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Chapter 2

Global Climatic Changes, a Possible Cause of the Recent Increasing Trend of Earthquakes Since the 90's and Subsequent Lessons Learnt

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Additional information is available at the end of the chapter

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1. Introduction

Over 1 million earthquakes a year can be felt by people on Earth. Large earthquakes and related effects rank among most catastrophic environmental events. Both tectonically active areas of lithospheric plates interactions along their boundaries and intra-plate fault displacements are responsible for rupture yielding seismic waves that shake the ground. Devastating effects of the earthquakes that occurred during the last decades underlines the necessity of a multi-hazard approach regarding the subsequent effect of the tremor waves, such as tsunami waves (Sumatra – Andaman Islands, 2004, NE Japan 2011), soil subsidence and major accidents at nearby chemical facilities (Turkye, Kocaeli, 1999), explosions at petrochemical and nuclear plant, after failure of the cooling system due to power failure, following the 10 meters tsunami wave (NE Japan 2011), submarine landslides (northern coast of Papua New Guinea, 1998), or landslides and soil liquefaction ("earthquake lake" at Sichuan, China, 2008, Christchurch, New Zeeland, 2011). The multi-hazard concept represents a new direction of research in an integrated manner, with applied global implications. The frequency of the disasters appears to increase in the last decades (Fig. 1,2), and the communities became more vulnerable to the natural hazards, generally due to the complex aspects generated by increased urbanization, land planning and environmental changes. The uncertainties involving the relations between different components of the surrounding environment made more difficult the investigation of each category of natural hazards [1]. Consequently it is necessary to study groups of hazards, not just a single case, and the interaction among them in order to have a clear view of the internal processes and causative factors of the disasters. From this point of view, the disaster seems to be more

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internationalized, due to global factors which interact and affect the population and the environmental factors.

2. Problem statement

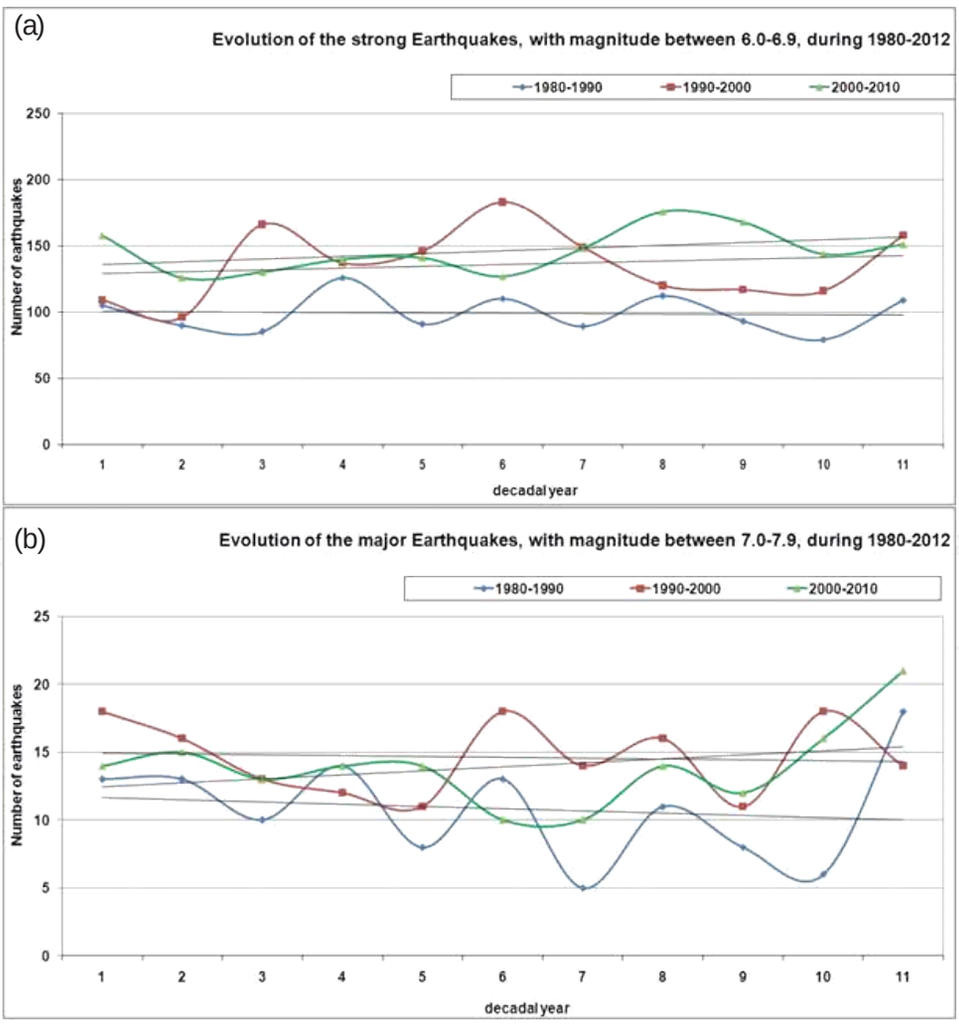
Recently it became relevant that, despite frequent large earthquakes, several countries located in prone areas didn't have strong building codes and many houses are built out of mud bricks and un-reinforced masonry, which do not stand up well to earthquakes. Mud brick didn't resist to the earthquake stress and too heavy tile and cement roofs generally collapsed into many houses. Other factors contribute to the severity of a quake, but earthquake resistant buildings can make a huge difference in the number of damages [2]. As a result, casualties and damage are much higher than similar earthquakes elsewhere in the world. Therefore recent major earthquakes such as Guarajat, India (2001), Bam-Iran (2003), Sumatra – Andaman Islands (2004), Kashmir-Pakistan (2005), South of Java – Indonesia (2006) or Sichuan, China (2008) led to heavy human casualties, compared with other similar earthquakes all over the world. The same magnitude earthquakes, for example the Northridge quake in Los Angeles in 1994 killed only 57 people and in Kobe Japan in 1995 a similar quake killed about 5,000. Another example could be the earthquake –magnitude 7 - from Haiti, at Port-au-Prince in January 2010, with almost 220,000 casualties compared with a similar earthquake in the next month, in Chile, magnitude 8.8, 500 times higher than the previous one in Haiti, resulted in less than 600 casualties. In case of major tsunamis, which cross an entire Ocean, or so called "tele-tsunamis", i.e the greater earthquake ever recorded by instruments, with a 9.5 magnitude, in Valvidia, Chile (1960), which produced damage in Hawaii and alarm in Japan, it became obviously the "globalisation" of the subsequent effects of the tremors. They can reach any coastal areas all over the world, not necessarily earthquake prone areas, and request dedicated building codes. A similar effect took place following the recent great earthquakes at Sumatra – Andaman Islands (2004), 9.1 magnitude, with damages 1 mile inside the affected coastal areas, with a maximum height of the tsunami wave up to 30m, or the recent NE of Japan (2011), magnitude 9, where tsunami waves inflicted severe damages 9 miles inside the coast areas. The recent catastrophe in Japan exceeds the worst case scenarios previously estimated in prevention measures, especially at the nuclear plants. The maximum possible height of a tsunami wave was estimated at 6 meters high, whereas the height of the wave reached 10 m (the maximum recorded height was 23m for the NE of Japan).

