ASIAN DISASTER REDUCTION CENTER

VISITING RESEARCHER 2022

FINAL REPORT

SEISMIC MONITORING, SEISMIC HAZARD, RISK ASSESSMENT AND EARTHQUAKE EARLY WARNING SYSTEM IMPLEMENTATION AS A PART OF SEISMIC RISK REDUCTION

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Disclaimer

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ACRONYMS

ADRC	Asian Disaster Reduction Center
ADESS	Automated Data Editing and Switching System
ARNAP	Disaster Risk Reduction National Platform foundation
CBDRM	Community Based Disaster Risk Management
CEA	The French Alternative Energies and Atomic Energy Commission
CMC	Crisis Management Center
CMSA	Crisis Management State Academy
COSMETS	Computer System for Meteorological Services
CTBTO	Comprehensive nuclear Test-Ban Treaty Organization
CTBT	Comprehensive Test Ban Treaty
DASE	Analysis, Monitoring, Environment Department
DCPC	Data Collection or Production Centre
DRR	Disaster Risk Reduction
EEW	Earthquake Early Warning
EMSC	European-Mediterranean Seismological Center
EPOS	Earthquake Phenomena Observation System
EQ	Earthquake
GDP	Gross Domestic Product
GEM	Global Earthquake Model Foundation
GEONET	GNSS Earth Observation Network System
GEORISK	Georisk Scientific Research Company
GISC	Global Information System Centre
GPS	Global Position System
GSI	Geospatial Information Authority of Japan
GSHAP	Global Seismic Hazard Assessment Program
GSN	Global Seismographic Network
GTS	Global Telecommunication System
HERP	Headquarters for Earthquake Research Promotion
HFA	Hyogo Framework of Action
IAEA	International Atomic Energy Agency
IRIS	Incorporated Research Institutions for Seismology
ISC	International Seismological Center
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JICA	Japan International Cooperation Agency

JMA	The Japan Meteorological Agency
J-SHIS.	Japan Seismic Hazard Information Station
MES	Ministry of Emergency Situations
MEXT	Ministry of Education, Culture, Sports, Science and technology of Japan
MTSAT	Geostationary Meteorological Satellite
NAPS	Numerical Analysis and Prediction System
NIED	National Research Institute for Earth Science and Disaster Resilience
NMHS	National Meteorological and Hydrological Service
NMC	National Meteorological Centres
NP	National Platform
PGA	Peak Ground Acceleration
PSHA	Probabilistic Seismic Hazard Assessment
RA	Republic of Armenia
RSSP	Regional Survey for Seismic Protection
SESM	Scenario Earthquake Shaking Maps
SFDRR	Sendai Framework for Disaster Risk Reduction
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNICEF	United Nations Children’s Fund
USA	United States of America
USGS	United States Geological Survey
WIS	WMO Information System
WMC	World Meteorological Centre
WWW	World Weather Watch

ACKNOWLEDGEMENTS

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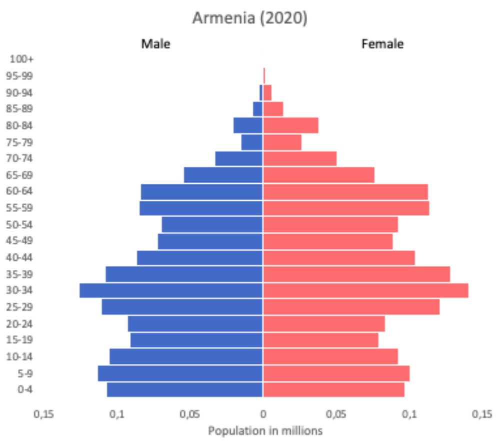
1. GENERAL INFORMATION

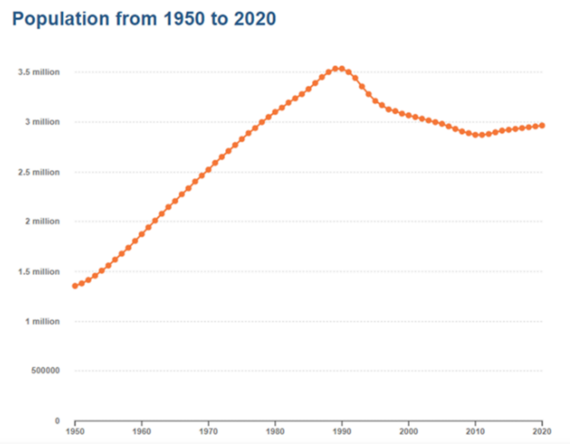
1.1. Republic of Armenia

Armenia is situated in western part of Asia, occupies the north-eastern part of Armenian plateau – between Caucasus and Nearest Asia (the inter-river territory between the middle flows of the rivers Kur and Araks). Armenia lies between latitudes 38° and 42° N, and meridians 43° and 47° E.

Official name	Republic of Armenia (RA), briefly – Armenia
Name in official language	Hayastani Hanrapetutyun, briefly – Hayastan
National flag	
The Coat of Arms	
The Anthem	“Our Fatherland”
Head of the State	President
Legislative power	Unicameral National Assembly

Official language	Armenian (is part of Indo-European family of languages)
Capital	Yerevan
Administrative and territorial unit	Marz (total number of 10), communities (total number of 502) Including: Urban: 49, in which Yerevan with its 12 administrative districts
National currency	Dram (international currency code - AMD)
Territory	29.74 thousand square km (is comparable with the territory of Belgium or Albania)
Neighboring countries	North - Georgia South - Iran East - Azerbaijan South-West - Nakhichevan (Azerbaijan) West – Turkey
Average elevation above sea level	1800 m (76.5% of the republican territory is on the height of 1000-2500 m above sea level)
The highest peak	Aragats mountain - 4090 m
The lowest altitude	Debed river canyon - 375 m
The greatest extent	from North-West to South-East comprises 360 km from West to East 200 km 65 km
Time zone	Greenwich mean time + 4 hours
Region	north latitudes of subtropics
Climate	4 seasons dry, continental
Average temperature	in January - -6.8°C, in July - +20.8°C
Population	3.0 Million

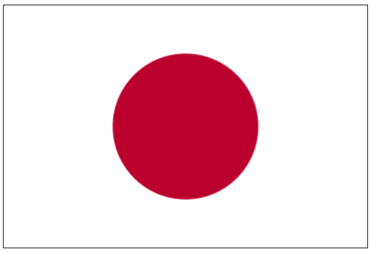
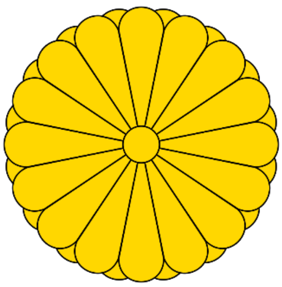




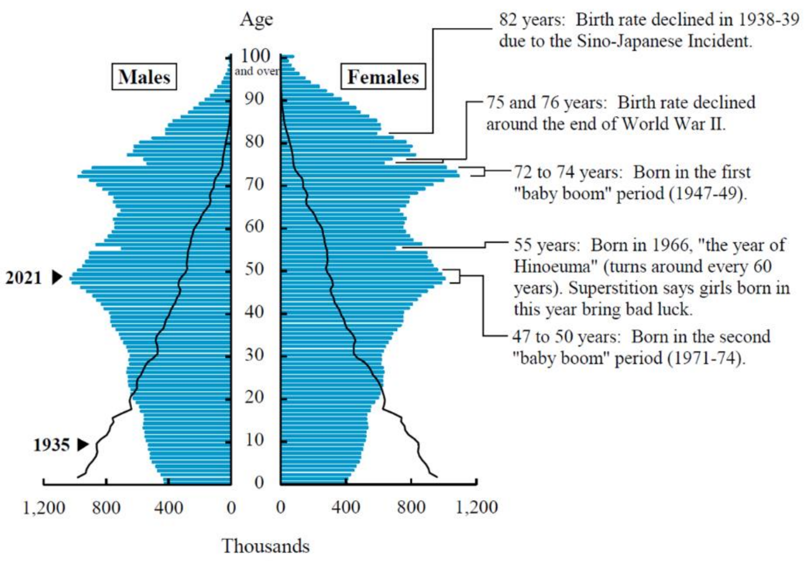
Source: https://worldinmaps.com/country/armenia/

1.2. Japan

Japan is an island country situated off the eastern seaboard of the Eurasian continent in the northern hemisphere. The islands form a crescent-shaped archipelago stretching from northeast to southwest parallel to the continental coastline with the Sea of Japan in between. The land is located between approximately 20 to 45 degrees' north latitude and between approximately 123 to 154 degrees' east longitude. It consists of the main islands of Hokkaido, Honshu, Shikoku, Kyushu and Okinawa, and more than 6.800 smaller islands of various sizes.

Official name	Japan
Name in official language	日本国, Nippon-koku or Nihon-koku
National flag	
Imperial Seal	
The Anthem	"Kimigayo"
Capital	Tokyo
National language	National language Japanese
Government	Unitary parliamentary constitutional monarchy
- Emperor	Naruhito

- Prime Minister	KISHIDA Fumio
Administrative and territorial unit	Region (total number of 8), Prefecture (total number of 47)
National currency	Yen (international currency code - JPY)
Territory	377.944 square km
Elevation extremes	lowest point: Hachiro-gata -4 m highest point: Mount Fuji 3.776 m
Natural resources	Negligible mineral resources, fish the largest consumers of fish and tropical timber, contributing to the depletion of these resources in Asia and elsewhere
Time zone	JST (UTC+9) /Summer (DST) not observed (UTC+9)
Climate	4 seasons Humid subtropical South: subtropical climate North: subarctic climate
Population	126.167 million



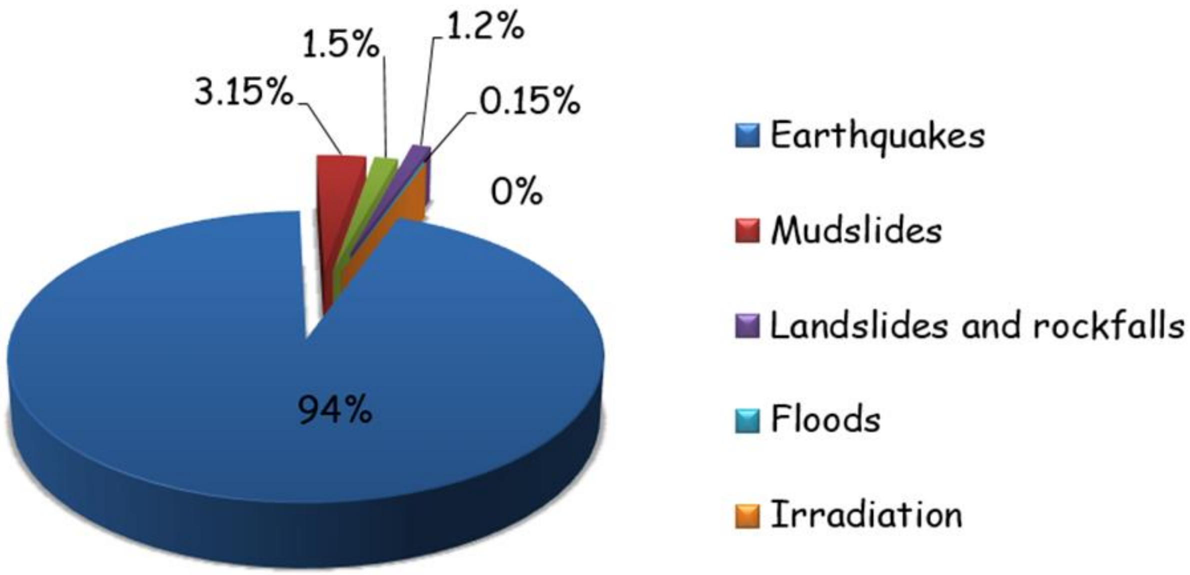
Source: ADRC

2. DISASTER MANAGEMENT IN ARMENIA

2.1.Natural Disaster Risks and Hazards in Armenia

Armenia is one of the most disaster prone countries in the southern Caucasus. Armenia is vulnerable to a number of disasters both due to natural hazards, such as earthquake, drought, flood, landslide, avalanche, mudslide, strong wind, snowstorm, frost and hail; and man-made hazards such as transportation and industrial accidents. Among various types of disasters, main hazard for the territory of Armenia is the earthquake-94%, and only 6% is another hazards, as well as the earthquakes have affected large numbers of people and caused significant economic losses.

The loss caused by different types of disasters in Armenia

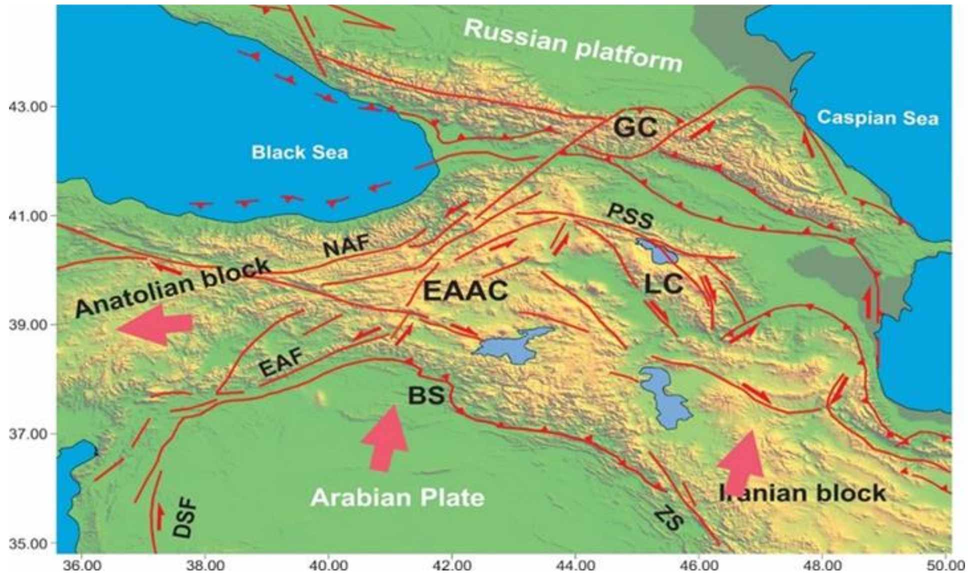


In Armenia, earthquakes are the most dominant hazard. As per Global Seismic Hazard Assessment Program (GSHAP, 1998), Armenia lies in a region with moderate to high seismic hazard. The analysis of disaster data shows that though the number of disaster events for earthquake is less than those for flood, the earthquake events caused a disproportionately large amount of damage to the country. The most devastating seismic event was the 1988 Spitak earthquake in Armenia that killed 25,000 people, injured 15,000, left 517,000 people homeless, caused significant damage to several cities, and resulted in direct economic losses of $ 14.2 billion. The July 1997, Noyemberyan city earthquake affected 15,000 people and caused an economic loss of USD 33.33 million.

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 mediumaltitude mountainous areas, where they typically occur once every three to ten years. During 2004-2007, mudflows damaged some 200 settlements and 600 sites on main transportation routes. Average annual damage from mudflows in the past four years is $2.9 million. Drought occurs almost every year in one or more locales of Armenia. In 2000-2001 a severe drought resulted in losses of around $143 million in Armenia (with 297,000 people affected). Hailstorms and strong winds cause significant damage to the agricultural sector, with average annual losses of $30-40 million and $3.6 million, respectively. Climate change is expected to amplify the frequency and intensity of meteorological hazards in Armenia. According to the available projections, by 2100 temperatures are expected to climb by 1.7°C, and precipitation is predicted to decrease by 10%. Boundaries of thermal belts in mountain areas are expected to move upwards by 150-900 m. The lengths of dry spells within years are projected to increase, precipitation to become more intense during wet periods, and the number of extremely moist and extremely dry years to rise. A shift in the beginning, peak and duration of hydrological drought and flood periods is expected, owing to greater share of rainfall and glacial melt and smaller proportion of snowmelt in river flow. Alternating drought and flood periods, together with shifting rainfall patterns, could expand mudflow zones in foothill areas. The risk of technological disasters is also significant. There are around 26 hazardous chemical enterprises in Armenia that use amonium, chlorine, chloric acid, nitric acid, etc., and over 1,500 enterprises that are at risk of explosion or catching fire. The Metsamor nuclear power plant is located in a seismically active zone. The poplation, economy, and environment of Armenia are highly vulnerable to natural hazards. Most significantly, according to the World Bank poverty incidence is around 30% and is concentrated in rural areas and provincial cities. A high degree of urbanization (64%) concentrates disaster (particularly seismic) risks in cities. The economy remains highly vulnerable. In any given year, there is a 20% chance that a major disaster will result in losses of 12.7% of GDP. During 1990-2005 Armenia lost close to 20% of its forest cover (around 63,000 hectares), which has greatly increased the likelihood of mudflows and landslides.

