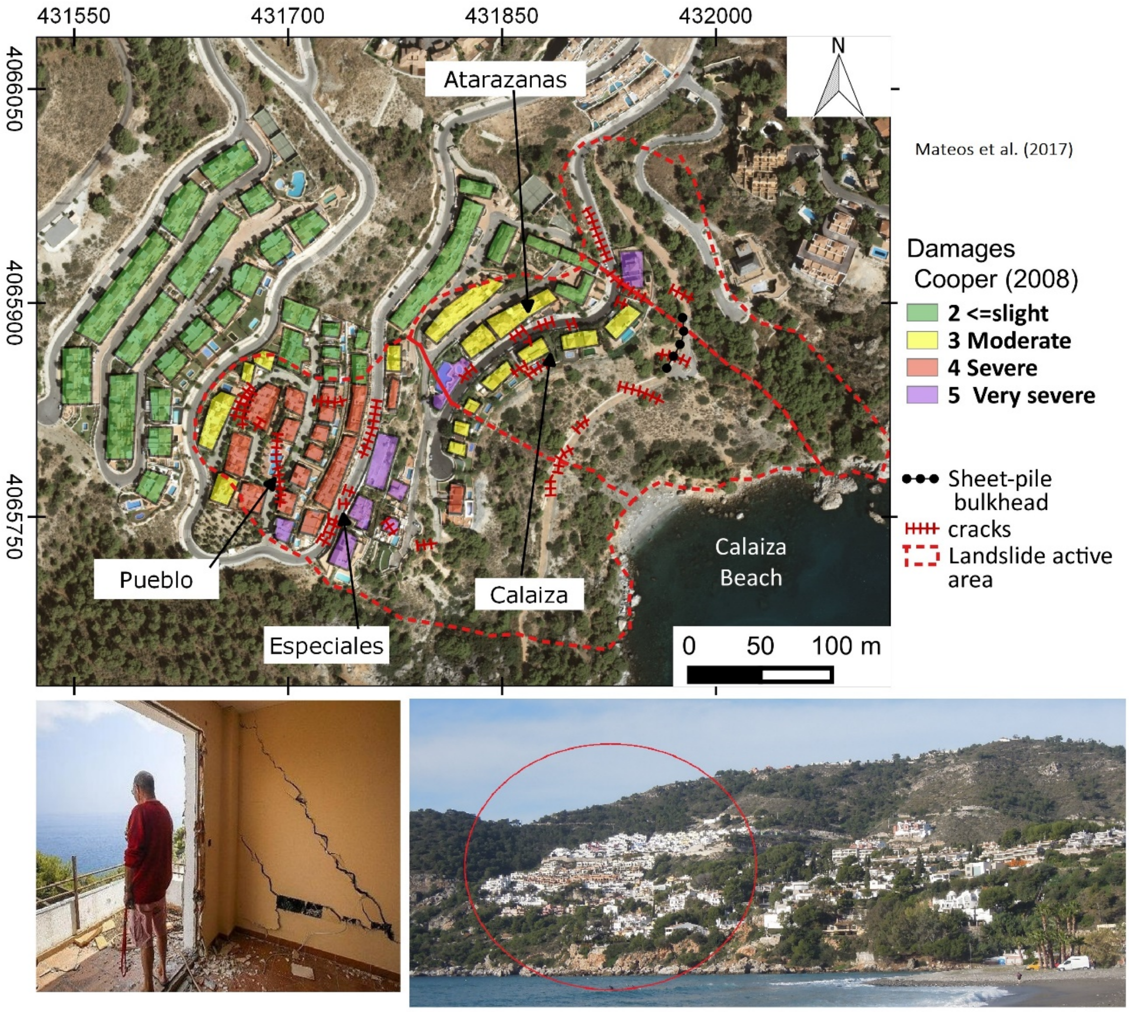

Figure 10 Cármenes del Mar urbanization in the Mediterranean coast of Spain (Granada). The resort was extended onto a previous landslide, which was reactivated by the housing causing widespread damages. The upper map shows the damage based on Cooper (2008) classification (Mateos et al. 2017)

3.5.2. The Limnes case in Cyprus

Pissori village is located in the SW part of Cyprus. “Limnes” is an area of 0.5 km^2 that was built between 1990 and 2012 over the surface of a dormant old landslide in very soft materials. Since 2012, Limnes urbanization faces severe problems due to both, settlement and slide movements which caused many damages on dwellings and infrastructures (Fig. 11A). Currently, the landslide is active and there is none judicial process for indemnifications yet. In Cyprus there is not any legislation in force for such cases.

Figure 11 A) The Limmes urbanization (Cyprus) which was built over a dormant landslide; B) Blidari village (Romania) where many dwellings were damaged by the reactivation of a landslide after the heavy rains occurred in March 2018; C) The Nižná Myšľa village (Slovakia) severely affected by slope movements triggered by extraordinary rainfalls in June 2010, and D) The church of the village of Čemšenik (Slovenia) affected by landslide activity since historical times

3.5.3. The Ropoto case in Greece

The first recorded damages from landslides in the Ropoto village (central Greece) were reported in 1963, when 100 dwellings were affected. From the beginning, the Geological Survey of Greece (IGME) realised the magnitude of the phenomenon and proposed either the gradual re-settlement of the village in a new safer place or/and the application of simple and inexpensive measures (at the beginning). Reactivations have occurred in 1979, 1984 and 2010. The most severe event took place in April 2012, resulting in major destruction of the central part of the village, which is still in ruins (Fig. 12). Ropoto case is a long story of 55 years of how a known instability is getting worst as not relocation or corrective measures were taken (Lekkas et al. 1998). Homeowners (many houses that were newly built) are waiting for compensation.

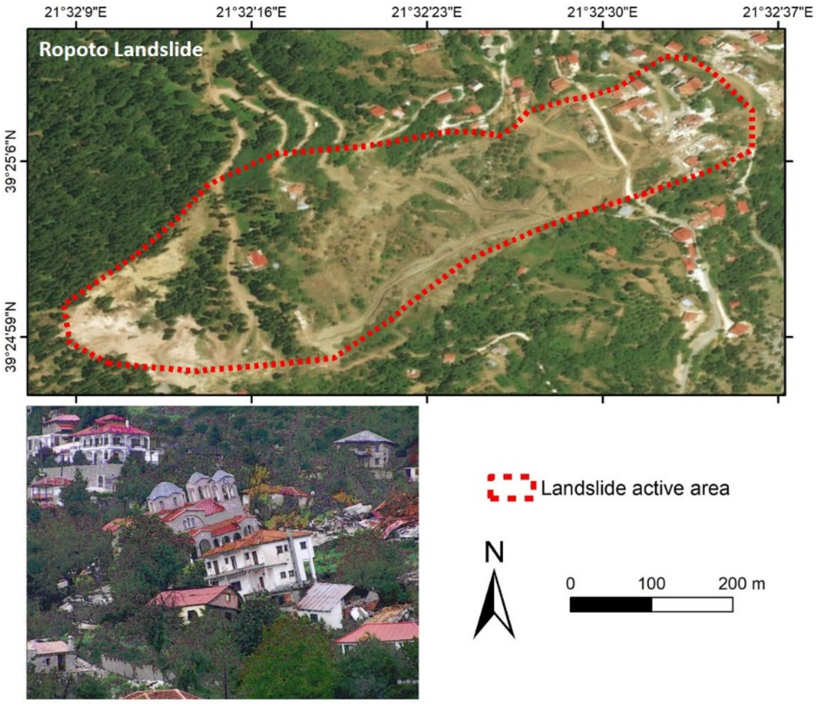

Figure 12 The Ropoto landslide in Central Greece. The most severe event took place in April 2012, resulting in major destruction of the central part of the village, which is still in ruins

3.5.4. The Sarno case in Italy

In May 1998, in the villages of Sarno, Siano, Bracigliano and Quindici in the Campania Region (S Italy), more than 140 landslides (mainly debris flows) occurred by a heavy rainfall event (Fig. 13): 159 victims, 178 destroyed and 450 damaged houses (Triglia and Iadanza 2012). Most of the urban areas located in hazardous zones (at the end of streams) were built after 1956. This case led the implementation of a relevant law in Italy (L. 267/1998) that regulates the need to identify landslide hazard and risk areas and the application of building restrictions in the hazardous zones.