3. Application area

The present analysis is based on data regarding the earthquake frequency and magnitude the world over, (Fig. 2), i.e. USGS (United States Geological Service) data base during the last 30 years [4]. It has to be specified that the earthquake monitoring activity network was used during the cold war [3], since 50's, to identify and localise nuclear tests all over the world, taking into account that a nuclear detonation is detected generally less than a 6 magnitude

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earthquake on Richter scale, where is produced, depending of the distance from the source. Therefore the data taken into consideration in the present earthquake evaluation includes just important earthquakes, which can produce significant damage (above level of stronger earthquakes, with the magnitude over 6 on Richter scale). As a conclusion, the thesis stipulating that just in the recent year the global network of seismographs was completed and that's why we have the "felling" of an increased trend of the earthquakes, and therefore the study of the past earthquake data didn't reflect complete the reality, because of "missing" earthquake, is falls. According with this theory, the same increasing pattern of the earthquakes should be observed since 80's, but as observed in the evolution trend of the similar earthquake magnitudes over each separate decade (in 80's and 90's), are significantly different, in both of magnitudes range and increasing trend from one year to another (please see below Fig.1.a-d, of evolution including subsequent linear trends). Should be noticed that only for the decade 1980-1990, the trend line is decreasing, compared with the period intervals of 1990-2000 and 2000-2010, when the evolution trend of earthquake frequency and magnitude, in visible increasing.



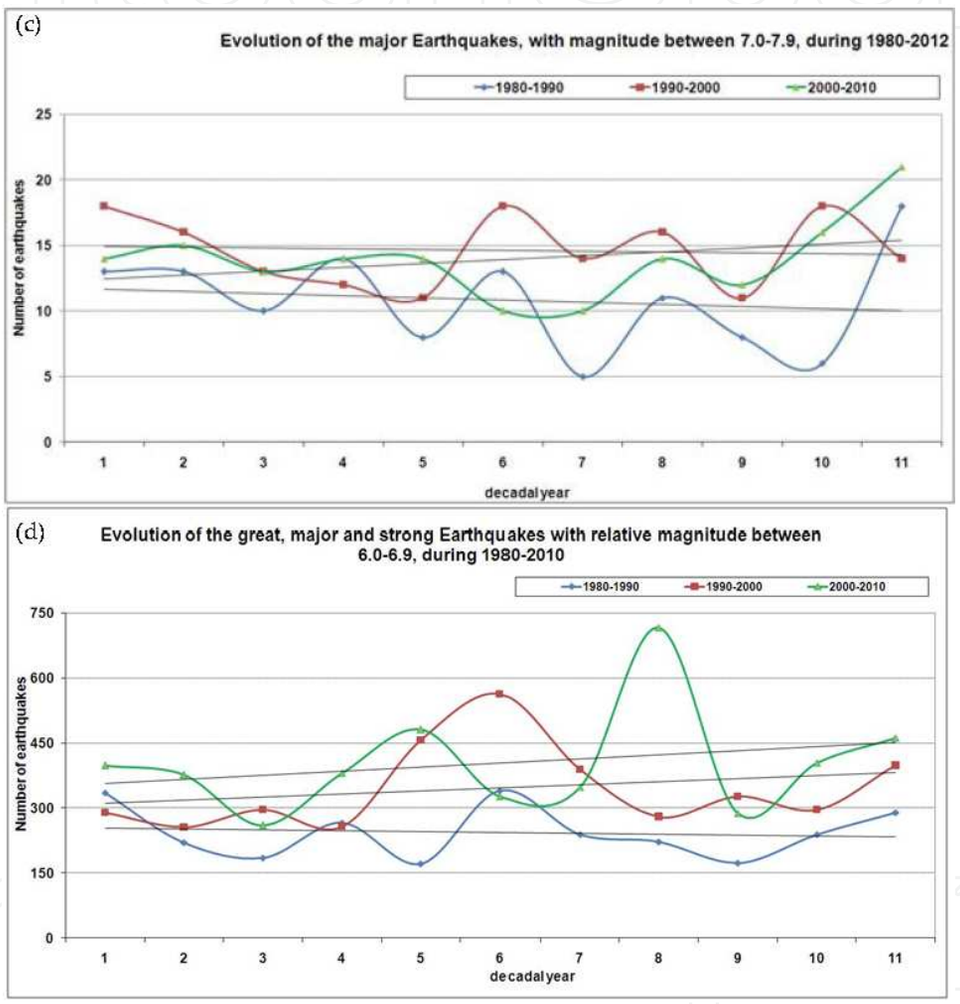


Figure 1. a. The strong earthquake type of 6 - 6.9 magnitude on Richter scale:b. The major earthquake type with the magnitude of 7 - 7.9 magnitude on Richter scale:c. The great earthquake type, with the magnitude over 8 magnitude on Richter scale:d. The great, major and strong earthquakes types, with the relative magnitude of 6-6.9 magnitude on Richter scale (combined).

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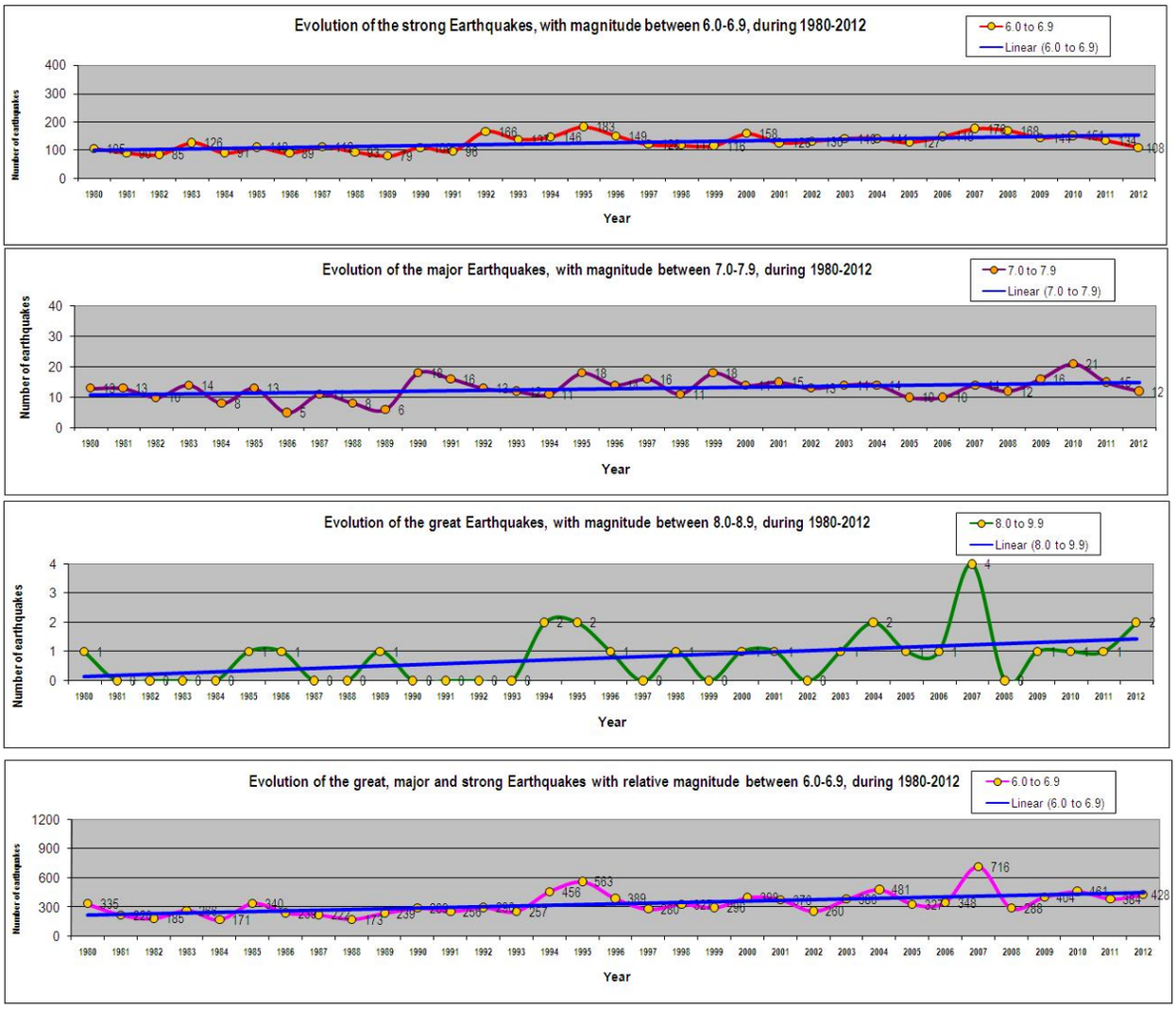


Figure 2. Earthquake trend evolution since 80's (blue thick line represents the increased linear trend and the coloured lines the frequency evolution for each type of earthquake category, strong, major or great):

4. Research course

The paper evaluate records of seismographs belonging to the international survey network over the last 30 years, assessing earthquakes frequency in order to detect evolution tendencies to be drawn. A simple linear correlation was used to categorize the trend of the seismic activity all over the world. Commonly the Earth seismic activity is almost constant in terms of frequency of earthquakes [3]. A possible increased tendency of earthquake activity was revealed studying the frequency of the principal earthquake types (such as: great, with the magnitude over 8, major with the magnitude of 7 - 7.9, and strong earthquake type of 6 - 6.9 magnitude on Richter scale), taking into consideration that an earthquake measuring 8 on the Richter scale is 10 times larger in term of ground motion than a 7 magnitude tremor, or 100 times larger than an earthquake measuring 6 magnitude, and so on. The results indicated an

unusual increased seismic activity since the 90's, which is in contradiction with the generally constant trend of the previous decade. Based on lessons-learning approach, the activity of implementation of an earthquake resilient activity worldwide at local, regional or national level in the areas prone to earthquakes have to be assured by taking into account valuable recommendations of the risk managers involved into decisional planning, as indicated in the research paper.

