Natural Hazards and Disaster Risk Reduction Policies

Loredana Antronico – Fausto Marincioni
Editors

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Cover: A woman shovels mud from her driveway in the aftermath of the October 2010 debris flow that affected the Province of Vibo Valentia (Calabria, southern Italy).

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CONTENTS

10. UNESCO Global Geoparks: living laboratories to mitigate natural induced disasters and strengthen communities' resilience

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Abstract

UNESCO Global Geoparks (UGGps) are forming a network of 140 territories all over the globe (GGN), that are located in various geographical settings that may be partly or entirely exposed to various natural hazards and extreme weather events. In recent years, natural hazards have already caused extensive damage to several UGGps. In addition, climate change seems to affect both occurrence and intensity of various hydro-meteorological hazards. In order to have a better understanding of the exposure of UGGps to natural hazards, and their activities to mitigate risks the GGN and UNESCO's Section on Earth Sciences and Geo-Hazards Risk Reduction team undertook in 2015 a thematic survey. Analyses of the data revealed the high risk that UGGps are facing, the important role of training and awareness raising actions, as well as of the existence and implementation of adequate risk management plans. Many UGGps in Asia and Europe have already set as top priority the reduction of naturally induced disasters and the protection of citizens and infrastructure, having implemented certain projects and developed concrete infrastructure and activities to raise awareness and mitigate risks. Existing knowledge of indigenous communities help UGGps to develop practices and initiatives to overpass crises and become more resilient. Hereby we present thus the results of the UNESCO and GGN

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survey in UGGps, as well as examples and good practices developed so far among the various geoparks.

Keywords: Global Geoparks, Natural Hazards, risk mitigation, geo-hazards, resilience.

1. Introduction

Natural hazards and Climate Change induced impacts are considered as the most serious threats for modern societies (WB, 2012; IPCC, 2014). Natural hazards vary in scale, time and magnitude and may modify, suddenly or in long term, earth's relief or atmospheric composition resulting often into serious losses, damages to or changes in the environment, human infrastructure and health both directly or indirectly.

Natural hazards are classified in three main groups in respect to their origin (UNISDR, 2004; WB, 2010). *Hydrometeorological* hazards are related with processes or phenomena taking place in the atmosphere and are subdivided in hydrological, meteorological and climatological hazards; *geophysical* or geo-hazards are those originating from solid earth; and *biological* hazards are those processes of organic origin or those conveyed by biological vectors.

Earthquakes and tsunamis may be considered as the most disastrous phenomena in terms of magnitude and scale, especially in those cases where they affect vulnerable infrastructure and assets. Those disasters primarily affect developing countries and result frequently in hundreds of thousands of deaths (UNISDR, 2009). Some of the most devastating disasters of the past decades took place in the Asian-Pacific region, such as the extreme earthquakes in China (2008) and in Nepal (2015) and the tsunamis of Sumatra (2004) and Tohoku region of Japan (2011). They resulted in the death and displacement of hundreds of thousands of people and caused huge socio-economic losses to the society (CRED, 2014). Similar smaller scale disasters took place in Europe and Latin America too (CRED, 2014). Wildfires or forest fires are occurring frequently in Mediterranean countries and have caused hundreds of deaths and the loss of millions of hectares of forest or scrubland in California and Australia. Extreme tropical cyclones and tornadoes struck the Caribbean, USA, Mexico and eastern coasts of Asia (i.e. Haiyan, Philippines 2014) affecting large areas and causing billions in damages and losses. During the first two decades of the 21st century, many areas of Europe and Asia faced the worst floods of the century.

It has been observed that poor people are disproportionally exposed to natural disasters (Hessel *et al.*, 2018) and that more than 90% of the deaths related to disasters from natural hazards occur in developing countries. Although the number of disasters increases and more people are affected, there are less people dying than in the past (WB, 2012). Middle- and high-income countries face greater proportional economic burden of damage than poorer countries (WB, 2012). Modern development trends and related social attitudes have led to a mass movement of populations from rural areas to urban ones leading to a high concentration of humans in big cities, increasing also their vulnerability to hazards. Associated modification of landscape and environment, deforestation, land degradation, soil erosion and resources over-exploitation near urban settings increase further the vulnerability of people and increase their disaster risk.

In addition, experience has documented that the response mechanisms after a disaster are never enough to cope with its effects (UNISDR, 2009). It is thus of extreme importance to focus our efforts in identifying and understanding the various hazards we are facing as societies, to minimize our vulnerability and increase our resilience. Accumulated social knowledge, scientific research and detailed studies can help us to understand better, how natural phenomena may become damaging and thus identify the hazards we may face. Societies should be robust to avoid damage and losses when a disaster strikes, sufficiently flexible to adapt to changes, have an integrated approach to allow consistent and fast decision making processes and have enough resources to respond sufficiently fast in case of a shock (Plodinec, 2009). Knowledge of available methodologies, technologies, best practices and available or potential resources is one way to prepare and make our societies more resilient to disaster risk.

2. The UNESCO Global Geoparks (UGGPs)

The UNESCO Global Geoparks (UGGps) are territories aiming to protect natural and cultural environment and support sustainable development through education, conservation and geotourism. In 2015 UNESCO Member States of UNESCO ratified the creation of a new label, the UNESCO Global Geoparks, during the 38th General Conference of the Organisation. This expresses governmental recognition of the importance of managing outstanding geological sites and landscapes in a holistic manner. At present 140 territories spread in 38 countries have been designated as UGGps.

