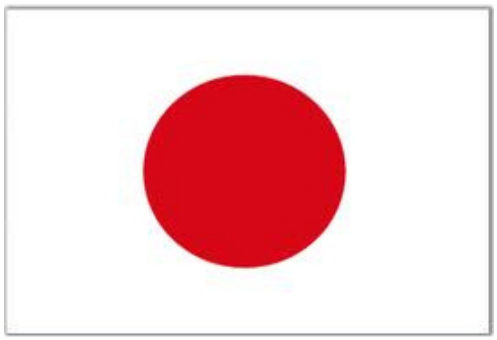

Asian Disaster Reduction Center

Research Paper

Study on Disaster preparedness and Early warning systems

Visiting Researcher 2011B in term of January 9- April 27 ,2012

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Disclaimer

This report was compiled by an ADRC visiting researcher (VR) from ADRC member countries.

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Chapter 1 Asian Disaster Reduction Center (ADRC)

1.1 Background to the Establishment of the ADRC

The Asian Disaster Reduction Center (ADRC) opened its office in Kobe, Japan, on July 30, 1998. The major steps leading up to ADRC's creation are outlined as follows:

(1) International Decade for Natural Disaster Reduction (INDNDR)

At its 42nd General Assembly in December 1987, the United Nations designated the 90's as the International Decade for National Disasters Reduction, and adopted a resolution aiming to sharply reduce damages caused by natural disasters around the world, particularly in developing countries, through joint international actions.

(2) World Conference on Natural Disaster Reduction

In May 1994, the UN organized the World Conference on Natural Disaster Reduction in Yokohama, Japan, to conduct an interim review of the decade long initiative and propose an action plan for the future. At the meeting, the "Yokohama Strategy for a Safer World" was adopted, which pointed out the importance of international cooperation in regions that share common types of disasters and disaster reduction measures. Disaster Reduction activities have since been promoted throughout the world based on this strategy.

(3) Ministerial-level Asian Natural Disaster Reduction Conference

As the first step in regional level cooperation as per the Yokohama Strategy, the IDNDR Secretariat organized a meeting in Kobe in December, 1995 to formulate a policy on disaster reduction cooperation in Asia. Cabinet members in charge of disaster reduction from 28 countries attended the meeting, which adopted the Kobe Disaster Reduction Declaration consisting of ideas for promoting international cooperation in disasters, including a proposal by Japan to launch a feasibility study on a system that would act as the disaster reduction coordinator in the Asian region.

(4) Asian Natural Disaster Reduction Experts Meeting

The Government of Japan and the IDNDR Secretariat co-organized an experts meeting in October 1996 to hash out how a central disaster reduction system, as stated in the Kobe Disaster Reduction Declaration, might be created for the Asian region. Key participants from disaster reduction bureaus of 30 countries attended and agreed to study the creation of an "Asian Disaster Reduction Center" (tentative name) that would serve as the secretariat for promoting activities of the proposed system.

(5) Asian Disaster Reduction Cooperation Promotion Meeting

The Government of Japan and the IDNDR Secretariat co-organized a meeting in Tokyo in June 1997 to discuss specific activities of the proposed central disaster reduction system. Once again, key personnel from disaster reduction bureaus of 23 countries attended the meeting, the overall goal of which was to promote cooperation in disaster reduction efforts through concrete action. It was proposed at the meeting to create an office in Japan as the secretariat for the proposed system.

(6) ADRC's Official start

With momentum gathering on this series of meetings, the Japanese government discussed the organization, budget and other aspects of the proposed office with other countries involved. Then, with the cooperation of Hyogo Prefecture, the Asian Disaster Reduction Center was officially established in Kobe on July 30, 1998.

1.2 Mission and Objectives

(1) To Enhance Disaster Resilience of the Member Countries.

(2) To Build Safe Communities.

(3) To Create a Society Where Sustainable Development is Possible.

The Asian Disaster Reduction Center was established in Kobe, Hyogo prefecture, in 1998, with mission 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.

The Center addresses this issue from a global perspective in cooperation with a variety of UN agencies and international organizations/initiatives, such as the International Strategy for Disaster Reduction (ISDR), the Office for the Coordination of Humanitarian Affairs (OCHA), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), the World Meteorological Organization (WMO), and the World Health Organization Regional Office for the Western Pacific (WHO/WPRO).

1.3 Composition

The ADRC had 29 member countries, 5 advisor countries and observer organization. The member countries were Armenia, Azerbaijan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Japan, Kazakhstan, Republic of Korea, Lao PDR, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Papua New Guinea, Maldives, Philippines, Russian Federation, Singapore, Sri Lanka, Kyrgyz, Tajikistan, Thailand, Uzbekistan, Viet Nam, and Yemen. The advisor countries were Australia, France, New Zealand, Switzerland, and USA.

1.4 Activities

(1) Information Sharing on Disaster Reduction

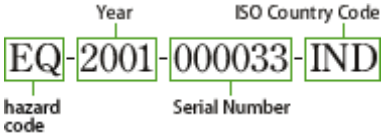
Learning from Disasters and Benefiting from Information

1.1) Provision of Information on the Latest Disasters, Disaster Preparedness of Member Countries, and Good Practices

ADRC provides information on the latest disasters in Asia and the other part of the world, disaster management in member countries, and good practices for disaster risk reduction. A multilingual glossary on natural disasters is available in English, French, Spanish, Chinese, Korean, and Japanese on its website.

