Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U06-01 Room:IC Time:May 24 09:00-09:25

Social and Intelligent Contributions by Earth Scientists for Natural Disasters

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[1]Visiting (Universities)

1. Introduction:
Japanese disaster-prone archipelago of volcanic earthquakes has become a world leader in science and technology to respond quickly to support our life against destructive disaster. However, to discuss with everyday life of citizens as seen from the perspective of earth scientists of long-term activity of the Earth, has not been sufficiently discussed so far. The purpose of the paper is to propose an appropriate and continuous way for the future from the view of earth science (also in Japan) against the declaration of safety addressed by the government committee of the earthquake in L'Aquila, Italy four years ago.

2. Earthquake formation and life-time from the views by earth scientist:
Large natural disaster which is based on rapid phenomena generated short shock-wave (volcanic eruption, earthquake and meteoritic impact) produces change of topography and environments on our surface. Therefore, it should recognize that disaster with lasting injury death is inevitable for human beings and living life formed on the surface surely. Thus, it is required individual situation (risk) control on a daily life with our intelligent increase against active Earth.

3. Main difference in time of earthquake and living life:
Living people might expect daily safety based on disaster treatment by one-day unit. The Earth scientists are discussed by long time-unit of million years activity to apply short micro-time unit of life-time. Due to differences in the length of time, it is assumed that data of Earth Science is uncertainty, or that Earth Science (Earthquake or layers) in not scientific differed from theoretical sciences or chemistry. Earth Sciences with wide multi-complex system (as air, water, rock circulatory system) should be required to be understood widely even in individual citizens.

4. General request to earthquake security treatment:
Human life in units from day to year is expected what is life without the earthquake security is expected. However, the frequency of a large earthquake is based on long Earth activity (with multi-processes) and fundamentally different from short life-time, where it is inevitable for earthquake disaster prevention for life-time unit. It is necessary to be understood that the predictions from the theoretical data-analysis and experimental data is the best scientific security (cf. trace of giant tsunami when the dinosaurs became extinct in the asteroid collision and remain deposits in the coastal Gulf of Mexico). It is important to build a museum and educational park for education (cf. the village ruined by the huge tsunami park in the southern part of the Hawaiian island). And it is important to support our individual increase of risk situations (cf. Japan equivalent place of earthquake in the western United States, where earthquake information on aired in public at the airport to watch and decide own behavior by ourselves).

5. Requests for mass-media and courts:
We expect that mass media and courts should recognized difference between our lifetime activity and the global perspective of researchers in units of different "time". Final self-guard is dependent to individual daily behavior for any disasters. The present court affairs on earthquake in Italy are local situation without continuous global risk-control, which should ask daily behaviors of the lived residents rather than all the bureaucratic and professional information. Thus, we should proceed our knowledge globally to determine on own final action by self-guards which will be supported widely by university and mass-media activities.

6. Summary:
The most safety strategy by the citizens from views on dynamic active Earth is to prepare global data with wide multi-dimensional data processing by university-laboratory and governmental offices, and to increase any situation (risk) control of the citizens by their own self-guards.

Keywords: Natural disasters, Earth Scientists, Social contribution, Intelligent contribution, Huge earthquake, Huge Tsunami

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U06-02 Room:IC Time:May 24 09:25-09:50

Victims Living at Teporary Housing - As of State in Miyako City, Iwate

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Unsolved problems have been piled up at the area stricken by the huge tsunami, although two years passed from the 9.0 magnitude earthquake off the Pacific Coast of the eastern Japan on March 11in 2011. Reconstruction from the disaster has not been enough and the road to recovery is too much farther.

Collaborative studies on living environment and resident's health in temporary housing have been conducted by the Study Group on Recovery of the Areas Affected by the 2011 Great East Japan Earthquake. This presentation aims to focus on studies on 1) room climate in temporary housing, 2) physical activities of daily living of temporary housing residents, 3) mental health of the residents with various experience related with the tsunami disaster, 4) spatial characteristics of living behavior of the residents in Miyako city, Iwate prefecture.

On November 6 in 2012, Miyako city's website confirmed 611 people had been dead or missing in the city, 5,968 buildings totally had collapsed, and 3,120 buildings 'half collapsed' or partially had been damaged. 8,889 evacuees in maximum took refuge in the official evacuation shelters immediately after the tsunami. Miyako city inquired of victims demand for temporary housing in the evacuation shelters for 5 to 7 days after the tsunami, and selected sites of temporary housing, furthermore carried out infrastructure development and construction temporary housing in the sites. After these steps above, 62 temporary housing complexes with 2010 units were built up at grounds of elementary schools and parks in around June 2011, and then 3742 victims moved into 1667 units.

1) Room climate: Characteristics of room climate in temporary housing from autumn through winter season are that the largest difference in temperature was observed between a living room and a bathroom (or a bedroom) at 8 a.m. and 6 p.m. after turning on heating, and that temperature of a lower part at a height of 15cm above floor had been 5 to 10 degrees Celsius lower than an upper at a height of 150cm. Talking 5 dead persons by heart attack or stroke from June 2011 to September 2012 in 8 temporary housing complexes into consideration, the extreme difference in temperature in rooms and heights is assumed to affect the person's health.

2) Physical activities: Physical activities of daily living of the residents who gathered in the meeting room of the temporary housing are almost normal. However some regarded as having small space of daily living and/or low ability of walk. From the viewpoint of increase in physical activities for prevention of disuse syndrome or lifestyle-related disease, it is necessary to more support individually not only the residents having small space of daily living but also isolated persons who rarely come to the meeting room.

This presentation will also consider "victim and temporary housing" by comparison with 3) mental health and 4) living behavior.

