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United Nations
Educational, Scientific and
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pour l'éducation,
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Organización
de las Naciones Unidas
para la Educación,
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Организация
Объединенных Наций по
вопросам образования,
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منظمة الأمم المتحدة
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联合国教育、
科学及文化组织

中国地震局
China Earthquake Administration

USGS
science for a changing world

International Workshop on Earthquake Risk Reduction in the Northeast Asian Region

China Earthquake Administration
Beijing, China

30 November - 3 December 2009

International Workshop on Earthquake Risk Reduction in the Northeast Asian Region

Initiating cooperation on earthquake data analysis in the Northeast Asia Region

UNESCO is exploring the timeliness, possibility and opportunity of pursuing a cooperative activity on earthquake data analysis which will be jointly promoted by UNESCO and the U.S. Geological Survey (USGS) in the sub-region of North East Asia comprising the Republic of Korea, the Democratic People's Republic of Korea, Japan, Mongolia, People's Republic of China and the Russian Federation.

UNESCO, the USGS and earthquake science organizations in the South Asia Region have been jointly carrying out since 2001 an activity for Reducing Earthquake Losses in South Asia Region (RELSAR). This activity involves seismologists and earthquake engineers. Participants from Afghanistan, Bangladesh, China, France, India, Indonesia, Iran, Nepal, Pakistan, Sri Lanka, Thailand, the United Kingdom, and the United States have attended workshops in the framework of this activity over the past years, workshops jointly organized by UNESCO and the USGS. Funds for these workshops were essentially provided by USA, on an extrabudgetary basis as a donation to UNESCO. The dates and location of these workshops entitled "International Workshop on Seismic Analysis in the South Asia Region" were as follows: the First Workshop was held in Kathmandu in September 2001; the second hosted by China Seismological Bureau (CSB), Kunming, China, 13-6 May 2002; the Third in Colombo, Sri Lanka, 30 September – 3 October 2003; the Fourth hosted by the Geological Survey of Bangladesh and the Bangladesh Atomic Energy Commission, Dhaka, Bangladesh, 12-15 September 2004; the Fifth was held in Xi'an, China, and co-hosted by the China Earthquake Administration and the Shanxi Earthquake Administration, 12-15 November 2005; the Sixth was co-hosted by the Coordinating Committee for Geosciences Programmes in East and Southeast Asia (CCOP) and the Department of Mineral Resources, Thailand, 4-7 December 2006, and the Seventh was held in Thimphu, Bhutan, 2-5 June 2008.

A similar effort is jointly carried out by UNESCO and the USGS, since 1993, in the Middle East region where a programme for Reducing Earthquake Losses in the Extended Mediterranean Region (RELEMR) is under way. Professionals from Egypt, Kuwait, Israel, Jordan, Lebanon, Syria, Turkey, Yemen, the Palestinian Authority, and other countries participate in the workshops of this programme.

Beyond their scientific value and merit, these programmes offer a forum for scientists and engineers from countries presenting a diversity of contexts to work together under UNESCO's umbrella and discuss regional approaches to improve collaboration in earthquake data exchange and analysis.

The USGS has proposed to UNESCO to now consider to initiate a similar or comparable USGS/UNESCO effort for the sub-region of North East Asia comprising the Republic of Korea, the Democratic People's Republic of Korea, Japan, Mongolia, People's Republic of China and the Russian Federation. The first step in this planned effort will be to hold the development of this international workshop, which is hosted in China by the China Earthquake Administration, under the aegis of UNESCO and in closed cooperation with the USGS.

Preliminary Program

Sunday, 29 November 2009

Arrive in Beijing, China

Monday, 30 November 2009

09:30 – 10:30 Opening Session
Chairpersons: **Liu Yuchen** and **Ren Jinwei**, CEA

Speakers:

- **Liu Yuchen**, Vice Administrator
  China Earthquake Administration
- **Abhimanyu Singh**, Director and Country Representative
  UNESCO Beijing Office
- **Jack Medlin**, Regional Specialist for Asia and the Pacific
  U.S. Geological Survey (USGS)
- **Ren Jinwei**, Director, Institute of Earthquake Science
  China Earthquake Administration
- **Badaoui Rouhban**, Director, Section for Disasters Reduction
  UNESCO, Paris

Introductions: Participants introduce themselves giving their country, institution, and scientific/engineering background

10:30 – 11:00 Tea/Coffee Break

11:00 – 12:30 Keynote Addresses:
Chairperson: **Jack Medlin**, USGS

Ren Jinwei, *China*: *Seismicity and Active Tectonics of the Northeast Asian Region*

Koichi Kajiwara, *Japan*: *Earthquake hazard mitigation and research efforts.*

12:30 – 14:00 Lunch

Session I Seismic networks in the Northeast Asia Region:
Chairperson: **Yasuo Awata**, Japan

[A representative of each country is asked to describe the seismic networks in his/her country]

