Integrated research on great earthquakes and disaster mitigation in Nepal Himalaya

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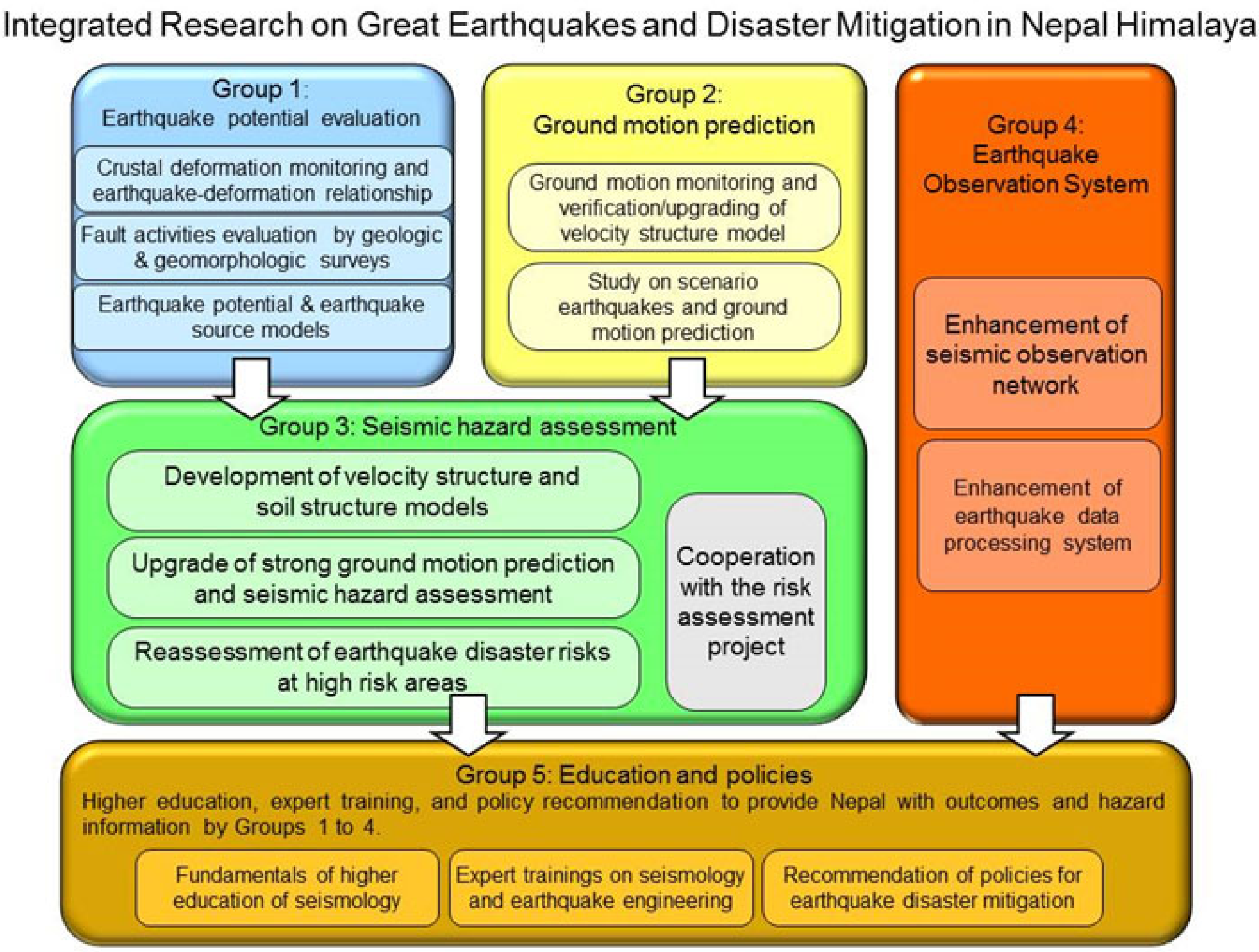
This project has been started in 2016, and will continue for five years under the Science and Technology Research Partnership for Sustainable Development (SATREPS) program of the Japan Science Technology Agency (JST) and the Japan International Cooperation Agency (JICA). Since Nepal is located at a convergent boundary, where tectonic plates collide with each other, it is suffering from great earthquakes and steep topography. Hazards of great earthquakes can get larger by mountainous topography such as basins. In addition, the population concentration to basins increases seismic vulnerability. However, few experts in seismology, which is a geophysical discipline for earthquake studies, have been struggling against the situation mentioned above. Consequently, Nepal is one of the highest risk countries in the world against earthquakes. it is urgent for Nepal to perform an integrated research on great earthquakes and disaster mitigation, in collaboration with Japanese researchers.