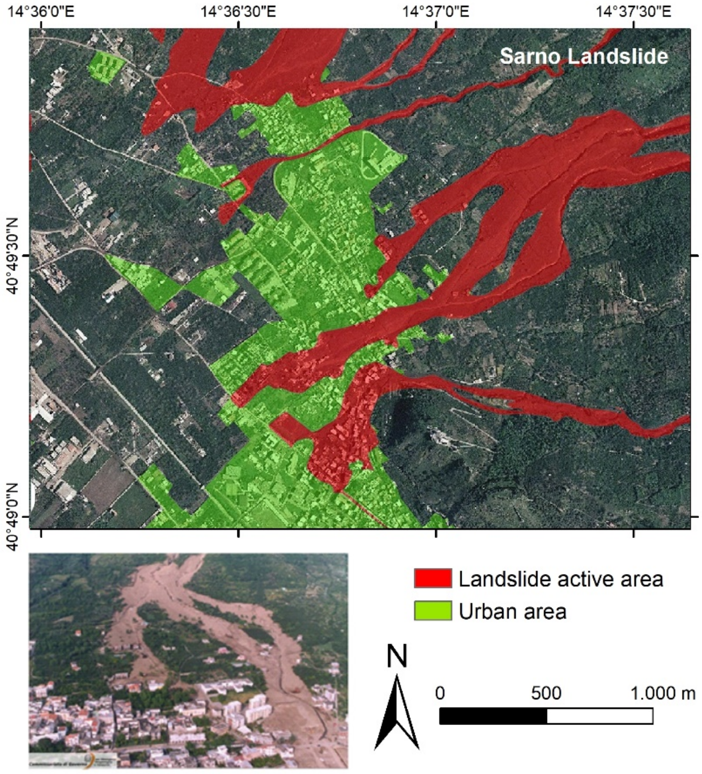

Figure 13 The village of Sarno (Campania, Italy) affected by many debris flows occurred by a heavy rainfall event in 1998

3.5.5 The Umka case in Serbia

Umka is one of the biggest landslide in Serbia (Abolmasov et al. 2015). It is located 20 km SW of Belgrade, on the right side of the Sava River and coalescing with the Duboko landslide (Fig. 14). Around 400 dwellings, the motorway IB-26, and many infrastructures are affected by the landslide. The total economic damage is calculated between €4-5million. Addittionally, the uncontroled leakage may cause great environmental problems such as groundwater and soil pollution and also the possibility of epidemic desease. Most of the dwellings were built without a building permit. In those that have it, constructors did not carried out the geotechnical studies because it is not obligated in order to get the license.