2.2. Recent Major Earthquakes in Armenia

Armenia, located in the central part of the Arabian Plate collisional zone with the Eurasian Plate, experiences N–S shortening and E–W extension expressed by strong earthquakes and volcanic activity. As a result of convergence of the Arabian and Eurasian plates, the Anatolian block is being ejected westward, and the Iranian block forced eastward. There are many potentially tectonically active faults accommodating plate convergence within the collision zone that have been collected in the Geological Datasets Layer.



Tectonic units and fault zones located around Armenia. North Anatolian Fault (NAF), East Anatolian Fault (EAF), Dead Sea Fault (DSF), Bitlis Gap (BS), Zagros Gap (ZS), Pambak-Sevan-Syunik Fault (PSS), Mets Kovacs (GC), Eastern Anatolian Complex (EAAC), Lesser Caucasus (LC)

During the history of Armenia, numerous strong earthquakes occurred which destroyed many buildings and took many human lives. About 2000 earthquakes occur each year. Weak tremors occur almost daily.

Deadly quakes are a tragic part of the nation's past. Practically strong earthquakes have occurred in Armenia beginning since 18-15th centuries a.c. The table lists some of the earthquakes that occurred in the 20th century that destroyed many buildings, claimed many lives, and caused large economic losses:

Severe Recorded Earthquakes in Armenia in the 20th century		
Name	Year	Magnitude
Leninakan (Gyumri)	1926	6.2
Zangezur	1931	6.5
Zangezur	1968	5.1
Parakar (Yerevan)	1937	4.7
Spitak	1988	7.0

- **Spitak Destructive Earthquake**

December 7, 1988 at 07:41:22.7 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 7.0. 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 12 500 people were hospitalized. Number of victims was about 25 000. Particularly in Gyumri (15 000-17 000) and in Spitak (4 000) 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.

Source: WWW Google.am. Images. Spitak Earthquake 1988

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.

Spitak 1988 Earthquake have proved the deficiency of Seismic protection system in Armenia. The state and population are not prepared to cope with devastating earthquake though it is not a secret that major earthquakes were occurred and will be occurred in Armenia. There were numerous faults and shortcomings in yet all the fields of seismic protection.

2.3.Regional Survey for Seismic Protection at the Ministry of Emergency Situations of the Republic of Armenia

The Spitak Earthquake served as a catalyst for important reforms and policies to make Armenia more resilient to natural disasters. From establishing disaster risk management agencies and developing a national strategy for reducing disaster risk, to working with international institutions to scale up resilience across sectors, Armenia's move toward a more proactive approach to disaster risk management has made its communities safer. In the three decades since the 1988 earthquake, for example, the National Assembly has passed legislation to improve risk reduction and emergency management systems.

Chronology of disaster risk management after the 1988 earthquake in Armenia

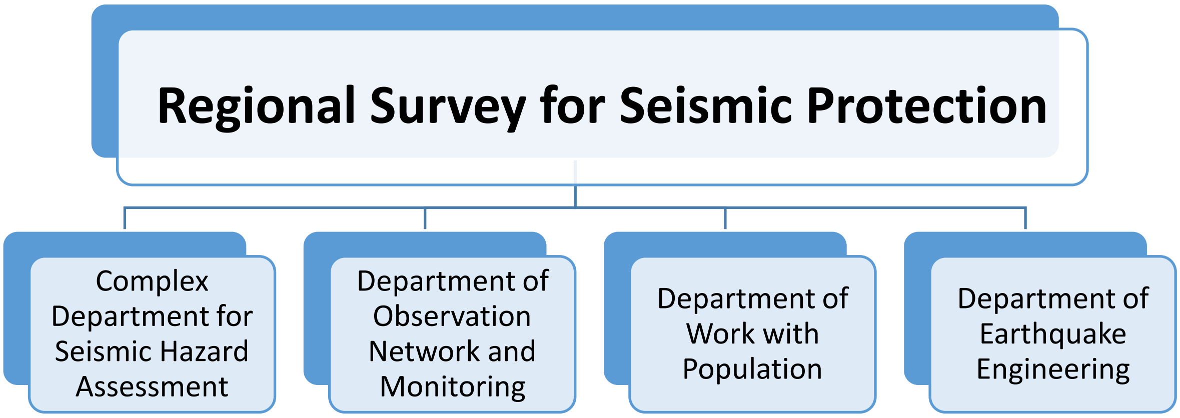
Source: https://www.preventionweb.net/quick/49550

The government (2008) reorganized its emergency management system, creating a Ministry of Emergency Situations (MES) and establishing a cabinet-level minister responsible for disaster response. In 2017, the government released its Disaster Risk Management National Strategy, with key targets to make the country even safer. 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.

As I have already mentioned, Regional Survey for Seismic Protection (RSSP) was founded in 1991 with the aim to organize population as well as buildings and structures seismic protection.

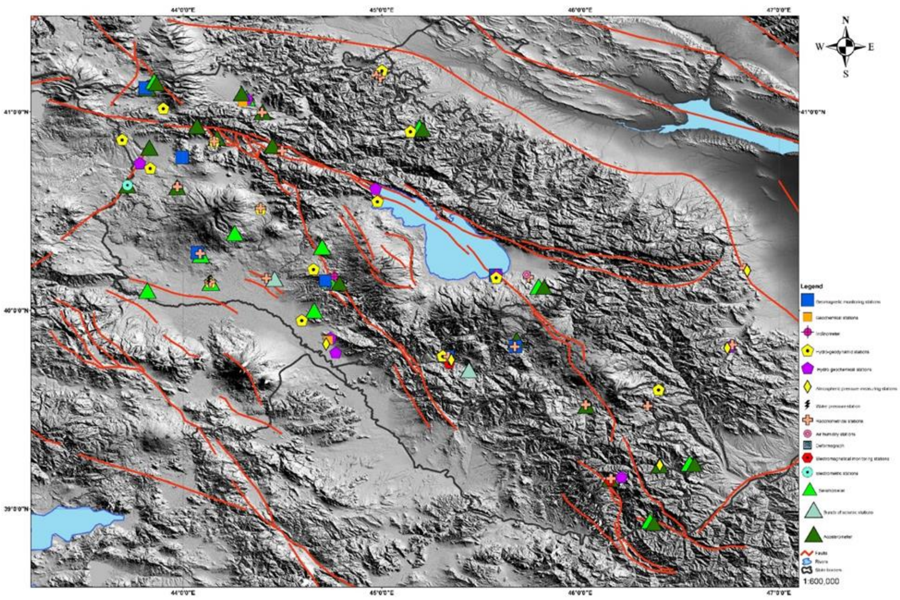
It takes various measures for earthquake disaster management. RSSP's main goal is seismic risk reduction in Armenia, the population residence hazard mitigation and the state economic and social loss reduction results from earthquake. It has developed two long-term Strategic National Programs on seismic risk reduction in Armenia and in Yerevan city. Today RSSP is not only a national but also a keystone international center. The Armenian RSSP is consists into 4 professional centers, according to the main goals և research directions.

The professional centers of the Regional Survey for Seismic Protection



The Armenian RSSP is monitoring about 51 geophysical, geochemical, hydrochemical, electromagnetic etc. parameters through National Observation Network incorporating about 150 stations. The monitoring systems involve in the global IRIS, Vayq network, Guralp network READINESS, CTBTO and COSMOS networks which enable to change and disseminate data on seismic hazard.

National Observation Network



The main objectives and the aims of Armenian RSSP 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.

2.4.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
Regulation	
Regional Survey for Seismic Protection	2017

Other normative documents, regulating organization of seismic protection have been also developed. Some of them are as follows:

- New seismic building codes;
- Principles of Seismic Microzoning;
- Instruction on conducting of observations in seismic, geophysical and other stations;
- The procedure of the expert analysis and providing the information about earthquake threat to the Government of RA.

2.5.Disaster Management Strategy based on the Hyogo Framework of Action and Sendai Framework for DRR

Natural and technological 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 Minister of Emergency Situations. The goal of the DRR NP is to establish a multi-spectral mechanism with involvement of all stakeholders.

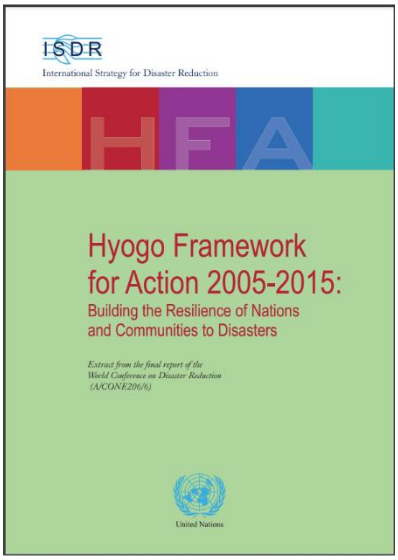
MES of RA has established a Crisis Management Centers as the main body for planning, co-coordinating and implementing measures related to natural and other forms of disasters (complementary to a National Platform on Disaster developed in cooperation with UNDP).

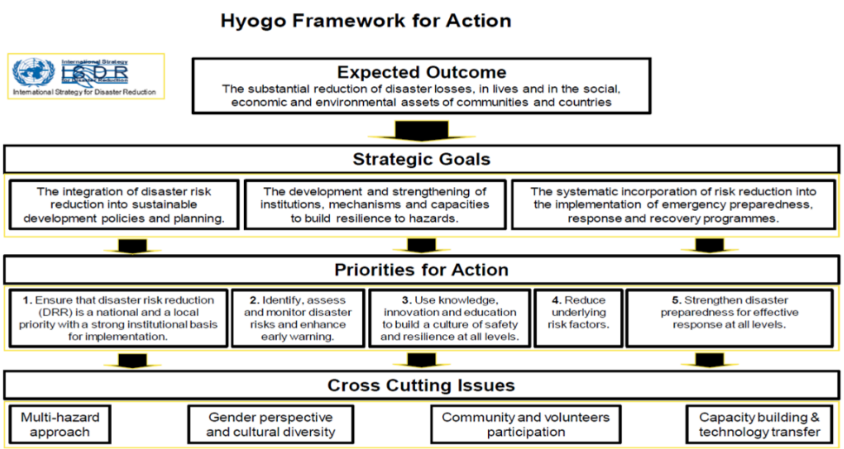
Crisis Management Centers in Yerevan


Source: MES websites

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 *Hyogo Framework of Action* HFA 2005-2015 “Building the Resilience of Nations and Communities to Disasters” and has taken a number of significant initiatives in this regard.



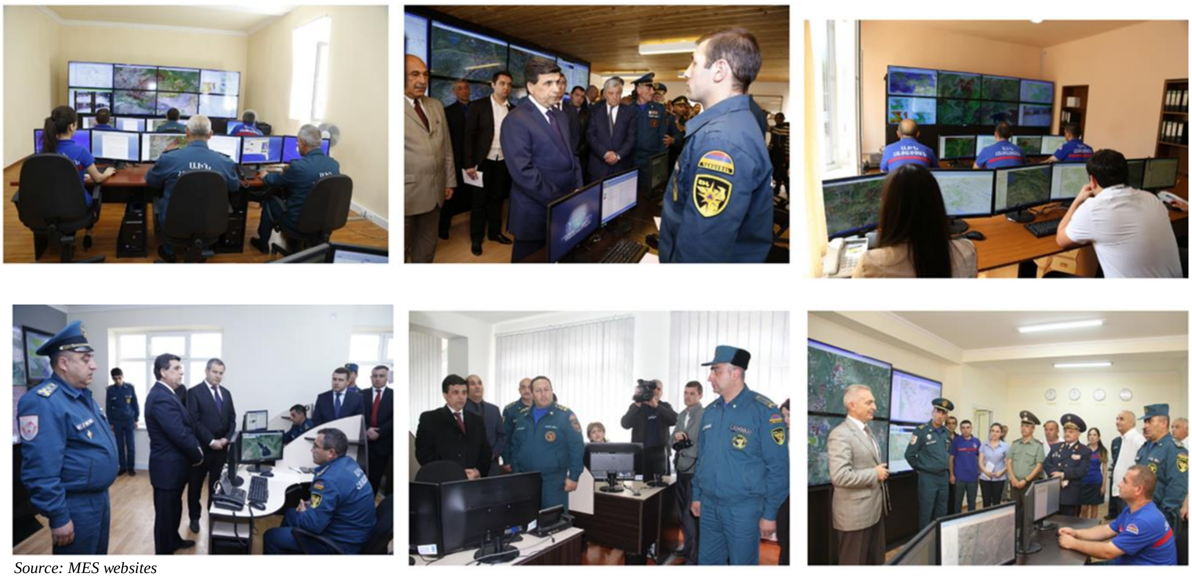


The cooperation of MES of RA with international organizations and local partners proved to be successful and productive over the years. Their efforts in DRR has become a priority in Armenia, thus contributing to the sustainable development of the country. It will be needed to mention the cooperation with JICA, ADRC, UNDP, UNDRR, BCPR, UNICEF, World Bank, Red Cross

Movement and a number of partner countries such as Japan, Sweden, Switzerland, USA, Russia, etc.

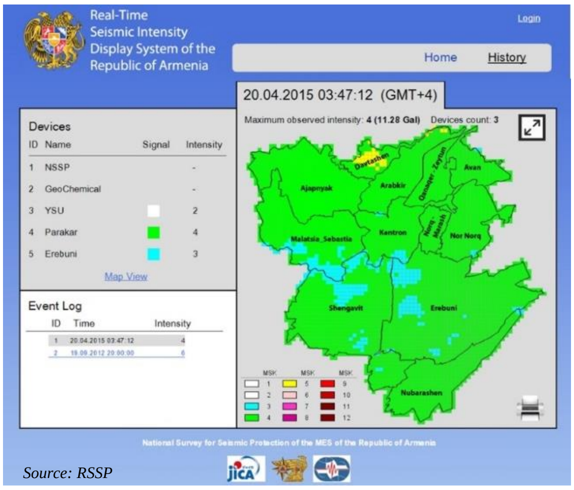
As a result of the mentioned activities, the Government of RA set DRR as a priority and the first steps to form the DRR culture are already established in the country. The best evidence of it is the fact that thanks to UNDP, Armenia became the first country in the region where by the Government’s decision the “ARNAP’ national DRR platform was established. MES develops National DRR Strategy, Crisis Management Centers and National Disaster Observatory. 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.

Crisis Management Centers in Marzes



Source: MES websites

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 RSSP and Crisis Management Center of MES which aims: to promote disaster prevention actions



Source: RSSP

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 Sendai Framework is the successor instrument to the HFA 2005-2015: Building the Resilience of Nations and Communities to Disasters. The HFA was conceived to give further impetus to the global work under the International Framework for Action for the International Decade for Natural Disaster Reduction of 1989, and the Yokohama Strategy for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation and its Plan of Action, adopted in 1994 and the International Strategy for Disaster Reduction of 1999. The Sendai Framework is built on elements which ensure continuity with the work done by States and other stakeholders under the HFA and introduces a number of innovations as called for during the consultations and negotiations. Many commentators have identified the most significant shifts as a strong emphasis on disaster risk management as opposed to disaster management, the definition of seven global targets, the reduction of disaster risk as an expected outcome, a goal focused on preventing new risk, reducing existing risk and strengthening resilience, as well as a set of guiding principles, including primary responsibility of states to prevent and reduce disaster risk, all-of-society and all-of-State institutions engagement. In addition, the scope of disaster risk reduction has been broadened significantly to focus on both natural and man-made hazards and related environmental, technological and biological hazards and risks. Health resilience is strongly promoted throughout.