Based on these backgrounds, the overall goal of the project is set to mitigate future earthquake disasters in Nepal. The project consists of research activities on seismic potential evaluation, ground motion prediction, seismic hazard assessment, earthquake observation system, and education and policies (Figure). 1. We evaluate the seismic potential of the Central Seismic Gap in the Main Himalayan Thrust and construct the source model of a future great earthquake. 2. We model the velocity structure in the Kathmandu Valley and perform scenario ground motion predictions using the constructed source and velocity structure models. 3. We assess the seismic hazards in the Kathmandu Valley due to the future great earthquake. 4. We enhance the seismic observation network and earthquake data processing system. 5. We educate graduate students and experts in seismology and earthquake engineering, and recommend policies for earthquake disaster mitigation.


Integrated Research on Great Earthquakes and Disaster Mitigation in Nepal Himalaya
Group 1: Earthquake potential evaluation
Crustal deformation monitoring and earthquake-deformation relationship
Fault activities evaluation by geologic & geomorphologic surveys
Earthquake potential & earthquake source models
Group 2: Ground motion prediction
Ground motion monitoring and verification/upgrading of velocity structure model
Study on scenario earthquakes and ground motion prediction
Group 4: Earthquake Observation System
Enhancement of seismic observation network
Enhancement of earthquake data processing system
Group 3: Seismic hazard assessment
Development of velocity structure and soil structure models
Upgrade of strong ground motion prediction and seismic hazard assessment
Reassessment of earthquake disaster risks at high risk areas
Cooperation with the risk assessment project
Group 5: Education and policies
Higher education, expert training, and policy recommendation to provide Nepal with outcomes and hazard information by Groups 1 to 4.
Fundamentals of higher education of seismology
Expert trainings on seismology and earthquake engineering
Recommendation of policies for earthquake disaster mitigation

Activities of the National Seismological Center, Department Of Mines and Geology in Nepal before and after the 2015 Gorkha Earthquake

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The National Seismological Center (NSC) under the Department of Mines and Geology (DMG), Nepal had established in collaboration with Laboratory de Geophysique (LDG) in France since 1978. It is the unique government organization in Nepal responsible to monitor seismic activities and conduct earthquake related research activities with different national and international research institutions. A dedicated network of 21 short period velocimetric stations is responsible for issuing the seismic alert as soon as an earthquake of local magnitude (M_L) greater than or equal to 4.0 occurred in Nepalese territory. The 2015 April, Gorkha, earthquake (M_L= 7.6) is the largest magnitude event which was well recorded by all the stations of this network. Till date NSC has reported 485 aftershocks of Gorkha earthquake having magnitude greater than or equal to 4.0 and documented the data base of about 30,000 of aftershocks having varying magnitude below this threshold reaching to its detection capability as low as magnitude 2.0.

After the Gorkha earthquake DMG collaborated with different international research institutions to deploy the number of temporary seismic stations to study, for example, the decay pattern of the aftershocks, strong ground motion, Paleoseismological trenching, microtremor exploration etc. for better understanding of this devastating event and also to assess the potential of the next big one.

In the presentation, we will explain some of the results obtained so far after the 2015 Gorkha earthquake and the progress of current national and international projects.

Keywords: Gorkha earthquake, Aftershocks, Temporary observation

Importance of surface ruptures and fault damage zones in assessment of earthquake hazards

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Most of the accumulated stresses along active faults are released through big earthquakes. Big earthquakes (generally > M 6) produce ***surface ruptures*** as well as ground motion. The length of surface rupture and offset produced by an earthquake depends on fault type and magnitude of the earthquake. Because rupturing stress along a rupture related with large earthquakes is enormous and quickly released during a short time of earthquake, any building can hardly survive. This type of earthquake hazard could produce very serious damages, even though it is concentrated along a very narrow zone. Therefore, it is very important to trace active faults around important sites such as nuclear facility sites.