5. Method used

Decision makers begin to understand that to save lives, they have to adopt an integrated, comprehensive and multi-hazard strategy for disaster risk reduction, regardless the type of the disaster management procedure. This strategy includes prevention, mitigation, preparedness, response, recovery and rehabilitation, therefore the following lessons learnt can be drawn:

5.1. Prevention measures

The latest tragedies highlighted the importance of the addressing of public buildings (such as: hospitals, schools, fire-fighter units, etc.) in the national earthquake protection policies;

A multi-hazard approach (earthquake plus tsunami) should be envisaged when response actions are planned. For example, access routes could have survived the earthquake but not the impact of the tsunami or some areas may remain flooded and therefore not able for rescue operations;

The constructions located in earthquake prone areas, erected before the last building regulation was put into force, have to be inspected in case of not complying with the norms, then have to be retrofitted or rebuild. A special attention should be done for retrofitting the construction for the most vulnerable socio-economical activities, which in case of earthquake could lead to severe loss of life, due to increased damages to the most vulnerable public areas (such as schools, fire-fighters units, hospitals, etc.), and interruption of public services (transportation, gas, electricity, water supply) by damaging the bridges, fall of power lines, pipelines rupture, etc;

The retrofitting works for all old buildings should take into account the new changing in the building resilience due to earthquake activity, taking into account the building codes for the specific earthquake area wherein the construction is located (for example, in Europe, the general rules for the assessment and strengthening of structures are available in the European Standard, Part 1-4 of Euro code 8, prEN 1998-3, and for other countries, the available guidelines in force). The designers and the constructors of the public units should pay more attention to structural issues;

As a result of the recent earthquakes, new building codes for earthquakes have to be introduced in the affected countries, including new seismic zoning of the whole country, with the purpose to improve the standards of building execution and maintenance. In addition, any dangerous

structural changes implemented over the lifecycles of schools or other public buildings which can weaken the building strength have to be avoided. Therefore an increased activity of inspection should be undertaken regularly, according with the building code in force, in order to interdict any possibility for improvisation or structural changes, mainly for the public buildings. In areas prone to natural hazards, including earthquakes and tsunamis, it is necessary to constantly review and implement the proper building codes for constructions. In particular, the presence of adobe-built houses or improvised makeshift shelters can become disastrous;

In the coastal areas prone to tsunamis, it is necessary to implement prevention measures such as structural ones: tsunamis walls, sea walls, beach-long protection wall, automatic and manual closing water gates, evacuation routes and signing, establishing safer distances between different land use categories and the coastal line, depending to their economical activity, for minimizing the impact of possible tsunamis, or inexpensive protective lines of trees and dense vegetation, by planting local resistant trees species (for example mangroves in the tropical regions, coconut trees, etc.);

In addition, non-structural measures involve elaboration of tsunami vulnerability and risk maps, implementation of building codes and land use planning in order to define safe areas, education of the population regarding the behaviour in case of a tsunami wave, implementation of a seismic observation network system in relation to the possible detection of the tsunami generated by earthquakes, coupled with installation of alarming systems for the early warning of the population, studies for mapping the hazard vulnerability in the coastal areas characterized by intense socio-economical activity;

Early disaster events could be further analysed having a look at underwater sedimentary deposits in order to get a full picture of the vulnerability (including the case of marine deltas where new settled sediments once loosing stability can trigger tsunamis waves on the nearby coastal areas);

Although relatively reduced vulnerability of Stromboli type island (prone to underground landslides due to volcano material flow during eruptions) could be high due to holiday seekers and volcano tourists. Therefore the continuous activities of the volcano should seriously be watched and appropriate vulnerability analyses be performed. The focus should be put on landslides and/or lava flows due to volcanic activities; in addition, a multi-hazard approach could be useful as small earthquakes and/or tremors together with landslides trigger local tsunamis whose potential of destruction should not be underestimated. In the case of Stromboli one could promote structural actions (enforcing parts of the shoreline) and non-structural actions (educating the local population and especially instructing non-residents like tourists of potential signs of tsunamis). In the particular case of Stromboli volcano, which is of small size and not flat, it would be more efficient to manage an easy but effective concept of early-warning system (for ex., the use of loudspeakers, sirens) together with an evacuation system that allows moving the local population towards safer places in extremely short time;

The recurrence maximum time period, taken into consideration by nuclear engineers for a tremor in relation with a nuclear facility, that is the 10,000 years quake event, does not

necessarily takes place after such a long period of time, and can occur anytime, even today or tomorrow, in the most earthquake prone areas all over the world, represented especially by the Pacific ring of fire, where the recent great earthquakes occurred;

The usual location for nuclear power plants are nearby large water available resources, sufficiently enough for assuring the cooling of water generated by the reactors, including tsunami prone areas nearby oceanic coastal shores. Consequently a higher location have to be selected for the backup power sources, and other electrical equipment for water pumps used to cool down the nuclear reactors following the automatic shut down due to largest possible tremor event ever recorded in the region, that means generally above 8 or 9 magnitude. Therefore every nuclear plant designs should take into account the resulting effects of this kind of event, including larger tsunamis than before experienced on a specific location chosen for nuclear development;

Periodical reevaluation of the nuclear power plant safety standards, depending of construction principle type e.g. light water cooled reactor (LWR), graphite-moderated, water-cooled reactor (RBMK), known as the Chernobyl type, heavy water moderated reactor (CANDU or AHWR), advanced gas cooled reactor (AGCR), liquid metal cooled reactor (LMF) or type of the nuclear fuel (uranium 253 and 258 or the most risky plutonium 239); NATECH scenarios (Natural Accidents that might trigger technical disasters) are to be considered, depending of natural hazards in the earthquake prone areas (e.g. landslides which may affect the land stability, storms or tsunamis which can flood the power generators, associated severe draught which may result in a water shortage in case of a water pipelines damage leading to nuclear fuel overheating), in order to avoid the worst case scenarios at a nuclear power plant, a nuclear leak due to melting down of the nuclear core, following failing of the cooling down of the exposed nuclear fuel rods.