Expected outcome and goal of Sendai Framework for DRR: While some progress in building resilience and reducing losses and damages has been achieved, a substantial reduction of disaster risk requires perseverance and persistence, with a more explicit focus on people and their health and livelihoods, and regular follow-up. Building on the Hyogo Framework for Action, the present Framework aims to achieve the following outcome over the next 15 years: The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries. The realization of this outcome requires the strong commitment and involvement of political leadership in every country at all levels in the implementation and follow-up of the present Framework and in the creation of the necessary conducive and enabling environment. To attain the expected outcome, the following goal must be pursued: Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience. The pursuance of this goal requires the enhancement of the implementation capacity and capability of developing countries, in particular the least developed countries, small island developing States, landlocked developing countries and African countries, as well as middle income countries facing specific challenges, including the mobilization of support through international cooperation for the provision of means of implementation in accordance with their national priorities.

To support the assessment of global progress in achieving the outcome and goal of the present Framework, seven global targets have been agreed. These targets will be measured at the global level and will be complemented by work to develop appropriate indicators. National targets and indicators will contribute to the achievement of the outcome and goal of the present Framework.

The seven global targets are:

1. Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020–2030 compared to the period 2005–2015
2. Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020–2030 compared to the period 2005–2015
3. Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030
4. Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030
5. Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020
6. Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030

7. Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.

In base of this collaboration the Government of RA approved the methodology for assessing the economic development potential in the regions, and the 2015-2030 program of improved seismic safety in the state secondary schools of the RA. The purpose of the methodology is to identify those territorial units, resource potential of which, are higher than the level of economic development, to make the implemented in the country programs targeted, to ensure the mitigation of differences of socio-economic development of regions, more effectively using the economic development potential. Armenia has recorded a number of achievements in DRR policy development and implementation, which became possible thanks to the effective cooperation with partner organizations. The Hyogo Framework for Action has fulfilled its mission, by creating basis for DRR system and effective development of a culture of sustainability. Based on these achievements, Armenia need to more constructively implement the priorities of the Sendai Framework for Action 2015-2030.

2.6. 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 an 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.

RSSP 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 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 amounts 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.

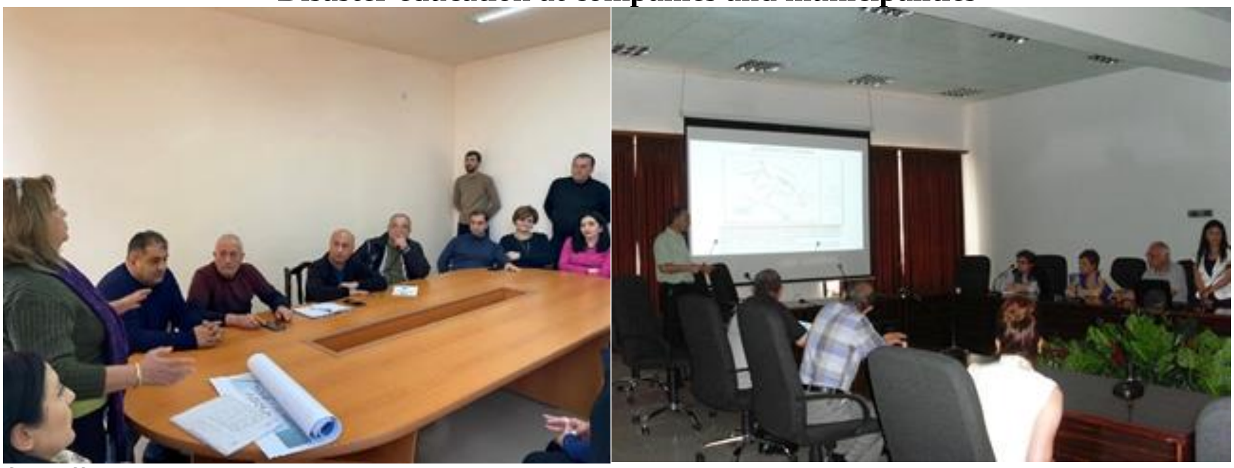
Disaster education at kindergartens and schools

Source: RSSP

Source: RSSP

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.

Disaster education at companies and municipalities



Source: RSSP

The Ministries of Emergency Situations and Education, Science, Culture and Sport, ARNAP Foundation and CMSA frequently organize competition the "School Disaster Preparedness Plan". On International Civil Protection Day of March 1, implements lecturs, trainings 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.

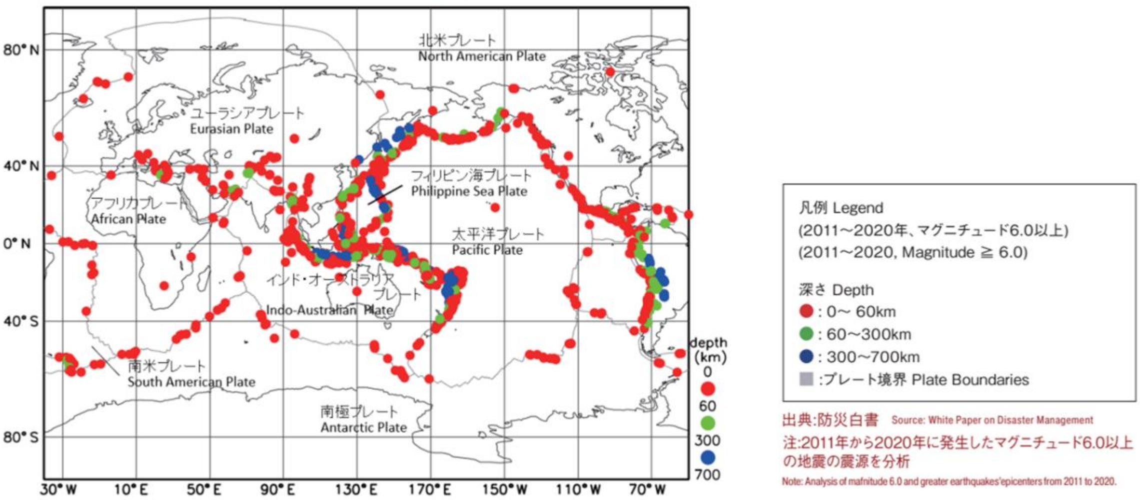
Ministry of Education, Science, Culture and Sport together with the Ministry of Emergency Situations in the frame disaster risk reduction program will submit to National Assembly proposals and additions for the Law "On Public Education" aiming at inclusion disaster risk reduction elements in the school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

3. DISASTER MANAGEMENT IN JAPAN

3.1. Natural Disaster Risks and Hazards in Japan

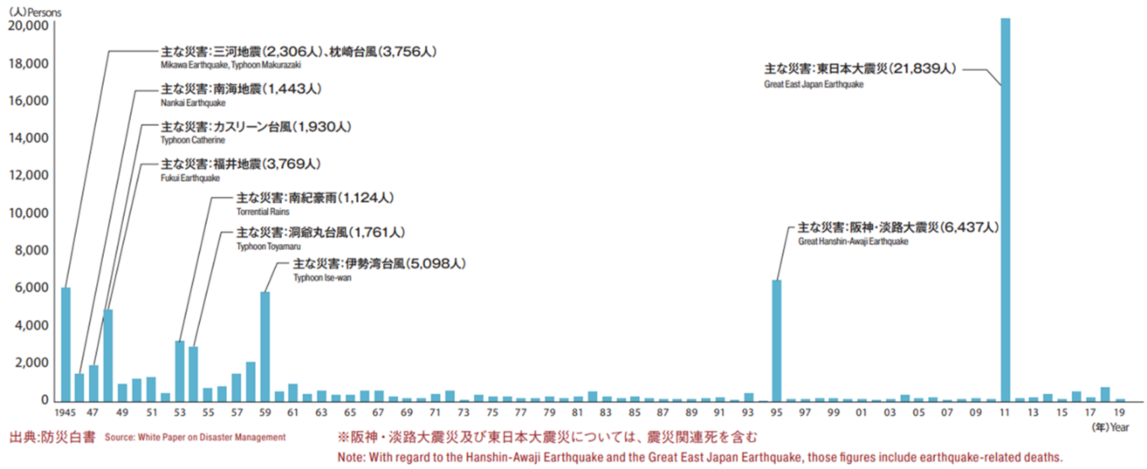
Japan is located in the Circum-Pacific Volcanic Belt or "Ring of Fire" where seismic and volcanic activities occur constantly. Japan and its surrounding areas experience roughly a tenth of all earthquakes that occur in the world. Of the world's active volcanoes, 7%* exist in Japan. In addition, because of geographical, topographical and meteorological conditions, the country is subject to frequent natural disasters such as typhoons, torrential rains and heavy snowfalls, as well as earthquakes and tsunami.

世界の震源分布とプレート World Geographical Distribution of Hypocenters and Plates



Every year there is a great loss of people's lives and properties in Japan due to natural disasters. Until the 1960s, largescale typhoons with earthquakes caused extensive damage and thousands of casualties. Thereafter, with the progress of society's capabilities to respond to disasters and mitigate vulnerabilities to disasters by developing disaster management systems, promoting national land conservation, improving weather forecasting technologies, and upgrading disaster information communications systems, disaster damage has shown a declining tendency.

自然災害による死者・行方不明者数の推移 The Number of Deaths and Missing Persons Caused by Natural Disasters



In spite of such efforts, in 1995, more than 6,400 people died of the Great Hanshin-Awaji Earthquake. Also, in 2011, more than 22,000 people died or went missing due to the Great East Japan Earthquake.

Japan has suffered enormous damages due to repeated mega disasters since ancient times, at present the country is considered to be leader in disaster management because it has increased its resilience every time a large-scale disaster is experienced.

Japan is one of the countries most affected by natural disasters. Two out of the five most expensive natural disasters in recent history have occurred in Japan, costing $181 billion in the years 2011 and 1995 only. Japan has also been the site of some of the 10 worst natural disasters of the 21st century. The types of natural disasters in Japan include tsunamis, floods, typhoons, earthquakes and volcanic eruptions. The country has gone through many years of natural disasters, affecting its economy, development, and social life.

3.2. Recent Major Earthquakes in Japan

Japan has an infamous history of earthquakes. Deadly earthquakes are a tragic part of the nation's past. Japan is located at a point on the earth's surface where four of more than 10 tectonic plates covering the globe are crushed against each other, making it an archipelago with geographic characteristics that make it susceptible to earthquake disasters. Japan has suffered great damages from the massive inter-plate earthquakes produced by plate subduction (such as the Great East Japan Earthquake of 2011) and the inland crustal earthquakes caused by plate movements (such as the Great Hanshin-Awaji Earthquake of 1995).

Source: White Paper on Disaster Management

- **Great Hanshin-Awaji Earthquake**

The Great Hanshin-Awaji earthquake or Kobe earthquake, was an earthquake that occurred on Tuesday, January 17, 1995, at 05:46 JST (16 January at 20:46 UTC) in the southern part of Hyogo Prefecture, Japan. It measured 6.8 on the moment magnitude scale (USGS) and Mw 7.3 (adjusted from 7.2) on JMA magnitude scale. The tremors lasted for approximately 20 seconds. The focus of the earthquake was located 16 km beneath its epicenter, on the northern end of Awaji Island, 20 km away from the city of Kobe city.

Approximately 6,434 people lost their lives (final estimate as of December 22, 2005); about 4,600 of them were from Kobe. Among major cities, Kobe, with its population of 1.5 million, was the closest to the epicenter and hit by the strongest tremors. This was Japan's worst earthquake in the 20th century after the Great Kanto earthquake in 1923, which claimed 140,000 lives. It caused approximately ten trillion yen ($100 billion) in damage, 2.5% of Japan's GDP at the time.

Most of the largest earthquakes in Japan are caused by subduction of the Philippine Sea Plate or Pacific Plate, with mechanisms that involve either energy released within the subducting plate or the accumulation and sudden release of stress in the overlying plate. Earthquakes of these types are especially frequent in the coastal regions of northeastern Japan.




Source: WWW Google.ru. Images. Great Hanshin-Awaji earthquake

The Great Hanshin earthquake belonged to a third type, called an "inland shallow earthquake". Earthquakes of this type occur along active faults. Even at lower magnitudes, they can be very destructive because they often occur near populated areas and because their hypocenters are located less than 20 km below the surface. The Great Hanshin earthquake began north of the island of Awaji, which lies just south of Kobe. It spread toward the southwest along the Nojima fault on Awaji and toward the northeast along the Suma and Suwayama faults, which run through the center of Kobe. Observations of deformations in these faults suggest that the area was subjected to east-west compression, which is consistent with previously known crustal movements. Like other earthquakes recorded in western Japan between 1891 and 1948, the 1995 earthquake had a strike-slip mechanism that accommodated east-west shortening of the Eurasian plate due to its collision with the North American plate in central Honshu.

- **Great East Japan Earthquake**

The 2011 earthquake off the Pacific coast of Tohoku, also known as the 2011 Tohoku earthquake or the Great East Japan Earthquake, was a magnitude 9.0 (Mw) undersea megathrust earthquake off the coast of Japan that occurred at 14:46 JST (05:46 UTC) on Friday, 11 March 2011, with the epicenter approximately 70 kilometers (43 mi) east of the Oshika Peninsula of Tohoku and the hypocenter at an underwater depth of approximately 30 km (19 mi). It was the most powerful known earthquake ever to have hit Japan, and one of the five most powerful earthquakes in the world overall since modern record-keeping began in 1900. The earthquake triggered powerful tsunami waves, which reached heights of up to 40.5 meters (133 ft) in Miyako in Tohoku's Iwate Prefecture, and which in the Sendai area travelled up to 10 km (6 mi) inland. In addition to loss of life and destruction of infrastructure, the tsunami caused a number of nuclear accidents, primarily the ongoing level 7 meltdowns at three reactors in the Fukushima I Nuclear Power Plant complex, and the associated evacuation zones affecting hundreds of thousands of residents.

Source: WWW Google.ru Images. Great East Japan Earthquake

The Mw. 9.0 earthquake at 14:46 and the series of large-scale earthquakes that followed had resulted in multiple tsunami waves of unprecedented scales at the coastal areas of Hokkaido, Aomori, Iwate Miyagi, Fukui, Ibaraki, and Chiba Prefectures. It has been reported that there were seven tsunami waves over a six hour period. Waves became more turbulent and more powerful upon reaching the inland areas. According to the experts, the fault rupture was about 500 kilometers long in a north-south direction and the tsunami waves hit the coastal areas from different directions, one crossing over the other, explaining the destructive power of the tsunami.

Source: WWW Google.ru Images. Great East Japan Earthquake

Several scientific investigations are being conducted concerning the scale of tsunami. Initial survey by Tokyo University of Marine Science and Technology found that tsunami waves had reached the heights of 14 meters or 15 meters in many coastal areas, and as high as 38.9 meters in Miyako City, Iwate Prefecture. This is higher than the previous record of 38.2 meters in Ofunato City in the same prefecture during the 1896 Meiji Sanriku Earthquake Tsunami.2 It is generally believed that timber houses will be destroyed by tsunami waves higher than 2 meters. By contrast, concrete buildings can withstand 4 meters, or so, but will be destroyed if waves exceed 16 meters. Additionally, survey conducted by Tohoku University found that tsunami waves had reached as far as 5.5 kilometers inland of Sendai Plain. By using remote sensing technologies and GIS, the Geospatial Information Agency of Japan estimated the tsunami swamped areas to about 561 square kilometers covering the hardest hit prefectures of Aomori, Iwate, Miyagi, and Fukui.