14:00 – 14:20 Country Report China
Zhang Xiaodong: *Earthquake Monitoring and Seismicity Characteristics in China*

14:20 – 14:40 Country Report Japan
Kenji Satake: *Earthquake activities and the seismic networks in Japan*

14:40 – 15:00 Country Report Mongolia
Demberel Sodnomsambuu: *Earthquake activities and the seismic networks in Mongolia*

15:00 – 15:20 Country Report Republic of Korea
Duk Kee Lee: *Earthquake activities and the seismic networks in the Republic of Korea*

15:20 – 15:40 Country Report Russian Federation
Alexei Malovichko: *Earthquake activities and the seismic networks in the Russian Federation*

15:40 – 16:00 Tea/Coffee Break

Session II

16:00 – 17:30 Discussion of other regional UNESCO programs – Part I:
Chairperson: **Badaoui Rouhban**, UNESCO

Frederick Simon: *Summary of RELEMR and RELSAR*

Open discussion focusing on the Northeast Asia Region

<u>Tuesday, 1 December 2009</u>

Session III Major Earthquakes and Seismic Activity in the Northeast Asian Region
Chairperson: **Alexei Malovichko**, Russian Federation

09:00 – 09:20 **Jiang Haikun**: *Major earthquakes in northern China and Summary of the M=8.0 Wenchuan, China, Earthquake of May 12, 2008*

09:20 – 09:40 **Evgeny Rogozhin**: *Seismotectonics and major earthquakes of the Far East region of the Russian Federation*

09:40 – 10:00 **Kenji Satake**: *Recurrence of Great Earthquakes and Tsunamis*

10:00 – 10:20 **Ulziibat Munkhuu**: Recent seismic activity around Ulaanbaatar area, capital of Mongolia

10:20 - 10:40	**Walter Mooney**: *The deadly Padang, Sumarta (Indonesia) M=7.6 earthquake of Sept. 30, 2009: Field and Seismological Observations*
10:40 – 11:00	Tea/Coffee Break
Session IV	Seismic Hazard Assessment in the Northeast Asian Region: Chairperson: **Duk Kee Lee**, Republic of Korea
11:00 – 11:10	Video (6 minutes): *The L'Aquila, Italy, Earthquake of 2009*
11:10 – 11:30	**Alexei Malovichko**: *The development of Russian seismic station network in the Northeast Asian region*
11:30 – 11:50	**Kenji Satake**: *CSEP-Japan: A rigorous earthquake forecast system based on seismicity data*
11:50 – 12:10	**Mengtan Gao**: *The main features of seismic hazard and risk in China*
12:10 – 12:30	**Demberel Sodnomsambuu**: Development of seismic monitoring system in Mongolia
12:30 – 14:00	Lunch
Session V	Seismology, geology, and earthquake engineering in the Northeast Asia Region: Chairperson: **Demberel Sodnomsambuu**, Mongolia
14:00 – 14:20	Video (10 min.): *Earthquake Early Warning: An Introduction*
14:20 – 14:40	**Koichi Kajiwara**: *E-Defense Facility*
14:40 – 15:00	**Dmitry A. Storchak**, ISC: *Integrating Seismic Bulletins in the North East Asia (1960-2009)*
15:00 – 15:30	*To Be Determinate*
15:30 – 16:00	Tea/Coffee Break
Session VI	
1600 – 1730	Discussion of other regional UNESCO programs – Part II: Chairperson: **Badaoui Rouhban**, UNESCO Open discussion focusing on the Northeast Asian Region
19:00	Dinner hosted by CEA

Wednesday, 2 December 2009

09:00 – 12:30 Visit to the China National Training Base for Search and Rescue

12:30 – 14:00 Lunch

14:00 – 17:30 Visit to the China Earthquake Networks Center

Thursday, 3 December 2009

Session VII Seismicity and Tectonics in the Northeast Asian Region:
Chairperson: **Gao Mengtan**, China

09:00 – 09:20 **Yasuo Awata**: *Characteristics of size and long-term slip-rate of the segmented major active-faults in Japan*

09:20 – 09:40 **He Honglin**: *Seismicity and Tectonics in northern China*

09:40 – 10:00 **Winston Chan**: *3-D Velocity tomography of Korean peninsula and surrounding regions*

10:00 – 10:30 *To Be Determinate*

10:30 – 11:00 Tea/Coffee Break

Session VIII

11:00 – 13:00 Closing Session and Discussion of future activities in the Northeast Asia Region:
Chairpersons **Walter Mooney**, USGS and **Frederick Simon**, UNESCO:

13:00 – 14:30 Lunch

14:30 – Free time for one-on-one discussions

Friday, 4 December 2009

Participants depart from Beijing

Seismicity and Active Tectonics of the Northeast Asian Region

Ren Jinwei

Institute of Earthquake Science, China Earthquake Administration
Beijing, China

Northeast Asia continent is controlled by the west Pacific Island Arc System. It is the first-order division for lithospheric dynamics. Although the major earthquakes are located along the subduction zone, the earthquakes in the northeast Asia continent are obviously affected by the dynamic process of the subduction between Pacific plate and Eurasian plate.