Geopark Networks were established in 2000 in Europe and represent rural territories which include an important geological heritage, wealthy natural and cultural environment, clearly defined boundaries and a large surface area where a sustainable territorial strategy is implemented aiming to sustainable development (Zouros and Martini, 2003). Since 2004 the Geoparks have been transformed to the Global Geoparks Network (GGN). Its main task is to communicate the memories of the Earth to as many people as possible, contributing to a better future for humanity and our planet (Martini and Pages, 1994).

This is achieved through the assessment and conservation of their geological and natural heritage and the development of educational and geotouristic activities (Fassoulas *et al.*, 2011) that contribute to local sustainable development. In addition, UGGps are bodies that are constantly in contact with ordinary people, i.e. pupils, inhabitants, visitors, and are the most suitable dissemination and education tools to share policies, skills and behaviors, as well as to build life attitudes (Zouros and Martini, 2003).

UGGps are located in various geographical settings, mostly in rural areas, and their territories may be partly or entirely exposed to various natural hazards and extreme weather events. In recent years, natural hazards, both geological (such as earthquakes, volcanic eruptions, landslides and tsunamis) and hydro-meteorological (such as floods, droughts and avalanches), have already caused extensive damage to several UGGps. In addition, climate change seems to affect both occurrence and intensity of various hydro-meteorological hazards. For instance, Japanese and Icelandic UGGps have been affected by multiple hazards, including earthquakes sometimes followed by tsunamis, as well as volcanic eruptions that damaged infrastructure and natural environment. Different types of landslides occur frequently on the slopes in mountainous areas damaging access roads and tourist paths. Many sites face a high flooding risk, as revealed by heavy floods in the past decade in Slovenia, Italy, Vietnam and many other regions.

3. Need for Action

The impact of disasters due to natural hazards is widespread in all aspects of social and economic life of modern societies and will increase further because of climate change (Forzieri *et al.*, 2017). This increasing magnitude of hazards and vulnerability and increasing frequency of disaster occurrence, activated multilateral organizations, scientific institutions and countries to act in order to prevent and minimize the effects of disasters and build more

resilient communities. In 2005 the global community set in place the Hyogo Framework for Action 2005-2015 (HFA), signed by 168 governments and international organizations (UNISDR, 2007).

Following up the HFA, in 2015 the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) decided by UN (UNISDR, 2015). The framework calls for collaboration at all levels (from local to international) in education, knowledge and technology transfer, in order to build resilient communities that will be better prepared, more equipped and skilled to prevent disasters and better organized to recover in a better way and sooner than in the past. It further requests Member States to monitor the impact disasters have on the educational, environmental and cultural sectors.

The Global Geoparks Network is now spread in all continents and is growing fast (Figure 1). UGGps are mainly located in rural areas meaning that in most cases a lack of skilled staff and of necessary structural and non-structural means to better design and respond in case of a disaster, occur. In addition, because UGGps are bottom up initiatives, they have built strong relationships with local communities, being thus able to communicate better with them, transfer knowledge, skills and attitudes and educate a great range of citizens than others (Zouros and Martini, 2003).

Being sensitized on Disaster Risk Reduction and joining the Global effort undertaken after the Tohoku 2011 disaster, the GGN adapted in 2012 the "Shimabara declaration" (EGN, 2012). In the 5th Global Geoparks International Conference held in Unzen UNESCO Global Geopark, 593 delegates from 31 countries affirmed their strong commitment to contribute in mitigating the risks from Natural Disasters through the Declaration. The congress was organized just one year after the devastating Tohoku Earthquake and tsunami that stroke the whole Japan and Pacific area. The "Shimabara Declaration" foresees that: 1. The Geoparks should utilize the experience of local communities and of the destruction that occurred as a tool for the education in geo-hazard prone areas of the Earth; 2. Geoparks recognize that education about our dynamic planet is the most effective way to help our local communities to coexist in accordance with our risky nature; 3. Similarly, Geoparks should educate on climate change and should strive to become known for a best practice approach to utilizing renewable energy and employing the best standards of "green-tourism"; 4. Geoparks should contribute in the sustainable use and need for natural resources, promoting also respect of the environment and the integrity of landscape; 5. Geoparks should conserve and utilize geological heritage by linking various bodies engaged in governing and conservation of geoheritage, building high quality facilities and providing high quality education programs to increase public

awareness; 6 Geoparks should establish collaboration with all territorial organizations, bodies and communities to achieve a real sustainable development through geoconservation, education, tourism and management.; 7. Networking, exchange of knowledge, practices and staff is necessary to promote, raise and maintain the high values of tangible and intangible heritage, and to recognize geodiversity as a key element for sustainable development of Geoparks; and 8. Geoparks in collaboration with UNESCO and Member States should improve collaboration to establish Geoparks as territories of ideas and real sustainable development, respectful of local traditions and desires that could enable a future development of an official UGGps initiative.

The Global Geoparks Network has thus a great potential to play an important role in the achievement of the Sendai Framework for Disaster Risk Reduction targets but most crucially, to support their communities to better cope in case of a disaster, contributing in raising of awareness and building resilient communities.

Figure 1 - *The Interactive map of Global Geoparks Network* (http://www.staridasgeography.com/world-Geoparks/ after Staridas & Fassoulas, 2015).