On 10 March 2015, a Japanese National Police Agency report confirmed 15.894 deaths, 6.152 injured, and 2,562 people missing across twenty prefectures, as well as 228.863 people living away from their home in either temporary housing or due to permanent relocation. A 10 February 2014 agency report listed 127.290 buildings totally collapsed, with a further 272,788 buildings "half collapsed", and another 747.989 buildings partially damaged. The earthquake and tsunami also caused extensive and severe structural damage in north-eastern Japan, including heavy damage to roads and railways as well as fires in many areas, and a dam collapse. Japanese Prime Minister Naoto Kan said, "In the 65 years after the end of World War II, this is the toughest and the most difficult crisis for Japan." The tsunami caused nuclear accidents, primarily the level 7


Source: WWW Google.ru Images. Great East Japan Earthquake

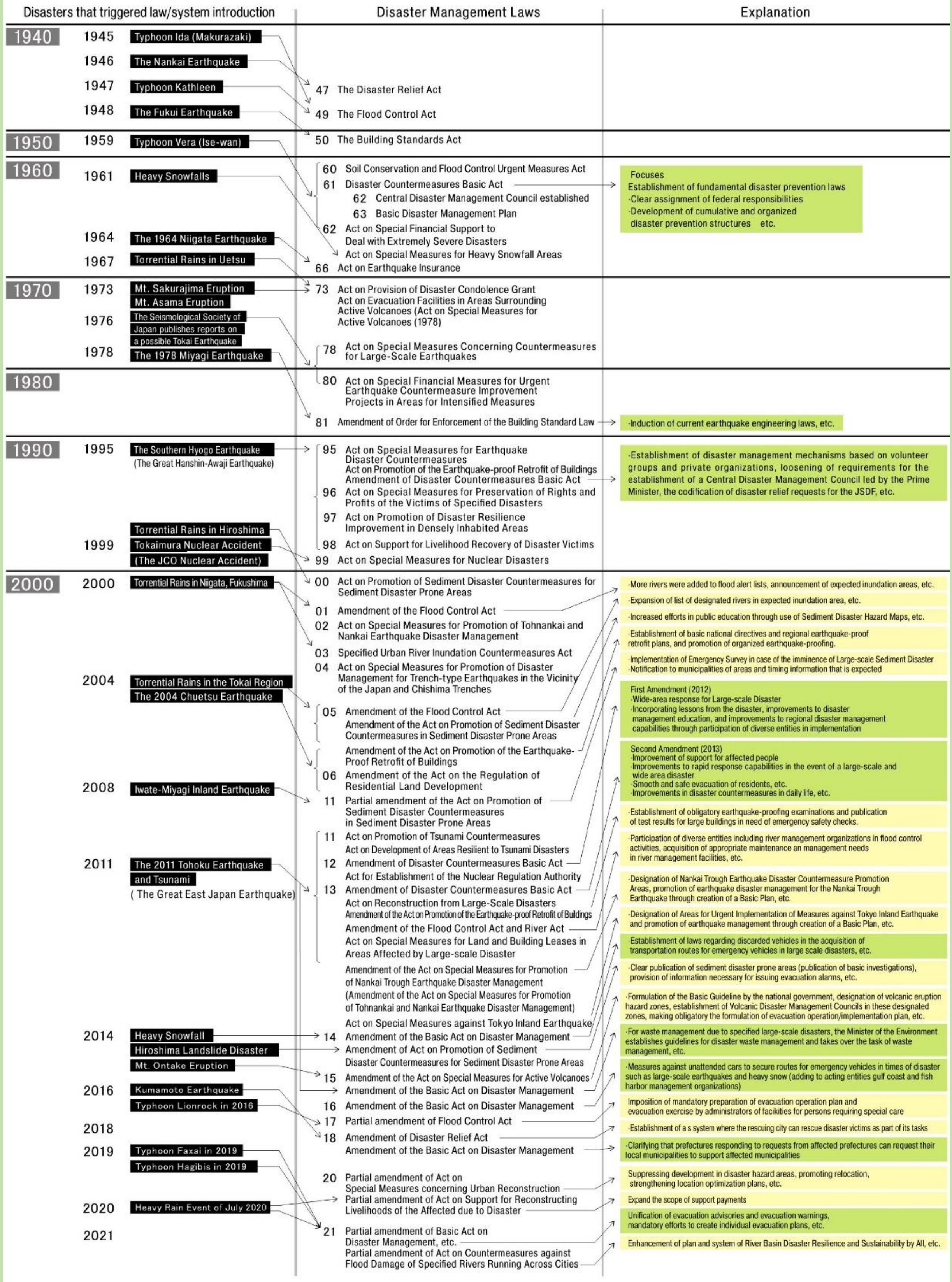
meltdowns at three reactors in the Fukushima Daiichi Nuclear Power Plant complex, and the associated evacuation zones affecting hundreds of thousands of residents. Many electrical generators were taken down, and at least three nuclear reactors suffered explosions due to hydrogen gas that had built up within their outer containment buildings after cooling system failure resulting from the loss of electrical power. Residents within a 20 km (12 mi) radius of the Fukushima Daiichi Nuclear Power Plant and a 10 km (6.2 mi) radius of the Fukushima Daini Nuclear Power Plant were evacuated.

3.3. Laws and Legal Systems of DM in Japan

In order to applying to all of the disaster phases of prevention, mitigation and preparedness, emergency response as well as recovery and rehabilitation, relevant laws and regulations were enacted. It is a national priority to protect national land as well as citizens' lives, livelihoods, and property from natural disasters. The turning point for strengthening the disaster management system came into effect in response to the immense damage caused by the Typhoon Ise-wan in 1959, and led to the enactment of the Disaster Countermeasures Basic Act in 1961, which formulates a comprehensive and strategic disaster management system.

Thereafter, the Disaster Countermeasures Basic Act has constantly been reviewed and amended since its first enactment, and with lessons learned from the Great East Japan Earthquake, provisions were added including enhancement of the measures concerning support activities mutually done by local governments in 2012 and the measures for ensuring smooth and safe evacuation of residents and improving protection of affected people in 2013. In 2014, provisions were added for strengthening measures against unattended cars in order to promptly clear them from the roads for emergency vehicles. In 2021, in order to ensure smooth and prompt evacuation in the event of a disaster and strengthen the implementation system for disaster measures, evacuation information was reviewed, individual evacuation plans were legalized, and consultation rules for wide-area evacuation were established. In addition, the government has taken measures such as making it possible to establish a disaster management headquarter for disasters of a scale that has not been able to establish a national disaster response headquarters.

Progress in Laws and Legal Systems since 1945



Source: White Paper on Disaster Management

3.4. Disaster Management

Japan has three administrative levels of governance; national, prefectural and municipal. Each level of governments has its own disaster management organizations, policy frameworks and budgets. When disasters occur, municipalities respond first. In case disasters are large in scale beyond their capacity, national and prefectural governments provide every possible support.

Japan’s legislation for disaster management system, including the Disaster Countermeasures Basic Act, addresses all of the disaster phases of prevention, mitigation and preparedness, emergency response as well as recovery and reconstruction with roles and responsibilities among the national and local governments clearly defined, it is stipulated that the relevant entities of the public and private sectors are to cooperate in implementing various disaster countermeasures.

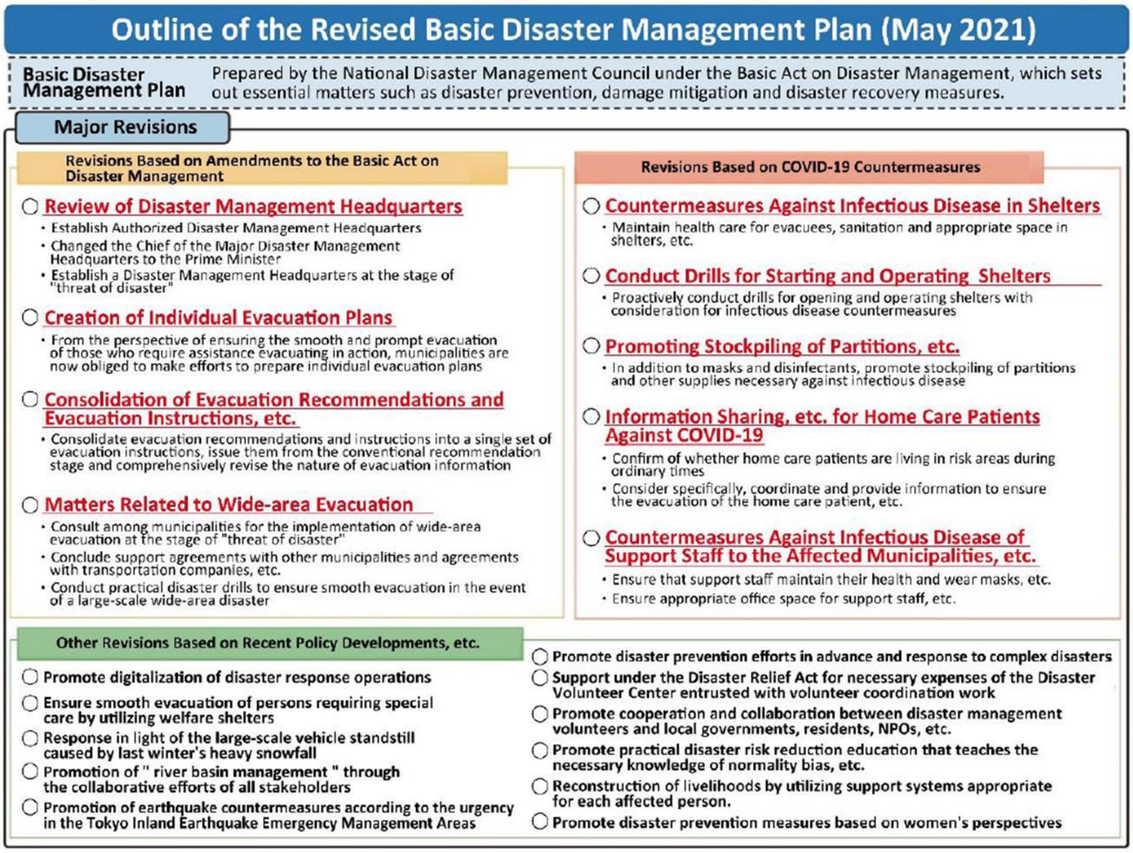
Along with a series of reforms of the central government system in 2001, the post of Minister of State for Disaster Management was newly established to integrate and coordinate disaster risk management policies and measures of ministries and agencies. In the Cabinet Office, which is responsible for securing cooperation and collaboration among related government organizations in wide-ranging issues, the Director-General for Disaster Management is mandated to undertake the planning of basic disaster management policies and response to large-scale disasters, as well as conduct overall coordination.

Source: White Paper on Disaster Management

Basic Disaster Management Plan: The Basic Disaster Management Plan is a comprehensive and longterm disaster management plan forming a foundation for the Disaster Management Operations Plan and Local Disaster Management Plan. It stipulates provisions for the establishment of the disaster management system, promotion of disaster management measures, acceleration of post disaster recovery and reconstruction measures, and promotion of scientific and technological research on disaster management. The plan was revised entirely in 1995 based on the experiences of the Great Hanshin-Awaji Earthquake. It defines responsibilities of each entity such as the national and local governments, public corporations and other entities. It consists of various plans for each type of disaster, where specific countermeasures to be taken by each entity are described according to the disaster management phases of prevention and preparedness, emergency response, as well as recovery and reconstruction. Further, based on the lessons learned from the Great East Japan Earthquake, a new chapter was created in December 2011, for Tsunami Disaster Countermeasures. Concretely, it reflects

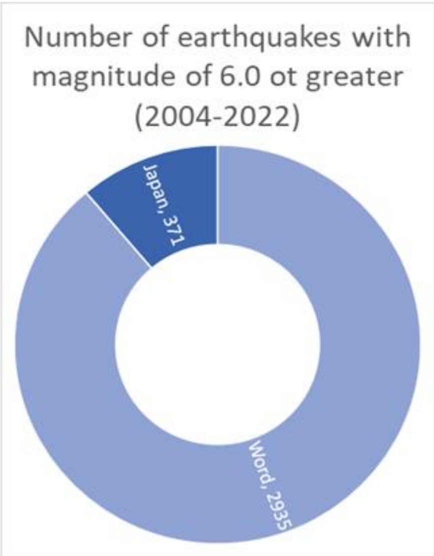
- ❖ a review of the Major Disaster Management Headquarters such as the rule to designate the Prime Minister as its Chief,
- ❖ integration of evacuation recommendation and evacuation instruction into a single evacuation instruction,
- ❖ a duty of effort to prepare individual evacuation plans and so on.

In recent years, lessons from disaster responses and developments in measures as well as responses to the COVID-19 have been taken into account for the revisions.



Source: White Paper on Disaster Management

3.5. Disaster Risk Reduction



Source: Data USGS

Japan is located at a point on the earth's surface where four of more than 10 tectonic plates covering the globe are crushed against each other, making it an archipelago susceptible to earthquake disasters. Nearly 12.6% of the world's earthquakes of magnitude 6 or greater have occurred in or around Japan.

Japan has suffered great damages from the massive inter-plate earthquakes produced by plate subduction (such as the Great East Japan Earthquake of 2011) and the inland crustal earthquakes caused by plate movements (such as the Great Hanshin-Awaji Earthquake of 1995).

It has been pointed out with a great sense of urgency that Japan can be struck by large-scale earthquakes in the near future, in areas such as Nankai Trough, the Japan and Chishima Trenches, and directly below Tokyo and the Chubu and Kinki regions. With regard to the Nankai Trough Earthquake, earthquakes around the ocean trench such as Japan Trench and Chishima Trench, and Tokyo Inland Earthquake, the government designated the areas where disaster reduction measures are to be taken in accordance with relevant laws and regulations. Also, the government is developing a plan concerning how to accelerate disaster reduction measures by administrative entities and private businesses.

Source: White Paper on Disaster Management

The Central Disaster Management Council has developed the Policy Framework for Large-scale Earthquake Disaster Prevention and Reduction a master plan of the countermeasures for the large scale earthquake, that includes a range of activities from preventive measures to post-disaster response and recovery; the Earthquake Disaster Reduction Strategy, to determine an overarching goal of damage mitigation and strategic targets based on the damage estimation; and the Guidelines for Emergency Response Activities which describes specific actions to be taken by related organizations. It is possible that an earthquake other than these large scale ones can hit any place in Japan as with the cases in the past 30 years. A guideline for the countermeasures against earthquakes by local municipalities has been compiled covering every step of the disaster response levels (preparation, initial response, response, and recovery).

3.6. Disaster Education and Human Resource Development

Education about disaster reduction is quite important for enabling individuals to have correct understanding about natural disasters, and be able to act on their discretion to prevent and reduce damages from disaster. In the Great East Japan Earthquake, case of an elementary school was reported to have safely evacuated based on their daily education of the past disasters and training about evacuation. Thus, importance is recognized to enhance education and training at schools and in local communities so that people are nurtured to be equipped with correct understanding about prevention and escape from the disaster.

In order for school children to be able to learn and acquire knowledge and practical skills about disaster reduction, Fire and Disaster Management Agency has compiled “Challenge Disaster Reduction 48” a textbook for school teachers and leaders. Ministry of Education, Culture, Sports, Science and technology (MEXT) has enhanced contents regarding disaster reduction in the new Curriculum Guidelines announced in 2017/2018. For example, during social studies for fourth grade in elementary schools, local natural disasters that happened in the past are introduced, and students learn to think about what they should do and what items should be prepared by imagining about a disaster that could happen locally. Further improvement with disaster management education is promoted through development of materials such as “Guide to Make a Disaster Reduction Manual for Schools (Earthquake and Tsunami),” and “Development of a Disaster Reduction Education to Nurture Power to Live On,” providing guidance for disaster reduction at schools.