5.2. Preparedness measures

The continuously monitoring of the areas prone to natural hazards, including earthquakes could lead to a better knowledge of the risk evolution of facing a possible disaster, also taking into account other vulnerability factors which can increase the probability of a disaster occurrence. Being known that many inhabited clusters could be closely located to an active tectonic area, and before some incipient earthquake activity will began, a detailed seismic analysis is necessary in order to detect the possible underground discontinuities. Generally speaking, even without having a historical evidence of earthquakes, worries can be raised regarding the overall seismic activity of a vulnerable area. In term of exposed population or industrial facilities, if an underneath fault is discovered, subsequent measures can be taken leading to a better preparedness activity for a possible earthquake;

The proper training of the personnel involved in emergency response and relief during natural disaster is essential for a better management of the emergency situations generated by an earthquake. Therefore constant simulation and drill exercises should be performed by the specialized personnel in order to be prepared in case of a major earthquake or for the possible forwarding aftershocks. An intense training program for the emergency personnel in the exposed areas should be performed using special trained sniff dogs and adequate equipment

for increasing the preparedness capacity. Population should be also involved in the training drills, in order to become aware of the basic rules of survival and for recovery actions, to assure a better cooperation with the local authorities involved in the disaster mitigation activities;

The damage assessment scenarios for inhabited areas located in tsunami prone areas, on the coastal lines, will re-evaluate the mitigation capabilities in case of a real disaster and lead to a better response of the emergency services;

Countries located in tsunamis vulnerable areas should set their own national tsunami warning system, capable to watch and warn in due time the local inhabitants about any danger of producing a catastrophic event occurring nearby the inhabited area. For maintaining the awareness and the response capability of an already implemented tsunami warning system, simulation exercises should be periodically organized. Different responsibilities and tasks of the emergency personal involved in monitoring activities are reviewed, assuring the communication in real time of the emergency relief cruses about the probabilities of producing the disasters and assurance of warning the population;

The existence of the emergency stock of materials and means of interventions, located in the vicinity of the prone areas of natural hazards, including tsunamis, allows an optimized relief activity after a disaster in the region, assuring a successful intervention activity and minimization of loss of lives and damages to the properties. It is crucial to have sufficient stock (including tents, blankets, medicine) available in order to support people that have fled from the tsunami;

An efficient preparedness measure depends of timely early warnings issued by the authorities following an earthquake with high magnitude, which often constitute the triggering factor for the tsunami;

Area that had been affected by similar events in the past should create a disaster prevention platform; it could help in better identifying vulnerable areas and/or weaknesses in preparedness activities;

Evacuation routes should be generated on the basis of flood maps and availability of shelters. If no natural shelters (hills, mounds, berms) are available it is advisable to construct vertical shelters.

It should be clear that living in houses which are built 1 - 3m above sea levels, a high level of preparedness is required in the case a tsunami hit;

Already established safety zones, implemented in the planning of the coastal areas, will lower the risk of the highly vulnerable areas, both by earthquakes tremors and tsunami waves, therefore a multi-hazard approach in emergency planning would be advantageous. Preceding disasters, like a heavy earthquake, could (partly) destroy evacuation routes and assembly places; therefore a multi-hazard approach (earthquake plus tsunami) should put particular emphasis on having such routes and places secured. Moreover, the emergency planning should take into account that subsequent disasters or inconveniences may happen and request alteration of early plans, i.e. heavy rainfalls which, in turn, produce landslides and mudflows.

Subsequently, people in emergency shelters had again to be redistributed in (different) safe locations;

In the particular case of Stromboli type volcanic island, due to the continuous activities of the volcano, constant preparedness is absolutely required, that is availability of responsible persons issuing the alarms, instruction non-residents, keeping free the evacuation routes;

On small islands telecommunication back-up system should be kept operating in order to start rescue operations;

The nuclear facilities located in the earthquake prone areas should have drilled in advance holes for vent up hydrogen released from the water cooling down reactor. The holes should be positioned at the top of the main building covering the nuclear reactor and containment vessel. This means preventing the hydrogen build up and risk of deflagration which might cause radioactive emissions, in case of core overheating due to breakdown of the cooling system. These hydrogen releases due to radiolysis may take place also because of the nuclear rods exposure in case of lowering down the water level in the cooling water pools with nuclear depleted material found inside the main buildings of the nuclear power plant;

Every nuclear power plant should take into consideration the availability of a pool of human resources to be used as a supplementary intervention in catastrophic event. In addition, a clean-up facility building located a few kilometers away from the main reactor facilities, including shelters large enough to host the emergency shifts for extended intervention in case of a nuclear incident. Such an action is recommended when the number of the normal available working shift personnel can not assure a proper emergency intervention in case of power failure and reestablishing the cooling down capabilities of a possible crippled nuclear reactor due to the twin action of a large scale tremor and subsequent tsunami event.