Northern China is characterized by intense activity of lithospheric dynamics. Upwelling of mantle convection cell produced by an undefined mechanism caused plastic flow of lower crust and brittle extension of upper crust, and hence led to the region to form a series of taphrogenesis basins. There is a ductile shear zone between the lower and upper crusts with different dynamic features. In this zone a low velocity layer is found. On the other hand, lateral compression caused by the subduction of west Pacific, marginal sea basin, deep plastic flow and shallow lateral compression caused by the uplifting of Tibet plateau produced a horizontal tectonic stress field with ENE-WSW compression imposed on this region.

Northeast China is a unique region for deep earthquakes in China. The lithosphere in this region may be distinguished into four layers with their total thickness of 63-150 km. In accordance with gravity and magnetic data, the region can be divided into three areas with different crustal structure. Since the Cenozoic time they have undergone differential movement, uplifting and subsidence. The lithospheric structure and seismicity in this region could be resulted from the deformation and tectonic adjustment by heating and pressure under the interaction of Pacific plate, lateral compression of Baikal rift, upwelling magma and gravity isostasy. During the last 1000 years, the seismicity in the region is mainly caused by the lateral compression of the Pacific plate.

In eastern China, distribution of historical earthquakes is similar to those recorded by the instruments, but seismological regionalization and degree of seismicity are remarkably different. Nevertheless, one thing is the same, almost all the earthquakes are generated in the middle and upper crust, and the epicenters are along the major faults in the direction of NE-NNE and NW-NWW. Focal mechanism solutions show that the principal compressive stress axis is in nearly EW direction in eastern China, in ENE direction north of the Yangtze River, and in ESE direction south of it.

The tectonic activity in the last 1000 years in northern China is characterized by uplifting and faulting, which are consistent with the Cenozoic active zones and with the belts of the historic and recent large earthquakes. From the attitude of sedimentary formations, the region was dominated by faulting in the last 10000 years, especially in the last 2000 years the regional uplift is evident. The faulting in this region has dislocated Holocene sediments, cultural relics and layers, controlling the distribution of river system and lakes.

Earthquake Monitoring and Seismicity Characteristics in China

Zhang Xiaodong

China Earthquake Networks Center, China Earthquake Administration
Beijing, China

There are existing 1244 seismology monitoring (network) stations and 2263 observation stations, including 191 national stations, 296 provincial stations and 757 county-level stations. There are 4858 current running seismic instrumentations, of which, the Seismic, deformation, electromagnetic, fluid subjects on China Earthquake Network. The numbers of instrumentations are as follows: 1500 sets, 808 sets, 861 sets and 1626 sets. At present, earthquake of magnitude 1-1.5 can be monitored in the metropolitan area, time of rapid earthquake information report is 5-10 minutes; Earthquake of magnitude 1.5-2 can be monitored in capital cities and eastern region, time of rapid earthquake information report is 10-15 minutes; And earthquake of magnitude 4 or above can be monitored in other regions, time of rapid earthquake information report is 20-25 minutes.

There are existing 1303 seismic observation stations, 358 deformation observation stations, 294 electromagnetic observation stations, 619 fluid observation stations. Sum of them precursor observation stations is 1271.

Our country's geotectonic environment brings the frequent seismic activity, so China is the highest earthquake activity area in the world. The seismic activity of China is very frequent due to it located between several tectonic plates and is also located at the intersection part of circum-Pacific seismic belt and Eurasia seismic zone. Earthquakes in Chinese mainland are about one third of the land ruinous earthquakes over the world, however, the land area of China is only 1/14 of the global one. Since 20 century, there are more than 1600 earthquakes in Chinese mainland with magnitude between 5 and 5.9, and the average is 16 times per year; 395 earthquakes with magnitude between 6 and 6.9 and the average is 4 times per year; 70 M7.0-7.9 earthquakes and the average is two times for three years; 8 M≥8.0 earthquake occurrence.

These seismic activities in space and time are not uniform. There are more earthquakes in west than east in space and have very obvious active and quiet alternative characteristics according to their occurrence time. These earthquake occurrences are intermediate focus earthquakes (with 70-300km depth of focus) in Taiwan and Himalayan areas, are deep-seated earthquakes (with more than 300km depth of focus) along the area from Heilongjiang to Jilin. Others are all shallow focus earthquakes with less than 20km depth of focus.

Every province in China has M≥5.0 destructive earthquakes. 30 provinces (excluding Zhejiang) have M≥6.0 earthquakes and 20 have MiÝ7.0 ones. Tibet, Xinjiang, Yunnan, Sichuan, Gansu and so on have the higher level of seismic activity. More than 40% national territory and 2/3 big cities with million people are located in the high intensity seismic regions which are above VII intensity.