Further, in order to enhance the disaster reduction education in local communities and schools nationwide, the Cabinet Office is carrying out a campaign “Disaster Reduction Education Challenge Plan” to nurture positive environment for more proactive disaster reduction education by picking up active local groups, schools and individuals who demonstrated better disaster reduction plans and actions, give support to them, and publicize the achievements (including education methods, materials used, precautions, contacts), through the Office's web site, intending that such plans and programs be widely recognized and utilized throughout the nation.

Human Resources Development. The Cabinet Office started a "program for developing disaster management specialists" for the purpose of developing and training people "who can respond to the emergency promptly and appropriately" and "who can form a network between the national and local entities" Specifically, it provides training programs to employees of local public organizations who are engaged in services at the Cabinet Office and take lectures from various organizations related to disaster management. It also conducts training programs organized at the Ariake-no-Oka Main Wide-area Disaster Management Base Facility, such as "Training on comprehensive management" tailored for core management personnel level, Themed trainings for specialists who are in charge of specific disaster field, and Basic training on disaster management for those who have recently appointed as disaster management personnel. In addition, it organizes trainings in various locations under a theme which is specific to characteristics of each location.

Disaster Reduction Drills and Exercises. In order to improve the disaster resilience of the community and to reduce disaster damages, there must be close cooperation among individuals, families, local community, businesses and relevant entities, to build momentum for a nationwide movement. The Government has designated the 1st day of September as the "Disaster Preparedness Day" and the week including this day as the Disaster Preparedness Week, and carries out various events to raise awareness and readiness about the disaster. Disaster drills and "Disaster Reduction Fairs" are held in various parts of Japan.

3.7. Asian Disaster Reduction Center

The Asian Disaster Reduction Center (ADRC) was established in Kobe, Hyogo Prefecture, in July 1998, with the following mission and objectives: to enhance disaster resilience of the member countries, to build safe communities, and to create a society where sustainable development is possible. The Center works to build disaster resilient communities and to establish networks among countries through many programs, including personnel exchanges in this field. Thus, the ADRC takes the leading role in promoting Sendai Framework for Disaster Risk Reduction (SFDRR) in Asia, with its three pillars of activities "to share disaster

Source: ADRC

related information", "to train personnel of the member nations", "to bolster disaster preparedness in local communities." So far, the ADRC has in its list 31 member countries, 5 advisor countries and 1 Observer organization.

The ADRC Visiting Researcher Program: The Center invites visiting researchers from the member countries every year for the period of four months to exchange information on DRR of each country, inform them of the framework and policy of DRR in Japan, and promote understanding of international cooperation in DRR and disaster risk management.

The researchers are provided with opportunities to discuss challenges for disaster management in their respective countries, enhance understanding of the Disaster Management System, Disaster Risk Reduction, and International Cooperation in Japan. Taking full advantage of the experiences acquired through the program, the researchers are expected not only to contribute to strengthen disaster management capacity in their countries, but also to further promote cooperation between their countries and ADRC in disaster reduction activities.

Experiences/Learnings and Knowledge Gained from the ADRC Visiting Researcher Program:

1. Field Trips/Visits/Educational Tours

Japan Meteorological Agency

Japan Meteorological Agency (JMA) provides meteorological information and is responsible for contributing to the improvement of public welfare through natural disaster prevention and mitigation, safety of transportation, development and prosperity of industries, and international cooperation activities. Its major activities include the issuance of warnings, advisories, and forecasts in short-range, one-week and long-range; dealing with the global environmental issues such as global warming and ozone depletion; and provision of information on earthquake and volcanic activities.

It monitors extreme natural phenomena, such as, earthquake, tsunami, typhoon, and heavy rains; focuses its efforts on monitoring the earth's environment and forecasting natural phenomena in the atmosphere, oceans and earth; and conducts research and technical development in relevant fields.

Cabinet Office, Government of Japan

The post of Minister of State for Disaster Management was established to integrate and coordinate disaster reduction policies and measures of ministries and agencies. In the Cabinet Office, which is responsible for securing cooperation and collaboration among related government organizations in wide-ranging issues, the Director-General for Disaster Management is mandated to undertake the planning of basic disaster management policies and response to large-scale disasters, as well as conduct overall coordination. The Cabinet Secretariat system was also strengthened with the appointment of the Deputy Chief Cabinet Secretary for Crisis Management and the establishment of the Cabinet Information Collection Center, to strengthen risk management functions to address emergencies, such as large-scale disasters and serious accidents.

Thereby, the Cabinet Office has a role in supporting the cabinet Secretariat regarding disaster management matters.

PASCO

Many countries in the world suffer enormous damage from natural disasters such as earthquakes, typhoons and torrential rain. In Japan, the government has steadily implemented disaster prevention measures including earthquake prediction system, river improvements and maintenance of mudslide-control dams, but we are still often threatened by forces of nature far beyond our prediction.

To protect people's lives from such disasters and minimize the economic losses caused by disasters, PASCO acquires emergency imageries of stricken areas by satellite and aircraft immediately after the occurrence of a disaster. The imageries are used to grasp the range and extent of the affected area and are utilized to prevent secondary disasters and enable smooth reconstruction work.

IMV Corporation

Introduction of Seismometer Technology

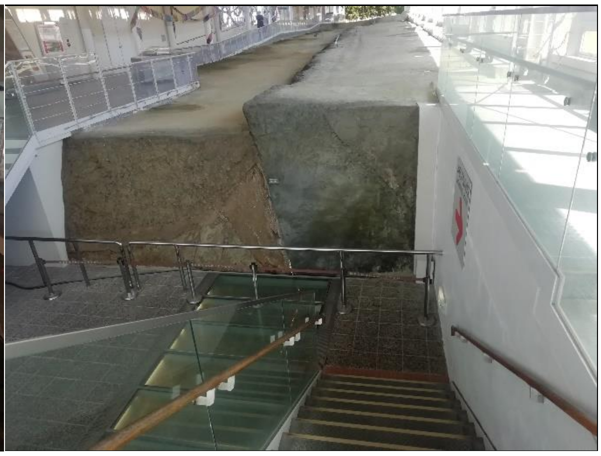
Giving evacuation instructions and stopping the facilities in the event of an earthquake have been mostly human-operated, which often resulted in inadequate response to the disasters.

To resolve the issues listed above, IMV Corporation created high-reliability vibration test systems. It makes prompt announcements to the area and vicinity, conduct safety shutdown of the equipment, and shut off gas and water valves on detecting the earthquake in order to limit the damage and prevent the secondary disasters.

Assess the situations at normal times and post-disaster by checking the seismic isolation or seismic resistance of the large structures, and recording vibration waveforms caused by the earthquake or other factors.


Hokudan Earthquake Memorial Park

The Hokudan Earthquake Memorial Park (Museum) in Awaji Island has preserved the actual Nojima Earthquake Fault which was caused by the Great Hanshin-Awaji Earthquake in 1995. It has become a great educational tool for all residents, students, and visitors of the Island. The museum also features an earthquake monument, a fault preservation zone, trench display, etc.

Tsunami Storm Surge Disaster Prevention Station

Osaka is considered Japan's foremost industrial region but it sits on a low-ground coastal area (below sea level); that is why different countermeasures (mitigation and preparedness projects/programs) are being undertaken by the government to protect the residents in the vicinity, such as anti-tidal measures, water contingencies, construction of dikes and floodgates.


Ujigawa Open Laboratory

The Ujigawa Open Laboratory is a leading experimental laboratory in the word, where many kinds of hydraulic and sedimentation experments are carred out Those observation and experimental facilities are widely used for various activitics by academic statts of DPRI educatton for students, international academic,exchange, and some social events for professienal firefig olcemen, government officers and school chiuren


Rokko Sabo Office

Rokko Sabo Office works to prevent disasters by building sabo dams to control the amount of sediment that flows downstream, planting trees on rough mountains, and carrying out construction work on mountain slopes to prevent cliffs from collapsing increase. Sabo dams built

in the upstream areas of mountain streams accumulate sediment and suppress production and flow of sediment. During our field visit to Tamba city, observed the Sabo works in the mountains. Those built at the exits of valleys work as a direct barrier to debris flow which has occurred. A Sabo dam with slits is particularly effective in capturing debris flow because it has a larger capacity of sand pool under normal conditions. In case that there is a fear of flowdown of driftwood, a slit Sabo dam is built as a preventive measure.

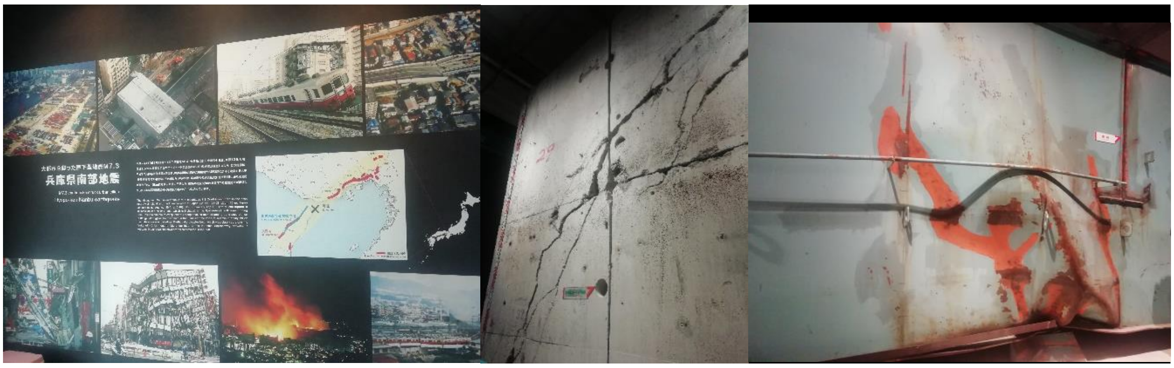
2. Educational, Informative, Worthwhile Activities/Programs/Experiences in Japan

Disaster Reduction and Human Renovation Institution Earthquake Memorial Building

Earthquake simulation truck/shaking table earthquake experience

Earthquake Engineering Research Center "E-Defense"

Hanshin Expressway Earthquake Museum



Ojiya Earthquake Disaster Museum

Port of Kobe Earthquake Memorial Park

3. Workshops/Trainings/Drills Attended

Annual Iza! Mikaeru Dai Caravan!

DRR Awareness Even


Rinkai Disaster Prevention Park

"Training directly under Tokyo 72h TOUR".

International Recovery Platform (IRP)

"International Recovery Forum 2023: Building Back Better and Long-term Recovery Outcomes: Aspirations for a Resilient, Sustainable Future"

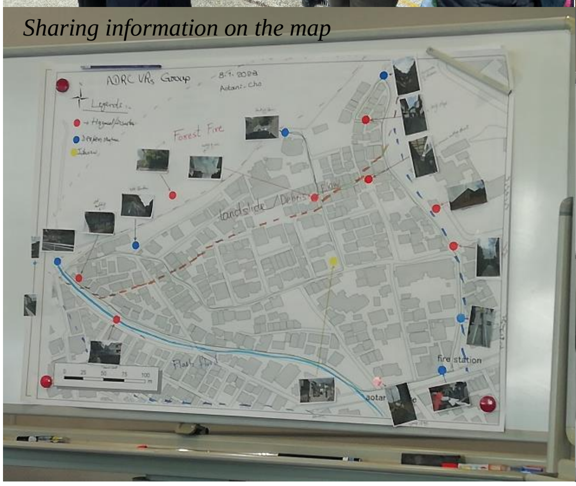
Asian Conference on Disaster Reduction 2022

Community-Based Disaster Reduction Activities Using Hazard Maps

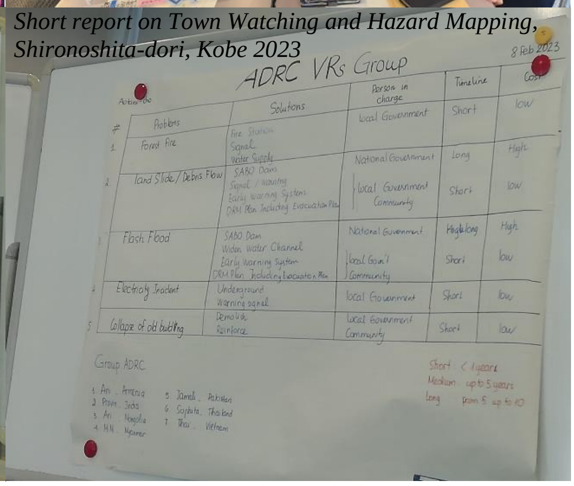
JICA CBDRM Training on Town Watching and Hazard Mapping, Shironoshita-dori, Kobe 2023

Start point

Discussing among participants



Sharing information on the map



Short report on Town Watching and Hazard Mapping, Shironoshita-dori, Kobe 2023

4. SEISMIC MONITORING, SEISMIC HAZARD, RISK ASSESSMENT AND EARTHQUAKE EARLY WARNING SYSTEM IMPLEMENTATION AS A PART OF SEISMIC RISK REDUCTION IN ARMENIA

4.1. Seismic Monitoring

RSSP is in charge of the seismic protection and seismic monitoring system. There are multiparameter network of seismic observation and monitoring in Armenia.

He first seismic station in the territory of Armenia was installed late in 1931 and was launched in 1932. Since 1960, 4 regional stations were already operating in our territory. By the beginning of the 1990s, 16 regional stations were already operating in Armenia.

After the devastating Spitak earthquake of 1988 with the purpose of increasing the accuracy of seismological observations, local networks of telemetry seismic stations were established in the territory of Armenia, with data centers in “Gyumri”, “Vanadzor”, “Yerevan-NPP”, “Kapan”. The networks are arranged around 4 major cities in Armenia. There are telemetric networks consisting of 8 stations around the cities of Yerevan and Gyumri, and networks consisting of 4 stations around the cities of Vanadzor and Kapan. These networks are equipment with short period three component sensors that cover a frequency band from 0.5 – 25 Hz. All four networks have their own acquisition and processing centers which are connected to the main processing center in RSSP (Garni).

1991 in the Garni geophysical observatory was installed The IRIS seismic station in the cooperation with USGS. This station included in the IRIS Global Seismographic Network (GSN) and providing seismographic data to research earthquake hazard mitigation and the verification of a Comprehensive Test Ban Treaty (CTBT).

Since 2010, the seismological network has been fully upgraded in collaboration with the USGS, the French CEA/DASE and the IAEA. In particular:

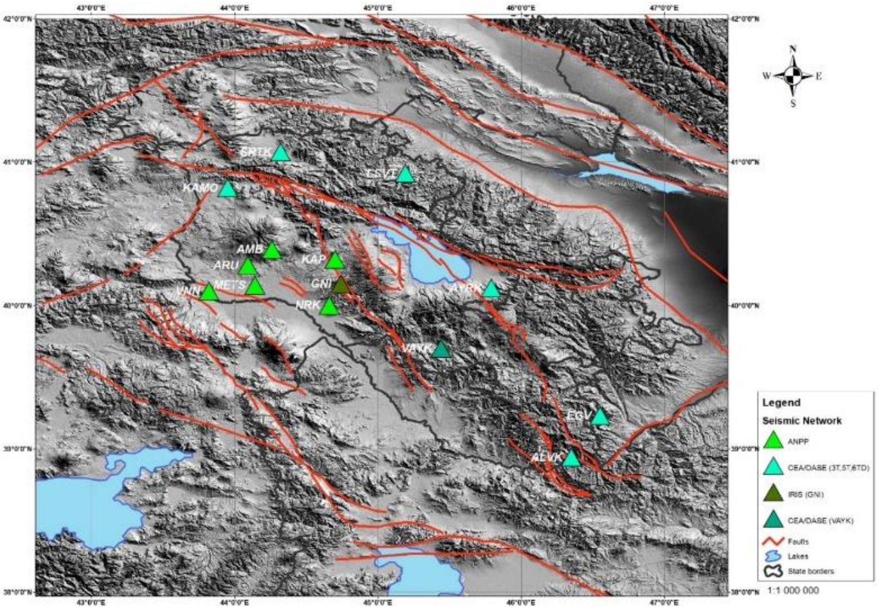
The IRIS seismic station was pgraded in the cooperation with USGS in 2010. It is broadband seismic station equipped with STS-1 VBB seismometers and STS-2.