4. Natural Risks in UNESCO Global Geoparks

4.1. Disaster record in UGGps

In Europe, many UGGps exist in very hazardous areas within respect to earthquakes and volcanism, like those in Greece, Italy, France, Portugal and Iceland. Historically, Psiloritis, Lesvos, Sitia and Helmos -Vouraikos UGGps in Greece were repeatedly affected by very strong earthquakes, which for the

case of Psiloritis reached 8.3 magnitude in Richter scale. In 1867 a strong earthquake devastated the town of Mytilene and several other villages of Lesvos. In 1920 a strong earthquake of 6.5R magnitude but also very high intensity affected the Apuan Alps UGGp in Tuscany Italy causing many victims and damages. In 1909 a strong earthquake happened in France with its epicenter located in the area of Luberon UNESCO Global Geopark, affecting also the nearby Haute Provence UNESCO Global Geopark, which resulted in several hundreds of deaths and an important economic cost. Many UGGps are also located near, or even established around active volcanoes as is the case of Azores and El Hierro, but also the Sicilian UGGps,the Cilento Vallo di Diano and Alburni in Italy. In 2010 the eruption of Eyjafjallajökull volcano in the Katla UNESCO Global Geopark of Iceland blocked for many hours the global air-traffic.

Several other UGGps located in central Europe are also facing a high flooding risk. This has been revealed during the past decade, when heavy floods occurred in Germany, Austria, Poland, Czech Republic, France and in the Balkans. In addition, other UGGps like the Chablais in France, CillentoValo di Diano and Alburni, Apuan Alps, Sesia Val Grande and Beigua in Italy and Swabian Alb in Germany experienced significant landslides in past that damaged infrastructure and the natural environment. The landslide of Hirschkopf in Swabian Alb UNESCO Global Geopark was declared as National Geotope of Germany, to stress the importance of mitigating the natural risks in future (Figure 2). In the Asia-Pacific region, severe disasters have been occurred in the past with several of them affecting strongly some UGGps. Hazards in that area are both of geophysical but also of hydro-meteorological origin, resulting in devastating earthquakes and tsunamis, big volcanic eruptions, as well as strong monsoonal cyclones and heavy storms. Japan is probably the country that is facing the most damaging hazards from all countries participating in the GGN, if considering the very recent Tohoku 2011 earthquake and tsunami. Many national UGGps have experienced in past and are still experiencing every year big volcanic eruptions, strong earthquakes, typhoons, as well as, their accompanying tsunami and landslide phenomena (like the 2013 landslide at Izu-Oshima National Geopark). Like their European counterparts the majority of the nine Japanese UGGps face a number of natural hazards with a great disaster risk. San'In Kaigan UGGp faced a very strong earthquake (7.3 R) in 1927 which devastated several towns, destroyed much of the existing infrastructure and resulted in many deaths. Another UGGp from Japan, Unzen Volcanic Area, is an outstanding case of the GGN that has been repeatedly affected by various disasters. In 1791 a cluster of earthquakes triggered by volcanic activity

resulted in a devastating tsunami that killed about 15.000 people. Volcanic activity occurred again in 1990 lasting for four years, killing many people and changing forever the landscape and nature in the Unzen area. China is also a country that in past and in very recent times, has suffered a lot from very damaging disasters such as floods, earthquakes, volcanism, typhoons and landslides (Figure 3a). The most striking case of recent times may be considered the 8.0 magnitude in Richter scale earthquake that happened at Sichuan territory on 12 May 2008, resulting in more than 35,000 deaths, considerable destruction of infrastructure mainly due to the landslides, and river bed changes. The earthquake affected the Xingwen UGGp but also the area of Qingchuan Earthquake Relic National Geopark of China that was especially established as a memorial to the devastating 2008 disaster (Wang & Tian, 2013). A very heavy flooding took place in Fangshan UGGp in 2012 affecting many of their geo-spot areas like the Shidu, Yesampo, Baishishan, and Shangfangshan, where almost all infrastructures were destroyed.

Figure 2 - *A signpost in Swabian Alb UGGp to notify the importance of Hirschkopf landslide in national level.*