Earthquake activities and the seismic networks in Japan

Kenji Satake

Earthquake Research Institute, University of Tokyo
Tokyo, Japan

Japan is one of the most active countries in terms of seismicity. Each year more than 100,000 earthquakes, or more than 300 a day, are detected. Thousands of seismic stations with various types of instruments are distributed throughout Japan, including about 800 Hi-net and KiK-net (high-sensitivity and strong-motion instruments in boreholes) stations operated by NIED (National Research Institute for Earth Science and Disaster Prevention), and about 200 seismic stations operated by Japan Meteorological Agency (JMA). These data are telemetered to JMA for Earthquake Early Warning, tsunami warning and making earthquake catalog. In addition, NIED operates about 70 broadband stations (F-net) and about 1,000 strong-motion stations (K-NET), and other agencies such as local governments operate additional a few thousands of seismic intensity meters. For geodetic monitoring, Geographical Survey Institute operates about 1200 continuous GPS stations.

After the 1995 Kobe earthquake which caused more than 6,000 casualties, the Japanese government established Headquarters for Earthquake Research Promotion, which includes Policy Committee and Earthquake Research Committee (ERC). The ERC meets every month to evaluate the current seismic activity in and around Japan. The ERC also made and has been updating National Seismic Hazard Maps, which consist of probabilistic seismic hazard maps for the entire Japan, and deterministic seismic hazard maps for specified source faults. These maps were made based on several steps. First, past occurrence of earthquakes were studied by paleoseismological and historical studies, from which probability of future occurrence of earthquakes is estimated. Then strong-motion is calculated based on models of earthquake faults and subsurface seismic velocity structure, following a standardized method.

Earthquake activities and the seismic networks in the Republic of Korea

Duk Kee Lee

Earthquake Policy Division, Korean Meteological Division
Seoul, Korea

KMA(korea Meteorological Administration) has performed the project for strengthening the Korea National Seismographic Network (KNSN) and the tsunami warning system since later 1990. KMA officially issue national earthquake and Tsunami dissemination and notification to public.

This system was completely constructed in 2002 and has been continuously reinforcing. This network is currently composed of 12 broad-band seismometers, 32 short-period seismometers, 4 borehole seismometers, 109 accelerometers and earthquake analysis system also. Many inland type seismometers and accelerometers were also installed in 2007. Especially, KMA installed 3 borehole seismometer and one geomagnetic observatory in 2008. The one-stop earthquake & tsunami analyzing and broadcasting (warning) system that disseminates warning messages to the relevant organizations has been improved continuously. The Republic of Korea is currently exchanging seismic data with Japan. KMA is keen to share seismic data with other countries. In addition, KMA is exchanging seismic data from 83 stations with other related institutions of Korea.

KMA has been executing simulated tsunami preparedness drills to evaluate the tsunami warning and notification system each year. KMA executed that drill in 2008. KMA also participated in the international tsunami drill titled 'Exercise Pacific Wave 08' held in charge of ICG/PTWS on October 29 in 2008.

In order to inform for the general public, KMA published one catalogue on earthquakes and related fields at 2008 and have executed many education programs about the earthquake & tsunami and how to behave against these disaster.
The earthquake division of KMA currently operated as a bureau level under the leadership of Director-General for Earthquake.

Korea has been increasingly aware of the importance of preparedness against earthquake and tsunami hazards and continually support KMA for earthquake hazard mitigation.

Seismotectonics and major earthquakes of the Far East Region of the Russian Federation

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The Far East of Russia is the most seismically hazardous region of the country. For last 15 years 8 major seismic events with intensity of 9-10 degrees (in MSK-64 scale) have occurred in this region. The M=8.2 Shikotan (1994) and M=7.9 Urup (1995) earthquakes in the South Kuril Islands, the M=7.6 Neftegorsk (1995) earthquake in the North of Sakhalin Island, the M=7.9 Kronotsk (1997) earthquake in the East of the Kamchatka peninsula, the M=7.0 Uglegorsk (2000) earthquake in the central part of Sakhalin Island, the M=7.8 Olyutor (2006) earthquake in the Koryak Region of the Kamchatka area, two M=8.3-8.2 Simushir (2006 and 2007) earthquakes in the Central Kuril Islands happened. More than 10 strong earthquakes (M=6.0-6.8; I=7-9) occurred in the Region for the same period. Thus, the seismic activation took place in the Far East region in the late XX and early XXI centuries.

Some of the events were accompanied by human losses, numerous destructions and disasters. For example, due to the 1995 Neftegorsk earthquake, about 2000 people were killed and several hundreds of persons were wounded. The settlement Neftegorsk was completely destroyed. After the Shikotan event the ocean bottom relief changed and 3 m high tsunami wave came.