Fault damage zones are now well known structures developed around faults, which are important to understand fault geometry and kinematics. Furthermore, in the point of earthquake hazard, they are very important to predict hazardous areas. Although we generally can consider ***respect distance*** to assess earthquake hazards around active faults, damages around faults or earthquake ruptures are not symmetric along the faults or ruptures. They are depending on *fault type*, *slip sense*, and *location* along the fault. Therefore, we should understand and consider not only respect distance but also fault damage zones and their characteristics to select proper sites for important facilities.

Several damages associated with big earthquakes show the importance of surface ruptures and fault damage zones. Although reported earthquake hazards along the surface ruptures and fault damage zones are very serious, the damages in several tens of meters away from the ruptures are generally not so serious (for strike-slip fault cases). Also, fault damage zones are important to understand locations for aftershock clustering, defining fault and earthquake segmentation, and triggering and termination of earthquakes.

Keywords: Surface ruptures, Fault damage zones, Respect distance

Present situation of Thailand on tsunami disaster mitigation as improvements from the 2004 Indian Ocean tsunami

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The 2004 Indian Ocean tsunami caused devastating damage to Thailand and other nearby countries. This presentation summarizes some improvements of tsunami disaster mitigation, especially for non-structural countermeasure namely tsunami warning system, tsunami evacuation drill and tsunami disaster education as well as issues on housing recovery and tsunami memorials based on lessons from the 2004 tsunami. Five months after the event, a new organization in Thailand so called National Disaster Warning Center (NDWC) was established. Currently, NDWC is under the Department of Disaster Prevention and Mitigation, Ministry of Interior. NDWC is not only in charge of tsunami but also all natural disaster warning in Thailand. For tsunami warning, NDWC works together with Thai Meteorological Department (TMD) on data sharing. NDWC and TMD monitor the data from their seismic stations, GPS buoy, as well as other data providers including the Japan Meteorological Agency (JMA). It took about 20 min for NDWC to announce tsunami warning message at the beginning but improved to 5 min at present. There is national tsunami evacuation drill conducted every year in the 2004 tsunami affected 6 provinces operated by local governments and NDWC. However, some small tsunami events such as in 2012 demonstrated that traffic problems during evacuation are still unsolved. Story of the 2004 tsunami has been telling to young generations by their parents, school teachers and medias. Ministry of Education is currently developing teaching materials for tsunami education referred to Japanese materials. About the tsunami disaster memorials, there are both locations with well maintain and location that need moderate to major reparations of the memorials as well as evacuation related facilities. Governments and private sector provided various types of post-disaster housing by different source of funding provider, but turn out that most of residents in provided houses project have less satisfy in their housing’s conditions. In the future, further improvements on non-structural countermeasures for tsunami in Thailand can be expected in various points of view.

Keywords: Tsunami disaster mitigation, 2004 Indian Ocean tsunami, Thailand

Geohazards, Globalization of Natural Disasters, and Their Impact on World Geopolitics

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Naturally caused and human-induced environmental changes produce significant effects on political, social and economic systems at a global scale, potentially altering global economy, human security and geopolitical stability. Geohazards, which are caused by short- and long-term Earth processes, result in catastrophic damages, casualties and destruction of social infrastructures. Yet, most geopolitical analyses omit such environmental changes and natural disasters in extrapolating future political and economic circumstances. A scientific approach to the history and the distribution of past civilizations clearly shows that their rise and demise were greatly influenced by geological processes and catastrophic events that took place in various time scales. The Indian Ocean tsunami of December 2004, the Katrina hurricane and flood (USA) of August 2005, the Icelandic Eyjafjallajökull volcanic eruption of April 2010, and the Tohoku (Japan) earthquake and tsunami of March 2011 are some of the most salient, modern examples of major natural disasters that have had adverse implications on global economy and on the regional/national security of the countries involved.

Regardless of the basic premises of the leading geopolitical scenarios about the future territorial configuration of power, the ramifications of large-scale natural events involving climate change, earthquakes, tsunamis, volcanic eruptions, floods and landslides are bound to be enormous and highly devastating for the sustainable development of the global economy and peace. The major geopolitical impacts of these events include: the collapse of agricultural productivity, the lack of fresh water, the disruption of electronic communication and industrial output, the destruction of coastal zones, and the unexpected shifts in shipping routes. These developments can easily lead to the creation of destabilizing problems and global conflicts as the nations and societies lose their resource base. We must educate the public and policy-makers about the importance of various geological processes and associated natural disasters for better preparedness for such environmental changes of global scales in order to maintain the world peace, security and prosperity. It is imperative that earth scientists, engineers, socio-economists, educators, health organizations, policy-makers and city-state officials make concerted, systematic and collaborative efforts to better understand and document various types of destructive geohazards and to put in place effective and functional programs and policies for risk assessment, preparedness, and mitigation. All these professionals and related organizations should collaborate to develop international standards for building a vast and accessible database and data exchange program. The newly established IUGS GeoHazard Task Group is ready to take on a leadership role in raising the visibility and effectiveness of public understanding of geohazards and their impacts on the societies, nations and governments around the world, and needs a proactive engagement of all stakeholders.

Keywords: Geohazards and disasters, Risk assessment and mitigation, Public awareness of geohazards and preparedness, Global geopolitics , IUGS Task Group on GeoHazards, Globalization of Natural Disasters

How to mitigate impending natural disasters by utilizing geological sciences: Discussion on the relevance of science for society in dealing with geohazards

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Natural hazards will result in future disasters but the impact of these events could be mitigated with assessment of human behaviors and thoughtful planning. Many hazards are predictable, derived mostly from natural and scientific principles, whereas disasters are partially the result of human error. Disasters are defined as loss of life and personal and public properties (including social and economic) resulting from devastating forces of natural hazards. Impacts of disasters might be minimized by thoughtful analysis of social and psychological elements of human behavior. For example, sociologists have promulgated the concept of ‘normalcy bias’, which shows that humans tend to behave normally when faced with grave and imminent danger; specifically, they over-focus on the actual phenomena instead of taking evasive action when facing instantaneous survival from disaster. In addition, we might be able to minimize the impact of disasters if we consider that hazards are composed of some social factors as well (over-population, too much dense, and too much fragile, less resilient, and caused by human activities). We should avoid such factors as soon as possible. We, in this case, should treat our IUGS GeoHazard Task Group project to be how we utilize our scientific knowledge and methodologies, and information for society. “Be prepared” is a motto of Boy and Girl Scouts, and this term fits also the objectives of our newly established project, IUGS GeoHazardTask Group. Then, the topics are to be: how to point out the effective ways to avoid the potential human hazard factors, and how to be prepared in each case. We will discuss the detail methods in coming four years from the world’s intelligent group of scientists.

Keywords: natural hazard , disaster, human activity, social effect, disaster preparedness, IUGS

Lessons learned from the recovery after the 2004 Indian Ocean tsunami in Sri Lanka

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Large tsunami is a low-frequency event and its impact continues for a long time. Therefore, long-term monitoring of impact and recovery after the event is crucial. In order to understand the lessons learned from the previous large tsunamis, we review the damages and recoveries both short-term and long-term after the 2004 Indian Ocean tsunami in Sri Lanka. Sri Lanka had been devastated by the 2004 tsunami, causing loss of approximately 30,000 people along the coastal area. In terms of impact to the natural coast, severe erosion and sedimentation has occurred both onshore and offshore. The recovery processes both for nature and human society have started soon after the event and continues even now in some extent. In fact, coastal environments have been well recovered and it is not easy to find any damages due to the tsunami along the coast. The affected human society has also recovered well, which is good for daily lives of local people. On the other hand, it is rather difficult to keep human memories about this event. Although, tsunami memorial monuments had been built in several places, part of the written characters were weathered and had become unreadable now. Considering that Sri Lanka has been suffered many costal disasaters including, tsunami, cyclones and severe coastal erosion, understanding and predicting past and future coastal hazards, development of a monitoring system, and capacity building are the keys for future disaster mitigation.

Recent progress on international collaborative projects of active fault and paleoseismology between Geological Survey of Japan and MTA, Turkey

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Over the last 30 years since 1980’s, General Directorate of Mineral Research & Exploration of Turkey (MTA) and Geological Survey of Japan have conducted international collaborative projects in the field of active fault and paleoseismological studies. Here, we introduce some of the results derived from the projects including on-going researches. The first progress since the initiation of the relationship between two organizations is mapping of the active faults all over the Turkey. The knowledge and technique of mapping of active faults has been exchanged and improved. The first active fault map over Turkey was published in 1992 by MTA at 1:1,000,000 scale. Later, more detailed mapping has been introduced using 1:10,000 scale airphoto interpretations, and now we have obtained renewal maps at 1:250,000 scale all over Turkey. The base maps of mapping were used at 1:25,000, then, they are compiled at 1:250,000 scale. Secondly, the first successful paleoseismic trench in Turkey has been brought under our collaborative project in 1990’s. After the occurrence of the 1999 Izmit and Duzce earthquakes, main purpose has shifted to paleoseismological researches on the North Anatolian fault system. Numerous successful paleoseismological researches have brought the exchange of knowledge and techniques. Now, MTA has already started to lead national project of paleoseismological researches of Turkey for long-term forecast of large earthquakes.

Earthquake (Mw 6.8) on 24th March 2011 caused by "international active fault" extending in Myanmar, Laos and China

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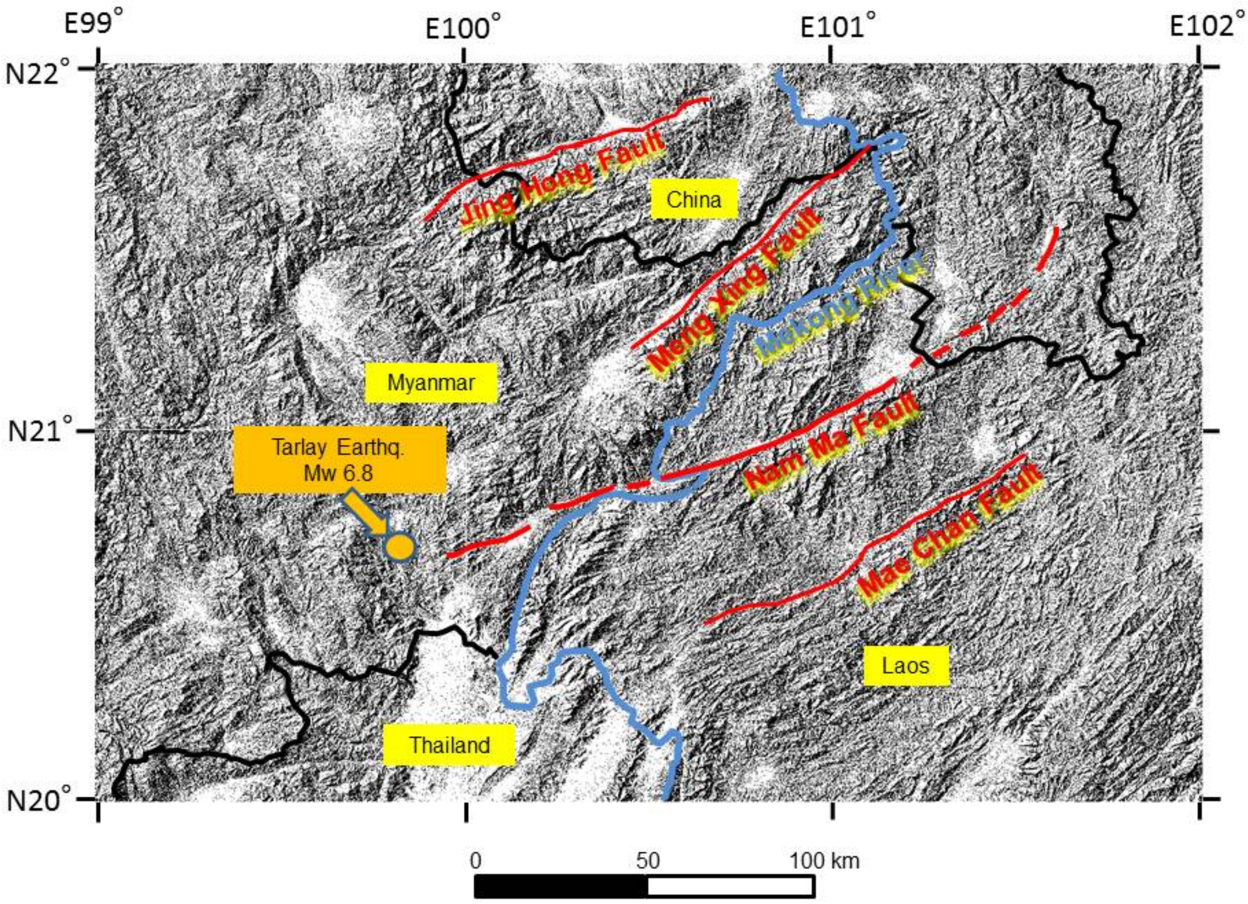
In 24 March 2011, an earthquake at the scale of Mw 6.8 occurred near Tarlay in Myanmar, which is located in the border region of China, Laos, Thailand called Golden Triangle. The news about the earthquake was released not by an organization of Myanmar but by US Geological Survey.
In the past century, many significant and destructive earthquakes occurred in and around the Golden Triangle region including the 1976 Longling earthquakes (Mw 6.7 and Mw 6.6), the 1988 Lancang earthquake (Mw 7.0), and the 1995 Menglian earthquake (Mw 6.8). The 2011 Tarlay earthquake is the most recent in this series.
The Golden Triangle region is bounded by two major strike-slip boundaries: the Red River and the Sagaing fault zones. Between these zones, numerous lesser strike-slip faults cut a region of rugged relief that ranges in elevations from 500 to 3000 m. Most of these lesser faults strike northeast-southwest and are arcuate. Nam Ma fault, 215 km long, running through Myanmar, Laos and China is one of the faults.
By field observation after the shock, Soe et al. (2014) confirms that the earthquake resulted from rupture of a structurally distinct segment of the Nam Ma fault, bounded on the west by the fault's terminus and on the east by the Tarlay basin stepover. If the 215 km Nam Ma fault were to rupture entirely in a single event, the magnitude of the resulting earthquake would likely be about Mw 7.7.
As the active faults cross over several countries and must damage a wide area, systematic observation under international cooperation is required.