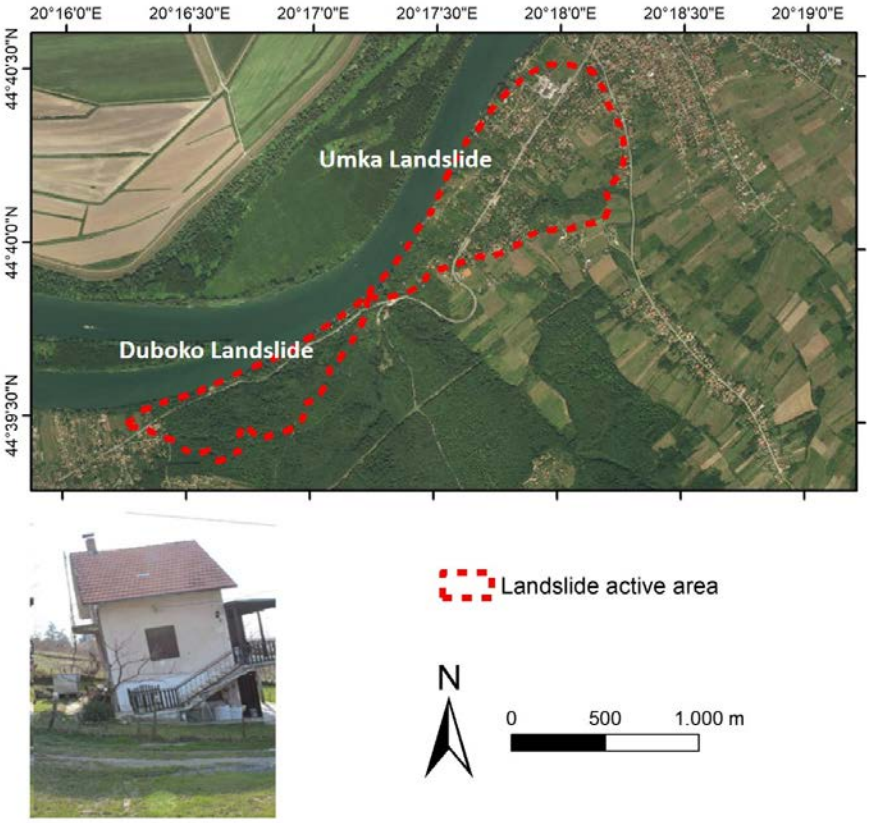

Figure 14 The Umka landslide on the right side of the Sava River (Serbia). Around 400 dwellings and many infrastructures are currently affected by the landslide

3.5.6 The Čemšenik case in Slovenia

The Čemšenik village (central Slovenia) was built on a fossil landslide area many centuries ago. After heavy and abundant rainfall in 2010 new cracks appeared on the church (Fig. 11D) and road, and about 20 residential houses were directly endangered. The Čemšenik case is not an isolated example in Slovenia. Many such populated landslides exist (Peternel et al. 2017). The Slovenian legislation needs to assign a much more relevant role to spatial planning than ever before, starting with the inclusion of landslide hazard and risk maps into (Mikoš et al. 2014).

3.5.7 The Nižná Myšľa case in Slovakia

In May and June 2010 extraordinary rainfalls induced more than 570 newly evolved slope failures in Eastern Slovakia. The most disastrous landslide occurred in the Nižná Myšľa Village on June 4th, 2010: 40 living houses were damaged along with the local infrastructure (Fig. 11C); 29 of them had to be demolished and several others became uninhabitable. Despite the fact that the landslide has been well known for several decades, scattered construction of housing estates continued further until the disaster of 2010. Since then several stages of remediation have taken place at the site, however, the landslide is still active at places.

3.5.8 The Lanckorona case in Poland

Lanckorona is a Polish village situated in the foothills of the West Carpathians. First information about landslide activity in the village comes from 1960 when 24 buildings were severely damaged. For next 50 years, due to lack of information about landslide activity in official documents, the area was again treated as a good place for housing. In 2010 extremely heavy rain reactivated the landslide (Fig. 15): numerous buildings were critically damaged and 26 families (> 100 people) had to leave their properties. The case was raised against commune authorities and it is still in progress.

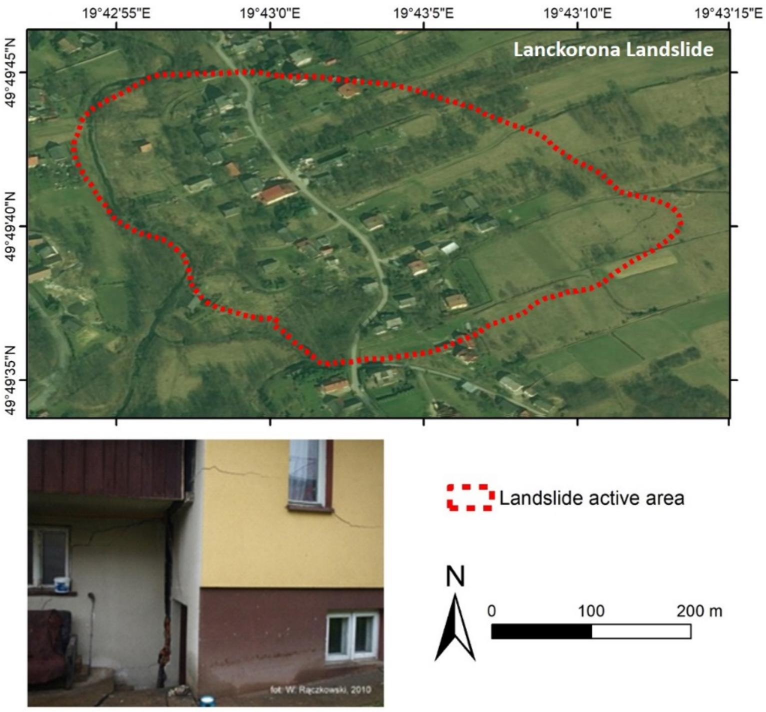

Figure 15 The Lanckorona landslide (Poland). In 2010 extremely heavy rain reactivated the landslide. Numerous buildings were critically damaged and 26 families were evacuated