Seismotectonic position of seismic sources for the strongest events was thoroughly studied for which both geological and seismological epicentral investigations were specially organized. As a result two main types of the sources were recognized: intraplate and interplate. Therefore, the Shikotan, Simushir (2007), Neftegorsk and Uglegorsk earthquakes had intraplate nature. They are not correspondent with movement on the margins of lithosphere plates. On the other hand the sources of the Kronots, Simushir (2006) earthquakes were interplate because their offset is well correspondent with displacements on the boundaries between the Pacific and Eurasian plates (subduction zone). The Olyutor earthquake source was interplate, too as it marked the boundary of the North America plate and the Bering microplate.
In some cases the successful prediction of major earthquakes was elaborated. For example, half a year before the Shikotan event the prediction was announced according to the data of specific solution to focal mechanism for deep focused foreshocks. The medium term forecasting of the Simushir 2006 major earthquake was formulated using the result of seismic gap analysis and GPS measurements for the Kuril Islands arc.

Complicated structure of the Neftegorsk and Olyutor seismic sources were reconstructed as a result of seismic and tectonic field study of surface rupture system carried out immediately after the main shock. In the first case the seismic fault of total length up to 40 km with amplitude of vertical offset up to 1 m and right-lateral offset up to 8 m was mapped on the surface of the Earth. The orientation of the fault was NNE and the northern end of the rupture zone looked like some tree branches. It had three additional smaller faults. The Olyutor earthquake system of ruptures looks like three echelon segments of total length up to 140 km, presented by a 75 km overthrust fault with vertical offset amplitude more than 3 m. The central segment 40 km long was presented by pure dextral strike-slip with offset 2.5 m and south-eastern segment had a length of 16 km and pure left-lateral strike-slip offset with amplitude up to 2 m.

The paleoseismic investigations were carried out in the mezoseismal area of the Neftegorsk and Olyutor earthquakes. Two trenches across the fault of the first event demonstrated that at least three seismic events occurred there about 1000, 1400 and 1800 yr BP. Recurrence interval is nearly 400 years. Three trenches were excavated across the fault of the Olyutor earthquake. Reconstructed ancient earthquake took place within 7000-6000, 3700-3500, 2500-2000 and 1500-1000 yr BP. Recurrence interval between 4 last events (including the 2006 Olyutor earthquake) was estimated to be a little bit more than 1000 years.

Recurrence of Great Earthquakes and Tsunamis

Kenji Satake

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Paleoseismological studies of subduction-zone earthquakes along the Pacific Rim, including those in Chile, Cascadia and Kuril subduction zones, had shown that giant earthquakes occur at 300 to 500 year interval, longer than the recurrence interval of typical subduction-zone earthquakes estimated from historical records. The 2004 Sumatra-Andaman earthquake (M 9.1) and the associated Indian Ocean tsunami demonstrated that such an earthquake occurs in Indian Ocean and cause unpredicted disaster.

Along the southern Kuril trench, the recurrence of earthquakes larger than those in the 200-year written history of Hokkaido has been revealed from coastal geology. Multiple sand layers indicate recurrence of unusually large tsunamis with an average interval of ~500 years with the most recent event in the 17th century. The inferred tsunami inundation area is best modeled by a multi-segment interpolate earthquake (M~8.5), which also triggered deep post-seismic creep that produced decimeters of coastal uplift. Similar unusual earthquakes have been inferred off Sendai along the Japan trench. The AD 869 Jogan tsunami brought tsunami deposits to Sendai and Ishinomaki plains and the deposits suggest that similar earthquakes repeat at a recurrence interval of ~ 1,000 years.

Such great earthquakes and the accompanying tsunamis can affect neighboring countries in Northeast Asia. Great earthquakes along the Kamchatka or Kuril trench can generate tsunami which may cause damage in Japan. Tsunami from an earthquake along the eastern margin of Japan Sea can affect Korean peninsula or Russian coast. Earthquakes in Korean peninsula, eastern China or southwest Japan can be felt in other countries. These indicate that studies of historical documents and paleoseismological evidence in neighboring countries may help to reconstruct history of past earthquakes. International collaboration on past earthquakes, as well as modern seismicity, in Northeast Asia needs to be promoted

Recent seismic activity around Ulaanbaatar area, capital of Mongolia: Results of seismic, geological and geophysical surveys

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A high seismic activity occurs in the western end of Ulaanbaatar basin, at about 20 km to the west from the city center of capital city of Mongolia since 2005. This area, which could be one of most seismic active zone around Ulaanbaatar, dramatically increases the seismic hazard of the capital of Mongolia where is concentrated about of 1/3 of the Mongolia population and the majority of industries of the country.

Since the beginning of this high seismic activity in middle of 2005, more than 2000 earthquakes with magnitude between 0.5 and 4.2 have been observed by our network through this area. Moreover, the analyses of the seismotectonic context is very interesting and challenging as this area is at the junction between high and low active tectonic areas revealing a clear paleoseismic activity . In addition to the complexity of the tectonics context, the lack of large magnitude earthquake in this area conjugated with the recent triggered high seismic, which has been well monitored by local digital seismic network, makes the study of this earthquake activity fundamental for the estimation of Ulaanbaatar seismic hazard. In this presentation, we will discuss results of geological survey and analyze this seismic activity, such as the time evolution of the earthquake swarms.