Keywords: Earthquake, active fault, strike-slip fault, Myanmar, Golden Triangle


E99°
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N22°
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Jing Hong Fault
China
Meng Xing Fault
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Myanmar
Tarlay Earthq.
Mw 6.8
Nam Ma Fault
Mae Chan Fault
Laos
Thailand
0
50
100 km

Active fault map and ASTER global digital elevation model in Turkey

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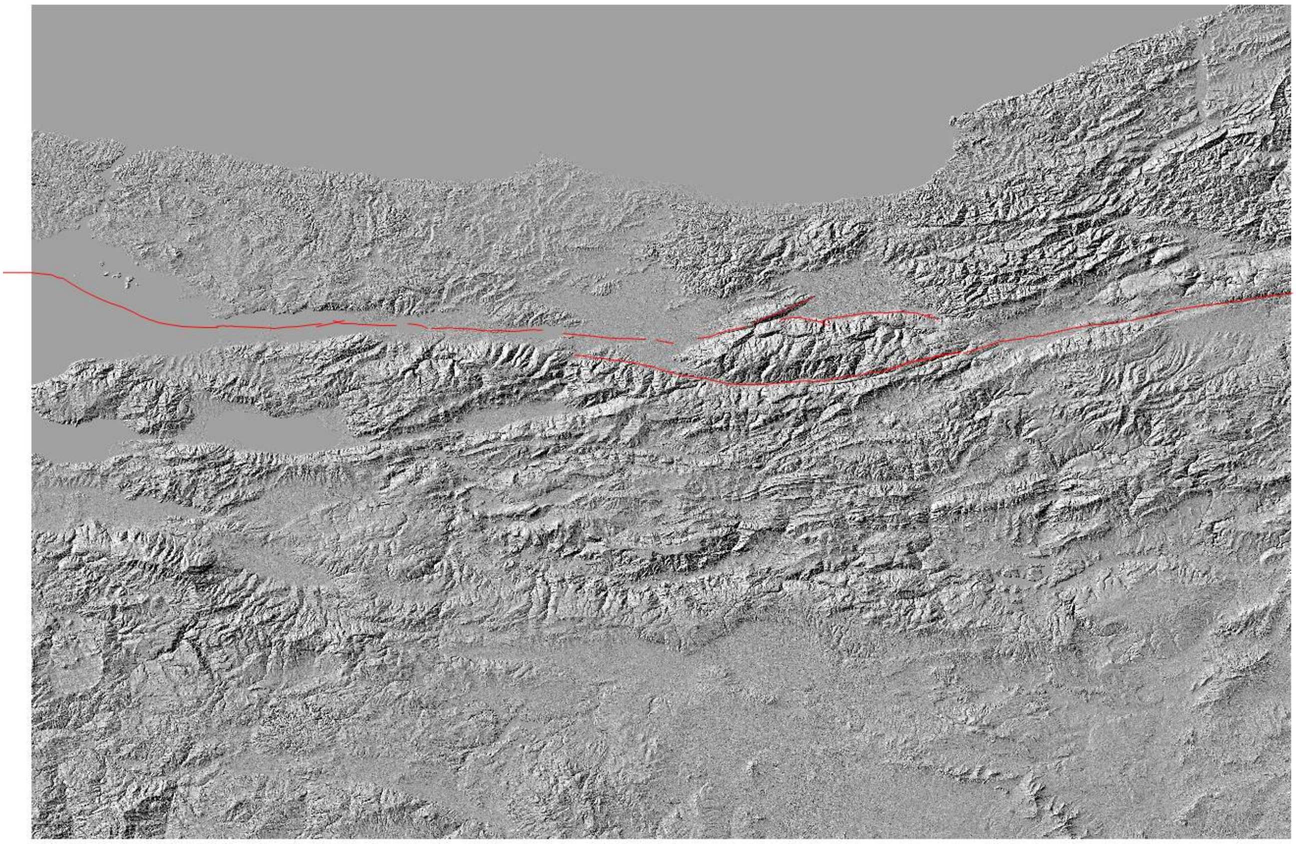
1. Geological Survey of Japan, 2. Japan Space Systems

Active fault map of the Turkish mainland, a guide document showing the geographic distribution and general characteristics of the active faults was published at a 1:1,250,000 scale by MTA (General Directorate of Mineral Research and Exploration, Turkey). This is the first seismotectonic database for Turkey under the framework of the National Earthquake Strategy and Action Plan—2023.

Turkey is located in one of the most seismically active regions in the world. On the basis of the data sets, 18 major seismotectonic zones were delineated for Turkey and the surrounding region. The compilation and storage of the seismotectonic data sets in a digital GIS will allow analyses and systematic updates as new data accrete over time.

ASTER GDEM (Global Digital Elevation Model) Version 2 with 30-meter postings has been released. The relief map delineates linear features, which clearly correspond to the active faults. These linear features in the GDEM suggest possibility to find more active faults.

Keywords: active fault, Turkey, Global Digital Elevation Model, ASTER, earthquake, seismotectonics



Resilience to floods in M’ diq Fnideq province (Northern Morocco): a new methodological approach to managing the hydro-meteorological hazard

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In the face of climate change, resilience has become an important goal for many cities around the world. Morocco, with the specifics linked to its geographical position and socio-economic factors, deserves to be more studied by new and different approaches, especially in the management of hydro-meteorological hazards, like floods. Several different traditional methods were used to modelling, understanding and anticipating the phenomenon but the urban resilience is studied by few authors in Morocco. The approach should uncover the role of the urban system components, economic, institutional and natural. The central aim of this study is to develop a new resilience strategy of M’ diq Fnideq Province (North of Morocco) to floods, across temporal and spatial scales to maintain or rapidly return to desired functions in the face of disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity.The Flood resilience index (FRI) is developed as an approach for evaluation of flood resilience using Geographic Information Systems. The research for this study started from the findings ad conclusion of Meerow, Sara. 2016 and Batica, Jelena 2015.

Keywords: Resilience, floods, Flood resilience index , hydro-meteorological hazards, climate change, Mdiq-Fnideq province