In addition, this study is one of the 2012 research aid programs supported by the Toyota Foundation (D12-EA-1017), to propose policy recommendation for solving problems in the affected area by the Great East Japan Earthquake.

Keywords: victim, temporal housing, health, living environment, Great East Japan Earthquake, Miyako City

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U06-03 Room:IC Time:May 24 09:50-10:15

Reflecting on disaster management policy based on lessons learned during and after the GEJET

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[1] ICHARM/PWRI

In Japan, disaster prevention measures have been systematically implemented under the Disaster Countermeasure Basic Act and other related laws to protect national land as well as life, body and property of the citizens. Storm and flood disasters with over 1,000 casualties were frequent up to around 1960; however, no disasters of similar scale have occurred since then. This fact can be explained by continued improvement in flood control facilities and structures as well as non-structural measures such as weather and flood forecasting.

Although tsunami hazards are less frequent than flood hazards, the Sanriku area, for example, has repeatedly suffered from tsunami disasters, and both structural and non-structural tsunami-disaster prevention measures have been continuously implemented. However, during the GEJET, the tsunamis were far higher than coastal structures, and more than 15,000 people were killed or missing. In this great devastation, what happened to two coastal districts, Taro and Fudai, was very different. Taro experienced huge tsunamis of 14.6 m in 1896 and 10.1 m in 1933 and has installed 10-meter-high seawalls. Fudai also experienced huge tsunamis in the same years and has installed a 15.5-meter-high tsunami gate designed to protect the area from a large tsunami in 1896. When the 3.11 disaster occurred, Taro was devastated with many victims, but Fudai suffered almost no damage except for the gate facility. Most coastal areas were destroyed severely and are still struggling for recovery in a very difficult situation. Local residents have been enduring considerable inconvenience for a long time. The long-term, as well as initial, impact of the disaster has been very severe on the residents, particularly on the disaster vulnerable. Quick recovery has been recognized as one of the pressing issues in the devastated areas.

In August 2012, the Cabinet Office announced anticipated tsunami heights and inundation areas in the event of a Nankai Trough earthquake. Most tsunamis are projected to be higher than existing seawalls built along the coastal line southwest-ward from the Tokai area. In addition, the tsunamis are anticipated to reach the coast faster than the ones of the GEJET. Local governments have been working on an evacuation plan to cope with the anticipated tsunamis. In Tokai and its neighboring areas are concentrated industrial zones and major transportation arteries such as Sinkansen and National Highway Route 1. It is urgent to take necessary measures to protect these areas from the anticipated tsunamis as well as to prepare effective evacuation plans.

In June 2012, a private company made a donation of 30 billion yen to build a tsunami embankment of 17.5km long along the Hamamatsu coast based on updated projection results on the anticipated tsunamis. Since it is crucial to minimize disaster damage as much as possible, the company deserves great praise for its intention. Tsunami hazards are infrequent but can cause extreme damage when it occurs. It is very important to continue preparing for them steadily.

Keywords: GEJET, tsunami, evacuation, seawall, recovery

U06-04 Room:IC Time:May 24 10:15-10:30

Proposal of a quantitative risk evaluation/comparison method for low-frequency megadisasters

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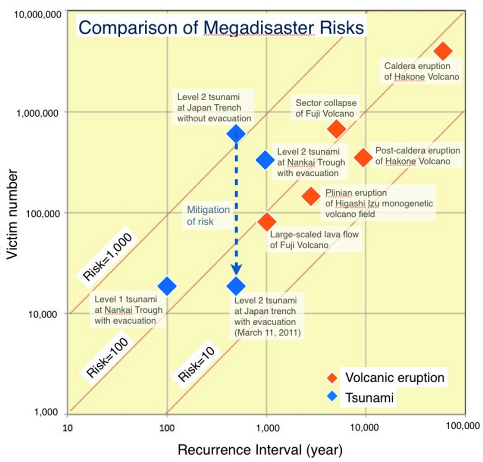
This study proposes a method for quantitative risk evaluation/comparison of low-frequency megadisasters. A logarithmic scatter diagram, of which x-axis shows an average recurrence interval of each megadisaster and y-axis shows a victim number without evacuation, respectively, is used for this purpose. In this diagram, the risk of each megadisaster is defined as a victim number divided by a recurrence interval, i.e. a victim number per one year. The risk of each megadisaster can be reduced by mitigation planning and evacuation. This diagram enables us not only to compare the risks of megadisasters of different origins, but also to determine the order of priority for mitigation planning.

Keywords: risk evaluation, risk comparison, low-frequency megadisaster, earthquake, tsunami, volcanic eruption



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U06-05 Room:IC Time:May 24 10:30-10:45

Possibility of recriticality of the meltdown uranium nuclear fuel at the Fukushima nuclear power station

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We discuss the re-criticality of meltdown nuclear debris in the Fukushima nuclear power station on the basis of the Oklo natural nuclear reactor.

Keywords: Fukusima nuclear power station, meltdown nuclear fuel, re-criticality, Oklo natural reactor, re-criticality monitor

U06-06 Room:IC Time:May 24 11:00-11:25

Toward the Physicalgeography of Tsunami Disaster based on Tsunami Sediments Research

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The Physical-geography of Tsunami Disaster based on Tsunami Sediments Research is strongly expected to be established.

Through the investigation on tsunami sediments the magnitude and the frequency of gigantic tsunami since last 6000 years must be examined along the whole coast of JapanTrench and Kuril Trench. For such an examination, we should observe more precisely, more carefully the behavior of 2011,3.11 Tohoku Tsunami from the view of Physical Geography / Geomorphology.