The Development of Russian Seismic Station Network in Northeast Asian Region

Alexey Malovichko

Geophysical Survey of Russia Academy of Sciences
Obninsk, Russian Federation

Few scientific and technical projects were implemented in the past decade with the aim of significant developing a seismic station network in the Far East of Russia. The most important project is “Upgrading of the Russian Tsunami Warning System”. Eight new digital seismic stations were installed in Kamchatka, the Kuril Islands, Sakhalin Island and Primorye region. All stations were equipped with broadband seismometers CMG-3ESPC and accelerometers CMG-5.

In the framework of the cooperation project "Research on Seismo-Tectonics around Okhotsk plate" between Japanese collaboration of Universities and Geophysical Survey of RAS eleven digital stations were installed. They were equipped with broadband seismometers STS-2. A local network of 9 short-period seismic stations was installed in cooperation with the Hokkaido University in the south part of Sakhalin Island.

To organize the real-time data transmission from stations to processing centers the 23 communication channels (through Russian geostationary satellite “Express AM-3") were installed.

Advanced observational facilities will provide new opportunities to study the space-time pattern of earthquake occurrence, the initiation and rupture sequence of earthquakes, three-dimensional structure of Earth’s interior and many other fundamental aspects of modern seismology. Improved understanding of seismic processes and continental structure and dynamics is important step for development strategy for solving earthquake risk reduction problem in region.

CSEP-Japan: A rigorous earthquake forecast system based on seismicity data

Hiroshi Tsuruoka, Kazu. Z. Nanjo, and Naoshi Hirata
presented by Kenji Satake

Earthquake Research Institute, University of Tokyo
Tokyo, Japan

We started CSEP-Japan, a program to quantitatively forecast time, place, and magnitude of future earthquakes in and around Japan, based on seismicity data. Our focus is a rigorous approach based on the following three steps: (1) developing the Testing Center, a framework to quantify the performance of registered earthquake forecast methods; (2) conducting comparative testing experiments within this framework to determine the registered forecast model's accuracy; and (3) aiming at the creation and buildup of sophisticated forecast models, based on results obtained from multiple experiments. To start this new research program, the Earthquake Research Institute (ERI) joined the global project "Collaboratory for the Study of Earthquake Predictability" (CSEP) that promotes rigorous research on earthquake predictability. In collaboration with CSEP, ERI implemented the Japanese Testing Center since summer of 2008 and formally started the 1st earthquake forecast testing experiment on 1 November 2009. In our presentation, we first give a brief introduction of the current national program. We then present our primary scope of the CSEP Testing Center and a short summary of the experiment's recent status. We finally conclude that our approach is becoming a good baseline for model development in order to move toward constructing earthquake forecast systems for Japan.

The main features of seismic hazard and seismic risk in China

Mengtan Gao

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Beijing, China

China is an earthquake prone country, and has suffered tremendous losses from earthquakes. In the last one hundred year, nearly 0.7 million people died from earthquakes, nearly hundreds cities and towns ruined by the earthquakes. Earthquake disaster mitigation is vital to the largest developing country in the world.

There are very good database for seismicity analysis. The historical catalogue contains nearly 12 thousands of events. The instrumental catalogue contains 250 thousands of events. The frequency of earthquake in China is very high. There is about one earthquake with magnitude equal or greater than 8 in ten years, and about one earthquake with magnitude equal or greater than 7.5 in 4 years. The distribution of earthquakes in China is inhomogeneous. The annual rate in western china is six time than that of eastern China. The dense epicenters have very well correlation with tectonic frames. The large earthquakes with magnitude greater than 7.5 occur along the block boundary of the tectonics.

The current used national seismic hazard map is published in 2001. This map was made by using probabilistic method. The seismicity model for the hazard map is benefit from the long history of earthquake events recording. The parameters in the hazard map are peak acceleration and the corner period of seismic response spectrum, and the exceeding probability is 0.1 in 50 yeas. The national seismic hazard map is used as the state standard for the seismic design. This presentation shows the seismic hazard map with different exceeding probability levels in China and also the progress of the methodology seismic hazard mapping.

China is in exposure of the highest seismic risk in the world. There are about 15% of the cities and towns in China which might be the epicenter regions of great earthquake with magnitude 7 or above. The seismic hazard and vulnerability are high in western China, but the exposure population is much lower than that in eastern China. There are dense population and economics in eastern China. There is the possibility of more than one hundred thousands people died in a earthquake with magnitude 8 in this region. There is also the possibility of one billion RMB economic losses from a moderate earthquake in this region.