3.5.9 The Blidari and Goleçti case in Romania

The villages of Blidari and Goleşti (central- south Romania) are affected by landslide activity with manifestations since 2006. In March 2018, after snow melting and a heavy rains period, the slides were reactivated (Fig. 11B). Numerous dwellings and infrastructures as well as the nearby railway are severely affected (Blidari-6 households in imminent danger, 12 with very high vulnerability; Goleşti- 8 households in imminent danger, 15 with very high vulnerability). All residents know that the area in which they are located may be affected by landslides, but in the current situation, although they have been evacuated from civil protection, some continue to return to homes that are severely affected. Land stabilization works have been carried out without success and the County Committee already declared the state of emergency in 2010. The problem is now, after the latest event, depending how local and central authorities respond.

4 DISSCUSION AND CONCLUSIONS

The survey carried out by the Earth Observation and Geohazard Expert Group from EuroGeoSurveys, through a questionnaire and a participatory exercise completed and developed by 21 European countries and 6 regions, allows discussing and concluding the following outcomes:

4.1 Impact of landslides in Europe

- Landslide is a widespread hazard in Europe producing significant social and e economic impact. Landslides are present in all the countries and represent the most important geohazard in Cyprus, Slovakia, Slovenia and Serbia. Landslide is the second most important geohazard in 12 of the participant countries. Intense rainfall is the primary cause of landslide occurrence in Europe.
- The most frequent and damaging typology is slide. Rockfall occupies the second position in frequency, but flows generate more damage. The most landslide-hazardous areas in Europe (in order of importance) are: mountainous regions, river basins and the coastal fringe.
- All the countries report damaging landslides events during the past 10 years. Landslides cause disasters resulting in fatalities, injuries, destruction to housing, infrastructures and properties, as well as loss of productive land. Additionally, eight countries report MORLEs events during the last decade. MORLEs are usually associated to other major natural disasters, such as floodings and earthquakes; that is the reason they are not well recognized, as the media overlook their effects. However their impact can be very significant.
- The socio-economic impact of landslides is difficult to quantify. In fact, there is a complete lack of information in 57% of the participant countries. In the cases we have data, they are an estimation of direct losses, mainly the reconstruction of and repair to exposed elements, but it is not usual to include indirect costs, as a large quantity of not readily-available information must be acquired and evaluated. Sometimes, like in Italy, landslide

costs are not considered separately; they accompany other geohazards such as floods/earthquakes. This fact decreases the visibility of landslide risk.

It is absolutely necessary to implement and harmonize the national landslide databases in the European countries. Herrera et al (2017) showed a large variability in the landslides databases from the Geological Surveys, with multiple scales and formats. In some countries, landslide mapping is systematic; others only record damaging landslides, whereas in others, landslide maps are only available for certain regions or local areas. A greater coordination effort should be made to increase data integration. Homogeneous national landslide databases are needed with the amendment of the INSPIRE Directive (2007) as open data freely available for distribution and use to the general public. It is well known that geological data easily accessible would make developers and property owners more aware of the risks and more motivated to build appropriately (EFG 2015).

4.2 Landslides in the Geological Surveys

- EuroGeoSurveys accounts for more than 180 experts on landslides. The National Geological Surveys produce not only geological maps containing location of landslide-susceptible lithologies, but also specific maps focused on landslides. They usually are inventory/susceptibility maps, and occasionally hazard and risk maps. The GSs can play a very important role not only managing the national landslide databases, but also improving landslide mapping through geoscience to identify accurately the landslide hazardous areas.
- The National Geological Surveys are involved in many cases of landslide monitoring, exploiting a wide range of techniques. Monitoring systems at the land surface are usually combined with observations from space, such as DInSAR techniques. In this sense, the EuroGeoSurveys have the knowledge of appropriate precursors which may provide vital information to initiate early warning decisions.
- The technic and scientific literature generated by the National Geological Surveys is generally unknown by the urban and land-use managers. Additionally, the knowledge of a considerable number of experiences on landslide monitoring is lost.