Keywords: Physicalgeography of Tsunami Disaster

U06-07 Room:IC Time:May 24 11:25-11:50

Active fault study for mitigating earthquake damage

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The accident resulted from dislocation of ground could not have been prevented. Thus, it is significantly important to investigate carefully characteristics of active faults. However, the evaluations of active faults in the vicinity of nuclear facilities in Japna ware clearly mistaken. The assumption concerning the degree of ground motion has been under-estimated, and, damage that can result from dislocation along active faults has been ignored, due to erroneous assessments. Appropriate examinations since 2012 reveal several active faults in some sites. The severe accident of the "Fukushima" was caused by this kind of intentional human carelessness of future hazard. In order to make an accureate estimate of future large earthquake and tsunami, it is essential to examine submarine active faults. Most of submarine active faults are recognized close to the hipocentral regions of historical large earthquakes and tsunami sources. We should draw attention to the distribution of active faults, otherwise the almost the same disaster will recur in active fault zones: the whole affair will end in tragedy again.

Keywords: active fault, marine active fault, earthquake, dislocation, tsunami, nuclear facility

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U06-08 Room:IC Time:May 24 11:50-12:15

Problematics in treatment and disposal of the radioactive waste produced by accident at Fukushima Daiichi NPP

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The Fukushima Daiichi nuclear disaster is a series of equipment failures, nuclear fuel meltdowns, and releases of the fission products and feasible neutron activated nuclides to the environment at the Fukushima Daiichi Nuclear Power Plant (NPP), following the 9.0 magnitude east-Japan earthquake and the ensuing tsunami on 11 March 2011. As the result of radionuclide releases, the soils, water, foods, building wall and road in Fukushima were widely contaminated with the radionuclides, especially ^{134}Cs and ^{137}Cs. Although it is urgent to figure out how radioactive materials were spread not only in the area close to the nuclear reactors but also over surrounding, rather wide district, decontamination methods of the radionuclides should be considered to reduce the public health impact and to regain their daily life. While the public health impact appears to have been low, the economic and nearby environmental consequences are severe. There is no doubt that land restoration will take over a decade and perhaps much longer. However, we have to work on the decontamination of radioactive cesium without further delay to take back daily life to the inhabitants in Fukushima. For the efficient decontamination, we have to understand the followings concerning the radioactive cesium in the environment: 1) distribution by environmental monitoring, 2) state (water extractable, cation exchangeable, passive states, and so on). During the operation of decontamination, huge amount of the waste with radioactivity will be produced. Therefore, the method of decontamination should be connect with how to disposal of the waste.

On the contrary, in the site of Fukushima Daiichi NPP, there is also huge volume of radioactive waste such as cutting down trees, debris produced at hydrogen explosion, adsorbents used in the decontamination system for water using in "feed and bleed" cooling of the reactor core. For the cutting down trees and concrete debris, the reduction of their volume will be a required action. Development of technology therefore will be necessary for safety and reasonable combustion and surface decontamination. Various kinds of adsorbents such as synthetic zeolites and ferrocyanide compounds have been used in the Cs decontamination system for the cooling water. Multi-nuclide Removal Equipment (ALPS) will be operated so that the radioactivity of the 62 nuclides in the cooling water want to be reduced to below the limit specified by the reactor regulation. In the ALPS system, various kinds of adsorvents such as ferric hydroxides, carbonates, active carbon, titanate, and resin will be used. After using those materials, we have to hold huge volume of the waste contaminated with various kinds of radionuclides. These wastes are more complicated to treat and dispose than adsorbents from Cs decontamination system for the cooling water because more complicated radionuclides should be contained in the wastes. For the present, however, it is still ambiguous for the treatment and disposal because there is no information about the following; what radioactive nuclides are contained and how much their concentration are. Consequently, we have to go ahead for treatment and disposal of the waste without sufficient information about the contamination.

In this presentation, the present status of the actions and inherent issues in decontamination of the radionuclides and safety waste disposal during the decontamination would be informed and discussed.

Keywords: Fukushima, Nuclear power plant, Cesium, Waste, Disposal

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U06-09 Room:IC Time:May 24 14:15-14:40

Nuclear power plants in the seismic Japanese Islands and earthquake science

Katsuhiko Ishibashi[1]*

[1]none

The Japanese Earth science community is considered to have liability for having allowed the Genpatsu Shinsai (an earthquake-nuclear combined disaster; Ishibashi, 1997) to occur due to the severe accident of TEPCO's (Tokyo Electric Power Co., Inc.) Fukushima Dai-ichi nuclear power plant caused by the gigantic off-Tohoku earthquake (M 9.0) of March 11, 2011. In this presentation, I review how earthquake science, a part of Earth science, had been taking part in nuclear power plants in the seismic Japanese Islands before the Fukushima Genpatsu Shinsai, and discuss what it should do in relation to NPPs from now on.

Earthquake scientists, as natural scientists, may consider that they need not be involved in social practical matters such as NPPs, man-made islands, the linear Shinkansen, and so on, even though the seismic safety of these facilities is essentially based on the outcome of earthquake science. However, since we cannot ignore the aspect of disaster science, earthquake scientists should be active in examining problems with seismic and tsunamic safety of these facilities (which are serious factors of earthquake disaster!), sharing them, and explaining them to the public if necessary. Especially, in case of NPPs, from the viewpoint that the site condition is the first step for ensuring safety, it is a matter of course that earthquake science is concerned about the safety of NPPs in the seismic archipelago and has responsibility to questions of citizens. Because social problems tend to have political coloring, many scientists may think that they should not be involved in such matters in order to keep political neutrality. However, as Ishibashi (2000) pointed out, to pretend neutrality by being silence brings about a rather clear political effect (if seismologists say nothing about the problem of NPPs and earthquakes, it almost equals that existing NPPs are safe against any quakes).