Development of Seismic Monitoring System in Mongolia

Demberel Sodnomsambuu

Research Center for Astronomy & Geophysics of Mongolian Academy of Sciences
Ulaanbaatar, Mongolia

In Mongolia, as well as in all seismic active countries in the world, the seismic monitoring and its study are important scientific and practical measures for their sustainable development.

The seismic pattern of Mongolian territory is determined by the deformation process which can be attributed to the collision and subsequent penetration of the Indian plate with respect to Eurasia and the extensional tectonics related to the active Baykal rift system. The occurrence and distribution of strong earthquakes are the manifestation and result of these widespread and varied styles of deformation.

The Research Center for Astronomy and Geophysics of Mongolian Academy of Sciences (RCAG MAS) is the national data center for seismology of Mongolia. First analog seismic station in Mongolia was installed by the Government of Mongolia in Ulaanbaatar in 1957. It was the beginning of the development of Mongolian National Seismic Network (MNSN) in Mongolia. Few months later, the 4 December 1957, a strong earthquake occurred in the Gobi-Altay (Mw=8.1). It confirmed the high seismic activity (three other events occurred earlier with Mw ≥ 8: the 1905/07/09, the 1905/07/23 and the 1931/08/10 in Mongolia and its immediate surroundings).

Since 1957, the MNSN has been developed and enables the RCAG to detect and localize precisely the seismic activity in Mongolia. Since 1994, the RCAG has a very fruitful technical and scientific cooperation with the "Laboratoire de Détection et de Géophysique" of the "Department Analyses Surveillance, Environment" (DASE – LDG) from France.

The seismic mini array PTS-25 of CTBTO was installed near the capital Ulaanbaatar and it allows consistent regional monitoring of UB surroundings. In 2007, we renewed all national regional analog seismic stations and installed a new digital seismic instrument: one component, short period seismometers.

All seismic data of MNSN are transmitted and archived in real time to the Mongolian National Data Center (NDC) of RCAG. The detection, interactive processing and data interpretation is carried out by researchers at NDC. At the present, MNSN received the data from 50 digital seismic stations which is equipped by different seismometers like one and three components short period, broadband and borehole instruments.

In 2009 the Government of Mongolia adopted the National Program on Seismic risk mitigation in Mongolia and RCAG, as one of the major executed organization of this program has a plan on future development of MNSN. We are planning to install three new permanent regional seismic stations near the significant seismic source areas in Mongolia.

E-Defense Facility

Koichi Kajiwara

Hyogo Earthquake Engineering Research Center
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Seismologists predict alarmingly high probability that hazardous earthquakes will hit major cities of Japan in the coming years. Among the most notable risks are the subduction zone earthquakes along the Tokai, Tonankai, and Nankai Troughs, which can cause category 7 (the largest in the Japanese seismic intensity scale) ground motion across the greater Tokyo area.

The Japanese citizen and our local and national governments are very aware of the risks, and are therefore, earnestly working to reduce earthquake hazards. The devoting research activities to improve earthquake-resistant construction comprise a part of this larger, national effort.

The Hyogo Earthquake Engineering Research Center, nicknamed E-Defense, is a branch of the National Research Institute for Earth Science and Disaster Prevention (NIED) of Japan. Inaugurated in 2005, E-Defense enables earthquake simulator testing of unprecedented, large-scale specimens. To date, 38 research programs have been completed to advance the state-of-art of earthquake engineering. The scope of research spans from immediate life concerns such as residential wood construction and school buildings, to critical facilities such as power generating stations.

The invaluable information produced at E-Defense has been used for academic research as well as education. Very convincing video images have been aired through the mass media and through the website of E-Defense. These images proved to be a powerful tool for increasing the awareness of earthquake hazards.

E-Defense is intended as a shared-use facility to benefit the international community. For example, a Memorandum of Understanding is in place between NIED and the U.S. National Science Foundation—Network for Earthquake Engineering Simulation. Under this MOU, collaborative research efforts activities are underway between the U.S. and Japan. E-Defense is hopeful that this collaboration will expand to the nations attending this conference to promote research, to promote earthquake risk mitigation, and to promote friendship.

In this presentation I will introduce the E-Defense facility and discuss selected research activities.

ISC: Integrating Seismic Bulletins in the North East Asia (1960-2009)

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The International Seismological Centre (ISC) is a non-governmental, non-profit making organization supported by 55 research and operational institutions around the world, including JMA, RAS, CEA, JAMSTEC, ERI and KMA. The ISC is charged with production of the ISC Bulletin – the definitive summary of world seismicity based on seismic reports from over 120 institutions. Jointly with World Data Center for Seismology (Denver), the ISC runs the International Seismic Station Registry (IR). The ISC updates and distributes the IASPEI Reference Event List (GT) and the EHB data collections.

The ISC plays the unique role in the North East Asia Region by integrating seismic bulletin data from seismic networks in China, Japan, Korea and Russia. This allows ISC to create the most definitive summary of seismicity in the region.