National Geological Surveys information on landslides is underutilized, since it is scarcely accessible to the public in many countries. In this sense, the GSs have to make a great effort to present the scientific and technical data as open information, freely available in digital form and to implement better practices in data dissemination. The communication between GSs experts and urban/land-use planners has to be considerably improved.

4.3 Landslides in the legislation

- 43% of the participant countries currently have no legal measures at all to account for landslides during urban and land-use planning. In particular, countries like Cyprus, Serbia, Slovakia and Slovenia -where landslides is the most important geohazard- have no national legislation to integrate landslides into the spatial development plans.

- In the rest of the countries (57%) some laws in force regulate this, but with a large governance heterogeneity. The legal measures taken for defining and mapping landslide hazard into the licensing process is very different from one country to another. In many cases, even in the same country, landslide zoning in an area can not be compared on a similar basis with zoning of adjacent areas.
- The landslide maps officially required for urban/land use planning are usually slope/inventory or susceptibility maps. Very few countries appeal for hazard/risk maps. 62% of the countries have developed official methodological guides to elaborate the maps. Nevertheless, there is a large heterogeneity of mapping methods, scales and procedures and a great confusion of concepts regarding susceptibility, vulnerability, hazard and risk. One of the most important deficiency detected is the lack of landslide maps at a detailed resolution (scales 1:5000 to 1:1000) in the legal procedure for urban planning. Most of the countries contemplate large-scale maps not adequate for urban purposes.
- Although the National Geological Surveys frequently participate in the elaboration of the guides and maps, they are not involved in the supervision and final acceptance of the urban/land-use plans. This supervision is mandatory only in 3 of the participant countries.

In Europe, there is a wide range of laws which regulate the integration of landslides into the urban/land-use planning. There is a large heterogeneity of mapping methods, scales and procedures. A common legislative framework and homogenization of the national legislations is required. It is not acceptable that legislation regarding landslide management is absent in many countries. To date, no specific policy on landslides have been implemented at EU level. European Council reaffirmed the importance of disaster prevention as a tool for adaptation to climate change. In this sense, the European strategy should be aimed at strengthening cooperation in law enforcement. It would be highly desirable in further improving legislation standars for landslides at the European level. More and more often, new constructions and infrastructures extend onto landslide-prone areas; we have to develop common legal requirements be sure that new constructions avoid areas of landslide hazard. Where control laws exists, authorities ensure their compliance and the risk is considerably reduced.

4.4 Landslide awareness and preparedness

- Most of the countries consider landslides as a regional/local problem. Residents and public managers in landslide-prone areas are aware of the risk, but usually only after a significant event. In general, policymakers underestimate potential effects of landslides, since they are usually associated with floods and earthquakes.
- Only 35% of the participant countries have a continuous plan to deal with landslides. The rest of the countries only take actions after a significant event. They act when the problem

is; prevention and mitigation measures against landslides are scarcely developed across Europe.

- Public awareness, education and communication systems have to be considerably improved in most of the countries. Only Half of the participant Geological Surveys have an outreach program to strengthen geohazard awareness.

Major efforts on dissemination have to be carried out. Authorities and residents of landslide hazardous areas must be aware of the dangers. The National Geological Surveys can play a vital role on this: to provide residents of landslide hazard areas adapted information to be aware of the dangers as well as to design specific training to policy-makers and land-use planners. These actions could be very beneficial to reduce the impact of landslides. Additionally, the communication between landslide experts and urban/land-use managers has to be improved. Urban and land-use competent authorities should develop strategies for landslide risk reduction in their municipalities/regions in collaboration with the scientific collective. In this sense, EOEG proposes to enhance the collaboration by means of European projects and national formative programs from both directions. There are some calls within the framework of H2020 focused on implementing prevention and preparedness actions for dealing with geohazards. Specific research lines to support this collaboration should be enacted on the particular field of urban and land-use planning.