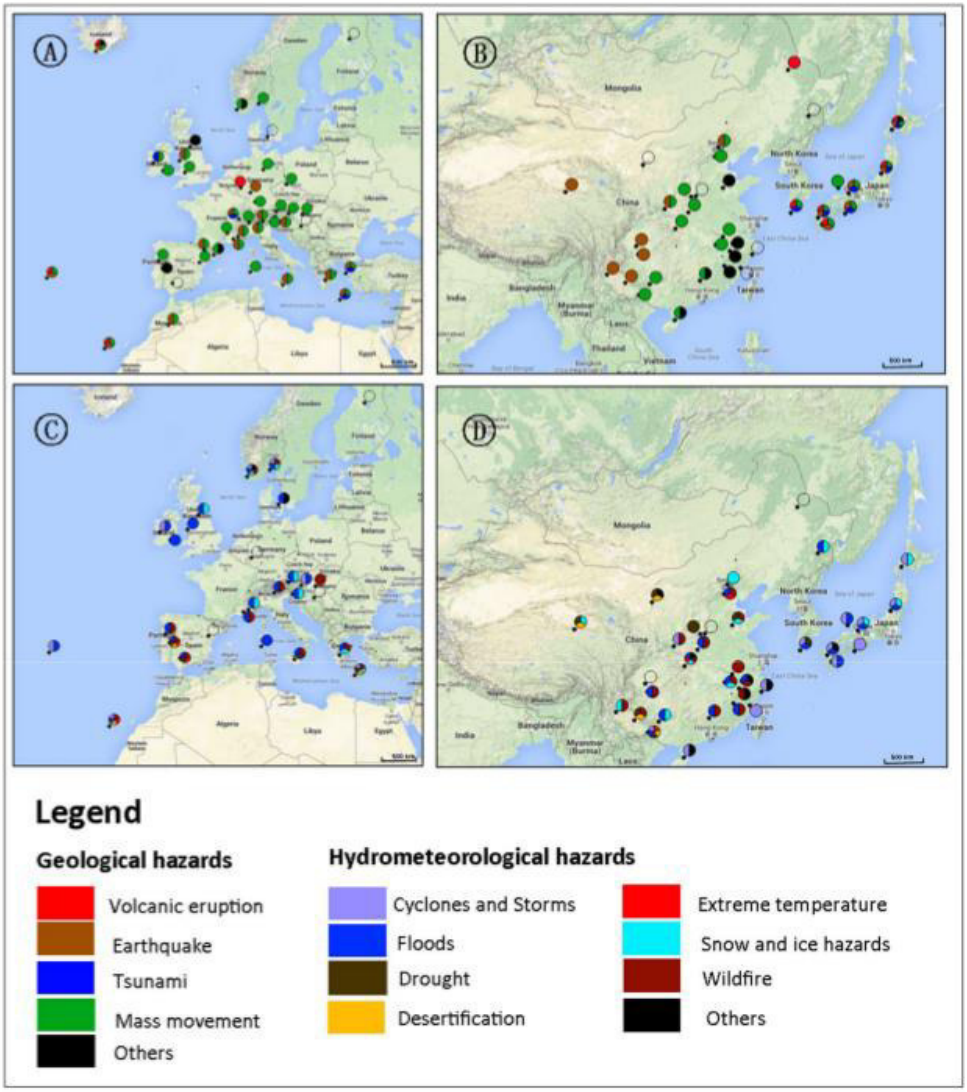

Figure 3 - *Distribution of natural hazards at Global Geoparks according site managers: geological hazards in Europe (A) and Asia (B), hydrometeorological hazards in Europe (C) and Asia (D).*

4.2. Assessing risk in UGGps

UGGps are thus facing high potential disaster risk due to their geophysical and hydro-meteorological hazards but this risk has not been studied and analysed in detail yet. A joined activity was developed by the Section on Earth Sciences and Geo-Hazards Risk Reduction of UNESCO and the

UNESCO Global Geopark Secretariat aiming to identify, catalogue and analyse the natural hazards and associated disaster risk in each UNESCO Global Geopark.

A survey questionnaire was developed in 2014 by the Section on Earth Sciences and Geo-Hazards Risk Reduction of UNESCO and shared with all UGGps by the UNESCO Global Geopark Secretariat. This on-line survey was composed of opened and closed questions (available at https://en.unesco.org/drr-sites/survey) and aimed to identify UGGps that are exposed and are vulnerable to natural hazards, as well as to obtain an overview of good management practices and awareness raising activities in UGGps. To date, 81 site managers of UGGps have responded to the questionnaire, 43 belonging to the European Geoparks Network (EGN) including M'Goon from North Africa, 35 to Asian-Pacific (APGN) and 3 to the American Networks (Fig. 3). About 73% of the UGGps replied, 66% of the EGN, 75% of the American, and 83% of the APGN (Dierickx *et al.*, 2016).

According to the questionnaire analysis, all UGGps are expected to face at least one natural hazard (Figure 4). Geophysical hazards that are perceived to be present in most UGGps are mass movements (reported in 70% of the UGGps), followed by earthquakes (39%) and volcanic eruptions (12.5%) and tsunamis (12.5%). Other types of geophysical hazards (like ash flows, lightings etc.) have been also reported in 15% of the survey responses. The hydro-meteorological hazards, the presence of cyclones, floods, droughts, desertification, extreme temperatures, snow and ice, wildfires and others were also examined. From those types of phenomena, floods are occurring in the 65% of the UGGps, followed by wildfires (46%), snow and ice (36%) and cyclones/storms (31%). These results are in line with a similar research conducted on other UNESCO designated sites network – World Heritage sites program (Pavlova *et al.*, 2017). Results showed that not less than 46% of world heritage properties are exposed to at least one of the four main geological hazards.

In the majority of UGGps the infrastructure is exposed to the hazards (Figure 4). It is interesting to notice that in some cases, these hazards resulted in damaging both structural and non-structural elements of the UGGps, affecting existing infrastructure like trails, paths, signing system etc., and in some cases also human health and well-being (Figure 5a). There is more relative exposure of the UGGps' infrastructure to geophysical hazards, compared to hydro-meteorological hazards. When the UNESCO Global Geopark has a risk on volcanic eruptions, in most cases the infrastructure is exposed as well; the same can also be observed for the case of tsunamis, while

less exposure in infrastructure is reported for earthquakes and mass movements.

The survey questionnaire requested also information for UNESCO Global Geopark's activities related to the preparedness, adaptation and recovery in case of natural disasters that can be used to identify the level of resilience of each UGGp (Manfredi *et al.*, 2014). According to the questionnaire analysis just 35 out of 81 UGGps appear to have developed strategies and actions to mitigate disaster risks in their territory. Although according to site managers responses for most of UGGps natural hazards are important issues to deal with, only 19 (23%) of sites have conducted risk assessment studies on their territory and 26 (32%) have incorporated a hazard and risk prevention analysis in their UGGp management plan. In addition, in 28 UGGps (34%) various educational activities with respect to natural hazards are provided and in 23 UGGps (33%) awareness raising activities are undertaken annually. Finally, it appears that most UGGps would like to develop training activities for their staff and visitors (83%) and, share good practices (34%), but only a surprising 20% (only 7 UGGps form the 81 participated in the survey), has already developed cooperation with other UGGps in this regard.