The ISC has a substantial development programme that would ensure that the ISC data will remain an important requirement for geophysical research. An essential part of this programme is a project to re-produce the entire ISC dataset (1960-2009). Consistency and uniformity of the long period data sets is a major requirement. At the ISC we recently started using ak135 velocity model instead of Jeffreys-Bullen. We also are preparing to introduce a more advance location algorithm soon. To make sure that newly produced seismic bulletin data are consistent with those in the past we are planning a massive project of re-producing the entire ISC dataset. We shall:

- Re-compute ISC hypocentres using new standard earthquake locator, ak135 velocity model and uniform thresholding algorithm, set of defining seismic phases (IASPEI) and error estimates;

- Re-compute event magnitudes using consistent treatment of amplitude measurement outliers, removing magnitude estimates based on too few measurements, providing previously unavailable magnitude error estimates and an account of which stations contributed towards the ISC network magnitude in each case;

- Collect, introduce and process essential additional datasets that have not been available at the time of original ISC Bulletin production;

- Fill known gaps in agency's bulletin reports in the past;

- Rectify known errors, inconsistencies and spurious events, identify and mark data from networks with erroneous time stamp, re-assign event type flags to provide consistency between reports of different agencies.

We invite comments, error reports, suggestions and missing bulletin datasets from those institutions in the North East Asia who are interested to help the ISC in this vital development.

Characteristics of size and long-term slip-rate of the segmented major active-faults in Japan

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Size and long-term slip-rate of active faults are fundamental parameters for evaluation of earthquake occurrence from those faults. We analyzed the fault parameters listed in the Active Fault Database of Japan (http://riodb02.ibase.aist.go.jp/activefault/index_e.html) to reveal the characteristics of fault length, slip per event, long-term slip rate and recurrence interval and regional distribution of these parameters.

Major active faults in Japan, which are 10km and longer in length and >= 0.1m/ky in slip-rate, are segmented into ca. 550 behavioral segments, based on geometry of fault strand separated by discontinuities of 2 km larger and bends of 20 degree and larger, and differentiation in faulting behavior, such as timing of paleoearthquake and long-term slip-rate. 550 segments consist of ca. 290 reverse faults, ca. 40 normal faults and ca. 220 strike-slip faults. The length of segmented faults shows a fractal-like structure with fractal dimension: D = ca. 1.6, braking at ca. 20km-long. The maximum value in fault length among those segments is 66. These dimensions of fault show indistinct regional distribution. These characteristic lengths of the segments may be controlled by the thickness of the elastic layer of the crust.

Amount of slip-per-event (mode or frequently-occurring value of net slip) can be estimated from field data on 65 segments. There is linear correlation between segment length (L in km) and the slip per event (D in m); $D = 0.12 L$. This scaling relation is consistent with the relationship between the length and the maximum displacement of the segmented historical surface ruptures on land of Japan, and suggests constant stress-drop during the rupturing of individual segment The traditional scaling relation between total length and slip of historical ruptures is well depicted by our new scaling relation and characteristic size of segmented active faults.

Long-term slip-rate and recurrence interval of the segments vary between 0.1 and 9.1 mm/yr, and 0.7 and 4.1 ky. These parameters on the fault activity show significant regional distributions. The activities concentrate along the primary active structure, namely the Itoigawa-Shizuoka Tectonic Line and the Median Tectonic Line, back arc margin of the Northeast Honshu Arc and the plate-colliding zone between the Eurasia and Philippine Sea plates. Long-term activities of the faults are consistent with the geodetic measurements during past 10 to 100 years in the back arc regions, where back-slip of the plate subduction earthquakes is negligible.

It is necessary to evaluate the interactions among neighboring fault segments to estimate the size and magnitude of future earthquakes, because an earthquake ruptures one or more contiguous fault segments. To evaluate the long-term rate of earthquake moment release, it makes no difference whether those faulting events are modeled as a single multi-segment earthquake or as separated earthquakes. However, there is a difference for the scenarios of future earthquake hazard.

3-D Velocity Tomography of Korean Peninsula and Surrounding Regions

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Seismic data in the Korean Peninsula were collected, verified, validated, and archived for the time period 1990-2003. Hypocenter locations for over 4500 events were determined and preliminary wave ray-densities examined. On the Korean Peninsula, bulletin data and waveform data from the Korean Meteorological Administration (KMA) of South Korea were collected supplemented by seismic stations in China. The waveform data were analyzed for a total of 207 events, phase arrival times for P- and S-waves determined, and hypocenters estimated. Pn phase information from the KMA waveform data was used to estimate a 3-D image of the Moho topography beneath the Korean Peninsula. The results reveal a slightly undulating interface with depth down to 34 km beneath the southern peninsula and 28 Km beneath the Yellow Sea and Sea of Japan. The structure of the Moho interface can be used to constrain crustal depth in future tomographic studies

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