I skip the details in this abstract, but in brief, Japanese earthquake science as a whole had not been eager in providing the latest knowledge of earthquakes and tsunamis in and around the Japanese Islands to the nuclear development community and in disseminating seismically dangerous factors of NPPs in Japan to the public, before the Fukushima Genpatsu Shinsai. And, although limited experts had been captured in "an atomic energy irregularity" and decreased the safety of NPPs by underestimating active faults, assumed earthquakes, design-basis earthquake ground motions, and tsunamis, the earthquake science community had not paid attention to the situation. Regardless of opinions for or against NPPs, such efforts as above should have been pursued as the social responsibility of science. At present, after we experienced the nightmarish Genpatsu Shinsai, the Japanese society lacks yet proper understanding of natural phenomena such as earthquakes, tsunamis, volcanic eruptions, weather disturbances, and landslides which are basic conditions for NPPs safety. Therefore, the Earth science community needs to make every effort to disseminate the latest knowledge.

In addition, the fundamental problem that is inseparable from the use of NPPs is the disposal of spent nuclear fuels. In Japan, at present, spent fuels are to be reprocessed and resulting high-level radioactive wastes are to be dealt with by geological disposal. However, the scientific possibility (safety during coming 100,000 years) of geological disposal in the Japanese Islands, an active mobile belt, is still open to investigation. In September, 2012, Science Council of Japan proposed a radical review of the geological disposal policy to Japan Atomic Energy Commission. It may be appropriate to set up a standing investigation committee in this Japan Geoscience Union in order to discuss whether the safety of geological disposal is guaranteed in Japan (although a session on geological disposal has been continued in the JpGU annual meeting since 2000, it basically assumes the enforcement).

Keywords: nuclear power plant, Japanese Islands, safety, Earth science, earthquake, geological disposal

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U06-10 Room:IC Time:May 24 14:40-15:05

Active fault and seismic safety evaluation: comments from experience of active fault assessment for nuclear power plants

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During the period from 2001 to 2012, when the author was participating in active fault evaluation for nuclear power plants, 1) judging whether the faults in the vicinities of the plants concerned are active or not, 2) evaluating the extent of multi-segment rupturing on the fault system concerned were major issues imposed on active fault researchers. Whether faults in nuclear power plants or beneath nuclear facilities are active became a new point of controversy after the submission of reevaluation reports in March, 2008, based on the new regulatory guide; especially after an on-site inspection of the Tsuruga power plant in April, 2012.

Concerning the faults in the vicinities of the nuclear power plants, opinion was not divided on the faults which everyone could judge active based on the latest knowledge of active fault. On the other hand, we had faults for which opinions were divergent even on each individual data, in addition to faults showing inconsistency among the conclusions from geomorphic, geologic and geophysical data. For the Yokohama fault, one of such difficult faults, on the west coast of Shimokita Peninsula, its characteristics as active fault were unveiled by additional surveys. From such experiences, the author thinks we should make every effort to acquire reliable data as many as possible and listen to different opinions before making the final decision.

Regarding multi-segment rupture, the author was impressed by negative attitudes of the power companies toward this issue. While the governmental HERP made efforts to evaluate the largest earthquake on every major active fault zone in Japan using ”5-km rule” based on Matsuda (1990), the companies seemed to try to shorten active fault segments as much as possible and evaluated only single-segment rupturing or ruptures involving a small number of segments. Although this is the case before the revision of the regulatory guide in 2006, similar evaluations of multi-segment rupture appeared even after that.

As the 3.11 earthquake was generated by a successive rupture of many source areas, multi-segment ruptures on active faults in the vicinities of nuclear power plants were reevaluated. The reevaluation has reminded the author that the distant-ward extension of multiple rupture has minor influence on short-period ground motion, and underestimate of near-site heterogeneous rupture and seismic wave amplification is more fatal. For the maximum ground motion, it is necessary to make continuous efforts to reach unique evaluation, neither underestimate nor overestimate, through digging out paleoseismic data hiding in history and under the ground, as well as promoting theoretical research and observation.

Is the fault concerned active? What properties does it have? Where does it stand in the cycle of activity? Replies to these questions are not necessarily the truths. We should keep in mind that scientific evaluations are hanging around the truths, and occasionally far away from them. We also must realize that we are affected by our own experiences and way of thinking, being constrained by social, cultural, and the times background inclusive of earthscience paradigms. It is also necessary to digest data in the fields adjoining our own, and examine them impartially. Only the data of a restricted field sometimes lead to a wrong conclusion.

Seismic safety evaluation of nuclear power plants must be done based upon the above scientific assessment of active faults, but should be done at another place with a wider view. The revision of regulatory guide for reviewing seismic safety in 2006 gave power companies an opportunity to modify their active fault evaluations. Future revisions of regulatory guide must not merely enhance the regulation, but should motivate the companies to ensure higher nuclear safety, and promote deepening of the scientific knowledge and technical innovation indispensable for more advanced active fault evaluation.

Keywords: active fault, nuclear power plant, multi-segment rupture, seismic safety, nuclear safety, regulatory guide

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U06-11 Room:IC Time:May 24 15:05-15:30

Contribution of Earth scientists and engineers to seismic safety of nuclear power plants in Japan

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The 11 March 2011 giant earthquake with Mw 9.0 occurred off the Pacific coast of Tohoku, which was the largest in the earthquake history in/near Japan. The huge tsunami generated by this earthquake attacked the east-coast lines in the Tohoku, killing or missing more than 30,000 people. Severe accidents of nuclear reactors at the Fukushima Daiichi Nuclear Power Plants extended disasters.

There are four nuclear power plants near the source area of the Mw 9.0 Tohoku earthquake, the Onagawa, the Fukushima-No.1, the Fukushima-No.2, and Tokai-No.2. The Onagawa NPP is closest to the epicenter of the earthquake. But, those four NPPs are located to almost the same distance if closest distance to the source faults is taken.

