Understanding and Quantification of Natural Hazards

DURATION: 2012 – 2013

TARGET COUNTRIES: All interested member countries, Japan, Democratic Republic of the Congo and Rwanda

PARTNERS INVOLVED :
Coordinating centre: ECGS Walferdange, Luxemburg
Other Centres:
Other Partners: GFZ German Research Centre for Geosciences in Potsdam, Germany, Royal Museum for Central Africa (Tervuren, Belgium), Musée national d'histoire naturelle Mnhn (Luxembourg)

OBJECTIVES OF THE PROJECT

Global objective for 2012-2013:

During the past few years, ECGS has contributed to the aims of the EUR-OPA Major Hazards agreement as outlined in the guidelines for the programme of activities 2012-2013 [AP/CAT 2011(21)] through a range of research and education activities. These included, among others, research activities aiming at a better understanding of the physical characteristics of earthquake ground motions (the latter being the fundamental prerequisite for adequate seismic hazard assessment, which in turn represents the basis for risk assessment and vulnerability reduction), the improvement of earthquake early warning systems (based on an in-depth investigation of the Istanbul earthquake early warning system), research aiming at monitoring ground deformations using state-of-the art space borne or ground based methods (e.g. for volcano monitoring, natural or man-made ground subsidence…), as well as several specialised workshops dealing with topics such as induced seismicity (ECGS-FKPE workshop 2010). These and other projects were carried out in collaboration with high-profile academic partners worldwide.

Specific yearly objectives:

2012:

In the framework of the 2012-2013 programme of activities of the EUR-OPA Major Hazards agreement, ECGS intends to continue and extend these research activities aiming at a better understanding and quantification of natural hazards in the Euro-Mediterranean region, but also on a global scale.
Indeed, ECGS is strongly involved in the processing of Japanese earthquake strong motion data, and in the coming two years, one aspect on which we will concentrate is the study of the implications of the massive M 9 earthquake that occurred on 11 March 2011. This is the first time that such a wealth of near-source strong motion data have been recorded from such a mega thrust earthquake, and thus the results obtained from the study of the near-source strong ground motions generated by this earthquake are of particular interest also for other regions threatened by the potential occurrence of mega thrust earthquakes. Besides the study of this particular earthquake, we will also work on the analysis of the variability of earthquake ground motions, an issue of utmost significance for seismic hazard calculations worldwide. These research activities will be carried out in close collaboration with scientists from the GFZ German Research Centre for Geosciences in Potsdam, Germany.
Besides these aspects of fundamental earthquake ground motions research, ECGS is also currently investing its efforts in developing a permanent seismic network for Luxembourg and the Great Region around (i.e. Luxembourg and neighbouring regions of Belgium, France and Germany), an infrastructure that was so far missing. With these efforts, we intend to close the gap of missing seismological recordings in the Grand Duchy and collect the necessary data to contribute to a significantly improved assessment of the seismic hazard in the area.
Furthermore, ECGS will also remain deeply involved in the study of volcanic hazards and ground deformation mainly in Africa and in the Great Region. For instance, in close collaboration with the Museum for Natural History of Luxembourg and the Royal Museum for Central Africa (Tervuren, Belgium) as well as European universities from Belgium, France and Italy, we study the Virunga Volcanic Province (VVP) at the bordering region of the Democratic Republic of the Congo and Rwanda. Two of the most actives volcanoes of Africa (Nyiragongo and Nyamulagira) indeed lie in the VVP and threaten the > 1 million inhabitants of the city of Goma and neighbouring urban areas and villages. In particular, the volcano-tectonic risk is extremely high in Goma as shown by the recent 2002 Nyiragongo eruption that destroyed 10% of the city, a city where the population doubled over the last 10 years. Similarly, methods developed for the study and the monitoring of that region were also successfully applied to other volcanic and tectonic areas such as in Tanzania, Cape Verde, and South Kivu as well as in the Great Region. This allowed to address in previous studies important questions such as whether the occurrence of recent seismic sequences in the East African rift were of purely tectonic origin or whether there was any magma involved (which has important impact in hazard assessment), as well as bringing fundamental information about the continental rifting process itself.. Applying these methods developed on the African targets and new methods developed recently by a postdoctoral fellow at ECGS, we also detected long-term subsidence related to the mining activity in Luxembourg and the Great Region.
The large datasets of satellite Radar images owned at ECGS (acquires since the nineties over active tectonic regions in Africa and over Luxembourg and surrounding areas) and the necessary computing facilities and processing tools, as well as various ancillary data or equipment to complement these remote sensing studies (GPS, tiltmeters, gravimeters, etc.) provide us with outstanding tools for conducting fundamental research and hazard assessment-oriented research.
In the years 2012-2013, further studies will be carried out, in particular with the aim of gaining insights into the

