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Disaster Risk Reduction from natural hazards

- The role of Geoscience

Intelligere, tueri noscendas - To understand, to identify and to protect

Panel of experts on Natural Hazards and Climate Change

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Disaster Risk Reduction from natural hazards – The role of Geoscience

1. STATE OF ART

Natural hazards are induced by natural phenomena such as landslides, earthquakes, volcanoes, storms, tsunamis, droughts and floods. Natural phenomena occur at irregular intervals and at varying intensity. There are regions and locations which are more at risk than others, depending on factors such as geology, topography and proximity of settlements and infrastructure to hazard sources. Natural hazards may be interrelated and may have global effects. Natural hazards often lead to disasters [1]. The risk posed by a natural hazard is in direct proportion to the population density in the area vulnerable to the risk.

As our world develops cities will grow, the population will rise and accordingly exposure of lives and property to disasters will increase although not evenly. Though exposure will rise, proper administration of policies and science can reduce vulnerability and risk [2,3].

The European Federation of Geologists (EFG), the professional scientific body that represents 24 national geological association members, would like to draw the attention of policy makers at international, European, national, regional and local level of the importance of geoscience in civil protection against natural hazards.

Geoscientists provide a first line of defence against natural disasters. Their knowledge can determine what hazards at particular locations to face, and how to mitigate the hazards effectively.

There is a strong debate about Geoethics to consider the geological knowledge in the decision making process to increase the quality of life and reduce the poverty of many millions of people in all the world. Europe can be a reference in Geoethics increasing the research and development in this field.

This advice document is written by the Group of Experts on Natural Hazards of the E.F.G. as a follow up of the press release on civil protection against natural hazards, presented at the official launch of the “Geology for Society” European report on 2nd June 2015. The aim of the press release was to outline to MEPs and EU policy makers the importance of geology to our society against natural hazards.

For the purposes of this document, hazard is defined as “a condition with the potential for causing undesirable consequences” whilst risk is defined as “a measure of the probability and severity of an adverse effect to health, property of the environment” and vulnerability as “the degree of loss to a given element or set of elements within the area affected by the natural hazard” [4]. The above definitions are also similar to the European Union (EU) Council Directive 96/82/EC [5].

EU Legislation on Human Rights [6] together with articles 196 and 220 on civil protection of the Lisbon Treaty [7], provide the right of all citizens to equal civil protection from natural hazards regardless of location.

Furthermore, investment in Disaster Risk Reduction (DRR) [8] saves lives during and after the disaster occurred and financially restricts the disaster cost [2] with high economic returns [9,10]. Benefit-cost ratios of 4 and higher are documented in the literature [11,12] on prevention.

This approach supports a proactive risk reduction response instead of the traditional post disaster action.

DRR includes any activity that prevents or reduces the risk from damages caused by natural hazards like earthquakes, floods, droughts, and storms [1,3]. According to Hyogo Framework for Action 2005-2015 [3] DRR is framed within information sharing and policy implementation under three pillars of action at which geosciences have an important contribution to offer (Figure 1) [13]:

1. Risk Assessment.
2. Risk Reduction.
3. Risk Financing & Transfer.

Risk Assessment identifies hazards and provides information on exposures and vulnerabilities on the population and infrastructure.

Risk Reduction is achieved with the installation of early warning systems and by implementing its core concept of Risk Prevention. The latter is based on land use planning, infrastructure development and maintenance, water resource management, agricultural planning, understanding the mechanisms of climate change, institutional coordination mechanisms, information and knowledge sharing.