When the earthquake happened off the Sendai, all of reactor-units at those four plants were automatically shut down and began to be cooled by cooling systems until they were attacked by big tsunami waves. All units at the Onagawa and Tokai Daini NPPs got out of troubles because the heights of tsunami waves were lower than the altitudes of the plant sites.

However, the Fukushima-No.1 and the Fukushima-No.2 plants were damaged by the big tsunami waves, because the heights of tsunami waves there were much higher the altitudes of the plant sites. The external electric power was stopped, water-tanks were broken, and further all of the independents power generation systems were broken. The independents power generation systems were located at the underground room of the turbine building without waterproofing. Therefore, the cooling systems at the Fukushima Daiichi NPP were completely broken. It made severe accidents of the reactors. On the other hand, the external electric power was temporally stopped, therefore the cooling systems at the Fukushima Dani NPP were temporally stopped. But, the water-tanks were not completely broken because the water-tanks were protected by rein-forced concrete buildings. Some of the independents power generation systems were located on ground surface and so not broken, although the rest of the independents power generation were located at underground room of the turbine building and broken by the tsunami waves. Therefore, the cooling systems at the Fukushima Daini NPP were soon recovered.

The severe accidents of the Fukushima No. 1 NPP were caused to deficiency of multifaceted protective mechanisms, not only the tsunami. If the Fukushima No.1 NPP had the defense in depth, the accidents might be minimized.

Most of Earth scientists and engineers have contributed their deep knowledge to seismic safety of nuclear power plants. They also played an important role in making regulatory guide for reviewing seismic design of nuclear power reactor facilities in Japan revised in 2006. The revised seismic regulations required more strict surveys of active faults near nuclear power site, careful evaluation of design basis ground motions and so on, to increase seismic safety of nuclear power plants. However, the accident of Fukushima Daiichi happened during the 3.11 Tohoku earthquake. It damaged public trust in science and technology for nuclear safety. We need to make best efforts to increase seismic safety of nuclear power plants to restore the public trust in science and technology from viewpoints of Earth scientists.

Even if nuclear power plants would be decommissioned, it is necessary to keep seismic safety of the nuclear reactors and fuel rods until the decommissioning projects will be completed.

Keywords: nuclear power plant, regulatory guide, design basis ground motion, design basis tsunami, active fault

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U06-12 Room:IC Time:May 24 15:30-15:55

Geological issues for evaluating the seismic durability of nuclear-energy facilities in tectonically active regions

Yasutaka Ikeda[1*]

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Judging from my several years of experience as a member of the Back-Check Committee for Seismic Durability of Nuclear Energy Facilities, the most serious problem would be excess compromises between the scientific evaluation for seismic hazards and a variety of demands, such as technological, economic, and social ones (and possibly of national security), which should have been considered independently from the scientific hazards evaluation. Similar problem existed in Japan's national projects for seismic disaster prevention, in which many seismologists were involved. Setting such demands aside for a while, I discuss in my presentation potential seismic hazards to nuclear energy facilities located in tectonically active regions.

Potential sources of seismic hazards for Japan's nuclear facilities fall into four categories: (1) subduction-zone megathrusts, (2a) major intra-arc emergent active faults, and (2b) major intra-arc blind active faults, and (3) minor active faults that are, in most cases, secondary to a master fault. Sources in category (1) are the most important in that a subduction zone megathrust produces big earthquakes of Mw 8-9, which are characterized by large-amplitude and very long-lasting motions, and in that the recurrence intervals such earthquakes are short (i.e., tens to hundreds of years). A fault in categories (2a) or (2b) produces large earthquakes of Mw 7 with high acceleration and should hence be considered if proximal to a nuclear facility. The recurrence intervals of earthquakes from a fault of these categories are a few thousand to tens of thousand years. Included in these categories are very long reactivated faults that had evolved during old orogenic phases and hence whose geometries are not fully adapted to the present-day stress field. Such faults are in general weakly active in terms of recurrence interval and slip rate, but could produce big earthquakes because of their lengths (e.g., the Longmenshan Fault in Sichuan Province). Emergent active faults (category 2a) have been almost fully mapped in Japan, but blind active faults (category 2b) have not. Minor active faults of category (3), which are mostly of secondary origin, are considered only when they are located beneath nuclear facilities and capable of causing fault-offset damages. They are less important (but are not negligible) in that recurrence intervals are very long ($>$ several ten thousand years) and amounts of offset are small ($<$ several ten centimeters per event).

Keywords: geologic hazard, subduction zone, plate-boundary fault, blind fault, emergent fault, earthquake recurrence interval

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U06-13 Room:IC Time:May 24 16:15-16:35

What was really accused in the L'Aquila trial

Shinbi Suzuki[1*]

[1]Japan Broadcasting Cooperation

NHK (Japan Broadcasting Corporation) broadcasted a TV program "Documentary WAVE" titled "Scientists accused - Sensation with an earthquake prediction in Italy" at 22:00 on 18 August, 2012. This program is a detailed report covering the case in which scientists and government officials are charged for manslaughter by the victim's families of the earthquake with M6.3 that occurred in April 2009 near L'Aquila city, central Italy. The earthquake was so devastating that it caused deaths of 309 people and collapses of more than 20,000 houses. This earthquake was preceded in several months by an earthquake swarm with more than 400 events, and local citizens in L'Aquila were very anxious about the possibility of major earthquake. The municipal authority of L'Aquila asked the governmental disaster management organization DPC (Department of Civil Protection) to gather the great risk commission (CGR), which consists of scientists and government officials, to cool down the potential of panic. The conclusion of the commission was transferred to the public as a "no risk statement", which means no major earthquake is likely to happen. The main shock happened 6 days after the meeting and caused a devastating damage. The reason why the victim's families in the city decided to sue the members of CGR is that they could have avoided the risk if "no risk statement" had never issued. Scientists argued that they will not say anything useful if they are judged guilty for the failure of prediction on the future issue that has inherently large uncertainty. The TV program verified how a predictive information on natural disaster should be transfer to the public based on the interview on the discussion in the CGR meeting.