The Vayk seismic array was installed in the cooperation with the French CEA/DASE in 2010 in is located near to Vayk town. Seismic array consists of 6 observation points, located in two concentric circles with one central site. Five one-component short-period seismometers are installed. Besides, there is a broadband three-component station with STS2 seismometer.

And also in the cooperation with the CEA/DASE installed GURALP type network: 6 High performance, low noise, compact, broadband 3T seismometers and 6 High performance, low noise, compact, broadband 5T accelerometers in the regions of Armenia: “KAMO”, “SRTK”, “LSVE”, “AYRK”, “EGV” and “ALVK”.

In cooperation with the IAEA the seismic network in around the NPP has been upgraded. Installed GURALP type seismic stations: 6 High performance, compact, medium-motion broadband 6TD seismometers (“VNN”, “METS”, “ARU”, “AMB”, “KAP” and “NRK”).

Seismic Networks in Armenia



For earthquake monitoring, the existing earthquake observation network in RSSP now consists of 14 seismic stations. The data are received to the Data Center on a real-time basis from whole stations homogeneously distributed in Armenia. Recorded data are transferred to through various means of communication including satellite, internet etc. These networks were established to find out quickly precise earthquake locations and to conduct investigation on weak seismicity in the territory of Armenia and adjacent areas. Due to these networks the lower representation magnitude level in the National earthquake catalogue was reduced down to M<1.0 during recent years.

4.2.Information about Earthquake

RSSP operationally monitors seismic activity throughout the country and adjacent areas and issues information to earthquakes. To monitor earthquakes, RSSP uses its seismic observation network, as well as data from international (adjacent areas) seismic stations.

When an earthquake occurs, RSSP immediately determines its hypocenter, magnitude and depth. If the earthquake is large enough and corresponds to the relevant approved documents in the RSSP, information about its hypocenter, magnitude and observed seismic intensity is immediately provided. RSSP issues Information in the following order:

After occurred earthquake the main earthquake parameters are defined and the first preliminary announcement is being made (7 - 10 minutes), and after main parameters adjusting, the final announcement is being made (10 - 20 minutes). Example of information provided:

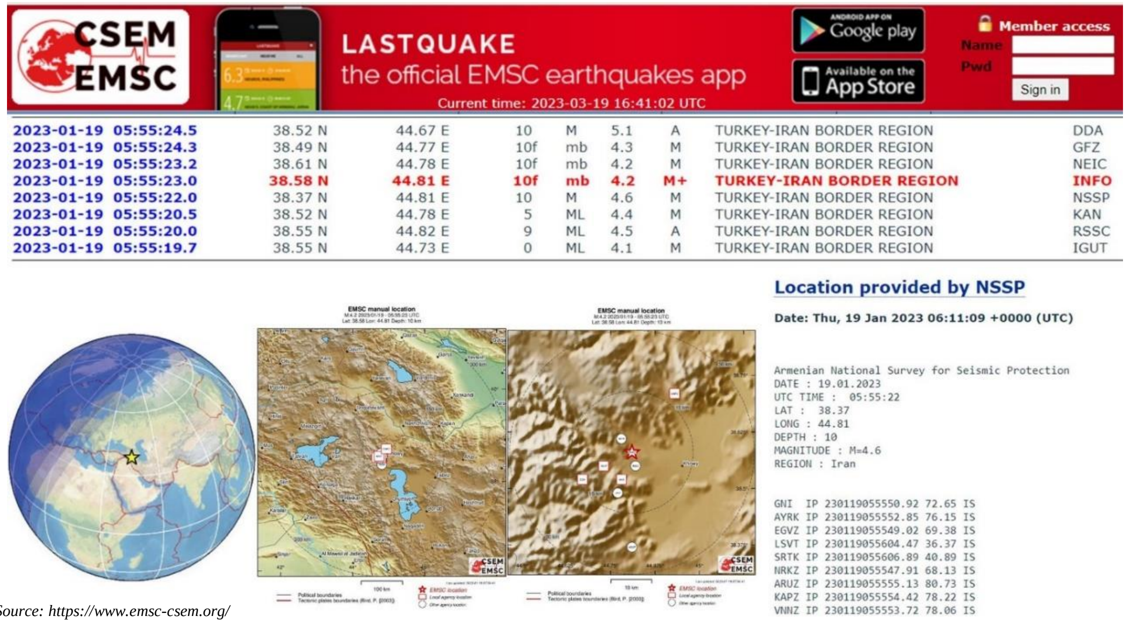
"On January 19 at 09:55 local time (at 05:55 by GMT), the Seismological Network of the Regional Survey for Seismic Protection of the MES of the RA recorded an earthquake at the northern latitude 38.37⁰ and eastern longitude 44.81⁰ geographic coordinates (20 km north from the city of Salmas, Iran), with 4.6 magnitude and 10 km depth. The tremor measured magnitude 6 points at the epicenter area.

The earthquake was felt in the town of Agarak in Syunik Province with 2-3 points intensity".

The information is provided to disaster prevention authorities and reaches the public through the media and local governments.

RSSP also provides data to international organizations such as European-Mediterranean Seismological Center (EMSC), International Seismological Center (ISC) etc.

Operative Estimation and Notification Of Earthquake Parameters

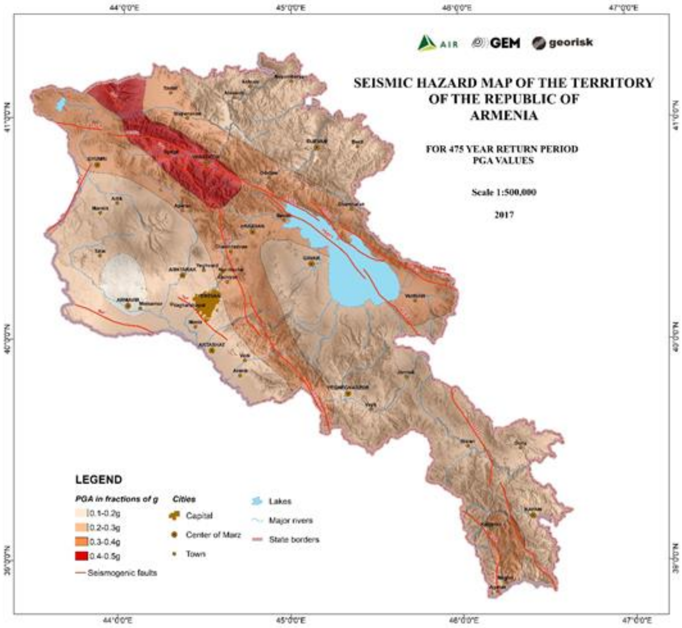


Source: https://www.emsc-csem.org/

4.3. Seismic Hazard Maps

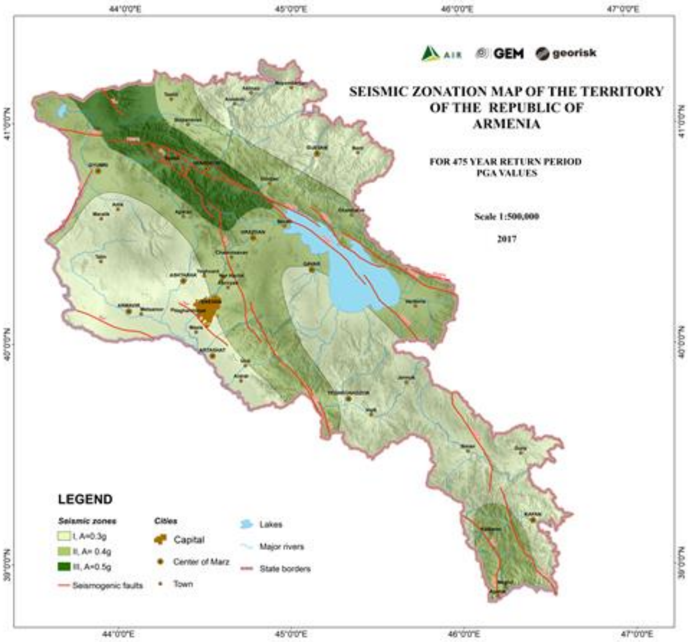
The new Seismic Hazard Maps for Armenia was prepared by the Consortium of AIR Worldwide Corporation, GEM Foundation and GEORISK Scientific Research at the initiative of the RSSP. Seismic hazard refers to the study of expected earthquake ground motions at the earth's surface, and its likely effects on existing natural condit structures.

Seismic Hazard Map of the territory of the Republic of Armenia at the scale of 1:500.000 was prepared by probabilistic assessment for 500 m/s velocity of shear wave propagation in soils within the RA area and 475 year return period, corresponding to a 10% probability of exceedance in 50 years. To perform a probabilistic analysis of the seismic hazard of the Republic of Armenia, the latest geological and paleoseismological information on active faults, strain rates from kinematic modeling of GPS data and all available earthquake data were used (historical, Early instrumental and Instrumental periods).



Source: Final report "Probabilistic Seismic Hazard Assessment for the Republic of Armenia"

The 1:500000 seismic zoning map of the RA is based on the same-scale probabilistic seismic hazard map for the return period of 475 years of given intensity earthquakes and for 90% probability of non-exceedance of the peak ground acceleration (PGA) intensity value in 50 years. According to the seismic zoning map, the area of the RA was subdivided into Seismic Intensity Zones I, II and III in ascending order of intensity covering, respectively, 50%, 40% and 10% of the total country area. The PGA values expected within Zones I, II and III comprise, respectively, 0.3g, 0.4g and 0.5g.



Source: Final report "Probabilistic Seismic Hazard Assessment for the Republic of Armenia"

The new seismic hazard and seismic zonation maps of the territory of the Republic of Armenia at a scale of 1:500,000 was approved by the order of the Minister of Emergency Situationsof the Republic of Armenia and is a regulatory legal act. There maps was the basis for developing new earthquake-resistant building code.

5. SEISMIC MONITORING, SEISMIC HAZARD, RISK ASSESSMENT AND EARTHQUAKE EARLY WARNING SYSTEM IMPLEMENTATION AS A PART OF SEISMIC RISK REDUCTION IN JAPAN

5.1. Seismic Monitoring

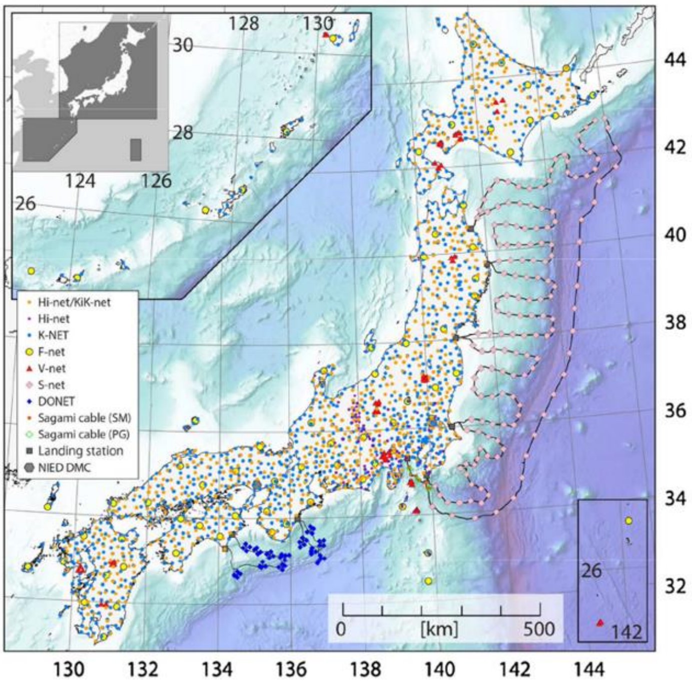
Seismic observation has a longer history in Japan than almost anywhere else. The Seismological Society of Japan was founded shortly after the Yokohama Earthquake of 1880 by the British scientist John Milne, an advisor to the Meiji government. This led to the development of the seismograph. Later, in the 1960s, Japan significantly expanded its observation network under its national earthquake prediction program. The proposition of the Tokai Earthquake theory in the 1970s led to the development of an earthquake prediction system based on the detection of preslips, which may occur prior to the main rupture.

Japan is an earthquake-prone country in which the importance of earthquake observations, both for research and disaster prevention, has been well recognized. Official earthquake observations in Japan first began in 1875 by JMA, which has conducted nationwide observations ever since. Other organizations including universities and research institutes mainly perform regional observations. National Research Institute for Earth Science and Disaster Resilience (NIED) has been conducting observations for nearly 50 years, including the Iwatsuki Crustal Activity Observatory which began operations in 1973 with a 3510-m deep borehole, the Kanto and Tokai Crustal Activity Observation Network, strong motion observation networks, and the Sagami-Bay Sea Bottom Earthquake Observatory. Prior to the 1995 Kobe earthquake, the primary focus of earthquake research was on short-term earthquake predictions, and observation resources were concentrated in designated regions that the Act on Special Measures for Large-Scale Earthquakes deems to be particularly important, such as the Tokai earthquake area. However, based on the lessons learned from that earthquake and the 2011 Tohoku earthquake and tsunami, the earthquake observation policies in Japan aimed at disaster prevention were modified drastically to perform uniformly spaced earthquake observations all over Japan on land, as well as earthquake observations on seafloors, in acknowledgement that earthquakes could occur anywhere in the country at any time.

In the aftermath of 1995 Kobe earthquake the Headquarters for Earthquake Research Promotion (HERP) was established to promote the fundamental survey and observation for earthquake research as a governmental policy. Regarding earthquake observations on land, NIED has overall responsibility for nationwide earthquake observations based on the fundamental earthquake survey and observation plans set forth by HERP in 1997. These observation networks aim to promote earthquake mitigation and deepen our understanding of earthquake phenomena through long-term evaluations of earthquake occurrences, evaluations of current seismic activity, seismic hazard assessments, and the rapid transmission of earthquake information for purposes such as early warning. The fundamental earthquake observation networks in Japan are High Sensitivity Seismograph Network Japan (Hi-net), which consists of about 800 stations to observe microearthquakes; Kyoshin Network (K-NET) and Kiban Kyoshin Network (KiK-net), which are strong motion networks that operate about 1700 stations in total; and Full Range Seismograph Network of Japan (F-net), which is a broadband network consisting of 73 stations that can observe broadband seismic waves of up to several hundreds of seconds. Portions of these observation networks have been in operation since as early as 1996, and most stations began operations in the early 2000 summarized for Hi-net, F-net, K-NET, and KiK-net. To facilitate crustal deformation observations, Geospatial Information Authority of Japan (GSI) has expanded the GNSS Earth Observation Network System (GEONET), which consists of about 1300 stations.

Regarding earthquake seafloor observations, that cable-type seafloor observation systems for earthquakes and tsunamis had been installed by JMA (one off Tokai in 1979, one off Boso Peninsula in 1985, and one off Tonankai in 2008), by NIED (Sagami Bay in 1996 and eastern half of the Nankai area 2011 (DONET)), by Earthquake Research Institute of the University of Tokyo (ERI) (off eastern Izu in 1994, off Sanriku in 1995 and off Awashima in 2010), by Japan Agency for Marine-Earth Science and Technology (JAMSTEC) (Muroto Cape in 1997, Kushiro and Tokachi in 1999). Taking into consideration the overall situation after the 2011 Tohoku earthquake and tsunami, the Japanese government decided to construct the Seafloor observation network for earthquakes and tsunamis along the Japan Trench (S-net) offshore of the Pacific coast of eastern Japan.