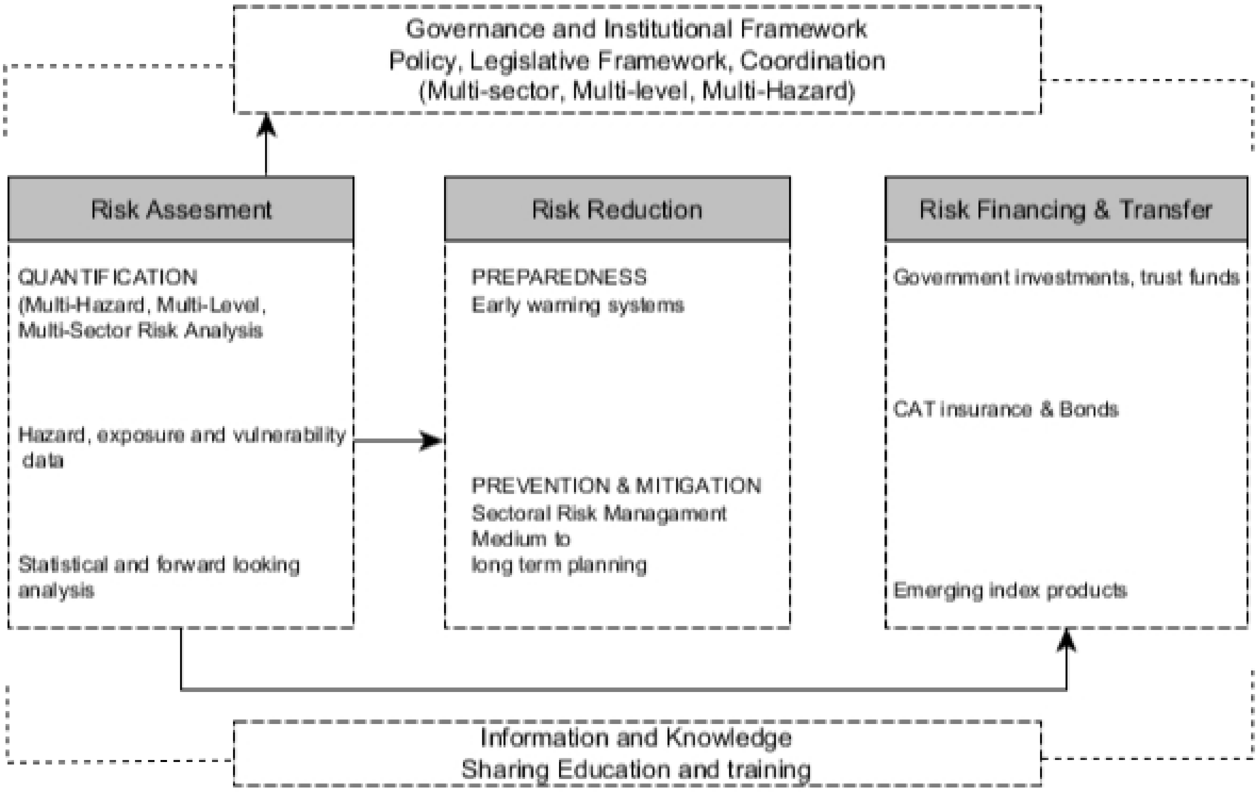

Figure 1.: Disaster Risk Reduction framework adopted from WMO Disaster Risk Reduction Programme [13].

Despite adequate prevention measures, hazards will take place and a financial intervention will be required for recovery and reconstruction [2]. The reduction of the disaster's financial impacts can be achieved by risk financing mechanisms such as indexed insurance products (insurance bundling) [14]. This facilitates risk spreading and reduces administrative costs per policy [13,15]. Proper knowledge of geological conditions underlying the hazardous factors can help to quantify the associated risk (e.g. estimation of earthquake recurrence [16]), and thus accurate calculate the insurance cost.

It is advisable that all DRR activities should be customised to specific hazards and locations, giving access to cultural and economic diversity. Consideration of the potential risk from natural hazards should be mandatory in advance of key infrastructure projects and where such hazards could lead to extensive economic loss or loss of life. For example, hospitals, schools, and critical infrastructure should not be located in areas at high risk from natural hazards or if that is the case, they should be designed with higher than usual margins of safety.

The EU Civil Protection Mechanism needs to develop the prevention as a very important component to reduce risks and educate the population. The decisions related with the use of the territory must be based in the technical and scientific knowledge to increase the prevention and help for the best economical development.

To further elucidate the importance and nature of natural hazards, several examples relevant to the European community are considered below.