In my presentation, as one of a member of the TV program team, I will discuss the social responsibility of scientists showing what was really accused in the trial.

U06-14 Room:IC Time:May 24 16:35-16:50

Sentenced scientists: Figuring out the L'Aquila earthquake trial

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Early in the morning on April 6, 2009 (local time), an M 6.3 earthquake occurred in central Italy, causing 309 fatalities and severe damage in and around L'Aquila. A meeting of the Major Risk Committee in the Italian government had been held six days before the earthquake. Five scientists and two officials attending this meeting were accused of corporative manslaughter by the families of the fatalities, and they were sentenced to be guilty in October 2012.

L'Aquila is seismically active compared to other areas in Italy, and it was in a state of earthquake swarm for a half year to March 2009. In early March, a couple of people were willfully issuing earthquake predictions so that the area was in slight panic. This panic was made worse by an earthquake as large as M 4 occurred on March 30. Accordingly, the Civil Protection Department of the Italian government called up the Major Risk Committee and held a meeting on March 31 at the region hall in L'Aquila. In the telephone tapping records submitted to the trial court as evidences, the head of the Civil Protection Department told the regional associate of civil protection that this call was "a media operation only for making people calm."

According to the minutes of the Major Risk Committee meeting brought to the prosecutor's office, the vice chairman (scientist) remarked "I heard the vice head of civil protection declare to media, although he is not a geophysics that when there are seismic sequences there is a discharge of energy and there are more probability that the large shock do not arrive. What can you say?" Since a million of small earthquakes need to occur for discharging the energy of an earthquake as large as M 6, the above declaration is scientifically incorrect. Therefore, the remark of the vice chairman is understood he was worried that the incorrect explanation to the media before the conference meeting would mislead the people as a kind of safety information. This intention of the administration side can be found in the talk of the department head in the telephone tapping records. The safety information was not denied in the press conference after the committee meeting, and local TV news announced "the safety was declared" later. Local newspapers carried similar reports in the issues of the next morning.

Six days after the release of the safety information, a large earthquake occurred against the safety information and this L'Aquila earthquake caused 309 fatalities. Many of them were due to the collapse of buildings of low seismic resistance such as historical buildings. A considerable number of the people among them had been evacuated from such buildings before March 30, but then came back into them following the vice department head's safety information. The families of those people made the accusation. Since the officials on the administration side mainly made the statement to the media before the committee meeting and the press conference after the committee meeting, the officials are responsible for the results of the safety information issued there. On the other hand, the scientists noted their worries about the safety information during the conference meeting as in the vice chairman's remark, so that it is not reasonable that the scientists were sentenced to be guilty of corporative manslaughter. The scientists looks having been readily exploited by the officials.

The scientists mostly mentioned only general remarks, saying that many of swarm activities do not lead to a large earthquake but they cannot declare no large earthquake. For example in the minutes, one scientist said "numerous swarms that have not preceded large earthquakes. Obviously, as L'Aquila is a seismic zone, we can not make a statement that there will not be large earthquakes."Another scientist said "There is a low probability of a large earthquake in the short term, as the 1703 earthquake, but this can not be excluded in a definitive way."

Keywords: L'Aquila earthquake, trial, scientist

U06-15 Room:IC Time:May 24 16:50-17:05

Statements against the L'Aquila trial and three proposals from a different standpoint

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The L'Aquila earthquake in central Italy on 6 April 2009 collapsed many houses and caused many fatalities. Failing to warn of this disaster, the L'Aquila court sentenced to jail researchers who attended the governmental committee (Commissione Grandi Rischi) on 31 March 2009. Against this, not only the National Institute of Geophysics and Volcanology (INGV, where two accused scientists were working) but also many international and domestic associations involved in seismological research announced their concern about the sentence. Although the final judicial conclusion will be left to the higher court, the present case will be remembered in the history of science. Investigating the statements by the Seismological Society of Japan and others, i.e., the International Association for Earthquake Engineering (IAEE), the Royal Society and the U. S. National Academy of Science, the Seismological Society of America (SSA), the Japan Association for Earthquake Engineering, the Geological Society of Japan and the International Association of Seismology and Physics of the Earth Interior (IASPEI), the author would like to ask questions about those statements and to present his counterproposals.

Some statements emphasized the importance of the freedom of scientific research and open discussion, protesting to convict the contribution of scientists. Including them, most of the statements criticized the present sentence or explain the situation of the scientists to the judicial community in Italy. Although they sought to protect the accused Italian scientists, it would also appeal not to investigate the accountability of the scientists in their own countries. In contrast, the statement of the Seismological Society of Japan appealed directly to the national citizens not to blame the scientists participating the administration for disaster prevention without limiting the particular cases. It is, however, questionable to be accepted by the public or obtain a historical evaluation that scientists will always be exempted from all responsibility. Apart from the statement of INGV, i.e., the institute involved, the statement that no scientists will contribute to the administration unless they are unconditionally exempted from responsibility is somewhat disappointing if it is actuary true in the respective scientific society.