5.3. Response measures

The endowment of the rescue teams with special equipments and means of intervention in case of emergency situations is essential for an efficient response, increasing the chance for saving lives and reducing the economical impact of the natural disasters, including earthquakes. In the aftermath of the disaster, many persons can be rescued beneath the rubble thanks to the sniffer dogs and hi-tech ultrasound equipment both from the national level or foreign emergency teams;

The existence of the communication routes through all remote communities within a prone area for natural disaster, including tsunami, is an essential factor for undertaken an efficient response activity in case of a disaster event;

For minimizing the pressure of the local community in case of disasters, the existence of an insurance system for the houses and goods against the natural disasters, including earthquakes is very efficient. This is due to the indemnity of the affected people, automatically covered by the insurance companies. The financial coverage of the response action will not be affected, in case of producing some damages. Commonly, in the aftermath of an earthquake, the only compensation of the homeless people in the affected areas are the subvention from the state

and foreign aid organizations, in order to assure the economical income for a normal social life. Anyway it couldn't cover always integrally the loss, in the absence of a national-wide efficient insurance system;

In the hazard prone areas where a certain disaster is present, the recovery activities are difficult to undertake, for example in arid regions there is the possibility that water tubes are broken triggering major damages. Response teams must be ready to get water lines repaired in short time;

In the rehabilitation phase the focus should be put on economical recovery and social sustainability within the affected communities. Therefore long-term intervention development programs have to be set up in the affected areas, for the benefit of the most vulnerable communities, mainly focusing on income generating projects;

The multi-hazard feature of the inhabited areas and population vulnerability, as a result of the economical developing, could worsen the condition of the affected population in case of a natural disaster, superposing the effect of more hazards. A prime task of the international assistance in the affected regions is the strengthening of the capacity to respond to future disasters in the area, because some regions could have been already suffering from the effects of other hazards before the earthquake, or to withstand to the associated hazards of the main event (such as aftershocks, tsunamis, fires due to broken gas pipelines or from the damaged reservoirs of the affected boats or cars carried by the waves into the houses walls, liquefaction and landslides, mudflows, etc.);

A prompt response activity in case of a natural disaster, including tsunami, is related to the existence of an already implemented, "Plan of emergency and intervention", at the level of local and central public authorities. It clearly stipulates the competencies and the activities during each phase of the emergency intervention for rehabilitation and clearance of the disaster effect. The plan should be constantly revised in order to assure the updating of the information with the changes in land planning activities at the level of the community, or modifications intervened in the structure of the emergency staff personal in charge with the response activities;

Rescue operators have to count with a lot of destruction and uninhabitable houses thus having to maintain a huge number of refugees over a long period;

The response capability in coastal areas, in the case of a tsunami event, should rely on the effectiveness of the early warning system for tsunami, which allows an efficient preparedness measure. In some vulnerable coastal areas the travel time for tsunami to reach the coastal area is very short (for example the Mediterranean region), generally in less than 10 min after start, due to relatively shallow and low step offshore bottom morphology. Consequently the period of time until the tsunami alert is initiated should be very short, in relation to an existing efficient alarm capability of the population and the emergency relief crews;

Automatic unmanned (anti-radiation proof for humans) crane coupled with long range powerful water pumps near a water source for spraying at distance large volume of waters, should be available for all nuclear facilities located in the earthquake prone areas, including

tsunamis. These special intervention equipments, including remote surveying robots with dosimeters, should be used in the event of a nuclear cooling down operation failure, following larger tsunamis that might drawdown the back up pumps used for emergency intervention. In addition, a longer enough power cable to be switched on at an existing nuclear facility from an outside existing power source, generally a mile longer, should be available to connect by emergency the main nuclear unit of reactors in case of power failure due to earthquake tremor or subsequent tsunamis. Large barge should be available nearby for transporting freshwater in case of a nuclear accident at a plant located at the sea shore, in order to cool down the reactors, because the marine salt water damages irrevocably the nuclear facility.

6. Information to the public

In the areas prone to natural disasters, including earthquakes, at the level of the regional or local administration, hazard vulnerability and risk maps should be available for all decisional factors involved in the management of this type of disaster but also for dissemination to the general public in order to be informed about the dangers nearby the inhabited areas;

The proper information of the population from the vulnerable areas to the earthquakes about the risk reduction issues and the possibility to reduce the vulnerability of their houses by applying correct building codes, is highly necessary. The using of the new building materials, such as iron or iron coated concrete beams, together with the traditional ones such as clay bricks, without respect to any elementary building code, sometimes worsened the strength of a construction, and put an increased risk of the inhabitants. For example, the use of the iron beam for strengthening and to allow the extra-store constructions, together with traditional materials (clay bricks), could increase the vulnerability in case of a possible earthquake, as well as in the case of recently affected areas by earthquakes, where multi-store buildings collapsed and produced more casualties than in a possible destruction of a one store house;

It is necessary to create a knowledge platform to disseminate information at the local level, to educate people about the risk reduction issues in case of an earthquake. For example, the existence of some water and food supplies, also some vital medicines in case of chronic diseases, available in case of trapping inside a house can increase the life expectancy in case of earthquake, which could produce the collapse of the inhabited house;

The adequate information regarding the situation nearby an affected area by a recent earthquake lead to a more donor support from the surrounding communities and countries. An information booklet and a Website describing the earthquake effects during the relief operations can bring more donor support and can contribute together with the information press for a humanitarian appeal from the international community;

The ongoing information of the public regarding the actions to avoid a tsunami wave (such as: the clear indication of the escape routes, the avoidance of the exposed coastal areas during the tsunami, urgent deployment to higher places, etc.) will lead to an adequate behaviour of the population in case of a real disaster, limiting the number of affected individuals;

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The information of the public about subsequent effects of a technological disaster (oil terminals and refineries, mostly located in the tsunamis prone coastal areas) or natural hazards in travel or inhabited area, including tsunamis, and about the presence of other possible accompanied triggered disasters, following an earthquake, such as landslides or rock falls, by all available means (police agents, local broadcasting, tv news, papers, warning panels, etc.), lead to avoid the risk and limits the consequences in the aftermath of a natural disaster;