4.5 Cases of bad urban practices in areas of instability

A combination of causes is behind the reported disasters, but there is a common element in all of them: The urban development was planned in areas of known instability. What failed?

In the case of Cyprus, Slovenia and Slovakia, landslides are not contemplated in the National Land Bill, and they have no legislative tools to regulate this. The lack of specific legislation on landslides led to disasters. In the case of Serbia and Spain, regulations depends on regional legislations; both report that constructors did not carried out the necessary geotechnical studies because they were not obligated. There are certainly weaknesses in the legislation. The case of Italy is clear: the catastrophe in the Campanian region, with 159 fatalities, aroused the need for stricter legislation. In the cases of Greece, Romania and Poland, they accounts with specific National legislation, but numerous weaknesses are detected in the control of its application. Although current Greek legislation related to urban planning for new areas includes landslide assessment, there are serious problems with already established settlements, like Ropoto. Greek central authorities claim that houses were built in an active landslide, disregarding that everything was done according to given building licenses from local authorities. Despite the recommendations initially done by the Geological Survey of Greece (IGME), nothing was done as these are not obligatory by law. In the case of Romania, there is no communication between actors involved; landslide maps are sometimes elaborated by non-experts, and they are not later revised. Additionally, the Romanian Geological Survey neither has legal significance or decision power. In the case of Poland, information about past landslide activity (in 1960) was not recorded in official (spatial planning) documents. Thus, commune authorities issued building permits without knowledge about landslide. In general, for all the cases exposed, the bad urban practices are related to a weak rule of law and/or absence of good governance.

Affordable single-family homes, with green surroundings provide a classical example of urban sprawl growingly in Europe. This kind of urban development increasingly takes place in locations in which the risk of landslides is higher. The social analysis of the exposed cases reveals that owners and renters were completely unaware of the risk before the disaster. Later, their life is in ruins: they have to move, they have to continue paying the mortgage, the value of their properties decrease, the insurances companies are not responsible for the damages and they have to face long judicial processes that usually conclude that permission for construction and housing should not ever have been granted.

When those affected are asked what measures to adopt, they placed a greater emphasis on hard measures (such as retaining walls, deepest foundations, etc.) to reduce the risk, whereas the experts tended to focus on better information and land-use planning. All the experts participating in the present work agree that landslide is not only a local problem, but an international one which demands urgent actions in order to control the spread of built-up areas in hazardous land. As the European Commission declared in 2003: "*where landslide related land use and control laws exist, authorities should always ensure their compliance"* (European Commission 2003).

5 FINAL CONCLUSION: TOWARDS A NECESSARY EUROPEAN DIRECTIVE ON LANDSLIDES

Finally, the last and most important conclusion upraises the interest of all the participant countries in the need of a common European legislative framework for a better integration of landslides into the urban and land-use planning. A European Landslide Directive should be promoted to establish this structure for the assessment and management of the risks that landslides pose to human health, the environment, cultural heritage and economic activity in the European Union.

Taking into account the deficiencies detected in the present work, and keeping in mind that landslides are phenomena which can be prevented, the Landslide Directive should integrate the followings items:

- The approach to be adopted in the production of landslide databases: to design common technical formats for the purpose of processing and transmission of data, including statistical and cartographic data.
- The approach to be adopted in the production of landslide maps: The legal framework has to set out the requirements in terms of the types (hazard and risk), scales and contents of the maps, on the basis of the specific objectives. Very stringent requirements

and high standards have to be applied for urban planning at local scale as well as construction projects. The maps have to include the different types of mass movements: slides, rockfalls, flows, etc.

- The approach to ensure that fundamental assessment steps are rightly conducted and applied in the management of landslide-prone areas. Geoexperts have to be involved in all the stages of the legal procedure, and specifically in the supervision and final acceptance of the urban/land-use plans.
- The determination of risks and definition of protection objectives: countries have to implement a protective plan including extensive and structural measures to minimize potential damages.
- The approach to be adopted in the design of outreach programs to strengthen landslide awareness as well as cooperation proposals between actors.

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