In order to avoid cases in which scientists will be prosecuted for their conduct, or rather, in order not to cause or mitigate avoidable disasters, the author proposes the following three points to the scientific community and to the public:

(1) Scientists should state their scientific knowledge and judgment as clearly as possible. In particular, they should clarify what subjects that cannot be judged conclusively. (2) The public is requested to understand that it will sometimes be difficult to make a conclusive scientific judgment. Hopefully probabilities will be discussed more widely in the public domain. (3) It is also requested to the Press not to force a conclusive judgment that is unsubstantiated by scientific examination. In addition, not only based on authorized or major sources, but also a different view, if existing, should be considered more in some cases.

Keywords: L'Aquila earthquake, L'Aquila court, statement, exemption from responsibility, subjects not to be judged conclusively, probability

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U06-16 Room:IC Time:May 24 17:05-17:30

How to prepare the risk of the mistake of scientific risk assessment: social condition for making precaution possible

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The case of L'Aquila earthquake trial has raised various questions concerning the relationship among science, politics and society. In this paper I will argue about two types of problems, those of risk communications and those of socio-political ones in risk management, from the viewpoints of how to prepare the risk of the mistake of scientific risk assessment as well as how to make precaution possible when sufficient evidence is not available.

The most crucial problem of risk communication regarding L'Aquila earthquake is the failure of advising the caution as to the uncertainty in assessing the risk of big earthquake. Although the scientists in the advisory board to the government admitted they couldn't deny the possibility that a big earthquake could happen, they didn't mention it to the public. This was obviously against one of the principles of risk communication that uncertainties should be communicated.

This mistake of risk communication is not only the problem of how to communicate the risk to society but also that of risk management strategy which is genuinely normative and political question. In general, the responsibility of scientists is to provide the evaluation and interpretation of facts and uncertainties, while that of policymakers is to make political, normative decisions. It is one of scientists' virtues that they refrain from making such decisions. But, in fact, judging whether scientists should advice caution to policymakers and the public depends on the risk management strategy, especially in terms of the burden of proof. Especially in the case where the scientific evidence of danger is not sufficient, taking precautionary approach requires the political legitimation of allocating burden of proof to the parties to claim the safety. On the contrary, if the policymakers give the highest priority to avoiding the counter-damages that could be caused when the caution turns out to be wrong, the caution tends to be easily neglected by policymakers. Furthermore in such cases, scientists tend to be reluctant to advice caution. In this way, whether to communicate uncertainty and precaution is a political matter in relation to risk management strategy.

In this paper, I will further argue the way of preparation in peacetime for finding right experts and employing right expertise in emergency.

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Information dissemination based on uncertainty of prediction of volcanic eruption

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As volcanic eruptions follow various precursor phenomena in many cases, many volcanic eruptions have been predicted in the world. The 2000 eruption took place after evacuation of about 15,000 people because the eruption had been predicted. However, it is impossible to predict volcanic eruption precisely (time, place, magnitude, style). The magmatic eruption of Shinmoedake in 2011 could not predicted and the JMA successively issued volcanic warnings according to the eruptive activity in which JMA widened the area in danger and in response to the warnings, local municipalities imposed restrictions on entering mountain trails and passing peripheral roads. On the other hand, eruptions don't follow volcanic unrests in many cases such as the activity of Iwate volcano in 1998.

The JMA announces Volcanic Alert Level from disaster mitigation point of view. Before a volcanic anomaly occurs, relevant organizations get together and share projections based on the volcano's past history of volcanic unrest (eruption scenario) and hazardous areas (volcanic hazard maps). They come to agreement on what criteria to use in deciding when to start various disaster responses. These procedures have to be done in the core group of the Volcanic Disaster Mitigation Council at each volcano in the stage when the volcanic activity is calm. The core group consists of local governments, meteorological observatories, erosion control (sabo) departments, and volcanologists. Disaster measures will evolve by the efforts of these members, such as elucidation of the eruption history or an eruption mechanism of each volcano by volcanology, and emergency drills and exercises.

On the other hand, the Coordinating Committee for the Prediction of Volcanic Eruptions (CCPVE), where the Meteorological Agency enacts a secretariat, makes judgment in the volcanic activities. The meetings of the CCPVE are held periodically and temporarily in volcanic unrests. In the case of the volcanic activity which has serious influence socially, the sectional meeting specialized in the volcano may be held. The examination results are announced through volcanic information from the JMA, and it is clarified that the government takes the responsibility for volcanic activity evaluation.

For volcanic disaster mitigation, not only precise evaluation of the activity but also consciousness on the activity including the uncertainty of the prediction of the volcanic activity among the members of the Volcanic Disaster Mitigation Council at each volcano are important at volcanic unrests.

Keywords: Prediction of volcanic eruption, Warning, Volcanic alert level

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U06-18 Room:IC Time:May 24 17:45-18:00

Current state of probabilistic forecast based on seismicity analysis

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Introduction

After the disastrous earthquake of L'Aquila, Italy in 2009, the Italian government set up a committee consisting of worldwide seismologists, which summarized the current state of earthquake prediction technology and proposed guidelines to utilize the precursory information of large earthquakes. The report was also accepted by IASPEI and comes to a consensus among seismologists. In the report it is described that 'reliable and skillful deterministic earthquake prediction is not yet possible' and 'any information about the future occurrence of earthquakes contains large uncertainties and, therefore, can only be evaluated and provided in terms of probabilities'. But then how much probability can be estimated scientifically before large earthquakes? So, in my presentation I will introduce the current state of probabilistic forecast by overviewing the actually published probability values mentioned below.

Long-term probability

The long-term probabilities for major active faults and major earthquakes in the sea area have been evaluated and announced by a special governmental organization, HERP (the Headquarters for Earthquake Research Promotion). Some examples assigned relatively high probability values at the evaluation time of Jan. 1, 2013 are as follows;

- Kannawa/Kozu-Matsuda fault zone with M(magnitude)7.5: 16% at most in 30 years (= 0.005% in 3 days),
- Itoigawa-Shizuoka-kozosen fault zone with M8: 14% in 30 years (= 0.004% in 3 days),
- Tonankai with M8.1: 80% at most in 30 years (= 0.02% in 3 days),
- Sothern Kanto with M6.7~7.2: 70% in 30 years (= 0.03% in 3 days).

Here, for convenience, I also added the values in 3 days that is not published by HERP.

Aftershock probability

Aftershock probability is basically calculated by combining two empirically derived laws, an exponential law of magnitude-frequency distribution and a power law of aftershock decay rate. Statistical analysis of the past aftershock data shows that, for inland mainshocks with M around 6, the probability of aftershocks whose M difference from a mainshock is 1.0 or smaller is about 25% within 3 days after a mainshock, and for mainshocks in the sea area with M around 7, similarly defined aftershock probability is about 33%. The probability gain that is usually defined as the ratio of the specific probability to the background one during an ordinary period, is about several 100s for aftershock probabilities.

Foreshock probability

The probability, for example, that an earthquake with M5.0 or larger in inland Japan is followed by a larger one within the 50 km radius and 30 days is about 3%, and in most cases a larger one occurs within 5 days. This probability makes probability gain about several 10s. But in some specific areas where successive earthquakes tend to occur, foreshock probability rises to about several 10s %, which gives probability gain about several 100s.

Probability based on a seismic quiescence

While seismic quiescence is well known phenomenon among seismologists, it is not yet well studied to obtain the probability of mainshocks following it. However, there is a research showing that when aftershocks caused by an M6 class mainshock have a quiet period of more than three months, the probability gain of earthquake occurrence with the same or a larger one within 6 years is estimated to be about 10.

Probabilities based on other seismic phenomena

Although there are many phenomena (e.g. seismic activation, b-value change, migration, correlation with earth tide) that may have relation to a mainshock and are reported retrospectively after a mainshock occurred, little research has been conducted on the view point of a rigorous prospective forecast. Therefore, it is a future task to evaluate the probabilities based on such phenomena.

Keywords: probabilistic forecast, earthquake prediction, long-term probability, aftershock probability, probability gain

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U06-19 Room: Time:May 24 12:15-12:40

Impacts of the 2011 tsunami on vegetation in coastal areas of northeast Japan and subsequent recovery processes

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The Great East Japan Earthquake of 11th March 2011 and subsequent huge tsunami caused widespread damage along the Pacific Ocean coast of the Kanto and Tohoku regions of eastern Japan. Topographically, the Pacific Ocean side of the Tohoku Region consists of the Kitakami and Abukuma Mountain Ranges, with the Sendai Plain in between. The Sanriku coastal area occurs where the Kitakami Mountains meet the sea, and is characterized by an extremely complicated, deeply indented rias coastline. South of the Sanriku Coast is the extensive Sendai Plain and coastal landforms in this region consist primarily of sandy beaches. Various types of vegetation are found in this area, including sandy beach and coastal cliff vegetation, coastal forests, back-marshes, and evergreen broad-leaved forests, which reach the northern limit of their distribution in the Sanriku area, on the islands and inlets.
This earthquake and tsunami resulted in immense ecological damage, caused by the enormous physical impact of the tsunami, as well as the physiological impact of inundation by seawater. The disaster, however, occurred in March, before vegetation in this region had entered the spring growth season. As a result, the damage to vegetation varied widely between woody and herbaceous plants. For example, herbaceous plants distributed in a narrow belt along the edge of the splash zone on rias rocky coasts have evolved to withstand pressure from breaking waves and being showered by salt spray, and thus suffered only some minor physical damage from soil wash-out and rock break. In contrast, along the shores of the Sendai Plain the vegetation distributes in a series of contiguous ecological zones running from the outer beach through the wetlands and on inland to the rice paddies. The powerful tsunami crashed over this coast, disturbing and mixing the soil in the various zones, filling the rice paddies with sediment, and uprooting and breaking pine trees in the coastal forests. In this region, traditional land uses such as rice paddies and forestry plantations were practiced in areas inland or on slightly higher ground. Rice paddies inundated by seawater can no longer be cultivated, and the vegetation in many paddies changed to a pattern dominated by Echinochloa crus-galli var. caudate grass. In paddies that were inundated for long periods of time even this vegetation disappeared. Sugi cedar (Cryptomeria japonica) timber standards that were inundated changed color and wilted.
The brunt of the damage from the tsunami was taken by the vital ecotones linking the ocean and terrestrial ecosystems. The ecotones of the alluvial and Rias coastlines, however, differ in structure, and the nature and extent of damage suffered thus differed accordingly. Two years after the disaster, the open areas created by felled or wilted trees in the pine woods of the Sendai Plain coastal area are being filled by alien species such as Robinia pseudoacacia and Phytolacca americana, etc. In the remaining pine woods, however, seedlings of Pinus spp. have sprouted naturally, and the plant communities on the outer beaches are also starting to recover. On the other hand, reconstruction works, including planting of new plantations and civil engineering projects such as building levees, now pose a new threat to the native vegetation communities that have survived and are in the process of recovering on their own power. The need to prioritize prevention and mitigation of damage due to future disasters is obvious, but this work should be implemented in a sustainable manner, while protecting the regional ecosystems and biodiversity. Japan has recently hosted the meeting of the 10th Conference of Parties to the Convention on Biological Diversity (COP10), and the current large-scale reconstruction work offers an excellent chance to put the principles developed at this meeting into practical use, by implementing the public works in an ecologically sensitive manner.

キーワード: The Great East Japan Earthquake, tsunami, vegetation, damage, biodiversity