The case of Stromboli type islands, visited by numerous foreign tourists, requires permanent, effective and multi-lingual instruction of residents and non-residents, i.e. leaflets let to those arriving, pictograms let in hotel rooms, warning signs put on beaches and nearby paths;

Populations should be kept informed by local authorities on the possible restriction zone, generally following an accident at a nuclear reactor due to the impact of a twin event of tremor and the subsequent tsunami wave. The restriction zone is declared generally as an exclusion zone for population, excepting the nuclear plant emergency personnel and fire fighter units, and is particularly coffined at a specific distance radius to the crippled nuclear reactor, commonly of value of tens of miles around the radiation source;

Radiation self-detection equipment (dosimeters) for personal use should be available for the population individuals located nearby nuclear facilities, or the persons travelling nearby, for auto monitoring of the radiation doses (e.g. the hourly radiation dose is 0.1 micro Sievers - μSv/hour). In case of exceeding the normal dose, depending on instructions from the emergency supervising personnel, a decontamination procedure is required (e.g. shower with water and soap washing); Food (milk and fresh harvested vegetables) and water nearby a crippled nuclear facility can be immediately affected by a nuclear leakage due to a catastrophic failure of the cooling down the nuclear reactor, or incidents at the nuclear rods being exposed, due to the wind dispersion (e.g. as far as 100 km radius far to the radioactive source);

Main radioactive isotopes (e.g. Iodine 131, Xenon-133, Krypton-85 and Caesium 137), produced during a nuclear accident due to subsequent tsunami of an earthquake event, can immediately affect the health on long term, due to the carcinogenic effect. Special medication for radiation prevention should be used only on the certified medical surveillance, because the main antidote, for Iodine 131, the iodine salts (e.g. potassium iodine) is available just for a time window of 4 days, when the results are affective (e.g. for avoiding the accumulation in thyroid gland by aerial way), and the self medication with other similar inhibitors (for example iodine salt), can shift the effective period before the radioactive cloud is atmospherically drifting on a certain vulnerable inhabited zone.

7. Status

Contemporaneous seismic activity as well as complementary volcanicity are genetically linked to Cenozoic plate kinematics, involving interacting plates and/or intra-plate rifting steaming from triple junctions. Upper mantle heterogenic seismic structures are intimately related to plate breaking and motion.

A series of natural facts are to be taken into consideration in order to approach the causes of such unusual trend of increasing major earthquake frequency after 1990 which led to destructive earthquakes in "classic" areas but also in areas not specifically known as prone area.

A cause of increasing trend of seismic activity may be induced by internal factors related to global tectonics. It is marked by intracrustal-subcrustal structural, sedimentologic and magmatic processes creating shallow or deep areas for large magnitude earthquakes., e.g. coupling convergence rate, age of subduction, lithosphere type, trench sediment thickness and so on.

Reality or mere coincidence, concurrent supracrustal processes at global scale may affect the Earth's structure and related sensitive tectono-seismic spots. Of them the global warming is considered by a large part of the academic world as major process with implications at atmospheric, hydrospheric, biospheric and lithospheric levels that represents the so-called Critical Zone of the Earth. So far Cenozoic eco-climate change was taken into consideration in order to explain seismic differences of orogenic regions based on sediment thickness, i.e. effect of coupling between tectonic and erosion.

The need for detailed analyses of the effects of the global warming and the assessment of all the aspects of the environmental factors, are due to the necessity to control the natural hazards at the level of the planet Earth, involving the approach of a global analysis. Therefore, to study the interrelation between global warming and the earthquakes can be made just analysing the involved phenomena (earthquakes, global warming, tectonic evolution) at the world scale level, taking into account all relevant aspects of the involved hazards, making reference to the historical evidence and data records.

Useful information can be provided by conclusions of the experts involved in the analyses of the core samples from the ice drillings 3000 m deep in Greenland, performed in early '90s. The unusual enriched content of sulphate found in the ice cores at a certain depth proved an episode of unusual intense volcanic activity, which took place at 7000 BC, induced by the tectonic instability due to the rapid defrosting of the continental ice sheet, because of a warmer climatic episode. The paleo-environmental reconstruction of the last major volcano activity occurred on earth, at 7000 BC, was a result of the analyses conducted on the ice drilling samples from glaciers by a research program performed in Greenland, through the European Science Foundation [6].

8. Results

The analyses of the earthquakes frequency trend all over the globe, in the recent years, correlated with the actual tendency of defrosting the ice from the polar regions [7], allow the study of presumable recurrences in future, of a similar event of volcano increasing activity and subsequently tectonic disturbance, as a result of the defrosting evolution of the actual glaciers due to global warming. The possible correlation between the analysed earthquake data and the actual ice sheet evolution, which covers actually 10% of the total crust (where the conti-

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nental area covered by the ice is reducing due to the increased global temperature), can induce serious consequences over the tectonic stability of the earth, respectively the frequency and magnitude of the related phenomena, such as subsequent volcanoes activity which can be induced by the plates movements and evolution, and generating earthquakes.

According to specific environmental evaluations that claim that the actual trend of global warming is continuing, in the next hundreds of years the continental ice will disappear. The rapid defrosting of the continental ice could lead also to some secondary tectonic effects due to the release of the equivalent pressure of the ice load. If the assumption of the paleo-climatologists is correct, a similar phenomenon, an increased warming episode, like the actual global trend, could lead to an unexpected increased tectonic activity, with unpredicted impact over the humans and surrounding environment. Therefore the actual increased trend of the earthquakes frequency could be a global indicator of the tectonic stress due to rapid defrosting of the continental ice sheet.

9. Further research

Furthermore the general lessons have to be implemented urgently by the risk managers involved in the activities of updating and implementing the building codes, seismic risk zoning and regulation, in order to avoid in the future any other misjudges of the earthquakes hazard, for minimizing the loss of human lives and material damages.