1.1 Flood

Flood as defined by the European Floods Directive (EFD) [17] is a temporary covering by water of land normally not covered by water. This includes floods from rivers, mountain terrain, Mediterranean ephemeral water courses, and floods from the sea in coastal areas, and exclude floods from sewerage systems.

Disaster conditions are created by reckless building in vulnerable areas and failure to control flooding. Levee failures are extremely difficult to alleviate with disasters being even worst as usually there are no contingency plans for such cases [18]. Floods damage human settlements, force evacuation, damage crops, strip farmland, wash away irrigation systems, result in erosion of land or make it otherwise unusable.

In 2012 heavy rainfall in Great Britain and Ireland, caused numerous floods resulting in power outages and damage to residential properties and infrastructure. Indirect impacts included lost working days, disruption to transport, communication and utility links. The total cost in the UK economy was estimated at £600 million [19].

In early June 2013, after several days of heavy rain in late May, extreme flooding occurred in Central Europe (Upper Danube Basin), the largest in the past two centuries. Based on flood records, similar floods, less severe, occurred at 2005, 2002, 1954, 1897, 1862 and 1787 [20].

During the 2013 flood damages affected nine EU Member States, primarily south and east German states (Thuringia, Saxony, Saxony-Anhalt, Lower Saxony, Bavaria and Baden-Württemberg), western regions of the Czech Republic (Bohemia), Slovakia and Austria [18]. The cities of Passau and Deggendorf saw the worst damage with the flooding reaching 12,75 m. Several levees collapsed and places like Fischerdorf had their buildings under 3 metres of water [18]. The flooding resulted in property loss, waterlogged fields, lost crops and flooded farm buildings. At least 1500 km^2 of fertile land had been flooded [21]. The economic losses resulted from the flood estimated at €12 billion [22].

Extreme floods expected to increase in frequency from once every 16 years to once every 10 years by 2050 [22]. The average annual economic losses due to flooding expected to be in the region of €23.5 billion by 2050, over five times the amount for the period 2000 to 2012 (€4.6 billion). These costs stress the resources of both insurers and governments [22].

1.2 Earthquakes

Earthquakes cannot be prevented, however their impact can be reduced through proper zoning and implementation of building codes based on site-specific risk analysis.

Severe earthquakes are most common in southern Europe, surrounding the Mediterranean. Earthquakes occur all the time; in Spain on May 11th, 2011 some 20,000 buildings have been damaged by an earthquake with a magnitude of 5.2 at Richter scale [23]. On May 29th, 2012 at 07:00 UTC, a magnitude 5.8 Richter scale occurred in Northern Italy. The area experienced important damages and casualties. At least, 17 people were killed. More than 14,000 people moved to temporary shelters. To finance earthquake relief the Italian government raised excise duties on petrol by 2 cents per litre [24] [25].

The most disastrous earthquake in European ground in the last 20 years occurred in Athens, Greece on Tuesday 7th September 1999, with a moment magnitude 5.9. As a result 226 buildings collapsed and claimed the death of 125 people. Another 18 people died from indirect causes such as heart attacks, falling debris and falls. Furthermore, 2000 human injuries were documented and an additional 4566 buildings had to be demolished due to extensive structural damage leaving 15,000 people homeless. Financial damage was significant with losses estimated at 2.95 billion US$ (2.5% of Greece’s GDP in 1999) while 1.4 billion US$ was the estimated indirect loss [26]. The Athens 1999 earthquake event demonstrates the high risk of hazard when seismicity occurs near densely populated areas.

The latest earthquake event of significance in Europe was a moderate destructive earth movement with a magnitude of 5.9 on the Richter scale that affected Cephalonia on the 26th of January 2014 [27]. However, it must be noted that the Cephalonia earthquake, it was not as destructive as the earthquake occurred on the same island at August 1953 due to successful implementation of the national building code which considers seismic zonation of the area.

Seismic zonation is the division of a national territory into regional areas with different potential for hazardous earthquake effects. It is based on peak ground acceleration for different return periods taken into consideration historic and predicted intensity of ground motion [28] and provides a significant first step towards earthquake risk mitigation.

Countries that have made seismic provisions in their respective building codes (mostly after Eurocode 8) adopting earthquake zonation are the following [28]:

1. Portugal
2. Spain
3. France
4. Belgium

5. Netherlands
6. Italy
7. Switzerland
8. Germany
9. Austria
10. Slovenia
11. Hungary
12. Czech Republic
13. Slovakia
14. Greece
15. Cyprus
16. Bulgaria
17. Romania

The above listed countries classify their territory into three or four seismic zones. Earthquake design requirements for buildings are generally the same within the defined seismic zone [28]. Some degree of building code harmonisation across the EU has been achieved with the implementation of Eurocodes 8 yet the problem of different seismic hazard zones on the two sides of a national border still exists [28].

1.3 Tsunamis

Geological, archaeological and relatively modern evidences show that tsunamis are existing geohazards in coastal Europe. Earthquakes, submarine slides, volcanic eruption and collapse are the two principal tsunamigenic mechanisms. Tectonically induced tsunamis in Europe occur mainly in the Mediterranean and the Black Sea, whereas tsunamis caused by submarine landslides have mainly occurred in Norway [29]. Similar to earthquakes, tsunamis cannot be prevented, but their impact can be reduced through proper zoning and site-specific risk analysis. Tsunamis can cause severe damages, due to their destructive energy and the extensive floods that they produce. An additional hazard appears when the retreating floodwater runs back into the sea. Moreover, there is the long lasting potential of altering the soil salinity of agricultural land caused by the infiltration of seawater and thus inhibiting plant growth [30].

In 1470 BP a tsunami, originated by the Thera volcano eruption hit Crete and the eastern Mediterranean coast. Wave heights near the eruption may have reached as high as 86 m [31]. In 1755 a tsunami up to 15m high impacted Lisbon and Western coastal Spain [32]. The event had so traumatic effect on the European continent that inspired artists to depict it in paintings of the time [33]. In 365 AD a series of earthquakes initiated a tsunami which devastated the Nile Delta [34]. On another occasion, 8200 years ago a tsunami occurred in the North Sea as a result of a gigantic underwater landslide on the Norwegian continental slope [35].

Whilst not frequent the magnitude of the potential impacts are such that risk exists. Many tsunami sources are located close to densely populated areas. Even though no devastating tsunamis have occurred in the last 100 years [29], scientific research suggests that under the right geological conditions the potential for large tsunamis recurrence in eastern Mediterranean can vary from every 5000 years to 800 years [36].

1.4 Landslides

Landslides include a wide range of ground movement events, such as rock falls, deep failure of slopes, and shallow debris flows. The high frequency of these events occurs in steep relief terrain, mostly associated with heavy rainfall [4].

Landslides have the potential to cause significant damages to infrastructure such as roads, dams, buildings and in cases the loss of human life. Of special importance are the frequent small landslides which affect transportation networks and have high cost of remediation [13].

In Italy inventories of landslides exist, including potential landslide regions. In May 1998 over 100 landslides occurred in the Sarno-Quindici area, 30 km east of Naples [37]. These landslides travelled up to 4 kilometres and impacted a number of towns resulting in severe destruction and the loss of 161 lives. Disaster cost estimated at the time at €33 million [38]

Most famous case, the Vajont Dam, in the valley of the Vajont River under Monte Toc, 100 km (60 miles) north of Venice, Italy. On 9 October 1963, a massive landslide caused a tsunami in the lake, the overtopping of the dam, and around 2,000 deaths. The disaster occurred as the dam engineering design ignored the geological conditions [39].

Landslide hazard maps are available in some regions, mainly in areas historically affected by landslides. A detailed unified map covering the whole of Europe is regarded as a high priority target. A European landslide hazard map that has been produced by ESPON illustrates the possibility of landslide hazards in general terms. The ESPON landslide hazard map provides an overview on the landslide hazard, but does not assess in any detail neither in which parts of the regions landslides occur nor the causes of landslides [29].

2. SPECIFIC CHALLENGES

Natural hazards pose challenges for uninterrupted balanced and sustainable development for whole Europe. When natural hazards occur, they may not confine to local or country barriers as in the case of earthquakes. Furthermore, mitigation of a hazard in one country may create the worst conditions in a different country. This might be the case of floods, where higher flood walls and levees might protect one country, but may worsen the situation in a different country, as they can cause increased water flow speed and volumes downstream [18].

This renders natural hazards as an international problem that requires collaboration, share of knowledge and mutual understanding heading from European Union administration policy making, to countries down to the local district council. To achieve this a common legislative framework and harmonisation of the national technical standards is required as illustrated in the case of the2007/60/EC flood directive [17] and European standards, especially Eurocodes 7 and 8.

Harmonisation at multilevel is integrated within European policies and is within the very core of the European idea. Legal and technical harmonisation removes barriers and creates the communication pathway for mutual understanding, spreading the knowledge and expertise to properly address the problem and provide appropriate technical solutions to the risk imposed by natural hazards. Furthermore, it helps to achieve a uniform level of protection for all citizens of the European Union [40]. At this time great pressure is on for European spatial data harmonisation under the INSPIRE Directive [41] which demands an enormous environmental data harmonisation effort at the EU level.

Different regions are exposed to different hazards of varying degrees, placing them in different risk areas. Alleviating the harmful effects of natural hazards requires reducing the vulnerability of human settlements and residences. Citizens living in such areas should be made aware of the risk areas and the precursors of the natural event. Plans for responding to natural hazards should be produced by local authorities.

An important aspect in undertaking the challenge posed by hazards is to shift from post-event disaster-orientation to a preventive orientation concentrating on risk management and mitigation [29]. These should take into consideration the characteristics of the area at risk, including geology, geomorphology, hydrogeology, land use and development, but also on the type and location of potential hazard occurrence and the timing of hazard triggering factors. Another important factor that may have direct and indirect influence on generation of natural hazards is climate change. Intense rainfall is the primary cause of flood and landslide occurrence in Europe [38,40]. Floods, droughts and landslides are one major pathway over which climatic extremes may become manifest [29,40].

One of the most important practical step is to identify high-risk areas through risk maps production showing natural hazard probabilities [18]. These should be of detailed resolution, included in the planning process for construction projects and risk mitigation policies and they should be made widely accessible to the public.

3. PROPOSED ACTIONS

The EFG strongly recommends that future emphasis should be placed on the development of existing co-ordinated European organisations for emergency and rescue response as well as relief and aid organisations. The continuation of the current status - an agglomeration of uncoordinated groups at disaster sites - should be avoided in the future. EFG through its national association links has the resource manpower to make available a fast reaction emergency group for use at the disposal of a European coordinated approach on any hazard.

The EU Policy instruments should contribute to even out the variability and difference in disaster amplitude as a matter of European solidarity. Measures to be taken for mitigating the effects of natural hazards can be grouped into five major areas:

1. Integrate geological information and knowledge into the future European Community and national legislation.
2. Public awareness, education and communication systems.
3. Develop and install harmonised warning systems (geo-indicators) in areas at risk.

4. Open access to the scientific data.
5. European coordination project on the above challenges.

An analysis of the above proposed actions is given below.

3.1 Integrate earth science knowledge base into future European Directives and national legislation

The risk from natural hazards can be reduced by avoiding areas of hazard or by implementing specific mitigation measures; however the locations for such action must be identified. A preferred legal solution for this is to designate these areas during the spatial development and land use planning stages. Another potential permitting option is prescribing the examination of this aspect during environmental permitting, e.g, when preparing the environmental impact study for a given new activity or facility.

On the Community level, EFG calls for the consideration of the amendment to the SEVESO III Directive [42], the SEA Directive [43], the EIA Directive [44,45] and by the inclusion of the Critical Infrastructures Directive [46] the need for defining and mapping natural hazards a priori to the eventual permitting or embedded into the licensing process.

In member states the generation of hazard maps for planning purposes to control construction in vulnerable areas, should be integrated into national, regional and local legislation as a prerequisite for decision makers in spatial development and land-use planning. It is already an existing legal provision and general practice in some Member States as in Hungary and Greece. Where legal framework for land use and control laws exist, authorities should always ensure their compliance [38].

To provide a consistent and universal understanding of natural events a standard European system is recommended with the same hazard, risk levels and information. This is especially relevant when considering that a significant portion of the EU Community budget is allocated to the aftermath management of such major cases resulted to natural catastrophic events. Such a harmonised information base and assessment/scoring system would assure EU taxpayers and decision makers that the allocation of these funds is justified and spent on a consensual base. Furthermore, harmonisation provides the incentive for professionals to freely move and offer their expertise on different European Union member states.

Geoscience content is critical to the generation of hazard maps and it is recommended that professional certification by individual experts is to be required to undertake such work. In Italy, for example, since 1989 the National and Land Protection Law requires compulsory geological studies on natural risk for river basins and land management. All urban planning instruments have to be redacted with geological support.

Similar legislation is in force in Greece and has successfully reduced both the risks from earthquakes and the amount of human life losses. EFG advises that all similar national standards be harmonised under the implementation of Eurocodes 7 and 8 with their national annexes.

3.2 Public awareness, education and communication systems

Increased effort should be made to raise the level of public awareness regarding the causes and effects of natural hazards. Many natural disasters are the result of inappropriate human actions or decisions.

Early warning systems are only as good as the ability to effectively communicate the message to the public and for the public to act on it. A warning system may identify the hazard and the public may have been trained how to react, but if the warning is not passed quickly to the right people in the hazardous area, then the reaction may be insufficient or even wrong (see also § 3.3.). Increasing the knowledge of disaster management teams and rescue operations on geosciences will assist to better understand the potential hazard impacts and reduce risks to personnel.

People living in vulnerable areas, e.g. in valleys affected by repeated flooding, should be aware of the potential risk and possible measures they can take to protect their lives and possessions. Local authorities must know when to alert the population and how to engage disaster management teams. The more that can be achieved at a local plan, the better the immediate measures.

Education ought to be implemented at different levels in society:

- at schools,
- at community
- at politicians and decision makers.

EFG is prepared to increase the presence of this topic in its social electronic media, to assist in editing schoolbooks, producing pamphlets and to arrange seminars in all member countries (to the general public, as well as specific education to policy-makers and land-use planners). Efforts can be focused on the specific priority schemes in each country.

3.3 Develop and install harmonised early warning systems (geo-indicators) in areas at risk

Early warning systems are implemented at local scale, regional scale or European level in relation with the natural event that are monitoring. Landslides depend very much on localised factors such as geology and climate and it is therefore recommendable that this issue should be monitored on a regional or local scale. On the other hand, floods and earthquakes are of cross-border concern, both in terms of causes and impacts. In that case it is necessary to install cross-border cooperation reaching from planning over protective measures to early warning systems [29].

Recent research shows that national early warning systems are suffering from heterogeneity without utilising state-of-the-art-scientific approaches [40]. At European level the European Flood Alert System (EFAS), Copernicus previously known as the Global Monitoring for Environment and Security (GMES) and PanGeo present the EU effort to address the natural hazards in European level.

EFAS offers international coordination on floods in large trans-boundary river basins [40]. The EFAS has been developed based on hydrological rainfall – runoff model and on meteorological data [47]. The Copernicus utilises mostly satellite data to provide emergency mapping after a natural event and an early warning service based on data already available. The system is used mostly for floods, and forest fires [48]. PanGeo was set up to provide free online geohazard information on ground motion caused by earthquakes and landslides [49]. Data was provided from satellite measurements of ground and building movement and geological information already held by National Geological Surveys. However, the project was time and space limited to 3 years (2011 - 2014) and to 52 large European cities, respectively. During that time, PanGeo fed data to the Copernicus system.

The Joint Research Centre under the INSPIRE directive initiative [41] currently works on a cross-domain interoperability framework for natural hazards utilising European spatial data. The data model provides for locations of natural hazards as observed events without addressing the processes of defining their location. [50]. This framework currently considers floods and forest fires.