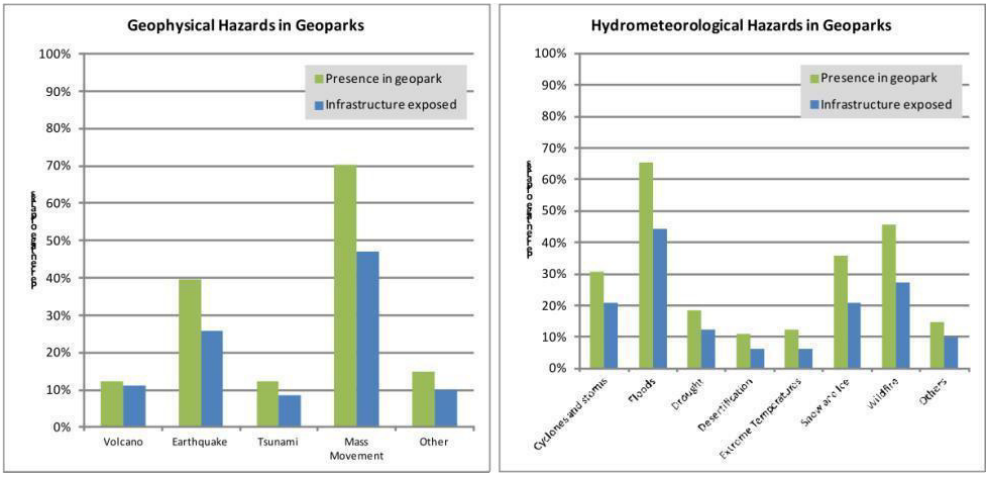

Figure 4 - *Statistical Analysis of Natural Risks in UGGps.*

5. What can UGGps do? Examples of Raising Awareness and Risk Mitigation for Natural Hazards

The UGGps are dedicated to implement the "Shimabara declaration", and already many UGGps are working to achieving those targets that focusing on safety, education and training, networking and collaboration. Various

examples demonstrating how UGGps adapt and implement the Sendai Framework for Disaster Risk Reduction and how those contribute to achieving the Sustainable Development Goals can be found.