10. Conclusions

Analysing the possible increased tendency of earthquake activity (Table no. 1), in order to clarify the cause of the unusual increased trend of the earthquakes frequency in certain periods of times after the 90's, a common fact was that all these recently past events surprised the local population as well as local and national level risk managers, because the hit areas were not considered before specific historically earthquake prone zone, so the building codes were not updated for a real seismic zone (including major cities as Kobe or Islamabad). The paradoxical issue of increased trend of earthquakes just after ’90 was never been tackled seriously before. Generally it is considered that just 10% of the total energy from tectonic plates movement are transformed in earthquakes, and remain 90% converted in other forms of energy due to rock displacement and heating up processes [5]. A constant increasing trend of the Earth’s earthquake energy, revealed by our analysis over the last 30 years seismic records worldwide, could indicate a shifting of the remain 90% of the tectonic energy, normally dissipated in plates interactions, towards earthquakes. For the the first time in modern history, were recorded in the same day two great earthquakes more than magnitude 8 on Richter Scale, in the same area (off the west coast of Northern Sumatra, during 2012), instead of a smaller aftershock of the same tremor, usually not exceeding a lower range magnitude (the aftershock shouldn’t exceed a magnitude 7 on the Richter scale). That’s mean we will witness a future increasing in the

earthquake pattern trend, which may have profound implications at a global scale, in our understanding of Earth dynamics.

Magnitude/ year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
8.0 to 8.9	1	0	0	0	0	1	1	0	0	1	0
7.0 to 7.9	13	13	10	14	8	13	5	11	8	6	18
6.0 to 6.9	105	90	85	126	91	110	89	112	93	79	109
		1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
		0	0	0	2	2	1	0	1	0	1
		16	13	12	11	18	14	16	11	18	14
		96	166	137	146	183	149	120	117	116	158
2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
1	0	1	2	1	1	4	0	1	1	1	2
15	13	14	14	10	10	14	12	16	21	15	12
126	130	140	141	148	148	178	168	144	151	134	108

Table 1. Evolution of the Earthquakes frequency (no/magnitude/year) during 1980-2012

All around the globe, in the earthquake prone areas, scientists monitor carefully earthquake activity, because many agglomeration centres, including large areas like Tokyo and Bucharest (later the capital of Romania, considered the most prone capital with a similar earthquake activity as Mexico City, in the opinion of the most celebre seismologist, Charles F. Richter) are expecting a devastating event, according to the statistics (Tokyo is expecting "the big one" earthquake following the last major event in 1923, so called "Kanto earthquake", and in Romania the same Vrancea source earthquake, with the last major event in 1977, with more than 2 billion US dollars in damage and 1500 fatalities).

Another explanation is that, following the global climatic changes, a large part of ice Polls sheet started melting (unprecedently during the summer of 2012, for the first time the Greenland ice sheet was partially melted at the surface, far exceeding with 100 years the climatologists previsions), so large volume of water were released into the ocean triggering potential changes in the global plate tectonic equilibrium. Taking into account that Antarctica (Southern Pole continent) is covered with snow and ice of almost 2000 m height, equivalent in weight of a real continent, whose melting can destabilise the established continental plates equilibrium. These sudden melting (which in terms of geological ages has never been experienced so fast until now in the whole Earth's geological history), might influence the global earthquake trend, a possible precursor of changes in the pattern of global plate tectonic movement. What is however certain is the fact that earthquakes are geological hazards of endogenous origin, and what is uncertain is the global warming itself and the potential influence of exogenous factors

over crustal/sub-crustal settings. Consequently, discerning mere speculation from evidence is still a priority.

The needs for increasing the resilience of the communities all over the world lead to more detailed studies on both small and large scale in order to try to explain the connection among factors which interact naturally on the Earth. The lessons learning activity based on the analysis of the recent tremors data all over the world can improve the preventive, preparedness and intervention means of the earthquake vulnerable areas.

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References

[1] Airinei, Ş. (1972). Geophysics (in Romanian), Ministry of Education and Science, Bucharest University

[2] Georgescu, E. S. B*ucureştiul şi seismele* (in Romanian), Editura Fundatiei culturale Libra, Bucuresti, (2007).

[3] Lazarescu, V. (1980). Physical Geology (in Romanian), Technical publisher, Bucharest

[4] Peter, M. Shearer, "Introduction To Seismology", Cambridge University Press, 1999http://earthquake.usgs.gov/hazards/about/workshops/thailand/downloads/CSMpp1_History.pdf,accessed 24 March (2012).

[5] U.S. Geological Survey, National Earthquake Information Center- *Earthquake list* http://earthquake.usgs.gov/earthquakes/eqarchives/year/eqstats.php, updated on 2012 (accessed 03 March 2012)

[6] Science daily: Underwater Earthquakes Geophysicists Discover Slippery Secret Of Weaker Underwater Earthquakes (2007)http://www.sciencedaily.com/videos/2007/underwater_earthquakes.htm,accessed 15 April (2012).

[7] Zielinski, G. A, Mayewski, P. A, Meeker, L. D, Whitlow, S, Twickler, M. S, Morrison, M, Meese, D. A, Gow, A. J, & Alley, R. B. *US Global Change Research Information Office-Increased Volcanism Linked To Climatic Cooling During The Period From 5000 To 7000 B.C. reference:* Record of Volcanism Since 7000 B.C. from the GISP2 Greenland Ice

Core and Implications for the Volcano-Climate System, Science, *http://www.sciencemag.org/content/264/5161/948.short),*accessed 2 May (2012). , 264, 948-952.

[8] National snow and ice data center (NSIDC) Sea Ice Decline Intensifies- (report on 28 September 2005); http://weathertrends.blogspot.com/2005/09/sea-ice-decline-intensifies.html,accessed 15 June (2012).

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