The monitoring systems previously presented rely their information on satellite imagery and spatial and historical data provided from national agencies. Many natural hazards are forewarned by precursors (geo-indicators), which are small but significant signs heralding the event [51,52] . Data from these sensors, including geophysical ones and monitoring systems at the earth's surface may be combined with observations from space for both local, regional and European early warning systems. Monitoring of appropriate precursors may provide means to identify an impending natural hazard sufficiently early to initiate mitigation measures [52]. As a consequence risk monitoring systems utilising geo-indicators offer real time increased resolution and can help to reduce the costs of reaching and also maintaining a given safety level, protection and quality [40].

A system of geo-indicators, covering a wide range of geological hazards, has already been developed by the International Union of Geological Sciences (IUGS) and could provide a framework for the development of monitoring systems applicable to European environments.

The EFG calls for a European unified hazard monitoring system integrating EFAS, Copernicus, the spatial platform under development from JRC coupled with the use of geo-indicators, geological and geotechnical data. Such a system should be extended to address the specific requirements of further specialised natural hazards as in the case of EU real time earthquake system apart from floods and forest fires. Furthermore, EFG recommends further research to improve these monitoring and early-warning systems and to effectively adapt them to European needs.

The above suggestions must be realized with special funds from the European Union [29]. The final effect of such a coordinated approach would be effective know-how, expertise and experience sharing, and substantial reduction of costs on a wide-European level while minimising redundant efforts. The experience gained from such exercise will also develop harmonised European technical specifications, as in the case of the Inspire Maintenance and Implementation Framework [50], which subsequently can be implemented in local or regional early warning systems.

3.4 Open access to the scientific data

In most European countries geological maps are already digitally available at their national Geological Surveys, containing boundary indications of river flood plain deposits, locations of soft clays and peats, areas of less stable rocks and steep slopes and caverns, earthquake risk zoning, gas upwelling locations, volcanically active terrains, maps on civic underground hazard locations (undermined areas, cellars, mine waste heaps and tailings, abandoned drill holes), marine hazards, to mentioned a few themes. It is also a spatial information topic required by the INSPIRE Directive [41].

Disaster risk reduction requires an all-of-society engagement and partnership this can be greatly achieved by the implementation of transparency and access to data [53]. The European Union through its digital agenda for Europe [54] strongly encourages the development of a pan-European digital service infrastructure for open data with a view of providing multi-lingual access to data published by public administrations at all levels of government in Europe. The World Bank report “Open data for economic growth” [55], recognises the large economic potential for generating economic growth and business innovation.

Making maps of flood plains, seismic fault lines and general geological data easily accessible would make developers and property owners more aware of the risks—and more motivated to build appropriately [12].

The EFG recommends the amendment of the INSPIRE Directive (2007) with provision to promote the release in digital form of high-resolution topographic maps, near coast bathymetry, geological, environmental and geotechnical maps, remote sensing data, geophysical data, including data for the early warning systems as open data freely available for distribution and use to the general public. It is highly anticipated that data dissemination will greatly reduce risk from natural hazards as it will assist the technical professionals to design and construct safer infrastructure projects at reduced cost. Furthermore, and equally important, it will provide in depth information to the public and stakeholders.

3.5 European coordination project on the above challenges

EFG recommends research projects on the geological knowledge and dissemination. A plan of research action is proposed below:

- Provide information on what legislation is in place on national and European level to mitigate natural hazards problems.
- Cross-correlate between the member states to ensure geohazards are not overlooked. Benchmark MS legislation and best practices
- Review the national legislation for its applicability in all the countries of the European Union.
- Produce a summary of what the known geohazards are to Europe, what litigation is used and propose amendments to maximise the mitigation measures.
- Investigation on countries with strong legislation in areas of natural hazards and analysis on how a good preventive policy has avoided major disasters and reduced economic losses.

The above should be used to determine the following actions, as described in this advice document including generating geohazard maps, firstly for the most vulnerable areas; educate general public, policy-makers and land-use planners; install early-warning systems where appropriate.

4. EXPECTED IMPACTS

Exposure to hazards is expected to increase, due to rapid population growth in cities, and the rising interdependence and inter-connectivity of risks [56]. As a result vulnerability will also increase unless proper measures are in place. Managing the risk of disasters is aimed at protecting human population and its property, health, livelihoods and productive assets while promoting and protecting all human rights [6], including the right to development.