Seismic Observation Networks in Japan



Source: https://doi.org/10.1186/s40623-020-01250-x

NIED completed construction of S-net in March 2017, and began operating it for real-time direct measurements of earthquakes and tsunamis using ocean bottom observation networks. S-net currently consists of 150 observatories equipped with seismometers and pressure gauges linked together by ocean bottom fiber optic cables. S-net is expected to provide prompt and accurate earthquake and tsunami observation to increase lead time of warnings for offshore earthquakes, and to contribute to a deeper understanding of offshore earthquakes. These observation data are shared with relevant organizations.

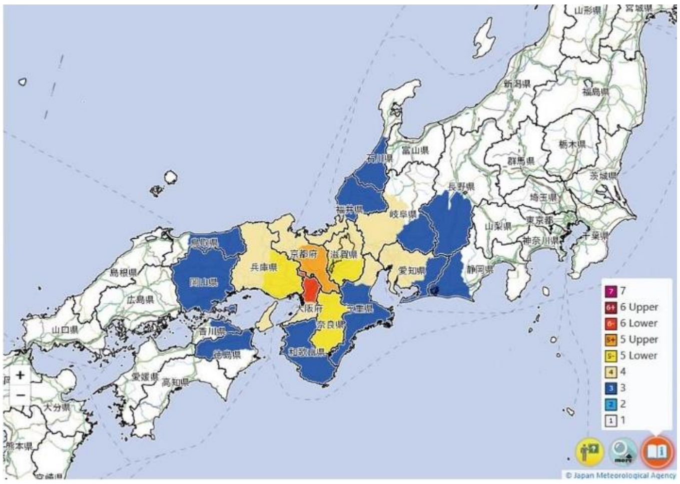
5.2. Information about Earthquake

Japan Meteorological Agency operationally monitors seismic and volcanic activity throughout the country and issues relevant warnings and information to mitigate damage caused by disasters related to earthquakes, tsunamis and volcanic eruptions. To monitor earthquakes, JMA operates an earthquake observation network comprised of about 300 seismographs and 700 seismic intensity meters. It also collects data from over 3.700 seismic intensity meters managed by local governments and NIED etc. 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 promptly issues earthquake information based on seismic intensity observations and determines its time of occurrence, hypocenter and magnitude. If the earthquake is large enough to require emergency action by the government and other related organizations, JMA issues Seismic Intensity Information in the following order:

- ***1.5 min** – Seismic Intensity Information*

  This information specifies the time of earthquake occurrence and identifies sub-prefectural regions where seismic intensity of 3 or greater has been observed (issued within 90 seconds of the earthquake).

Seismic Intensity Information

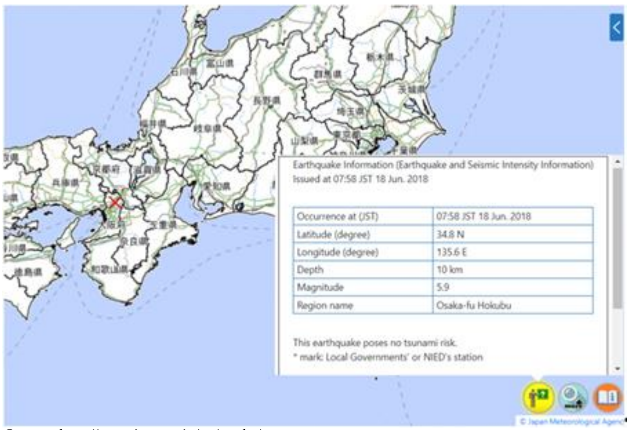


Source: http://www.jma.go.jp/en/quake/

❖ **After 3 min** – *Earthquake Information*

This information specifies the hypocenter and magnitude with the information “No threat of tsunami” or “Sea levels may fluctuate slightly, but no danger is expected” for earthquakes with a seismic intensity of 3 or greater (if no Tsunami Warning/Advisory is announced).

Earthquake Information



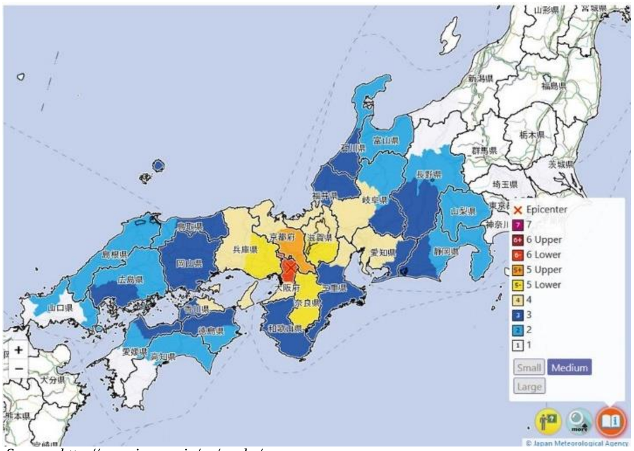
Source: http://www.jma.go.jp/en/quake/

❖ **After 5 min** – *Provides 2 types of information*

1. *Earthquake and Seismic Intensity Information*

   This information specifies the hypocenter and magnitude, and identifies sub-prefectural regions and cities/towns/villages where seismic intensity of 3 or greater has been observed and those where the estimated seismic intensity is 5-lower or greater but related observation data are incomplete. This information is posted on the JMA website when seismic intensity of 1 or greater is recorded.

Earthquake and Seismic Intensity Information



Source: http://www.jma.go.jp/en/quake/

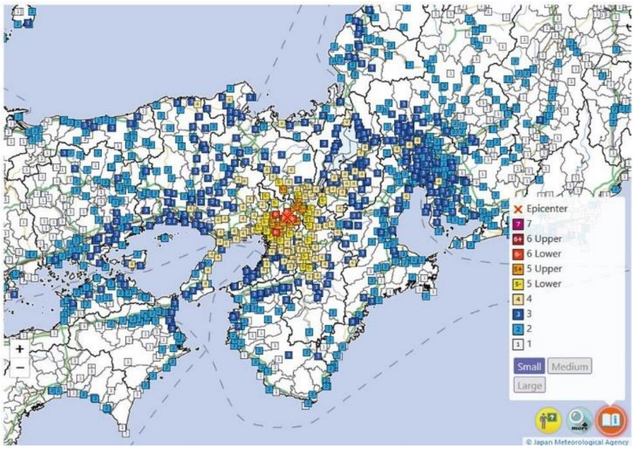
2. *Information on Seismic Intensity at each site***.**

   This information specifies the hypocenter and magnitude, and identifies individual sites where seismic intensity of 1 or greater has been observed and those where the estimated seismic intensity is 5-lower or greater but related observation data are incomplete.

When earthquakes occur repeatedly, this information is issued only for those with a seismic intensity of 3 or greater. The number of tremors smaller than this is included in the information on the number of earthquakes.

In JMA XML messages, “Earthquake and Seismic Intensity Information” is combined with “Information on Seismic Intensity at each site”.

Information on Seismic Intensity at each site

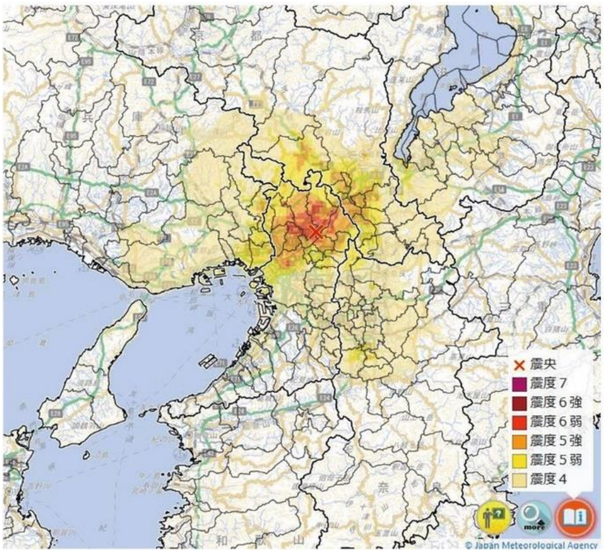


Source: http://www.jma.go.jp/en/quake/

- **After 15 min** – *Estimated Seismic Intensity Distribution Maps*.

  When the observed maximum seismic intensity of is 5- or greater, JMA issues Estimated Seismic Intensity Distribution Maps showing expected Seismic Intensity based on observation data in consideration of site amplification to areas where seismic intensity of 4 or greater has been estimated.

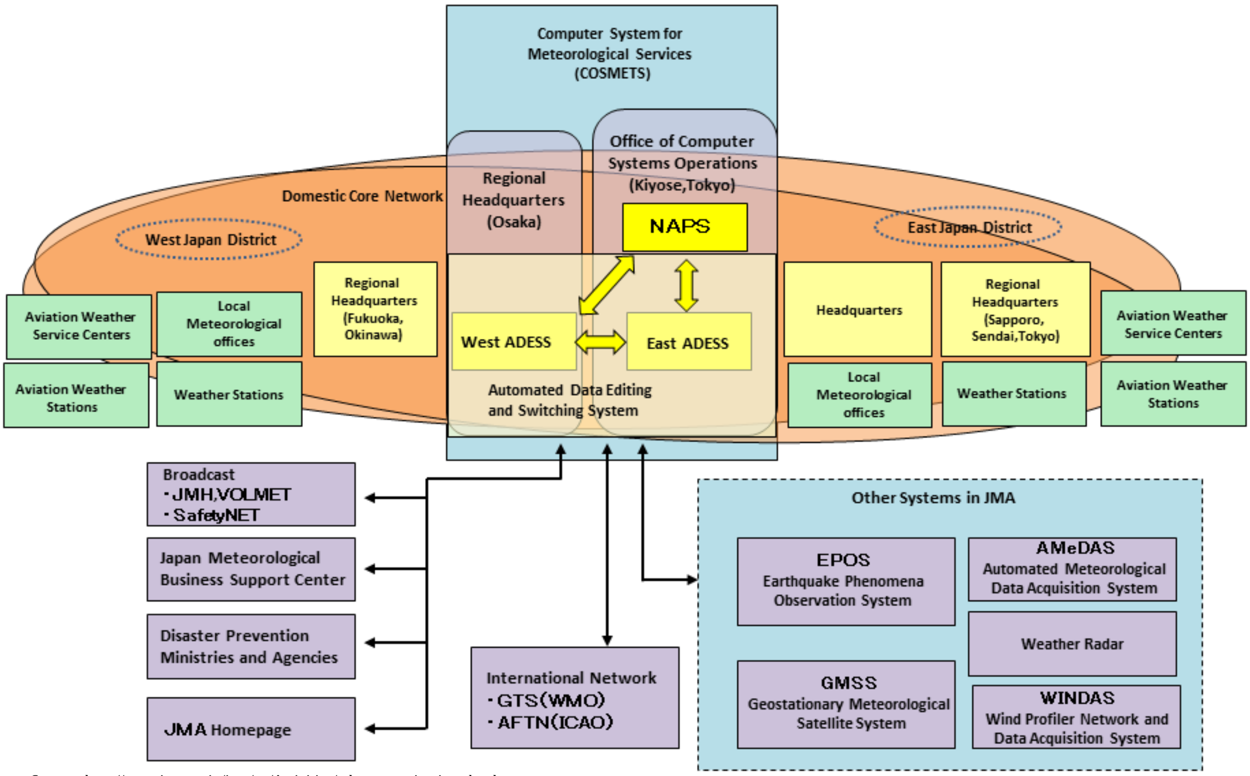
Estimated Seismic Intensity Distribution Map



Source: http://www.jma.go.jp/en/quake/

Such information is broadcast via TV, radio and other medias, and is also used to trigger emergency action and emergency disaster control measures implemented by disaster-prevention organizations.

JMA maintains state-of-the-art computer systems to enable these operations. JMA operates two major computer systems; one is the Automated Data Editing and Switching System (ADESS) for the treatment of observational data and products, and the other is the Numerical Analysis and Prediction System (NAPS). ADESS is linked to individual JMA facilities for meteorological services as well as various related authorities (including both the central government and local governments) via exclusive landlines. To complement landline-based communication, JMA installed a communication channel through the Geostationary Meteorological Satellite (MTSAT-1R) for the delivery of earthquake reports and tsunami warnings due to the urgency and level of reliability required in disseminating such bulletins. NAPS is a super-computer system used for the computation of numerical weather predictions.

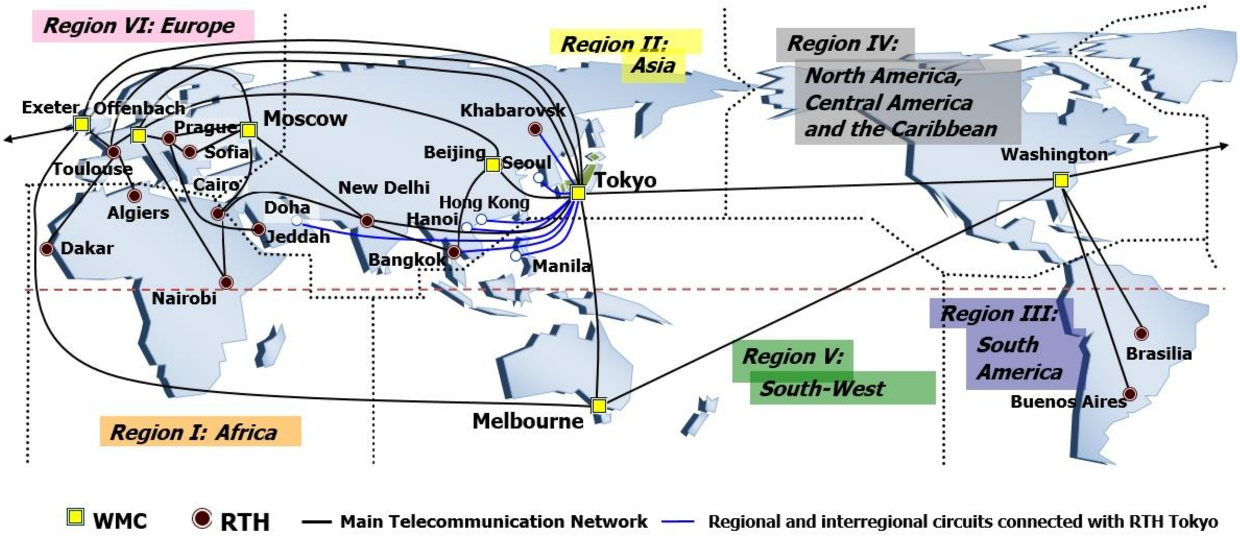


Source: http://www.jma.go.jp/jma/en/Activities/telecommunications.html

To cope with constantly increasing demand for computing performance and capacity, JMA updates NAPS with the latest high-performance computer every five years, and the most recent replacement was conducted in June 2018. ADESS and NAPS are collectively called the Computer System for Meteorological Services (COSMETS), and constitute a comprehensive system for data communication and processing.

In addition to its role as described above, ADESS also exchanges observational data and weather-related products with National Meteorological and Hydrological Services (NMHSs) through the Global Telecommunication System (GTS), which is run under the WMO World Weather Watch (WWW) Programme. JMA serves as a Regional Telecommunication Hub (RTH) for the GTS Main Telecommunication Network, and is connected to World Meteorological Centres (WMCs), other RTHs and National Meteorological Centres (NMCs).

The Agency also operates a Global Information System Centre (GISC) and Data Collection or Production Centres (DCPCs) of the WMO Information System (WIS) for the collection and sharing of information for all WMO and related international programmes. See JMA's WIS Services for details of actual services.



Schematic overview of Global Telecommunication System (GTS)

Source: http://www.jma.go.jp/jma/en/Activities/telecommunications.html

5.3. Seismic Hazard Maps

The Seismic Hazard Maps for Japan is prepared by a governmental organization, the Headquarters for Earthquake Research Promotion (HERP) to estimate strong motions caused by earthquakes that could occur in Japan in the future and show the estimated results on the maps. They contain an enormous amount of information including the data required for mapping such as seismic activity models, seismic source fault models, subsurface structure models, and other models.