magmatic system of Nyiragongo volcano. As a first step towards this goal, a field mission was carried out in September 2011, providing an invaluable dataset to tackle this issue

2013:
see above

EXPECTED RESULTS

2012:
see above

2013:
see above

RESULTS OBTAINED IN 2012

Work package 1 (prepared by ECGS):

Description:
Fundamental seismological research on ground motion prediction equations and ground motion variability

Associated deliverables:
A better understanding of how earthquake ground motions are generated and how their variability can be treated in seismic hazard assessment

During the year 2012, significant progress has been made in the project "Understanding and quantification of natural hazards", led at the European Centre for Geodynamics and Seismology. The year was in particular marked by the work on ground motion and source parameter variability of earthquakes in Japan, and the workshop Earthquake source physics on various scales, which was organized by ECGS with cofounding from the EUR-OPA Major Hazards Agreement, and relates directly to the research carried out at ECGS.
In 2012, we carried out a study on the regional variability of earthquake source parameters (such as stress drop and released seismic energy) in Japan, starting from the earlier results of Oth et al. (Geophysical Research Letters, 37, 19304, 2010), who had analysed the average source scaling behaviour (i.e., how earthquake source parameters scale with earthquake size) in Japan. The more detailed analysis of the regional variations of these parameters revealed very interesting insights. First of all, crustal earthquakes in the northern part of Japan's largest island Honshu exhibit very low stress drops and released energy per unit moment, while the contrary is the case for the island of Kyushu in southernmost Japan. Compared to the distribution of quaternary volcanoes (i.e., the volcanic arc of Japan) and heat flow measurements throughout the country, there is a striking relationship between the latter and the source parameters of earthquakes. In the volcanic areas, where the crust is obviously warmer, stress drops are very small. When compared to other geophysical parameters, such as strain rate determined from GPS measurements or the focal mechanisms, the relation of the source parameters to heat flow seems to be the most robust, indicating that most likely, the thermal strength of the crust is the main determining factor for how much energy is radiated by an earthquake.
Furthermore, there are also clear regional variations in the scaling, and not only in the absolute stress drop values. These are currently under further investigation, and we are currently in the process of preparing a publication on this work.

Work package 2 (prepared by ECGS):

Description:
Establishment of permanent seismic network in Luxembourg

Associated deliverables:
Operating seismic network covering the entirety of the Luxembourgish territory by the end of 2013

Progress was also made concerning the establishment of a seismic network in Luxembourg. A temporary network of 6 seismic stations is already up and running, in cooperation with the Karlsruhe Institute of Technology (KIT). ECGS has purchased 6 seismic sensors that are currently in the process of being deployed. The first three of these are deployed in the framework of a project funded by the National Research Fund of Luxembourg (FNR), with the aim of using seismological measurements to make estimations of bedload transport in rivers (project BEDLOAD). While these stations are primarily destined to serve this project for the coming 1-2 years, they will nevertheless also provide earthquake registrations, since they are measuring continuously. The other 3 stations will be deployed in Luxembourg for seismological monitoring purposes, in addition to the permanent station in the Walferdange Underground Laboratory for Geodynamics (WULG) and the six stations already present. This network provides the first dataset of continuous seismic recordings covering the entirety of the Luxembourgish territory.

Work package 3 (prepared by ECGS):

Description:
Processing of the field mission data acquired on Nyiragongo Volcano in September 2011

Associated deliverables:
Improved understanding of the dynamics of the Nyiragongo lava lake

The work on the field mission data acquired on a field mission on Nyiragongo volcano in September 2011 has started and will be continued throughout the coming year.

ACTIVITIES PLANNED IN 2013 (split by partner)

Working package 1 (prepared by ECGS)*:*

Description:
Associated deliverables: