**ASIAN DISASTER REDUCTION CENTER**
**VISITING RESEARCHER FY 2012A**
**(AUGUST-NOVEMBER 2012)**

# DISASTER RISK REDUCTION.
# CURRENT SEISMIC HAZARD ASSESSMENT.
# ANOMALOUS RADON CONCENTRATION AS AN EARTHQUAKE-PRECURSOR.

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And finally, I would like to express my appreciation to the ADRC staff, who made my time in Japan an experience that has far surpassed my every expectation.

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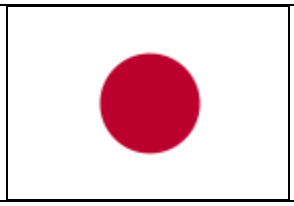
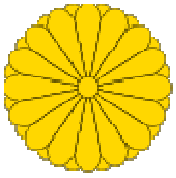
# 1. GENERAL INFORMATION

- **Republic of Armenia**

| | |
|---|---|
| Official name | Republic of Armenia (RA), briefly – Armenia.<br>(Armenian: Հայաստանի Հանրապետություն) |
| Location |  <br>South Caucasus region of Eurasia, at the crossroads of Western Asia and Eastern Europe |
| National flag |  <br>Red-Armenian Highlands, Armenians' incessant struggle for survival, Christian faith, liberty and independence.<br>Navy- the aspiration of the Armenian nation to live under the peaceful sky.<br>Orange- the talent for creative work and diligence of the Armenian people. |
| Coat of arms |  |
| Name in official language | Hayastani Hanrapetutyun, briefly - Hayastan |
| Head of the State | President |
| Legislative power | one-chamber National Assembly |
| Official language | Armenian (is part of Indo-European family of languages) |

| | |
|---|---|
| Capital | Yerevan |
| Administrative and territorial unit | Marz (11 Marzes in all including Yerevan city) |
| National currency | Dram (international currency code - AMD) |
| Territory | 29.74 thousand square km (about 1/13 the territory of Japan) |
| Neighbouring countries | north- Georgia<br>south- Iran<br>east- Azerbaijan<br>south-west- Nakhichevan (Azerbaijan)<br>west- Turkey |
| Average elevation above sea level | 1800 m |
| The highest peak | Aragats mountain - 4090 m |
| The lowest altitude | Debed river canyon - 380 m |
| The greatest extent | 365 km |
| Region | north latitudes of subtropics |
| Climate | dry, continental |
| Average temperature | in January - -6.8℃, in July - +20.8℃ |
| Time zone | Greenwich mean time + 4 hours |

- **Japan**

| | |
|---|---|
| Official Name | Japan (Japanese: 日本 Nihon or Nippon; formally 日本国 Nippon-koku or Nihon-koku, literally the State of Japan) |
| Location: |  Eastern Asia, island chain between the North Pacific Ocean and the Sea of Japan, east of the Korean Peninsula |
| Flag |  |
| Imperial Seal |  |
| Geographic coordinates: | 36 00 N, 138 00 E |
| Map references: | Asia |
| Area: | total: 377,835 sq km<br>land: 374,744 sq km<br>water: 3,091 sq km<br>note: includes Bonin Islands (Ogasawara-gunto), Daito-shoto, Minami-jima, Okino-tori-shima, Ryukyu Islands (Nansei-shoto), and Volcano Islands (Kazan-retto) |
| Area - comparative: | slightly smaller than California |
| Land boundaries: | 0 km |
| Coastline: | 29,751 km |

| | |
|---|---|
| Maritime claims: | territorial sea: 12 nm; between 3 nm and 12 nm in the international straits - La Perouse or Soya, Tsugaru, Osumi, and Eastern and Western Channels of the Korea or Tsushima Strait<br>contiguous zone: 24 nm<br>exclusive economic zone: 200 nm |
| Climate: | varies from tropical in south to cool temperate in north |
| Terrain: | mostly rugged and mountainous |
| Elevation extremes: | lowest point: Hachiro-gata -4 m<br>highest point: Mount Fuji 3,776 m |
| Natural resources: | negligible mineral resources, fish |
| Land use: | arable land: 12.19%<br>permanent crops: 0.96%<br>other: 86.85% (2001) |
| Irrigated land: | 26,790 sq km (1998 est.) |
| Natural hazards: | many dormant and some active volcanoes; about 1,500 seismic occurrences (mostly tremors) every year; tsunamis; typhoons |
| Environment - current issues: | air pollution from power plant emissions results in acid rain; acidification of lakes and reservoirs degrading water quality and threatening aquatic life; Japan is one of the largest consumers of fish and tropical timber, contributing to the depletion of these resources in Asia and elsewhere |
| Environment - international agreements: | party to: Antarctic-Environmental Protocol, Antarctic-Marine Living Resources, Antarctic Seals, Antarctic Treaty, Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands, Whaling |
| Geography - note: | strategic location in northeast Asia |
| Time zone: | JST (UTC+9) /Summer (DST) not observed (UTC+9) |

## 2. DISASTER MANAGEMENT STRATEGY IN ARMENIA

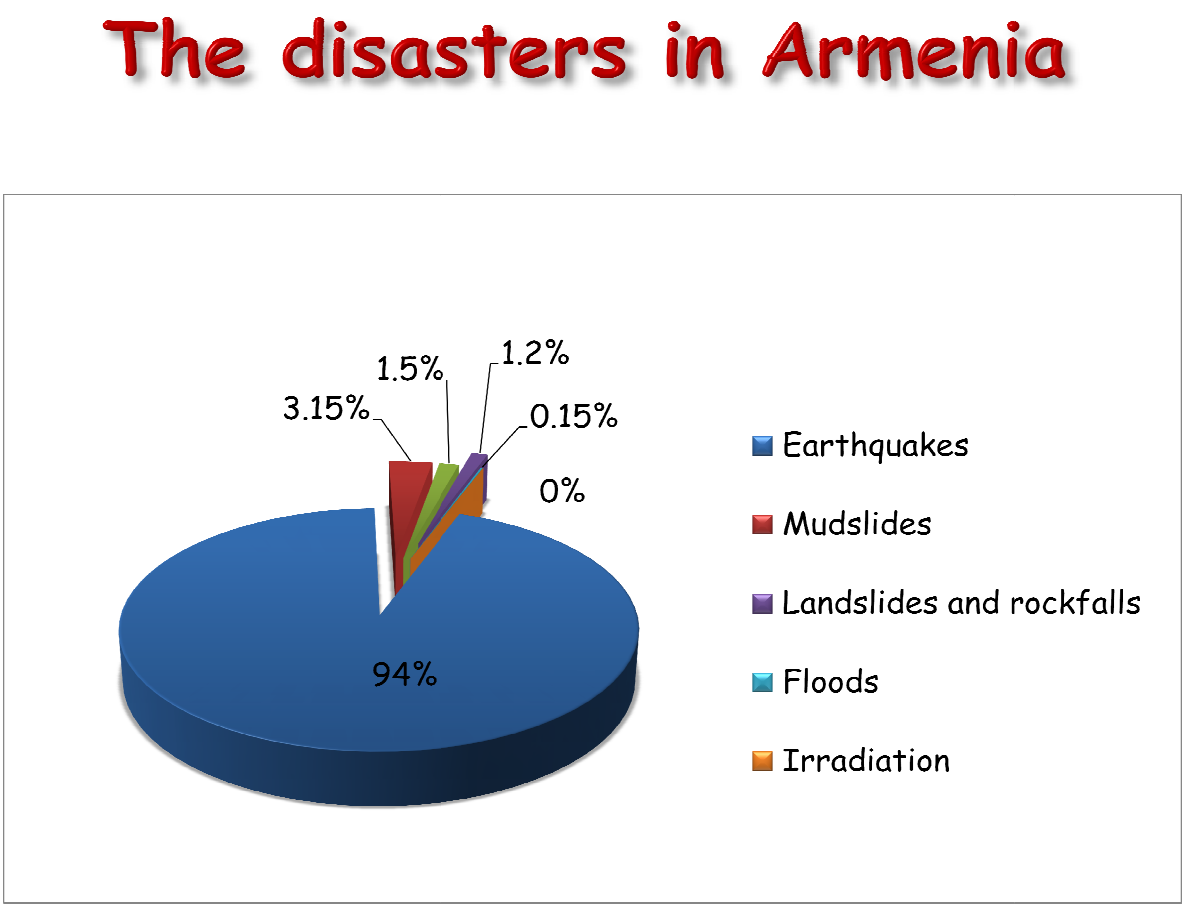
- **Natural Hazards Likely to Affect the Country**

Armenia is one of the most disaster prone countries in the world (except the sea disasters). It is at high risk of natural hazards, owing to high levels of exposure and vulnerability.

Meteorological disasters have become more frequent and intense in the last few decades. Floods, mudslides, and debris flows threaten half of the country's territory, mainly in medium-altitude mountainous areas, where they typically occur once every three to ten years.

Risks associated with geophysical hazards are significant. The landslide hazard zone covers one-third of the country, primarily in foothill and mountain areas. As Armenia lies in one of the most seismically active regions of the world, the earthquakes have affected large numbers of people and caused significant economic losses over the past 20 years.

| | |
|---|---|
| Earthquakes | 94% |
| Mudslides, Landslides, rockfalls, Floods, Irradiation | 6% |



- **Recent Major Disaster in Armenia**

## Spitak （1988）Destructive Earthquake

December 7, 1988 at 7.41.22.7 GMT (11.41.22.7 local time). The epicenter by the records of seismographs has the following coordinates: latitude 40.92°N, longitude 44.23°E. The depth of the hypocenter, measured by various methods and means, varies from 2.5km to 10-15km. It is natural as the earthquake source as a spatial. The magnitude of the earthquake was 6.9. The intensity at the epicenter was 10 value on MSK-64 intensity scale.

The earthquake hit 40 % of the territory of Armenia, densely populated region with 1 ml people. The affected area, where the intensity of the earthquake was ≥ 8, involved 30002 km area. 21 towns and 342 villages were destructed, 514.000 people were left without shelter, 20.000 people were injured and 12500 people were hospitalized. Number of victims was about 25.000. Particularly in Gyumri (15.000-17.000) and in Spitak (4000) number of victims was more than anywhere else. 17% funds of dwellings were destroyed, the work of 170 industrial companies were halted, the great losses were caused to villages and agro industrial complexes as well as to the architectural, historical and cultural monuments, 917 public buildings were destroyed.

The rescue activities were systemized only two or three days later. From the first second the earthquake strike, the population carried out restless rescuing works. Anyhow the absence of their experience and sometimes the lack of basic knowledge on actions in emergency caused real difficulties for the efficiency of rescue operations. Even there were cases when the public unawareness brought to life losses. Also there was a need of rescue equipment. With the efforts of population and the rescuers 45.000 dead or alive people were brought out from the rubble and 12.5000 people were hospitalized.

- **National Survey for Seismic Protection (Armenian NSSP) at the Ministry of Emergency Situations of the Republic of Armenia (MES of RA)**

MES of RA is a republican body of executive authority, which in line with such competences as are vested in it by laws and other legal acts, develops, implements and coordinates RA government's policy in the area of civil defense and protection of the population in emergency situations.

| MINISTRY of EMERGENCY SITUATIONS of ARMENIA | | | | | |
|---|---|---|---|---|---|
| Rescue Service (including Crisis Management Center- the main body for planning, co-coordinating and implementing measures related to natural and other forms of disasters) | National Survey for Seismic Protection (Armenian NSSP) | Hydro-meteorology and Monitoring State Service | National Technical Safety Center | Atmospheric Phenomena In Active Service Impact | State of Emergency Crisis Management Academy |

| "NSSP" AGENCY | | | |
|---|---|---|---|
| "Northern Survey For Seismic Protection" State Non-Commercial Organization | "Southern Survey For Seismic Protection" State Non-Commercial Organization | "Western Survey For Seismic Protection" State Non-Commercial Organization | "Eastern Survey For Seismic Protection" State Non-Commercial Organization |

# Armenian NSSP

The 1988 Spitak Destructive Earthquake reveals that there is no seismic protection system at all and the Government RA and people were helpless to withstand the disaster.

First, Armenian NSSP was founded in 1991 with the aim to organize population as well as buildings and structures seismic protection. It takes various measures for earthquake disaster management.

NSSP's main goal is seismic risk reduction in Armenia, the population residence hazard mitigation and the state economic and social loss reduction results from earthquake. It has developed two long-term Strategic National Programs on seismic risk reduction in Armenia and in Yerevan city. Today NSSP is not only a national but also a keystone international center.

The Armenian NSSP is monitoring about 40 geophysical, geochemical, hydrochemical, electromagnetic etc. parameters through National Observation Network incorporating about 150 stations. The monitoring systems involve in the global IRIS, READINESS, CTBTO and COSMOS networks which enable to change and disseminate data on seismic hazard.

**The main objectives and the aims of Armenian NSSP are as follows:**

- ✓ provision of seismic hazard monitoring in the territory of Armenia
- ✓ assessment of the seismic hazard and seismic risk of the territories
- ✓ seismic risk reduction
- ✓ assessment of the levels of caused seismicity
- ✓ assessment of other secondary hazards connected with the seismic hazard.

- **The Legal Authority in Seismic Risk Reduction**

Seismic Protection activities are regulated by a number of laws and legislative acts and national programs of the Republic of Armenia:

| | |
|---|---|
| **Law of Republic of Armenia** | |
| The Law of the Republic of Armenia on Seismic Protection | 2002 |
| **Resolutions of Government** | |
| The Complex Program of Seismic Risk Reduction in the Territory of Armenia | 1999 |
| The complex program of seismic risk reduction in Yerevan city | 1999 |
| The Resolution of the Government of RA on establishment of the list of critical important and general facilities in the field of seismic protection | 2003 |
| **Regulation** | |
| "National Survey for Seismic Protection" Agency | 2008 |


- CHAPTER 1. GENERAL PROVISIONS
- CHAPTER 2. GOVERNMENTAL MANAGEMENT IN THE FIELD OF SEISMIC PROTECTION
- CHAPTER 3. SEISMIC HAZARD ASSESSMENT
- CHAPTER 4. ASSESSMENT AND REDUCTION OF SEISMIC RISK
- CHAPTER 5. THE RESPONSIBILITY FOR OFFENCES IN THE FIELD OF SEISMIC PROTECTION
- CHAPTER 6. FINAL PROVISION

This law prescribes basics for organization of seismic protection in the Republic of Armenia and regulates the relations connected with them.

**CHAPTER 1**
**GENERAL PROVISIONS**

***Article 1. The legislation on seismic protection***

The legislation on seismic protection consists of the present law, other laws and legal acts.
If under international agreement in the field of seismic protection, established standards differ from standards established under the legislation, the standards of international agreement are applied.

***Article 2. The basic concepts used in the law***

In the present law the following basic concepts are used:

1. strong earthquake- an earthquake stronger than 5,5 by magnitude scale;
2. seismic protection- legal, social, economic, educational, organizational, scientific, engineering and technical, and other special measures directed on ensuring seismic safety of the state and society and its sustainable development;
3. seismic hazard- threat of possible strong earthquake in region, shown by strong shocks;
4. seismic zoning- mapping of possible maximum seismic hazard distribution in the region;
5. seismic situation- general characteristic of current seismic hazard from the point of view of seismic protection;
6. seismic risk- human, material and other possible losses caused by strong earthquake;
7. seismic risk reduction- complex, various long-term actions of the state and society (administrative, legal, social, economic, tutorial, educational, scientific, engineering- technical, organizational etc.), directed to the reduction of human, material and other possible losses caused by strong earthquake;
8. early warning- notification on temporary infringement of population natural vital functions, with the purpose of ensuring its safety;
seismic protection of buildings and structures- ensuring of seismic stability of buildings, structures;
9. assessment of buildings and structures vulnerability- prediction of buildings, structures behavior at strong earthquake;
10. task forces of seismic protection- specialized, multi-profile formations in the field of seismic protection for rendering an immediate aid to population at strong earthquake or its threat.

***Article 3. The basic goals of seismic protection accomplishment***

Basic goals of seismic protection accomplishment are:

1. implementation by a plenipotentiary body (hereinafter plenipotentiary body) of unified state policy in the field of seismic protection;
2. ensuring of prevailing of preparedness and warning principles above consequences rehabilitation in the unified state and international interstate policy in the field of seismic protection;
3. equal priority of all elements of seismic risk reduction;
4. involving the governmental bodies, local authorities and society in the realization of the state and interstate programs of seismic risk reduction;
5.internationalization of state programs on seismic risk reduction.

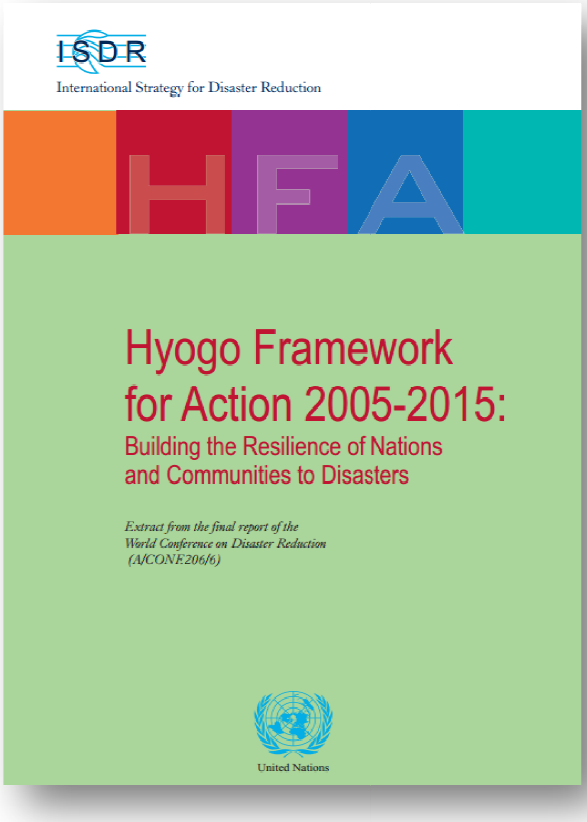
- **Disaster Management Strategy based on the Hyogo Framework of Action (HFA)**

Natural hazards threatening Armenia urge the need of development and strengthening of DRR system in Armenia. This process implies involvement of all the potential of the country, which can be achieved through elaboration of Disaster Risk Reduction National Platform (DRR NP). DRR system is a framework of functions and processes with the aim to reduce population's vulnerability to disaster risks. It is aimed at prevention or reduction of negative impacts of hazards and contributes to sustainable development of the society. Fund for DRR NP was established in 2010. The Head of the Board is MES of RA. The goal of the DRR NP is to establish a multi-spectral mechanism with involvement of all stakeholders.

MES of RA has established a Crisis Management Center as the main body for planning, co-coordinating and implementing measures related to natural and other forms of disasters (complementary to a National Platform on Disaster developed in cooperation with UNDP).

Crisis Management Center

Coping with disasters globally is possible only with joint efforts and partnerships. Armenia is considered as a high-risk country, prone to disasters such as earthquakes, landslides, hailstorms, droughts, floods, etc.




The Government of RA recognizes the threats to country development posed by natural hazards. Since 1991 It has worked to address DRR and to increase disaster response and recovery capacities for the sustainable development of the country. Armenia is committed to achieving the strategic goals of the HFA 2005-2015 "Building the Resilience of Nations and Communities to Disasters" and has taken a number of significant initiatives in this regard.

The cooperation of MES of RA with international organizations and local partners proved to be successful and productive over the years. Their efforts in DRR has become a priority in Armenia, thus contributing to the sustainable development of the country. It will be needed to mention the cooperation with JICA, UNDP, UNISDR, BCPR, UNICEF, World Bank, Red Cross Movement and a number of partner countries such as Sweden, Switzerland, USA, Russia, etc.

As a result of the mentioned activities, the Government of RA set DRR as a priority and the first steps to form the DRR culture are already established in the country. The best evidence of it is the fact that thanks to UNDP, Armenia became the first country in the region where by the Government's decision the "ARNAP' national DRR platform was established.

Currently, the development of National DRR Strategy, as well as establishment of Crisis Management Center and National Disaster Observatory are in process. Armenia has also registered a progress in the implementation of HFA, and among the key developments towards establishment of decentralized DRR system has been decree of the MES on appointment of Heads of MES Regional Representations as HFA implementation focal points at the country regional (marz) level.

- **Disaster Education and Human Resource Development: Current Situation of the Training and Disaster Education in RA**

In Armenia various governmental and other organizations have been involved in DRM Education, within the framework of the HFA. MES of RA is a executive authority, which in line with competences vested by laws and other legal acts, develops, implements and coordinates RA government's policy in the area of civil defense and protection of the population in emergency situations.

The ARNAP Foundation (Disaster Risk Reduction National Platform), Crisis Management Center (CMC) and Crisis Management State Academy (CMSA) have been established for dealing with various aspects of Disaster Risk Reduction.

**National Survey for Seismic Protection of MES RA (Armenian NSSP) develops various means for earthquake disaster management:**

- ✓ develops the basic directions of state policy in the field of seismic protection;
- ✓ provides seismic risk assessment;
- ✓ coordinates activities performed in the field of seismic risk reduction in the territory of the RA;
- ✓ organizes preparedness and training of the population to cope with strong earthquakes;
- ✓ coordinates and controls the execution of the state programs in the field of seismic risk.

**Basic tasks of seismic risk reduction are:**

- ✓ reduction of territories vulnerability;
- ✓ raising population knowledge and preparedness;
- ✓ training of trainers in government bodies and local authorities;
- ✓ creation of earthquake early warning system;
- ✓ ensuring medical preparedness;
- ✓ organization of relief and rehabilitation of population and sustainable recovery;

**The raise of knowledge and preparedness of population is provided by means of state training system.**

**The state training system includes the following subsystems, which are done regularly:**

- ✓ training of target groups beginning from kindergartens and schools:
- ✓ educational programs, methodical manuals, relevant interactive materials;
- ✓ TV and radio programs, publications in mass media;
- ✓ social-psychological preparedness.

The state training system ensures the reliability and availability of the given information.

The stage of recovery of a zone suffered from strong earthquake is the intermediate between the stages of an emergency seismic situation and reconstruction. The duration and the strategy of recovery stage defined by the Government RA.

The one of the main principles of the accomplishment of recovery works is based on the creation of the conditions for population active participation in recovery works in the disaster zone.

The purpose of aid rendering to the population and its rehabilitation is the reduction of material and psychological losses of the state after an earthquake.

Rendering of aid to the population and its rehabilitation is a multi-stage process: operative (first few days), short-term (first month), mid-term (first year) and long-term (more than one year).

**Rendering of aid to the population and its rehabilitation are based on the following principles:**

- ✓ preliminary planning of works amount on rendering aid and rehabilitation before the catastrophe and their adjustment right after the catastrophe;
- ✓ active participation of government bodies and local authorities and society.

***Current Situation of the Training and Disaster Education***

The Government RA established National Strategy of DRR in RA in March 2012, which will be implemented by the mutual efforts of the following organizations: Armenian Red Cross, Oxfam, UNICEF and Save the Children.

YEREVAN BASIC SCHOOL №56


The Ministries of Emergency Situations and Education and Science, ARNAP Foundation and CMSA launched the "School Disaster Preparedness Plan" competition for secondary schools in RA in 2012.

On International Civil Protection Day of March 1, 2012 162 events have been accomplished in the capital city of Yerevan and regions including lecturing, training and drills. Armenia collaborating with ADRC (since 2000) and JICA (since 2007) in the frame of various projects and programs implements the research, education and training for the DRR specialists who acquired and shared valuable Japanese experience.

Ministry of Science and Education together with the Ministry of Emergency Situations in the frame disaster risk reduction program will submit to National Assembly proposals and additions for the Law “On Public Education” aiming at inclusion disaster risk reduction elements in the school curricula

**At present the training and disaster education are performing in the frame of HFA Framework for Action including:**

## "BE PREPARED TO FACE DISASTER" QUIZ- GAME


- Education on seismic protection behavior rules
- Alert drills and exercises
- Elaboration of evacuation plans and practical implementation
- Information on hazards and risks through mass media
- Training of decision-makers at national, regional and community level
- Developing of community-based approach including volunteer involvement.

## TRAININGS IN ARMENIAN POLICE

*with Police Academy students and stuff*

Further development of population preparedness to disasters will be done in compliance with valuable experience of Japan during and aftermath of Great East Japan (Tohoku) Earthquake and Tsunami and best practice of the recent earthquakes in Chile, New Zealand and United States and lessons learned from devastating earthquakes in Kashmir, China and Haiti.

- **Recent Major Project on Seismic Risk Reduction**

**"Seismic Risk Assessment and Risk Management Planning Project" in Armenia:**

**The Real Time Seismic Intensity Display System (Joint MES of RA-Japan International Cooperation Agency (JICA) project)**

Test-Presentation of the Real Time Seismic Intensity Display System


Based on Japanese earthquake experiences, JICA has been supporting Armenian earthquake disaster prevention through "Seismic Risk Assessment and Risk Management Planning Project" by utilizing Japanese technology.

The main goal of "Seismic Risk Assessment and Risk Management Planning Project" is to reduce vulnerability to large-scale earthquakes in the capital city of Yerevan, where a third of the country's population is concentrated, by providing assistance in preparing risk management plans which cover all viewpoints surrounding disaster management cycle from prevention, emergency response to recovery/reconstruction. Real Time Information System on Seismic Intensity was installed at the Crisis Management Center of MES which aims: to promote disaster prevention actions of the citizens through publicity of disaster information and to raise public awareness towards disaster prevention. The project also focuses on awareness raising activities for citizens. The project time period is 2010-2012. However, plans to introduce a similar system in other large cities of Armenia as well.

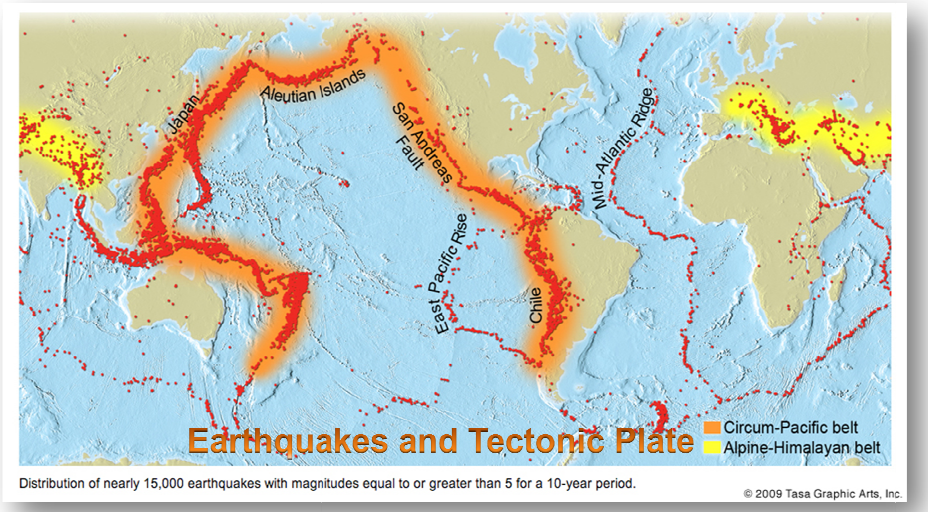
## THE DISASTER MANAGEMENT SYSTEM IN JAPAN

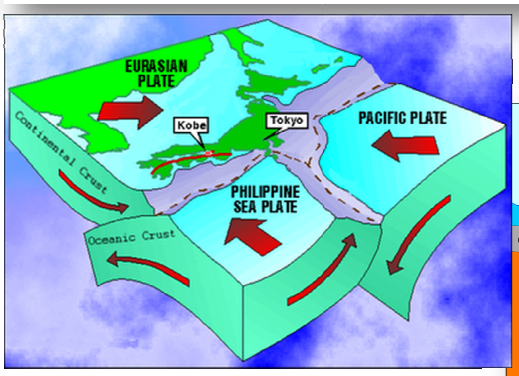
- **The Natural Hazards (Earthquakes) in Japan**

Japan has trouble with many different natural disasters, and the most common ones:

### ✓ Earthquakes

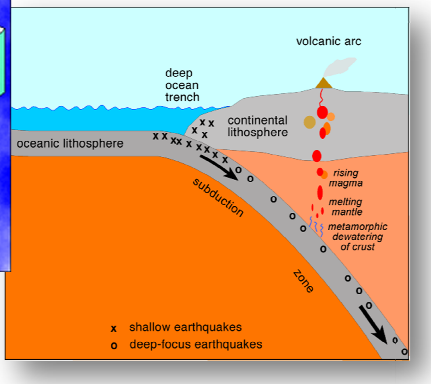
Japan is on a subduction zone, which is where one plate is being forced beneath another. It is also at the meeting point of 2 pieces of the giant Pacific plate, which are moving in different directions alongside each other. Japan can have up to 5000 earthquakes each year.



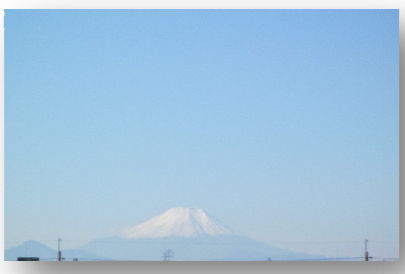

Tectonic plates in Japan

Depth of earthquakes at a subduction zone




### ✓ Volcanoes

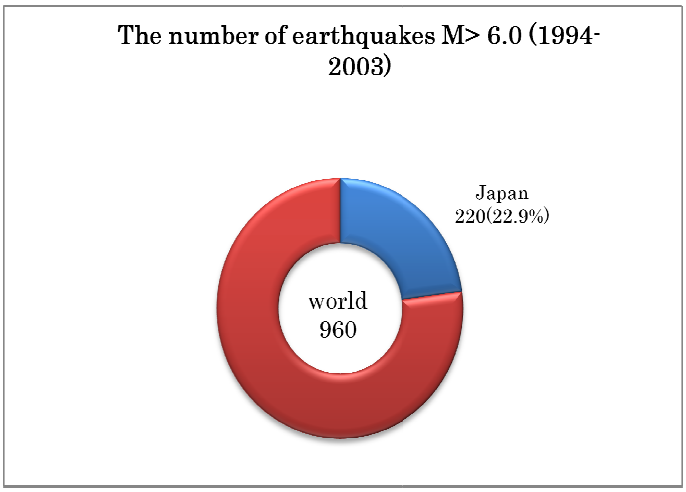
Mount Fuji

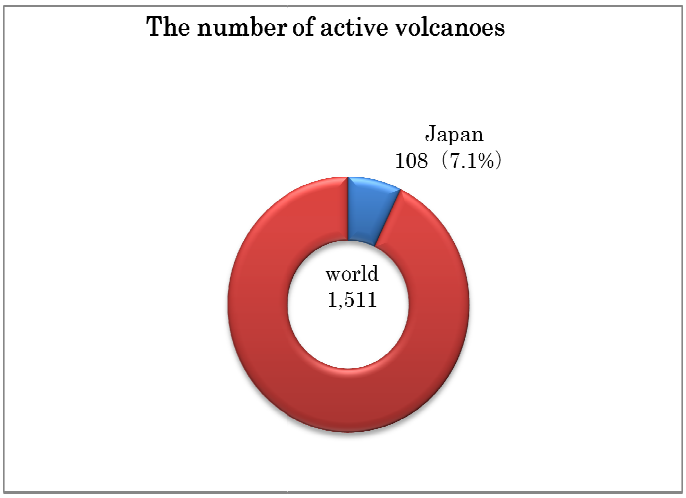


Japan has about 1/10 of the worlds active volcanoes and hundreds of inactive volcanoes. Mount Fuji is the highest mountain and is still active as are Asama, Aso, Banai, Miharaand and Sakurajima. There are actually more than 40 active volcanoes out of a told of 180.

Because of the potential dangers of volcanic eruption, the JMA monitors the activity of these volcanoes closely.

# Earthquake-prone country, Japan




**About 20 % of large scale earthquakes in the world occur in Japan**
**The number of earthquakes M≥ 6.0 (1994-2003)**

***(Japan's data from Japan Meteorological Agency and the world data from Cabinet Office based on USGS)***

**The number of active volcanoes**
**Active volcano is defined as volcano which erupted within about past 10,000 years.**

***(Japan's data from Japan Meteorological Agency (JMA) and the world's from Cabinet Office based on Smithsonian Institution (1994))***

### ✓ Tsunamis

When large earthquakes occur in ocean areas, the sea floor rises or sinks. Accordingly, massive amounts of water on the sea floor also move up or down, and this movement spreads out in all directions in the ocean. The resulting waves are called tsunamis. Tsunami waves become slower as the sea becomes shallower. As a result, trailing waves catch up with those ahead near the coast, and the tsunami grows much higher. Even if a tsunami does not seem very high in offshore areas, it can turn into a big wave near the coast.

### ✓ Typhoons

Typhoons in Japan come in August, when it hits the heavy rain season. Typhoons can bring wind and rain that causes much damage, including landslides and floods.

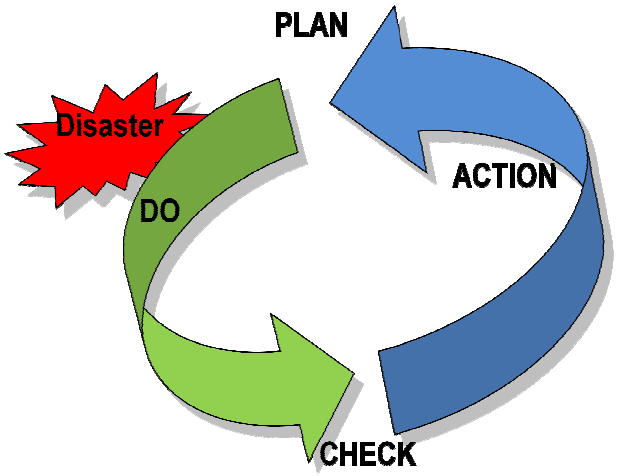
- **The Disaster Risk Reduction in Japan**

Japan's swift and effective response is a clear reflection of the focused preparations the country has made in disaster preparedness, especially since the Kobe earthquake in 1995.

Kobe Earthquake (1995)

Japan has invested heavily in DRR, strengthening the seismic performance of buildings and of national and local response capacities and warning systems. While the loss of life and damage have been devastating, they would have been far worse without the risk management investments made over the last several decades. In this regard, Japan can serve as an example for around the world.

Japan shows the value of early warning systems and evacuation plans and drills for reducing loss of life and injury.




The Great Tohoku Earthquake and Tsunami (2011)

The Government has opened shelters across many parts of Japan (for Hyogo Prefecture- Miki Earthquake Disaster Memorial Park (202ha)).

Japan's DRR efforts were quite successful in limiting damage and loss of life from the Great East Japan Earthquake (03.2011). Prompt evacuation alerts saved many residents, but the unexpected scale of the tsunami, triggered by an unprecedented earthquake (magnitude 9.0), destroyed the north-west part of the country. Dealing with these issues requires systems that are flexible and ready to be applied in a wide variety of potential scenarios. This is a challenge Japan - along with the world.

**Japan has a world leader in DRM systems. It also is a leader in helping other countries address these critical needs.**

- **Laws and Legal System of DM in Japan**

**The Basic Disaster Management Plan** is the master plan and the basis for DRM activities in Japan. DM system in the country has been developed and strengthened following the bitter experiences of large-scale disasters and accidents.

| Events | Disaster Management Acts | Disaster Management Plans and Systems |
|---|---|---|
| **1940** | | |
| 45・Typhoon Makurazaki<br>46・Nankai Earthquake<br>47・Typhoon Catherine<br>48・Fukui Earthquake | 47・Disaster Relief Act<br>49・Flood Control Act | |
| **1950** | | |
| | 50・Building Standard Law | |
| 59・Typhoon Ise-wan | | |
| **1960** | | |
| 61・Heavy Snowfalls | 60・Soil Conservation and Flood Control Urgent Measures Act<br>61・Disaster Countermeasures Basic Act<br>62・Act on Special Financial Support to Deal with Extremely Severe Disasters<br>・Act on Special Measures for Heavy Snowfall Areas | 61 Disignation of Disaster Reduction Day<br>62 Establishment of Central Disaster Management Council<br>63 Basic Disaster Management Plan |
| 64・Niigata Earthquake | 66・Act on Earthquake Insurance | |
| **1970** | | |
| 73・Mt. Sakurajima Eruption<br>・Mt. Asama Eruption | 73・Act on Special Measures for Active Volcanoes | |
| 76・Seismological Society of Japan's report about the possibility of Tokai Earthquake<br>78・Miyagi-ken-oki Earthquake | 78・Act on Special Measures for Large-Scale Earthquakes | 79 Tokai Earthquake Contermeasures Basic Plan |
| **1980** | | |
| | 80・Act on Special Financial Measures for Urgent Earthquake Countermeasure Improvement Projects in Areas for Intensified Measures<br>81・Amendment of Building Standard Law | 83 Designation of Disaster Reduction Week Campaign |
| **1990** | | |
| 95・Great Hanshin-Awaji Earthquake | 95・Act on Special Measures for Earthquake Disaster Countermeasures<br>・Act on Promotion of the Earthquake-proof Retrofit of Buildings<br>・Amendment of Disaster Countermeasures Basic Act<br>・Amendment of Act on Special Measures for Large-scale Earthquakes<br>96・Act on Special Measures for Preservation of Rights and Profits of the Victims of Specified Disasters<br>97・Act on Promotion of Disaster Resilience Improvement in Densely Inhabited Areas<br>98・Act on Support for Livelihood Recovery of Disaster Victims | 95 Amendment of Basic Disaster Management Plan<br>Disignation of Disaster Reduction and Volunteer Day |
| 99・Torrential Rains in Hiroshima<br>・JCO Nuclear Accident | 99・Act on Special Measures for Nuclear Disasters | |
| **2000** | | |
| 00・Torrential Rains in the Tokai Region | 00・Act on Promotion of Sediment Disaster Countermeasures for Sediment Disaster Prone Areas<br>01・Amendment of Flood Control Act<br>02・Act on Special Measures for Promotion of Tohnankai and Nankai Earthquake Disaster Management<br>03・Specified Urban River Inundation Countermeasures Act | 01 Establishment of the Cabinet Office<br>03 Policy Framework for Tokai Earthquake<br>Policy Framework for Tonankai and Nankai Earthquakes<br>Tokai Earthquake Countermeasures Basic Plan |
| 04・Niigata-Fukushima Torrential Rains, etc.<br>04・Niigata-ken-Chuetsu Earthquake | 04・Act on Special Measures for Promotion of Disaster Management for Trenchtype Earthquakes in the Vicinity of the Japan and Chishima Trenches<br>05・Amendment of Flood Control Act<br>・Amendment of Act on Promotion of Sediment Disaster Countermeasures for Sediment Disaster Prone Areas<br>・Amendment of Act on Promotion of the Earthquake-proof Retrofit of Buildings<br>06・Amendment of Act on the Regulation of Residential Land Development | 04 Tonankai and Nankai Earthquake Countermeasures Basic Plan<br>05 Tokai Earthquake Disaster Reduction Strategy<br>Tonankai and Nankai Earthquake Disaster Reduction Strategy<br>Policy Framework for Tokyo Inland Earthquakes<br>06 Policy Framework for Trench-type Earthquakes in the Vicinity of the Japan and Chishima Trenches<br>Tokyo Inland Earthquake Disaster Reduction Strategy<br>Basic Framework for promoting a Nationwide Movement for Disaster Reduction<br>08 Disaster Management Strategy for Trench-type Earthquakes in the Vicinity of the Japan and Chishima Trenches<br>09 Chubu and Kinki regions Inland Earthquake Countermeasures Basic Plan |

伊勢湾台風，1959
写真提供：岐阜県

Ise-wan Typhoon, 1959
Photo: Gifu Prefecture

長崎豪雨災害，1982
写真提供：長崎市

Torrential Rains in Nagasaki, 1982
Photo: Nagasaki City

Disaster countermeasures are taken based on the Disaster Countermeasures Basic Act and various disaster management related laws.

**[Basic Acts]**

1. Disaster Countermeasures Basic Act (1961)
2. Act on Prevention of Marine Pollution and Maritime Disaster (1970)
3. Act on Disaster Prevention in Petroleum Industrial Complexes and other Petroleum Facilities (1975)
4. Act on Special Measures for Large-scale Earthquakes (1978)
5. Act on Special Measures for Nuclear Disasters (1999)
6. Act on Special Measures for Promotion of Tonankai and Nankai Earthquake Disaster Management (2002)
7. Act on Special Measures for Promotion of Disaster Management for Trench-type Earthquakes in the Vicinity of the Japan and Chishima Trenches (2004)

**[Disaster Prevention and Preparedness]**

1. Erosion Control Act (1897)
2. Building Standard Law (1950)
3. Forest Act (1951)
4. Act on Temporary Measures for Disaster Prevention and Development of Special Land Areas (1952)
5. Meteorological Services Act (1952)
6. Seashore Act (1956)
7. Landslide Prevention Act (1958)
8. Act on Special Measures for Disaster Prevention in Typhoon-prone Areas (1958)
9. Act on Special Measures for Heavy Snowfall Areas (1962)
10. River Act (1964)
11. Act on Prevention of Steep Slope Collapse Disaster (1969)
12. Act on Special Measures for Active Volcanoes (1973)
13. Act on Special Financial Measures for Urgent Earthquake Countermeasure Improvement Projects in Areas for Intensified Measures (1980)
14. Act on Special Measures for Earthquake Disaster Countermeasures (1995)
15. Act on Promotion of the Earthquake-proof Retrofit of Buildings (1995)
16. Act on Promotion of Disaster Resilience Improvement in Densely Inhabited Areas (1997)
17. Act on Promotion of Sediment Disaster Countermeasures for Sediment Disaster Prone Areas (2000)
18. Specified Urban River Inundation Countermeasures Act (2003)

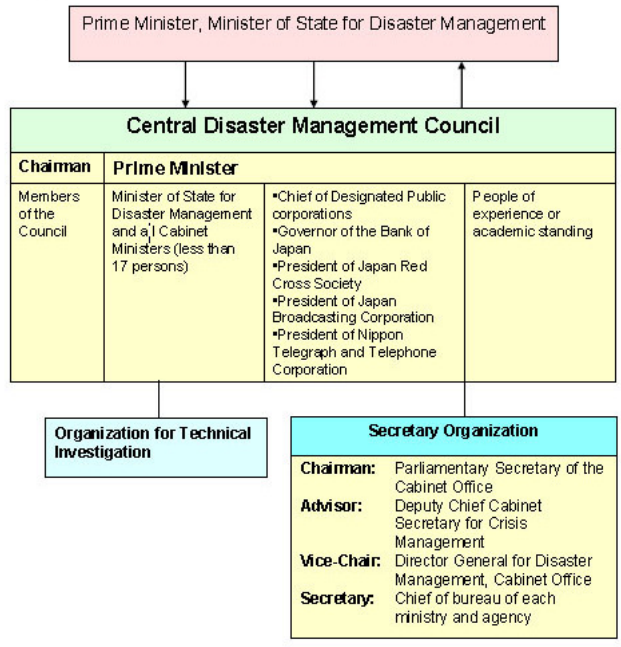
**[Disaster Emergency Response]**

1. Disaster Relief Act (1947)
2. Fire Services Act (1948)
3. Flood Control Act (1949)

**[Disaster Recovery and Reconstruction, and Financial Measures]**

1. Forest National Insurance Act (1937)
2. Agriculture Disaster Compensation Act (1947)
3. Housing Loan Corporation Act (1950)
4. Act on Interim Measures for Subsidizing Recovery Projects for Agriculture, Forestry and Fisheries Facilities Damaged Due to Disasters (1950)
5. Small-Medium Business Credit Insurance Act (1950)
6. Act on National Treasury Share of Expenses for Recovery Projects for Public Civil Engineering Facilities Damaged Due to Disasters (1951)
7. Public Housing Act (1951)
8. Fishing Boat Damage Compensation Act (1952)
9. Agriculture, Forestry and Fisheries Finance Corporation Act (1952)
10. Railway Improvement Act (1953)
11. Act on National Treasury Share of Expenses for Recovery of Public School Facilities Damaged Due to Disasters (1953)
12. Act on Interim Measures for Financing Farmers, Woodsmen and Fishermen Suffering from Natural Disasters (1955)
13. Airport Improvement Act (1956)
14. Small-scale Business Equipment Installation Financial Support Act (1956)
15. Act on Special Financial Support to Deal with Extremely Severe Disasters (1962)
16. Fisheries Disaster Compensation Act (1964)
17. Act on Earthquake Insurance (1966)
18. Act on Special Financial Measures for Group Relocation Promotion Projects for Disaster Mitigation (1972)
19. Act on Payment of Solatia for Disasters (1973)
20. Act on Special Measures for Reconstruction of Disaster-stricken Urban Areas (1995)
21. Act on Special Measures for Reconstruction of Jointly Owned Buildings in Disaster-stricken Areas (1995)
22. Act on Special Measures for Preservation of Rights and Profits of the Victims of Specified Disasters (1996)
23. Act on Support for Livelihood Recovery of Disaster Victims (1998)

Organization of the Central Disaster Management Council



- **Main Activities of ADRC**

### ✓ Information Sharing on DRR and Supporting application of technologies and tools

ADRC provides information on the latest disasters both in Asia and all other part of the world, disaster prevention of the member countries, like Armenia, China, Kirgizstan, Yemen etc, and the advisor countries, good practices for disaster risk reduction and other related information.

Main Contents of Country Reports are: Natural Hazards affected the country; DM plan and system; Budget size on national level; Progress and situations of the HFA; ADRC Counterpart.

Also, as a new initiative, ADRC in cooperaion with UN-OCHA (Kobe), has proposed a globally common, unique identification format for disaster events, as a tool for facilitating the sharing of disaster information around the world.

Sentinel Asia' Project established for DRM system in Asia, using earth satellites (2006). ADRC receives emergency observation requests from the member countries and other organizations which participate in collaborative projects. And the part of this project the 'Disaster Management Support System' offers maps and satellite images, as well as disaster information in the Asia Pacific region.

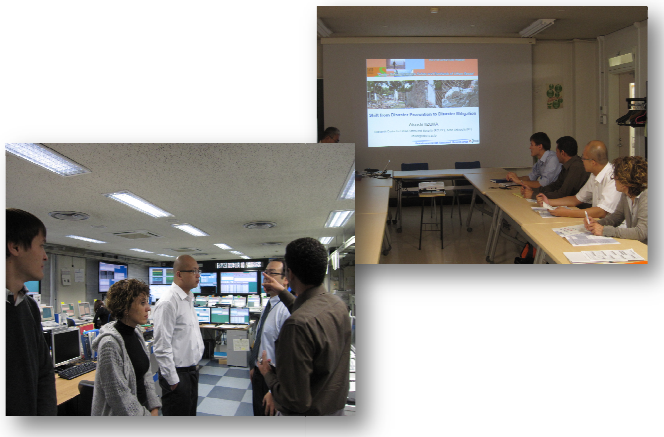
ADRC convenes an annual international conference participated by disaster officials from the member countries and disaster experts from international organizations to promote information sharing, exchange opinions, and enhance partnerships among participating countries and organizations. ACDR 2013 follows up the progress made towards the implementation of the HFA and identify the common tasks toward post-HFA in the Asian region. It also provides an opportunity to discuss the future activities.

### ✓ Human Resources Development

ADRC organizes and conducts various conferences, workshops and trainings for enhancing the human resources capability of pursuing effective DRM in member countries.

Each year, ADRC invites four officials in charge of DM from member countries as visiting researchers (term Basically 6 months but 3 months can be acceptable). The VRs are provided with opportunities to discuss challenges for DM of each country, enhance understanding of the DM system, lessons from the latest disasters, DRR and international cooperation in Japan.

ADRC Visiting Researchers (2012A term) in Kobe University



ADRC VRs in Volcanic Observations and Information Center (Tokyo)

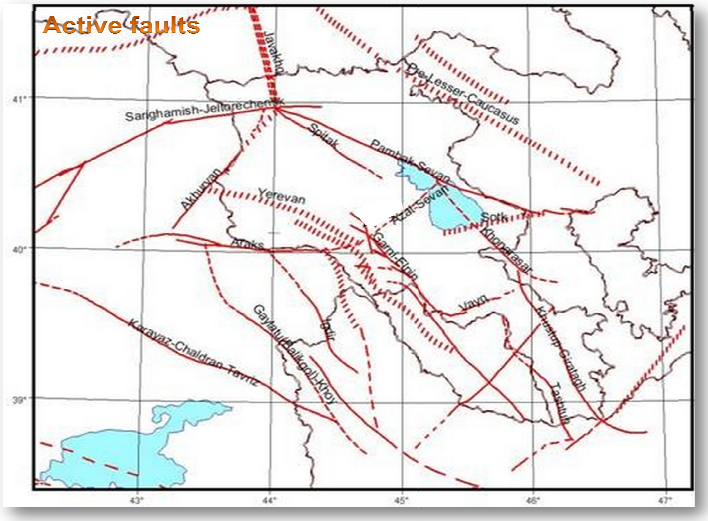
### ✓ Building Communities Capabilities

ADRC undertakes various efforts including increasing public awareness of DRM, development and dissemination of tools for reducting vulnerability of communities. In Armenia ADRC has planed Program for Enhancement of Disaster Education Programs in Schools.

## 4. RESULT OF THE RESEARCH

- **Current Seismic Hazard Assessment and Earthquake Prediction in Armenia**

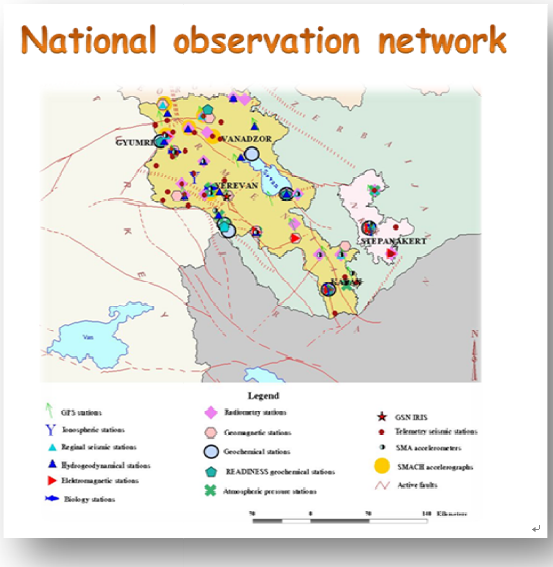
Armenia is located in the Alpine-Himalayan and Balkan-Carpathian seismic belts, a high seismic hazard zone.




Seismic hazard refers to the study of expected earthquake ground motions at the earth's surface, and its likely effects on existing natural conditions and man-made structures for public safety considerations. One of the Seismic hazard assessment elements is the primary seismic hazard assessment, which includes current assessment (short-term) of seismic hazard (CSHA).

CSHA in Armenia enable the NSSP. CSHA is the prediction with the defined probability of place, magnitude and time of possible strong earthquake.

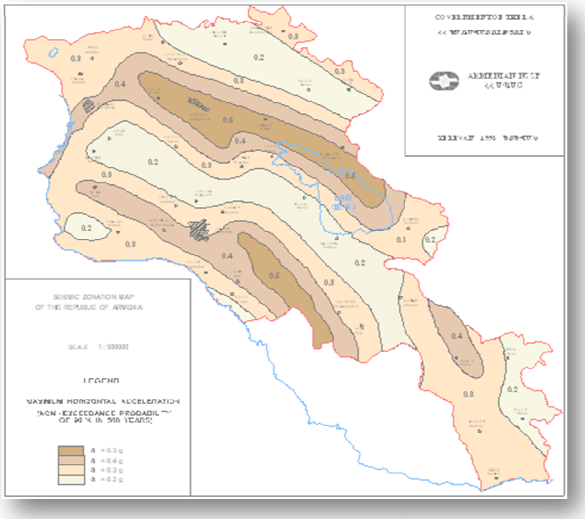
For seismic monitoring and CSHA in the territory of Armenia the national multiparameter network of seismic observation operates. The network consists of national and international observation stations, which are included in a world global network. At seismic stations are directly implemented round-the-clock multiparameter observations and the received results are transmitted to the data acquisition center of plenipotentiary body, where they are collected in unified databank.




**The CSHA includes:**

- ✓ Definition of probabilities of current anomalies' seismic realization based on testing of strong regional earthquakes (M≥6.0) and local notable earthquakes (M≥3.7) and monitoring time period
- ✓ history analysis using “SeisHelp” (Monitored the time series, the anomalies are selected visually);
- ✓ for seismogene anomalies using “Dynamic Fields”; probability evaluation;
- ✓ of the site, time and magnitude of expected earthquake using “Expert” programs;
- ✓ Evaluation of crust stress based on monitoring data;
- ✓ Complex evaluation of CSH based on operative complex map using seismotectonic data and seismic hazart map of RA territory.

**Seismic hazard map of RA territory (scale 1:500.000), compiled at Armenian NSSP In 1998**



In case of prediction of strong earthquake in the territory of Armenia and adjacent areas the Expert of the Armenian NSSP for prediction confirmation has being immediately conveyed early non-urgent actions are being undertaken after based on the decision of the analysis, information, in order, established by a plenipotentiary bodies.

Before expected earthquake, in case of emergency declaring the Armenian NSSP acts according to the relevant approved documents.

After occurred earthquake the main earthquake parameters are defined and the first preliminary announcement is being made, and after main parameters adjusting, the final announcement is being made.

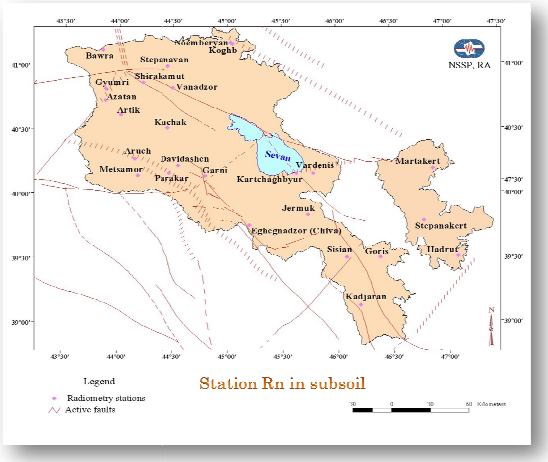
After occurred earthquake, in case of emergency declaration the actions are being undertaken according to the relevant approved documents.

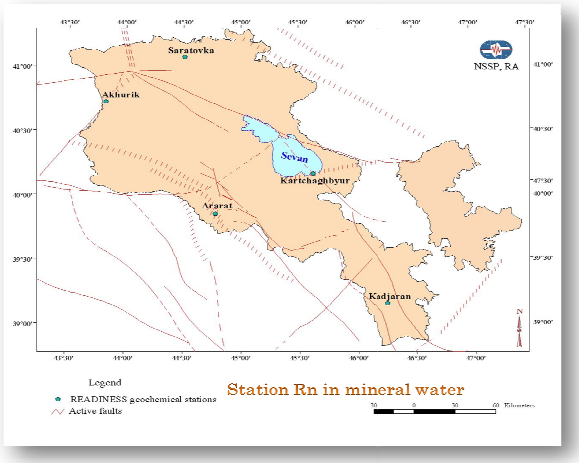
## Anomalous radon concentration as an earthquake-precursor (Armenian experience)

Preparation of a strong seismic event is known to be associated with an accumulation of gigantic elastic strain energy in the medium. In Armenian NSSP is observed Radon concentration:

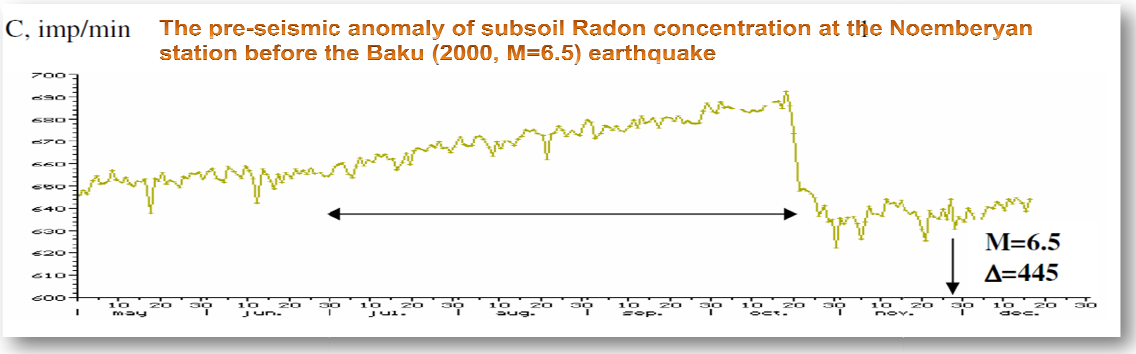
- in mineral water (imp/min) ,which includes Hydrogeochemical READINESS network;
- in subsoil (imp/min)

So based on the retrospective analysis of practically all seismic events which had occurred 1983-2002 in Armenia and adjacent territories are systematically tested and based the Catalogue of precursory anomalies. It was supplemented few times, and the anomalies included were critically overestimated and sometimes rejected. Naturally, the Catalogue will be supplemented with the tests of future strong regional and perceptible local earthquakes. The Catalogue is in daily use at the Armenian NSSP for CSHA.

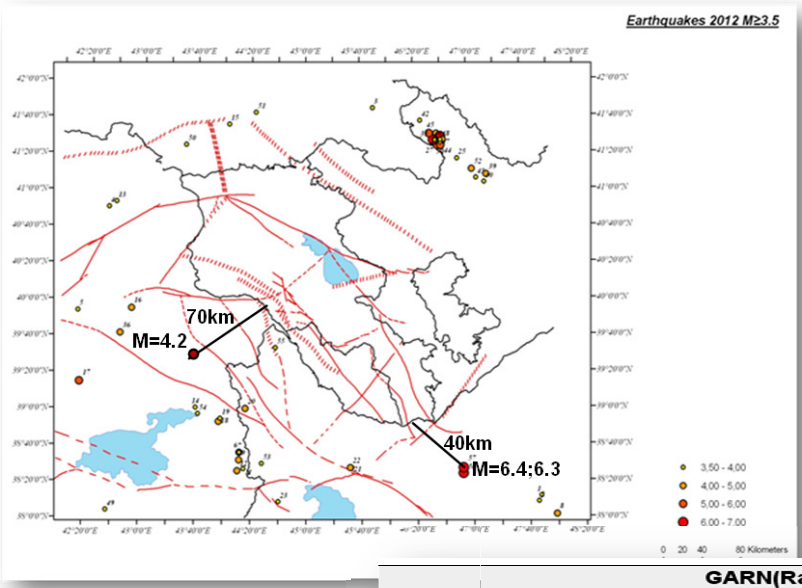


The examples, in particular, the imposing of precursory anomalies of different order, as well as the presence of pre-, co-, post-seismic periods in observed.

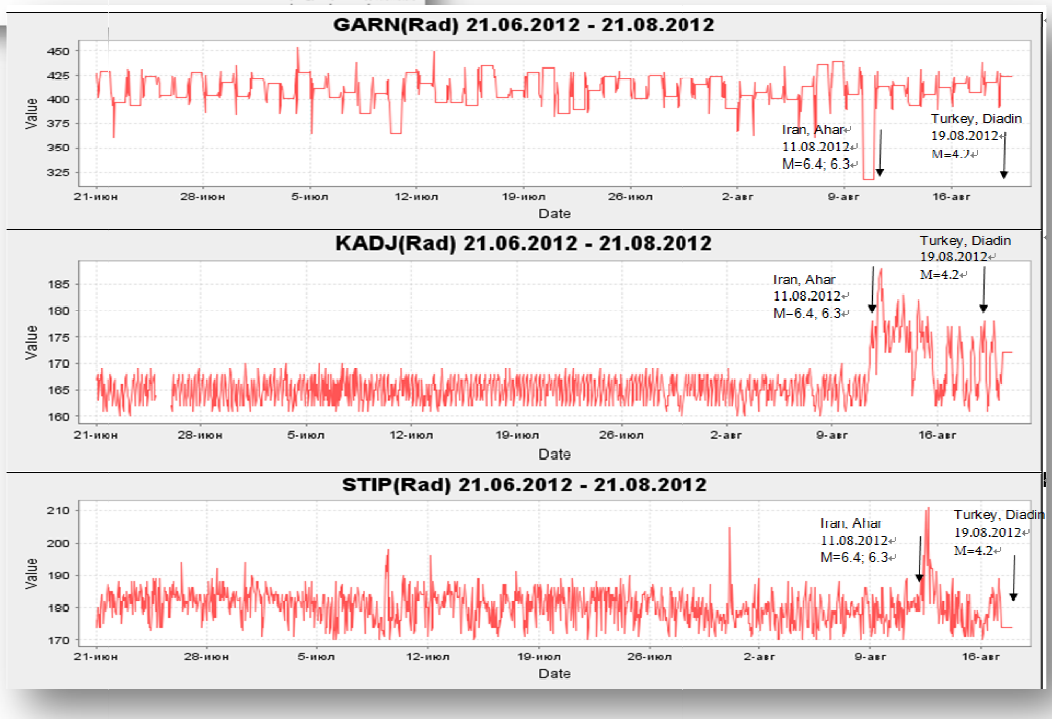



National Seismic Catalogue




For the resent seismic events in the adjacent territories (M=6.4;6.3, in 2012, Iran), (M=4.2, Turkey)

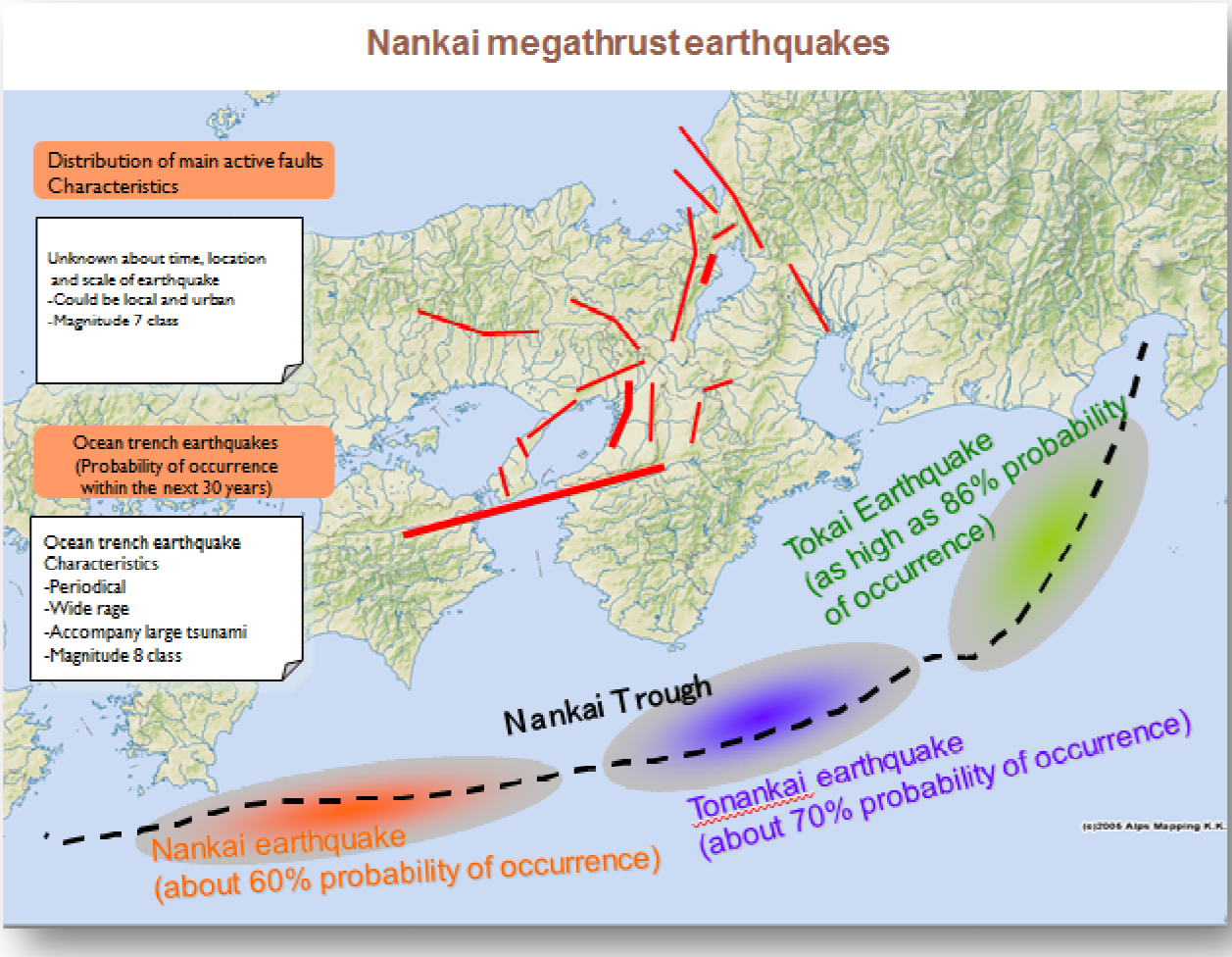
In subsoil Rn gas concentration probably-seismogenic short-term anomalies at the Garni (operative), Qajaran and Stepanakert stations.



- **Future Mega-earthquake Risk and preparedness in Japan**

  ✓ **The Nankai megathrust earthquakes**

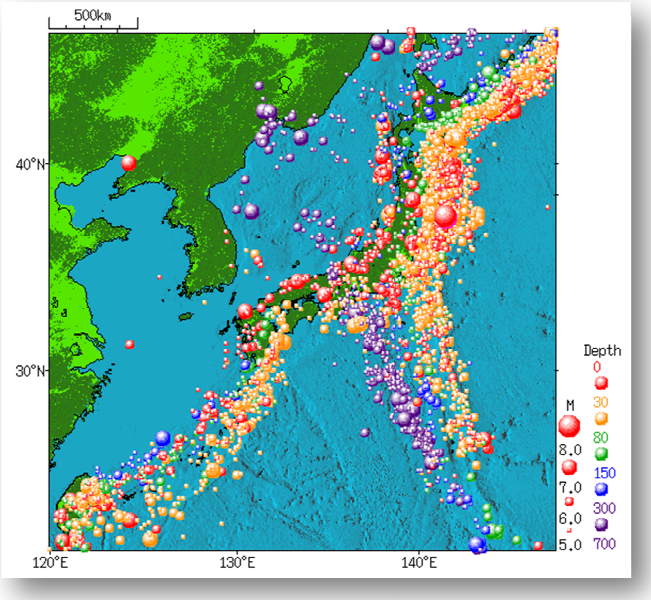
The Nankai megaearthquakes are great earthquakes that occur along the fault that forms the plate interface between the subducting Philippine Sea Plate and the overriding Amurian Plate (part of the Eurasian Plate), which dips beneath southwestern Honshu, Japan. All of these great earthquakes have given rise to damaging tsunami.




The northeastern most part of the megathrust (Tokai) has not ruptured since 1854. A future great earthquake involving rupture along this and possibly other segments has been proposed as a major risk for the southern coast of Honshu. In 1999, the likelihood of the occurrence of a great earthquake in the Tokai area in the period 2000-2010 was estimated to be in the range of 0.35.–0.45. The earthquake repeat intervals are generally in the range 90–200 years.

## ✓ Seismic monitoring in Japan

Located in one of the most active seismic and volcanic zones in the world, Japan is frequently affected by earthquakes. JMA operationally monitors seismic activity throughout the country and issues relevant warnings and information to mitigate damage caused by disasters related to earthquakes.



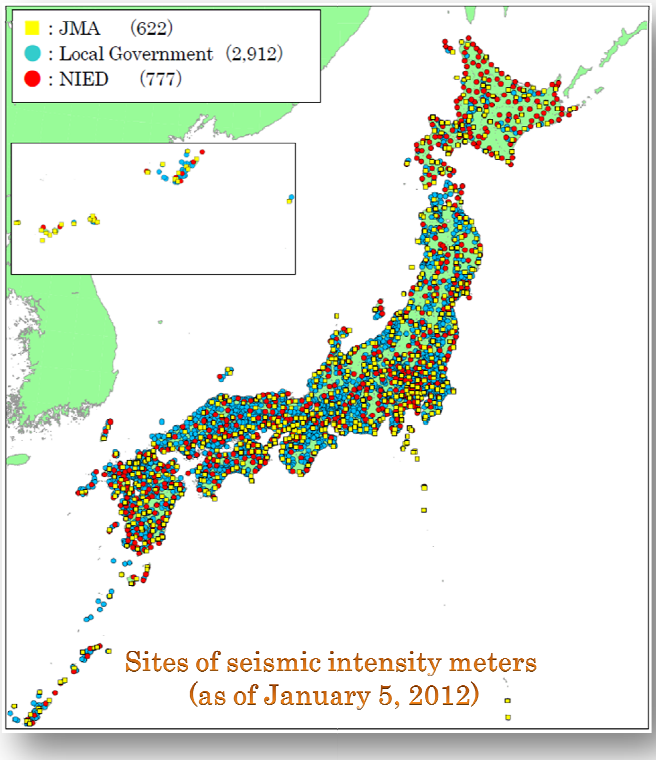

Earthquake distribution around Japan (1960-2011)

To monitor earthquakes, JMA operates an earthquake observation network comprised of about 200 seismographs and 600 seismic intensity meters. It also collects data from over 3,600 seismic intensity meters managed by local governments and the National Research Institute for Earth Science and Disaster Prevention (NIED). The data collected are input to the Earthquake Phenomena Observation System (EPOS) at the headquarters in Tokyo and the Osaka District Meteorological Observatory on a real-time basis.

When an earthquake occurs, JMA immediately issues information on its hypocenter, magnitude and observed seismic intensity. If the seismic intensity is 3 or greater, the Agency issues a Seismic Intensity Information report within 1.5 minutes.

To process data for earthquake predictions, three centers for different disciplines were set up: in the Geographical Survey Institute, the Japan Meteorological Agency, and the Earthquake Research Institute (University of Tokyo). A newly established committee, called the Coordinating Committee for Earthquake Prediction, which consists of about 30 specialists, analyzes the data flowing into these three channels. The committee issues a warning of earthquake danger, whenever possible.

A tentative strategy for achieving earthquake prediction is proposed. An attempt is made to evaluate ratings of earthquake threats on the basis of probability theory.




Sites of seismic intensity meters
(as of January 5, 2012)

### ✓ Prediction of the Tokai Earthquake

A Tokai Earthquake is the only earthquake at present with a possibility of being predicted just before it occurs. Data presumed to be effective for earthquake prediction are monitored in real-time by JMA. Upon detecting any anomalies in the data, observation, caution and prediction information regarding an earthquake in the Tokai region will be announced. The Prime Minister will then issue a warning declaration based on the earthquake prediction report and implement necessary measures including establishment of the Earthquake Disaster Warning Headquarters.

The actions for the warning of Tokai earthquake are followed:

| 1 Information | 2 Explanation | 3 Actions recommended or required for disaster prevention when the information is issued |
|---|---|---|
| 4 Tokai Earthquake Report | 5 1. A small anomaly is observed that is insufficient to be interpreted as being directly related to the occurrence of the Tokai Earthquake.<br>2. A number of anomalies are observed that are interpreted as being irrelevant to the occurrence of the Tokai Earthquake (i.e. indicating no risk of such an earthquake). | 6 Attention should be paid to TV/radio information. No further action is required. |
| 7 Tokai Earthquake Advisory | 8 A number of anomalies are observed that are interpreted as indicating an increasing possibility of the Tokai Earthquake occurring. | 9 Attention should be paid to TV/radio information. Follow notifications from the government and the disaster management plan of local governments. |
| 10 Tokai Earthquake Warning | 11 Anomalies are observed that are interpreted as indicating the Tokai Earthquake is expected to occur. | 12 Attention should be paid to TV/radio information. Act on warning statements from the Prime Minister and the disaster management plans of local governments. |

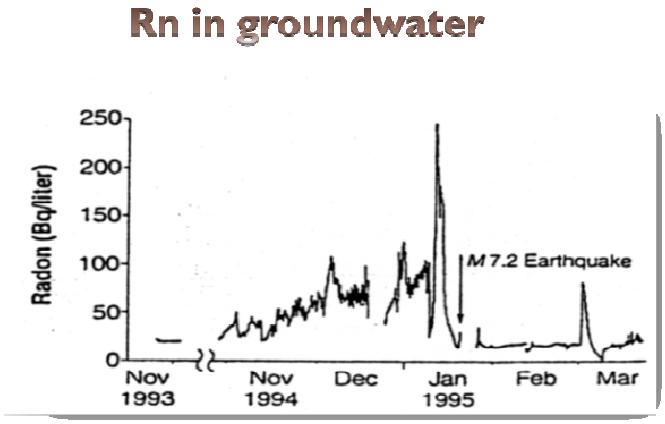
If observed anomalies are judged as being irrelevant to the occurrence of the Tokai Earthquake, the information is canceled.

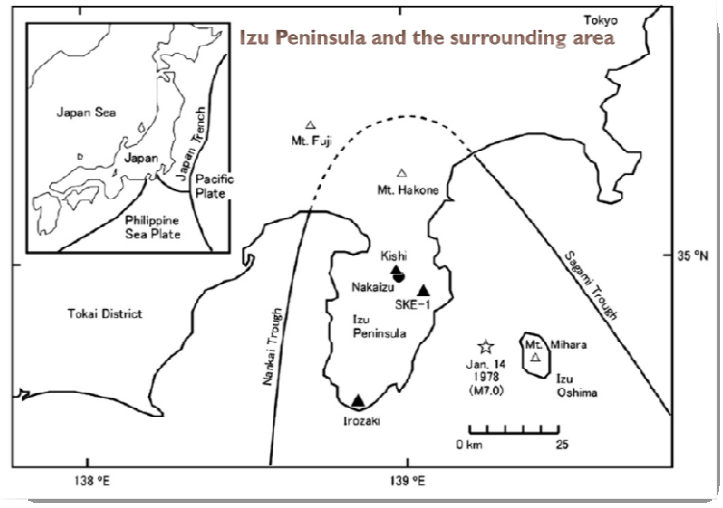
- **Anomalous radon concentration as an earthquake-precursor (Japanese experience)**

The relationship between radon anomaly and earthquakes has been studied for more than 30 years. Most of the studies dealt with radon in soil gas or in groundwater.

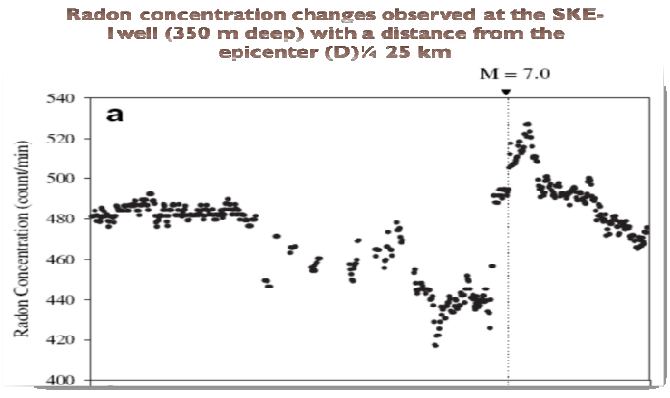
Groundwater/soil radon measurements for earthquake prediction began in 1970's in Japan as well as foreign countries. Radon groundwater concentration anomalies prior to earthquakes have been reported in various countries (the former SU, Italy) and regions.

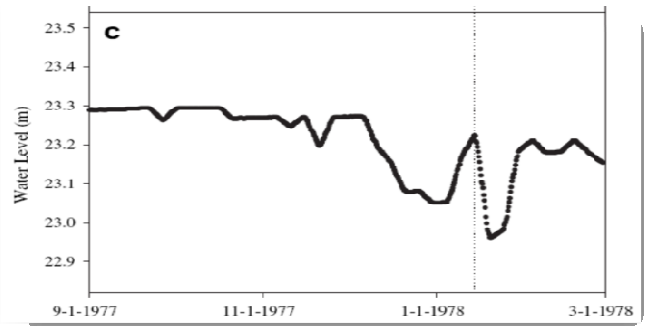
The scientists discovered that there was a rapid increase (several months) of radon in groundwater, and the peak concentration occured 10 days before Kobe earthquake (Great Hanshin-Awaji earthquake) in 1995, M=7.2, then returned to background levels after the main earthquake subsided.




Depending on the 1978 Izu-Oshima-kinkai earthquake Precursory changes in groundwater radon concentration, temperature, water level and flow rate of groundwater were observed at 5 stations located in the area within 90 km from the epicenter. The patterns and occurrences of these changes are quite similar to each other. The mid-term anomalies started from the end of October, 1977 and significant short-term anomalies were also observed a few days before the main shock. Occurrences of these variations related to the movement of groundwater coincide with those of other geophysical phenomena.



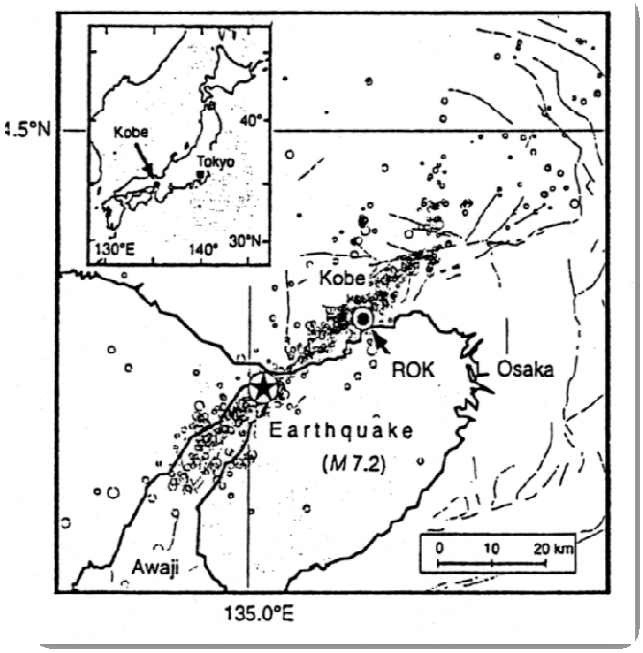

Water level changes observed at the Kishi well (500 m deep) with D ¼ 30 km

Contrary to soil/groundwater radon, they paid less attention to atmospheric radon before earthquakes. However, it might be possible to detect precursors in atmospheric radon before a large earthquake.

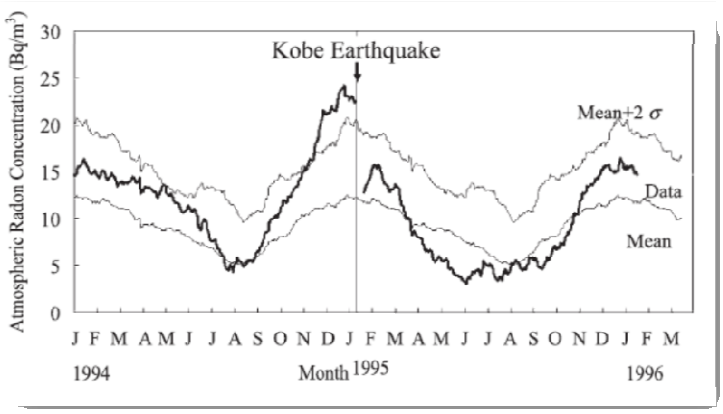
According to the scientists, similar atmospheric anomalies have been observed a few days prior to the earthquakes in Tashkent (1966), China (M=7.9, 2008), Italy (M=6.3, 2009).

In the Kobe Pharmaceutical University measured athmospheric radon from 1984 to 1996 on one o the Rokko fault lines, which was the source of the Kobe earthquake 1995.

**Magnitude 7.2 earthquake struck Kobe Jan. 17, 1995**




**Changes in atmospheric radon concentration at Kobe.**

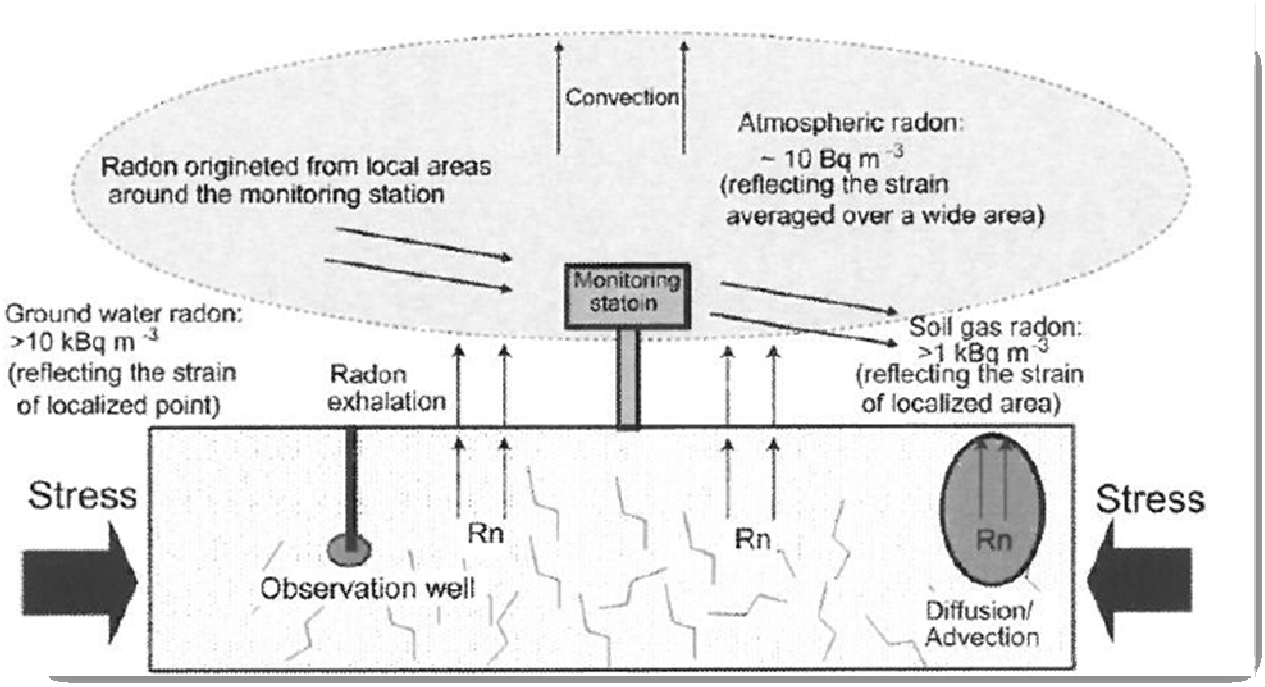



Rn often shows distinct anomalies preceding an earthquake Unfortunately, not always clear where or what to monitor, Atmospheric radon anomalies may offer promise of integrating larger areas

The scientists explain these precursory atmospheric events, that the air is ionized by the emission of radon and other gases from the Earth's crust in the vicinity of an active fault.

While atmospheric anomalies appear to precede and coincide with earthquakes, it is still question how accurate and reliable such measures are for predicting earthquakes. Future research is important and compelling nature of the scientific findings to improve our understanding of atmospheric changes that precede earthquakes.

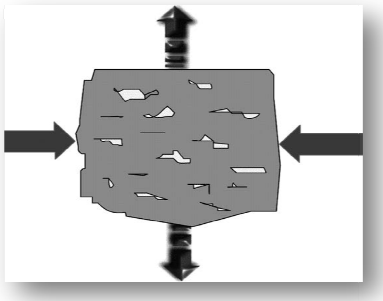
## Conceptual diagram of Rn concetration anomalies and observation of Rn concetration in groundwater, soil and the atmosphere.




Earthquakes that cause destruction at the surface of the earth can be detectable before they strike, unless they are:

- ✓ manmade;
- ✓ caused by an extraterrestrial source,
- ✓ too deep to be detected,
- ✓ too far away from a sensor to be detected,
- ✓ cloaked by a larger earthquake (in which case; it basically is detectable since the intensity is so high)

### Rn Emanation Processes



The scientists recognized the significance of radon in earthquake prediction research, but recently its limitation was also pointed out. The radon gas enters groundwater via fractures and microfractures in the rock. Before a large earthquake rupture, increasing stress growing up, because of manation process in microfractures (expansion or compression). Some researchers are looking for a better indicator for precursors; simultaneous measurements of radon and other gasses are new trials in recent studies.

- **Conclusion**

The researchs for earthquake prediction is being carried out in Japan and in Armenia.

Earthquake-proof strengthening of the structures and infrastructure, population knowledge and preparedness, and earthquake prediction are the 3 pillars of the earthquake disaster reduction.

Extensive damage by a large earthquake is still inevitable, and a lot of lives will be saved if the earthquake is foreseen a day or even one hour before. This is why earthquake prediction is always ranked at the top of urgent problems in all the public opinion polls.

However, till the world hasn't succeeded in predicting the earthquakes.

Only an earthquake was predicted in China in 1975, M=7.3. Local political leaders ordered evacuations a day before the earthquake took place. This successful evacuation saved many lives. This was the only successful evacuation before a devastating earthquake in history. In the years, months and weeks leading up to the event various phenomena were reported which could be interpreted as precursors to an earthquake, including strange animal behavior.

An Earthquake is a vibration of the earth called a "seismic wave", generated by destruction of rocks under the ground. Destruction here is the rapid slip motion at a fault due to the stress. Displacement of the Nojima fault of Awaji-shima was 1 to 2 meters during the Kobe Earthquake (1995, M=7.2 ). Plate tectonics says that the stress is caused by the jostle and slip between plates. Plates move at speeds of centimeters per year. Large stresses build up at plate boundaries until ruptures occur producing earthquakes.

Plate tectonics theory which brought the earth sciences a revolution in the latter half of the twentieth century clarified that Earth has an approximately 100 km thick rigid surface layer which is divided into about 10 plates that are moving with such speeds. The earthquakes of the world occur chiefly in the boundary zones of the plates. About 10% of the earthquakes of the world occur in the Japanese area because the Pacific Plate and the Philippine Sea Plate surge to Japan and subduct under the Japanese Islands.

Many scientists doubt that reliable and accurate earthquake predictions are even possible. Presently, scientists are fairly good at predicting where on Earth earthquakes are likely to occur – along the shifting boundaries of moving land plates. But the scientists couldn't determine exactly when an earthquake is going to strike yet.

It is important the short-term prediction which requires catching short-term precursory phenomena. The problem are both in Japan and in Armenia, that the seismic observation is not enough for this purpose because seismographs in principle provide only information on the earthquake that has already occurred. It is therefore necessary to adopt a new strategy of encouraging observations of anomalous changes in non-seismic phenomena, including not only crustal deformation but also underground water, gaseous release such as radon and carbon dioxide, and terrestrial magnetism and earth currents etc.

It is important to increas amounts of data, new theories, and powerful computer programs, and scientists are using those to explore ways that earthquakes might be predicted in the future.

**I certainly hope that in future we'll be in a world where an earthquake can be anticipated and predicted before it occurs.**

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