Disaster risk reduction is essential to achieve sustainable development. Release of funds that otherwise would be spent on disaster mitigation caused by natural hazards will become available for development in other sectors of the economy.

European legislation on use of geological data as prerequisite for local planning and production of hazardous maps will provide practise harmonisation through the use of Eurocodes. It will also render the driving force for further development of technical standardisation.

The Sendai Framework recommends that disaster risk reduction practices need to be multi-hazard, inclusive and accessible in order to be efficient and effective [53]. The unification of the European early warning systems and its extension to include more natural hazards coupled with geological data will offer a multi-hazard multisectoral people-centred preventive approach to disaster risk. Additionally, the international cooperation required for such a unified task will forge stronger ties within European Union member states and other European countries.

The information gathered from such unified system will allow focusing on known and emerging disaster risk factors. Based on the previous, subsequent development of medium to long term prevention and post disaster scenarios for national, regional and local policy implementation will prevent and reduce vulnerability to disaster and increase preparedness for response and recovery. The expected result will be the substantial increased protection of human lives and infrastructure, decreased financial suffering and reduced cost for recovery. All these will strengthen society's resilience.

The unlimited access of scientific data will result on a more conscious and better informed public. The open exchange and dissemination of disaggregated data will integrate disaster risk management into business models and practices through disaster-risk-informed investments. This will ensure business continuity, increased factor of safety and decreased risk. Moreover, the decreased risk will ensure substantial reduced financial cost of disaster insurance and increased market penetration rate of the latter. This will facilitate risk spreading and reduce administrative costs per policy, while limiting ex-post government relief [15].

5. CONCLUSIONS

Natural hazards such as earthquakes, floods, landslides, tsunamis, volcanic and gas outbursts and other natural hazards pose risks to society. From 2000 to 2013 natural hazards have claimed some 80 000 people's lives. The average yearly economic loss during this period estimated at €11.2 billion [56].

There are still no methods to predict or prevent hazardous natural phenomena. Nonetheless, the impacts can be avoided or at least substantially mitigated. An understanding of geological processes is the first step towards this. Proper legislative measures, such as harmonised building codes and reliable hazard maps that require geological input, can be used in land-use planning to help eliminate the worst disaster scenarios and to help mitigate the effects of smaller scale hazards.

The EFG has both expertise and established communication network to organisations in other parts of the world, like the Natural Hazard Center in Colorado. The scope of EFG requires that the organization should be launched and administrated on a European basis.

As mentioned above, the objective of this document is to highlight the issues from natural hazards. The EFG recommends :

- Introduce and accelerate known mitigation and preparedness approaches, including the establishment of unified European monitoring systems.
- Collect harmonised data of existing hazard mitigation experience and best practices.
- Develop specific scientific and technological knowledge to improve hazard mitigation.

Experience demonstrates that today's society has enough knowledge to reduce both human and property losses from natural hazards substantially. It would be irresponsible not to implement the necessary measures.

About EFG: The European Federation of Geologists is a non-governmental organisation that was established in 1981 and includes today 24 national association members. EFG is a professional organisation whose main aims are to contribute to a safer and more sustainable use of the natural environment, to protect and inform the public and to promote a more responsible exploitation of natural resources. EFG's members are National Associations whose principal objectives are based in similar aims. The guidelines to achieve these aims are the promotion of excellence in the application of geology and the creation of public awareness of the importance of geoscience for the society.

About the EFG Panel of Experts on Natural Hazards: The group has been established in March 2003, in relation to EC initiatives on Civil Protection, DG Environment, and has since then provided many contributions to the EC. Dr Pavlos Tyrologou, the new coordinator of this Panel of Experts is Chartered Geologist and holder of EurGeol title on the field of Engineering and Environmental Geology. Furthermore, he is member of the Technical Committee in Engineering Practice of Risk Assessment and Management of the International Society for Soil Mechanics and Geotechnical Engineering. http://eurogeologists.eu/european-network.

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