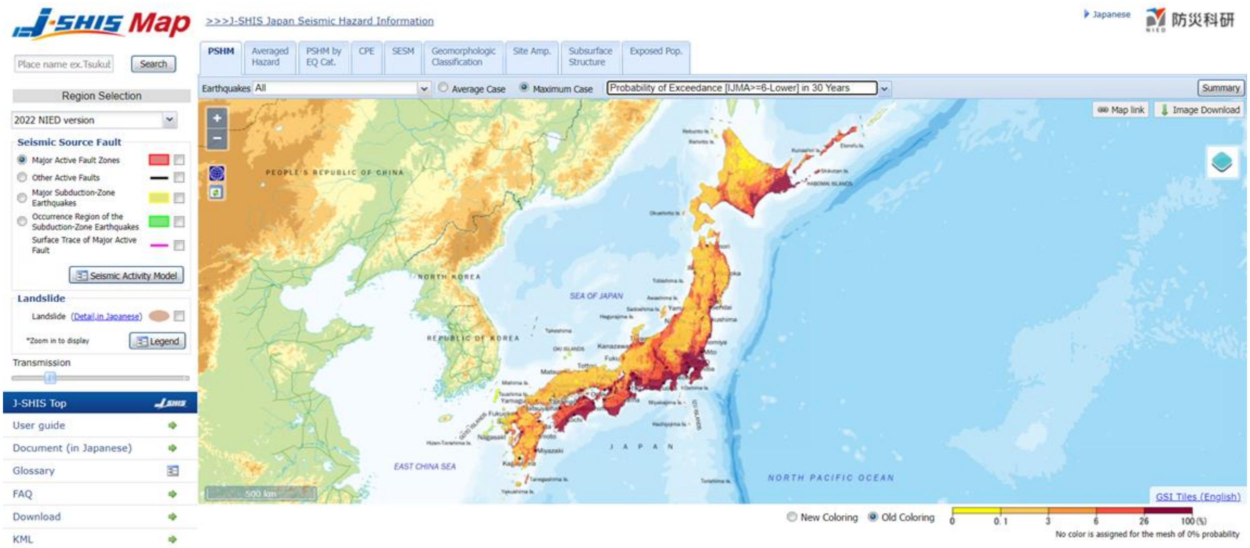
The Seismic Hazard Maps for Japan consist of two types of maps different in nature:

1. Probabilistic Seismic Hazard Maps that combine long-term probabilistic evaluations of earthquake occurrence and strong motion evaluation,
2. Seismic Hazard Maps for Specified Seismic Source Faults (also referred to as Scenario Earthquake Shaking Maps), which are based on strong motion evaluation for scenarios assumed for specific earthquakes.

1. Probabilistic Seismic Hazard Maps (PSHM)

PSHM are prepared by calculating the probability that a given site will experience ground motion intensity exceeding a certain value within a target period. For this calculation, evaluation is conducted by using a probabilistic approach on the site of occurrence, probability of occurrence, and magnitude of all earthquakes that could occur in and around Japan, and the intensity of the ground motions caused by those earthquakes are evaluated with variance. Seismic hazard evaluation is conducted for each site and by fixing any two parameters of the ground motion intensity, period, and probability, the value of the remaining parameter is obtained. PSHM show the distribution of such values.

The examples of PSHMs are maps of probabilities that seismic intensity exceeds the JMA scale 5-, 5+, 6- and 6+ in 30 or 50 years, and maps of the JMA seismic intensity corresponding to the exceedance probability of 3% and 6% in 30 years and of 2%, 5%, 10% and 39% in 50 years. The figure shows a map showing the probability that each location will be affected by an earthquake with a JMA >= 6-Lower within 30 years.



Source: https://www.j-shis.bosai.go.jp/map/

2. Scenario Earthquake Shaking Maps (SESM)

Meanwhile, for earthquakes that occur at specified fault zones, SESM are designed to estimate the ground motion intensity around the faults at the occurrence of the earthquake and show the results on the maps. SESM have enabled accurate estimation of near-fault strong motions by simulating seismic wave propagation considering complex subsurface structure based on a physics model of fault rupture. Although the estimation methods used here are very complicated, the strong ground motion estimation method (Recipe) for earthquakes with specified source faults has been developed as a result of standardizing the methods.

As a part of its studies on utilization of seismic hazard maps, the NIED has set up an engineering application committee (Chair: Hiroyuki Kameda) to explore into the issue. The Committee's report recommends that the seismic hazard maps should be considered as a sharing platform of the seismic hazard information by regarding the maps as a group of information incorporating the underlying data used in the evaluation process, such as the seismic activity models, seismic source models, and subsurface structure models, rather than mere maps as final products. In order to put this recommendation into practice, NIED developed an open web system for seismic hazard maps the name “Japan Seismic Hazard Information Station (J-SHIS)”. And so J-SHIS was established to help prevent and prepare for earthquake disaster by providing a public portal for seismic hazard information across Japan. It includes the new National Seismic Hazard Maps for Japan which consist of PSHM for Japan with a 250 m mesh resolution and SESM based on detailed strong motion estimation of earthquakes occurring at major active fault zones, as well as the deep subsurface structure models for Japan and 250 m mesh geomorphological land classification models used for the required calculations.

5.4. Earthquake Early Warnings System

Earthquake Early Warnings (EEWs) provide advance notice of estimated seismic intensities and expected arrival times of principal motion just after an earthquake occurs. Although strong tremors arrive quickly (within a few tens of seconds at most), EEWs are utilized in various situations to mitigate earthquake-related damage by providing precious seconds before shaking starts. EEWs can be either **warnings or forecasts**, depending on the criteria.

Categories	Criteria	Details	Features	Transmission methods
Warnings	• For estimated I_{JMA}5- or greater. (Provided for areas where I_{JMA} is expected to be 4 or greater)	• Estimated origin time and hypocenter • Areas where I_{JMA} is expected to be 4 or greater	• In principal, issued only once for each earthquake (reissued if expected I_{JMA} in areas where warnings are not issued becomes 5- or greater.)	• TV, radio • Cellphone, smartphone (Emergency Alert Email), disaster management radio communications systems
Forecasts	• For estimated I_{JMA}3 or greater • For estimated magnitude is 3.5 or greater	• Estimated origin time, hypocenter and magnitude • Areas where I_{JMA} is expected to be 4 or greater, estimated I_{JMA} and arrival time of principal motion with I_{JMA}4 or more	• Issued whenever predictions change (sometimes 10 times or more)	• EEW receivers, dedicated systems, EEW reception application for smartphone (provided private company)

Warnings are issued widely through various media such as not only TV and radio, but also cellphones and smartphones to help people protect themselves from strong shaking.

It is advisable to prepare in advance by creating a safe space and implementing drills for immediate self-protection in the event of a Warning.

To support the rapid implementation of self-preservation measures, TV/radio and cellphones/smartphones emit individually unique alarms. Get to know the sounds they make so that you will recognize an alert as soon as it is issued.

Forecasts are issued quickly even when the accuracy of available information remains limited, and are updated iteratively with increasing precision over time. As a result, Forecasts can provide alerts of shaking before **Warnings** in some cases.

Some corporate operators licensed for forecasting predict seismic intensities and times at which strong shaking will start in specific locations based on forecast data from JMA. This information can be used to enable advance preparations such as mechanical control of machinery/equipment and issuance of automatic announcements in indoor environments.

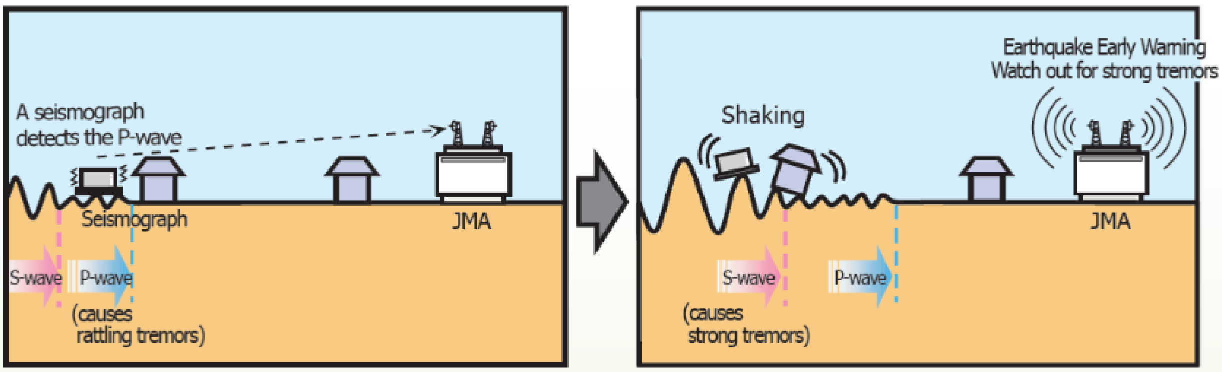
Users can subscribe to these forecasts by contracting with the relevant licensed company or installing dedicated applications.

Source: JMA websites

JMA provides residents in Japan with EEWs. This is a system that issues prompt alerts just as an earthquake starts, providing valuable seconds for people to protect themselves before strong tremors arrive. On 1 October 2007, JMA launched EEW service for provision through a number of media outlets such as TV and radio.

EEW system provides advance announcement of the estimated seismic intensities and expected arrival time of principal motion. This information is based on the estimated hypocenter and magnitude of the earthquake quickly calculated from the P-wave data obtained at seismic stations near the epicenter. The P-wave is a longitudinal wave that propagates 6-7 km/s through the earth's crust, while the S-wave is a transverse wave that propagates 3.5-4 km/s through the earth's crust, arriving later and causing the more severely destructive phenomena. The time lag between the P-wave and the S-wave can make it possible to mitigate earthquake damage by enabling disaster prevention actions to be taken before the major shaking begins (when the S-wave arrives).

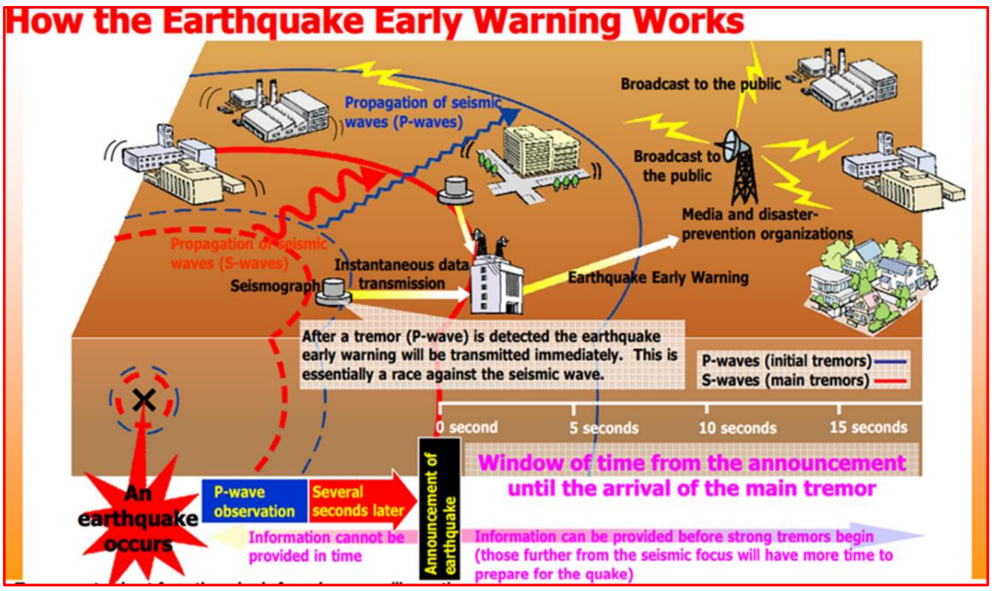
Flow of Earthquake Early Warning



Source: https://www.jma.go.jp/jma/en/Activities/earthquake.html

EEW is aimed at mitigating earthquake-related damage by allowing countermeasures such as promptly slowing down trains, controlling elevators to avoid danger and enabling people to quickly protect themselves in various environments such as factories, offices, houses and near cliffs. The period between EEW and the arrival of strong tremors is very short, i.e. a matter of seconds (or between several seconds and a few tens of seconds).

Early Warning Dissemination Mechanism



Source: https://www.jma.go.jp/jma/en/Activities/how.pdf

As a result, areas that are close to the focus of the earthquake may not receive the EEW transmission before strong tremors hit. There are limits to the accuracy of the Earthquake Early Warning:

- In areas close to the hypocenter, Warnings may not arrive in time before strong shaking hits.
- EEW Seismic Intensity estimations have an error margin of ±1 or so.

- Warning accuracy may vary due to calculation with the limited data available immediately after an earthquake.

The JMA has therefore built an online system that links relevant ministries and agencies, local government bodies, and media organizations. The information issued by the JMA is conveyed to prefectures via local meteorological observatories, the Fire and Disaster Management Wireless Networks, or regional satellite communications networks, and then conveyed to municipalities via prefectural systems. Municipalities have established their own disaster management wireless networks that enable authorities to directly transmit warnings and evacuation orders to residents. The most frequently used tools for disseminating information to the very end users, the residents, are simultaneous wireless communications systems used with outdoor loudspeakers or indoor private radio receivers.

CONCLUSION

As large-scale natural disasters continue to occur around the world, there is a serious and growing need to improve natural disaster early warning capabilities. For natural disaster early warning systems to be truly useful in mitigating disasters for those who are facing natural disaster risks, they need to:

- ✓ Enable the issuance of prompt and accurate early warning information based on more accurate, real-time measurements of various natural phenomena and scientific data analysis
- ✓ Incorporate systems for sharing warning information among relevant organizations and disseminating it to residents.
- ✓ Incorporate disaster reduction awareness outreach and education activities to ensure that more timely and appropriate disaster reduction actions are taken based on the warning information issued.

It is very necessary and important:

- ✓ **Information Sharing Among Relevant Organizations.** The development of a quick and accurate communications system is essential to the effective use of early warning information.
- ✓ **Partnering with the Telecommunications Industry.** Given the usefulness of mobile phones and the Internet in information distribution, and thus in crisis management and information exchange at the individual level, efforts are being made to actively promote practical applications for the vast array of information technologies that have been developed in recent years.
- ✓ **Disaster Awareness.** Outreach to reduce disaster-related damage, it is important to make residents of at-risk areas aware of safe evacuation methods and nearby evacuation routes and sites ahead of time so that they will take appropriate actions based on early warning information.
- ✓ **Use of Hazard Maps.** Municipalities have to create and distribute hazard maps that show the are as most vulnerable to earthquakes as well as evacuation information.

EEWs provide advance notice of estimated seismic intensities and expected arrival times of principal motion just after an earthquake occurs. The elapsed time between the issuance of the EEW and the start of major shaking will differ significantly depending on a location's distance from the epicenter. EEWs may not be issued in time to areas located just above the hypocenter of an inland earthquake. However, when a large earthquake occurs near an ocean trench, there may be a time lag, albeit a very short one (ten seconds to several tens of seconds), between the issuance of the EEW and the start of severe shaking. This may be just enough time to mitigate damage by triggering emergency stops on trains, plant operations, and elevators, or even just by allowing people to take basic risk-reduction actions, such as extinguishing flames or taking cover under a desk.

To ensure that the best response measures possible are being taken against natural disasters such as earthquakes, tsunamis, typhoons, and torrential rainstorms, we need to conduct accurate and widespread observations of phenomena occurring all over the world and to use those results to develop better policies.

For example, in an effort to achieve a system for disaster crisis management that uses earth observation satellites Japan is striving to cooperate and form ties with other countries in the Asia-Pacific region while actively striving to develop a Disaster Management Support System in the Asia Pacific Region.

Recommendation

- ❖ To improve the earthquakes monitoring system, in particular, to create a single interconnected system between the RSSP and the research institutes of the RA.
- ❖ Create on the earthquakes warning system using the Internet and mobile phones.
- ❖ Create a network of seismic intensity meters stations in Armenia

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