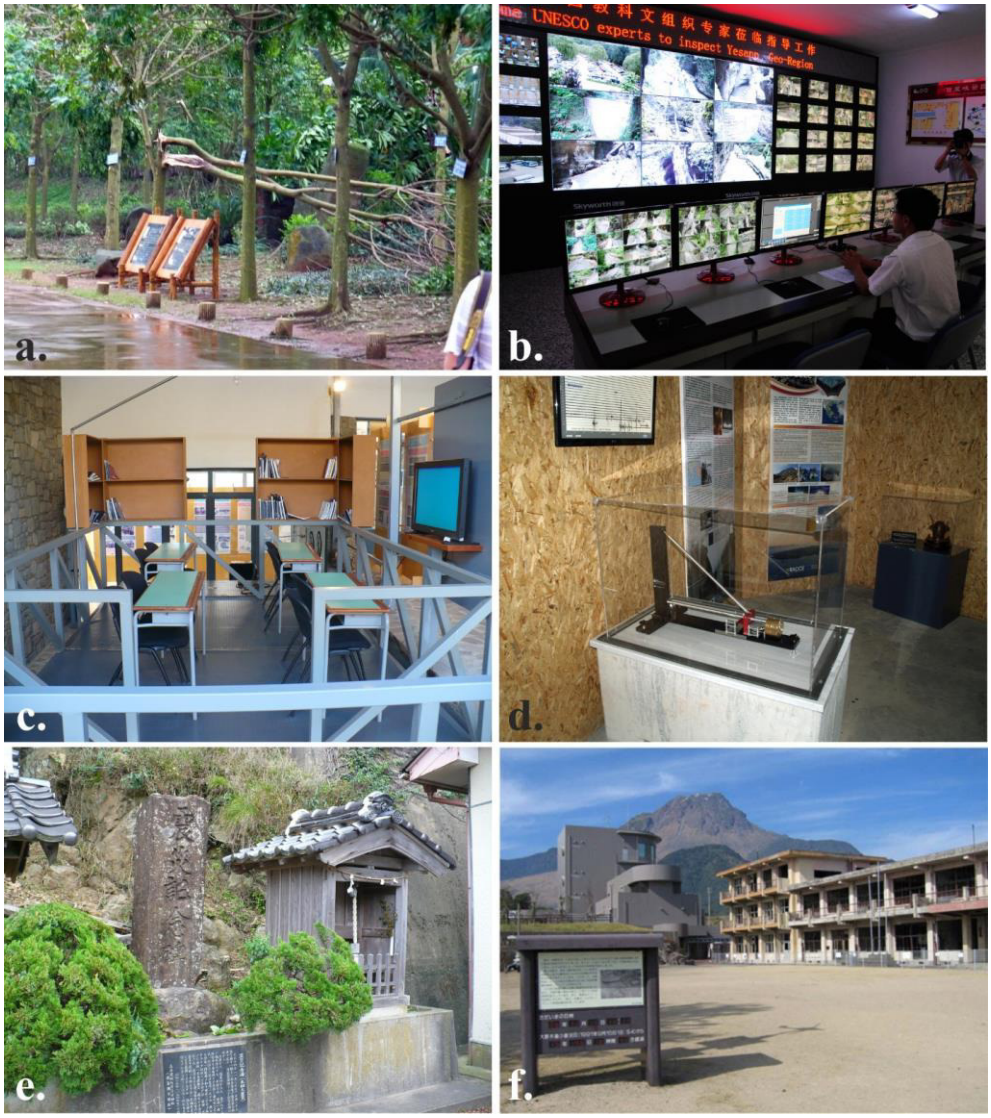

Figure 5 - *a. Damages by the summer 2010 typhoon in infrastructure of Zhan Jiang geospot area in Leiqiong UGGp in China; b. The Yesampo monitoring center at Fangshan UGGp in China; c. The earthquake simulator at Lesvos Petrified Forest museum in Lesvos UGGp Greece; d. The educational seismograph in Natural History Museum of Crete in Psiloritis UGGp in Greece; e. Memorial statue for the 1927 earthquake in Kinosaki area of San'In Kaigan UGGp in Japan; f. The Ohnokoba primary school destroyed in 1991 by pyroclastic flows of Unzen volcano, now preserved as statue in Unzen UGGp in Japan.*

5.1. Safety

Based on the replies of the 81 UGGps to the UNESCO's questionnaire (Dierickx *et al.*, 2016) and their annual activity reports many UGGps appear to be very active in achieving the "Shimabara Declaration" goals and developing a more resilient community on their territory. UGGps contribute to enhanced prevention and preparedness by ensuring the safety, security and the protection of their staff, visitors and also established infrastructure.

For example, several Japan UGGps cooperate on the operation of Early Warning Systems for earthquakes, volcanic eruptions and tsunamis that have been established. The Aso UGGp in Japan is hosting a 24 hour monitoring system for Nakadake crater measuring fluctuation, tectonic movements, heat, etc. Similarly, in Europe the El Hiero UGGp is also operating a 24 hour monitoring system of volcanic activity through a geophysical and geochemistry network.

In China more and more UGGps are installing centralized monitoring systems of visitor's flow, which enables a more accurate analysis of the exposure to different geohazards. Fangshan UGGp established a monitoring system of visitors' traffic and flooding risk in certain geosites and spot areas and has constructed shelters and escape routes in several cases (Figure 5b). Ningde and Yandangshan UGGp installed about 180 and 90 electronic surveillance detectors to control and protect the key geoheritage sites, roads, tourist centers, squares, and risk prone areas in the UGGp. Shilin UGGp created a Data Management Center which is responsible for daily monitoring the park through a quick-bird video monitoring system, whereas the Wudalianchi UGGp is operating since 1988 the Earthquake and Volcano Monitoring Center.

Some UGGps have already conducted risk analyses for their geosites and infrastructure and have moreover undertaken and engaged in their Action and Management plans to undertake measures to secure visitors' safety, infrastructure armor and staff capacity to act in case of an emergency. Examples of these are the Katla's UGGp Risk Assessment for Geosites or the Unzen Action Plan for volcanic danger. Similarly, Evacuation Plans have been prepared in few cases (Lesvos Museum for Petrified Forest; Funiushan and Muroto UGGps' Annual Prevention and Mitigation plans; Sierra Norte, Andalusia Emergency Plan for Flooding, etc.). Psiloritis UGGp in Greece participated through its partner the Natural History Museum of Crete (NHMC) in a European project titled "PATCH" that created guidelines and tools to contact Emergency Plans for museums and the cultural heritage in

case of a disaster, available in several languages at project's website (http://www.montesca.it/patch/index.asp).

5.2. Education and Training

The majority (56 out of 81 responses) of UGGps implement training and educational activities on a constant and annual basis. Examples of these are training staff on risk occurring in the UGGps, on the preparedness and response measures, as well as on the implementation of the existing Emergency and Evacuation plans, providing them with skills and capacities to support visitors needs in case of an emergency. For these purposes, UGGps are collaborating with experts, university and local Civil Protection authorities.

The main target group are however the visitors and the general public and for them a great variety of activities and initiatives are provided. Special Museum Exhibitions focused on geohazards and associated disasters have been created in many UGGps. This is the case for Lesvos Petrified Forest Museum, the Natural History Museum of Crete in Greece, the Wudalianchi Science Hall in China, the Aso Volcano Museum, the exhibition for earthquakes and volcanoes in the Fossa Magna Museum of Itoigawa UGGp and Mt. Unzen Disaster Memorial Hall (Volcano Museum) in Japan. In addition, under various occasions other UGGps develop or participate in temporary exhibitions like the "Seismotour" that was hosted in Luberon and Haute Provence UGGp in the memory of the 1909 France earthquake.

Special installations and displays do exist in several UGGps to demonstrate to their visitors simulations of natural phenomena. Lesvos Petrified Forest Museum and Natural History Museum of Crete in Greece host modern earthquake simulators that can perform real earthquakes and provide information on the preparedness and prevention measures (Figure 5c). Seismographs are installed in several museums and exhibitions, some connected also to national monitoring networks like in Japan and Greece, and others for educational purposes (Figure 5d). Marble Arch Caves UGGp in Ireland as well as the partner of Psiloritis UGGp (NHMC) display educational seismographs that can record global earthquakes providing their data to the global seismological community through the IRIS's (Incorporated Research Institutions for Seismology) "Seismographs in Schools" project (http://www.iris.edu/hq/ssn/events).

Many UGGps develop and implement educational activities for their visitors and inhabitants, as well as specialized programs targeted at schools,

families, and disabled people. These activities are undertaken at museums, visitors' and educational centers and at special georoutes or geosites and can be found at UGGp's webpages. Apuan Alps UGGp, twenty years after the 1996 catastrophic flood, launched the "Rains & Ruins" project as a best practice to warn the local communities about the natural hazards and risks of the future using the memory of past disasters. The project, which is still in progress, included an educational exhibition hosted at the Geopark Visitor Centre in Seravezza, together with the related catalogue printed in 2017 (Bartelletti *et al.,* 2017; Figure 6a). Several lessons at primary and secondary schools have been performed to share as much as possible the teaching of how past disasters boost scientific and community cooperation to prevent such events in the future. Furthermore, collateral photographic exhibitions and movies on the flood memory have been set up in the "red zone" of the 1996 flood. Sesia val Grande UGGp develop educational initiatives devoted to extreme alpine environment, snow and avalanches at the "Istituto Angelo Mosso", an alpine Science Center at 2900 m asl in the Western Alps. The interpretation center is also an active scientific laboratory for monitoring the alpine environment and global changes within the international L-TER network (https://lternet.edu/).

Muroto and Unzen UGGps in Japan organize summer schools focusing on natural hazards in partnership with Universities and local institutions, whereas Aso UGGp is holding annual workshops for knowledge sharing on volcanoes addressed to the broader public. Initiatives that adapt the "Shimabara declaration" goals to encompass existing knowledge of local people in story telling experiences have been developed in Itoigawa UGGp of Japan. There locals are engaged in the interpretation of many of the geosites within the UGGp stricken by disasters and their influence on people's lives during geotours and other educational activities; the same approach is also used at Muroto UGGp. Furthermore, Toya-Usu Volcano UGGp trains and certifies local residents as "Volcano Meister" who are expected to work as educators, local leaders for disaster mitigation and also tour guides. They also organize educational program as well as tours that show the characteristics of the volcano.

In 2011, three European UGGps, the Psiloritis through NHMC, the Lesvos and the Haute Provence, implemented with other European territories a project titled "RACCE: Raising earthquake awareness and coping with children's emotions", funded by the European Civil Protection financial instrument. The project resulted in various outcomes like exhibitions, training activities and the creation of several educational and dissemination tools in five languages (Figure 6b). The products are addressed to children aged 5-13,

as well as to teachers and families and can be downloaded free from project's website (http://racce.nhmc.uoc.gr). The RACCE project was promoted by the EU through its presentation at the Civil Protection Forums of 2012 and 2014, was also presented at the Kinosaki 2013 International Academic Conference for "Natural Disaster and Regional Resources in Geoparks" held in San'In Kaigan UGGp (Fassoulas, 2013), whereas parts of the Educational material is also hosted at the Prevention-web platform of UNISDR.

Another project funded by the EU Civil Protection instrument related to UGGps is the EVANDE (http://www.evande.eu), which focused on e-training of volunteers and Civil Protection operators. The project is still under implementation by two European UGGps, Psiloritis and Beigua, and the active engagement of all European UGGps is foreseen during the training and dissemination activities (Fassoulas and Burlando, 2015) in order to establish local networks of experienced volunteers.

Many UGGps, especially in Japan, are preserving past disaster remnants and land effects as memorials to the people affected and use them for educational and awareness raising activities, trips and educational projects. In San'In Kaigan UGGp several memorial statutes and stone monuments occur in many areas that have been devastated by the 1927 earthquake, like in Kinosaki and nearby villages (Figure 5e). The same stands also in Unzen UGGp for the two catastrophes of 1791 in Shimabara and 1991 in Unzen (Figure 5f; Nakada, 2014). In China the Sichuan 2008 great earthquake was the reason for the creation of the Qingchuan Earthquake Relic National Geopark where fault traces, ruptures and other structures related to the generation and the impact of the earthquake are preserved and used for geoeducation (Wang and Tian, 2013).

UGGps often take the opportunity to benefit from global campaigns to promote further their activities on natural risk mitigation. The International Day for Disaster Reduction (IDDR) celebrated by UN on the 13th of October is a good chance for a large number of UGGps to organize activities for raising awareness on natural hazards and better inform people (Figure 6c-f.). Similarly, the majority of Chinese UGGps take benefit of the International Earth Day celebration (April 22) and of the Safety Awareness Month (June). Finally, various drills are performed in most UGGps due to national regulations related to evacuation plan implementation for earthquakes, fires, flooding etc.

The vast majority of UGGps have produced several kinds of publications, posters, booklets and info panels explaining the natural disaster risk and associated geohazards of their territories. Hazard maps, evacuation plans, shelters and accumulation areas are also printed and shared to all locals and

visitors of the UGGps. Ultimately, all UGGps support and enhance scientific research activities in their territories or even participate directly in research projects to identify, analyze and assess the natural disaster risk they are facing, like the participation of Lesvos Petrified Forest in several projects related to earthquake risk.

Figure 6 - *a. Rain and Ruins, an educational project for landslides and floods by Alpi Apuan UGGp in Italy; b. The Museum Kit of RACCE project travelling to Santorini volcano by Psiloritis UGGp in Greece; c. Implementing training activities at schools during IDDR on 13 October 2017 at Lesvos UGGp Greece; d. Public talk on risk mitigation during the celebration of 13th October at Azores UGGp in Portugal; e. Training activities at Cilento Vallo di Diano and Alburni UGGp in Italy in collaboration with Prof. S. Nakata from Japan Geoparks Network; f. Presentation of school projects for the celebration of IDDR on 13 October 2018 at Psiloritis UGGp in Greece.*

5.3. Networking and Collaboration

Initially there are only 13 UGGps that declared their cooperation with other Geoparks or UNESCO affiliated sites on natural hazard prevention and mitigation. Following the comments that were provided, it appeared that 28 UGGps would like to share their practices on natural hazard prevention with the Global Geoparks Network. Other 59 site managers from UGGps have confirmed their interest to be trained or organize a workshop at their UGGps on the thematic of natural hazard prevention and mitigation.

In many European and Japanese UGGps the managing authorities are closely collaborating with local, regional and state Civil Protection authorities to develop hazard maps, evacuation plans and drills, organize seminars and training activities and to produce various publications. Furthermore, Japanese UGGps are engaged in the development of national and local, early warning systems for tsunamis and volcanic eruptions and are part of the alerting mechanism in their territories. In addition, many UGGps have installed in collaboration with local authorities signs, marks and guiding directions in case of a tsunami. Similarly, in Europe different UGGps are participating in regional and national emergency and evacuation drills, as well as the adaptation and application of regional Civil Protection Plans.

In 2016 the GGN decided to create a special working group that will be focused in risk mitigation mainly against nature induced disasters. The GEOHAZARDS group was founded in 2017 to design, coordinate, implement and monitor activities related to risk assessments, raising awareness, training and capacity building, as well as collaboration against nature and climate change induced disasters. In EGN a similar working group was also established to coordinate activities at regional level, and APGN is planning to set a similar working group too. The working group developed in 2018 a 4-years action plan that is currently under implementation, organized two thematic sessions during the 2017 and 2018 International UGGp Conferences at Azores and Adamello-Brenta UGGps respectively, as well as coordinated the celebration of the IDDR on 13th October 2017 with the participation of the vast majority of UGGps (Figure 6 c-f.).

The “Shimabara Declaration” has created the obligation to all UGGps to collaborate and work on a global scale to mitigate the disaster risks of natural hazards under common activities and collaborations with international organization such UNESCO’s Section on Earth Sciences and Geo-Hazards Risk Reduction, as well as the tools of UNISDR. At present, the Section has revised the questionnaire for the survey on Natural Hazards in UNESCO

designated sites, asking managers of these sites to participate in the common action.

6. Conclusions

The Global community was shocked by the devastating destructions that came as a result of the 2004 Sumatra as well as the 2011 Tohoku earthquakes and subsequent tsunamis in the Asia-Pacific region. The effects of these catastrophes were so extensive and universal that forced all engaged parties in Civil Protection and Risk Reduction to intensify their efforts and contributed along with other initiatives, to the formulation of the Sendai Framework of Action. The impact of these disasters was exaggerated due to oblivion on such hazards, the lack of knowledge and the improper preparedness.

UNESCO Global Geoparks use existing scientific and indigenous knowledge to develop educational products and training activities, to produce publications and dissemination tools, to develop common projects and to organize events and workshops to raise awareness and sensitize their inhabitants for natural risks. The more vulnerable of those appear to be better prepared, more organized and more active in minimizing the disaster effects. They have strengthened and armored their infrastructures and facilities, secured their visiting areas and services, are continuously monitoring and evaluating risks, and are simultaneously offering and promoting awareness and educative activities.

Nevertheless, UGGps are initiatives benefiting from their extraordinary geological heritage including structures and remnants of geological processes of the past and very recent, that can be considered as memorials of disasters. Having at the core of their existence the conservation of natural heritage and the education of public, UGGps could be key players in achieving the aims of the Sendai Framework for Disaster Risk Reduction. The geological memories dating back to 4.6 billion years of earth's history are the capital of UGGps to exploit and utilize for the mitigation of disaster risks and for promoting the development of better and resilient communities. The latter statement is very clearly demonstrated by the moto of EGN "4.6 billion years of Earth history to serve our future".

The "Shimabara Declaration" has set the basic concept and framework for the active participation of UGGps into the global effort for Disaster Risk Reduction. Human capital of local and indigenous people that offer long-lasting experience dealing with disasters can be further incorporated in

educational activities for younger generations, decision makers and planners. It can also be used for developing training seminars for staff and visitors and could be part of geotouristic products like geotours, story-telling, and site interpretation. Modern technology offers many tools for monitoring hazards and provides early warning services alerting or alarming in case of an emergency. Adaptation or use of these tools in risky areas can increase further visitors' and staff's safety and support local authorities and communities in implementation of Civil Protection Plans.

A topic of ultimate importance for intervention in UGGps could be Climate Change impacts that can affect all geoparks regardless their nature, location or geological origin (O'Brien, 2006). Hydro-meteorological hazards are expected to intensify their impact in the future in every corner of our planet, with coastal areas to be more vulnerable due to the expected global sea level raise. UGGps are ideal institutions that are well positioned to increase preparedness and adaptation of citizens by appropriate training and educative activities, exhibitions and displays at their visitors and info centers, as well as awareness raising campaigns.

The most challenging and promising topics however are networking and collaboration among the increasing community of UGGps. Many territories carry a huge amount of knowledge, practices and experiences that can be exchanged with each other. Based on this capital, UGGps can develop further common activities, projects and synergies to support local communities in getting more prepared for the forthcoming hazards, in coping with the expected impacts and in becoming more resilient and able to recover soon and on the best way from a disaster. This is now formulated by the establishment of the GEOHAZARDs working group and the implementation of a 4 years Action Plan by all UGGps. In addition, as UGGps receive a great number of children and schools, they can play a crucial role in building a resilient consciousness and environmentally friendly attitudes for the future generations that could ensure a safer planet and wiser use of natural resources.

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