1.2) Promotion of GLIDE (Global unique disaster IDEntifier)

ADRC proposed a globally common, unique identification scheme for disaster events, as a tool for facilitating the sharing of disaster information archived by organizations around the world. The idea was launched as the new initiative, "GLIDE", jointly with such organizations as the OCHA.



1.3) Disaster Management Support System (Sentinel Asia Project)

'Sentinel Asia' Project was launched in 2006 in order to establish a disaster risk management system in Asia, using earth satellites. The Asian Disaster Reduction Center receives emergency observation requests from the member countries and other organizations which participate in collaborative projects. 'Disaster Management Support System' is a part of such 'Sentinel Asia' project and offers maps and satellite images, as well as disaster information in the Asia Pacific region from ADRC.

1.4) Organization of International Conferences

ADRC convenes an annual international conference participated by disaster officials from the member countries and disaster experts from international organizations to promote information sharing, exchange opinions, and enhance partnerships among participating countries and organizations

(2) Human Resources Development

Disaster Risk Reduction begins with Capacity Building

2.1) Organizing Conference, Workshops & Training on Disaster Risk Reduction

ADRC organizes and conducts various conferences, workshops and trainings for enhancing the human resources capacity of pursuing effective disaster risk management in member countries.

- Workshop on Total Disaster Risk Management (TDRM)*
- Workshop on Flood Risk Management (Viet Nam)
- Workshop on Earthquake Disaster Management (Mongolia, Bangladesh, and Tajikistan)
- Disaster Risk Management Training for Local Government Officials (Cambodia, Sri Lanka)
- Urban Search and Rescue Training in Singapore
- Training on Supply Management System (SUMA) in the Philippines
- JICA Seminar on Disaster Management

*ADRC, in cooperation with UN-OCHA (Kobe), developed the Total Disaster Risk Management (TDRM) as an effective and strategic approach for disaster risk reduction, and disseminates the concept to member countries and other countries in Asia. The concept of TDRM centers around two crucial principles. They are; "involvement of all stakeholders" and "implementation of measures during all phases of disaster," i.e. prevention/mitigation, preparedness, response and rehabilitation/reconstruction. The promotion of TDRM approach to minimize potential impact of natural disasters is in line with the implementation efforts for achieving sustainable development

2.2) Program for Inviting Visiting Researchers from Member Countries

Each year, ADRC invites four officials in charge of disaster management from Member Countries as visiting researchers for a term of about half a year. The researchers are provided with opportunities to discuss challenges for disaster management of each country, enhance understanding of the disaster management system, disaster reduction, and international cooperation in Japan.

(3) Building Communities Capabilities

Community Participation is a Key to Effective Disaster Reduction

3.1) Development and Dissemination of Tools for Encouraging Community Participation

Risk reduction measures are most successful and effective when they involve the direct participation of the community most likely to be exposed to hazards. ADRC undertakes various efforts including increasing public awareness of disaster risk management, and development and dissemination of tools for reducing vulnerability of communities.

- Town Watching Program for Disaster Risk Management
- Community-based Disaster Risk Awareness Program (Indonesia, Nepal, India)
- Development and Distribution of Posters and Brochures for Disaster Risk Awareness (Papua New Guinea)
- Program for Enhancement of Disaster Education Programs in Schools (Philippines, Armenia)

3.2) Support for the Activities of Asian Disaster Reduction and Response Network (ADRRN)

ADRC and UN OCHA agreed to form the Asian Disaster Reduction and Response Network in 2002. Since then ADRC has supported the effort to improve networking among Asian NGOs which play an important role in disaster reduction and response. This leads to more efficient and effective activities for the network members.

1.5 How We Work

(1) Accumulation and provision of information on natural disasters and disaster reduction

ADRC	Member Countries
* Share data from each country and exchange information. * Provide analysis on disaster reduction programs. * Distribute newsletters	* Accumulate, organize and provide data. * Set up and manage websites.

(2) Studies on the promotion of disaster reduction cooperation

ADRC	Member Countries
* Provide study results, exchange information.	* Provide materials and know-hows. * Personnel cooperation to studies.

(3) Gathering of information on emergency relief during times of disaster

ADRC	Member Countries
* Provide information to each country.	* Provide information on damages. * provide information on emergency relief.

(4) Developing of materials for dissemination of knowledge and raising of disaster reduction awareness

ADRC	Member Countries
* Accumulate and provide materials and data. * Propose projects.	* Collect and provide public relations materials. * Collaborate in projects.

(5) Developing of education and training programs dealing with disaster reduction information

ADRC	Member Countries
* Accumulate and provide materials on education and training programs. * Propose projects.	* Collect and provide materials on education and training programs in each country. * Collaborate in projects.

2.1 General Information of Thailand

1. General Information

Thailand is located between 5º and 21º N latitude and between 97º and 106º E longitude. It shares land borders with Myanmar (Burma) in the north and west, the Andaman Sea in the west, Laos in the north and north-east, Cambodia and the Gulf of Thailand in the east, and Malaysia in the south. The weather is warm and rather humid with an average high temperature of 34ºc and the low of 23ºc. As of December 2010, the total population stood at 65.9 millions.

1.1 Geographical Data

Thailand is situated in South-East Asia, covering an area of nearly 513,115 square kilometers (198,114 square miles), extends about 1,620 kilometers (1,007 miles) from north to south and 750 kilometers (482 miles) at its widest point from east to west, or approximately the same size as France, with a coastline of approximately 2,700 kilometers (1,143 miles) on the Gulf of Thailand and 865 kilometers (537 miles) along the Indian Ocean. It is roughly the size of France.

Lowest point: Gulf of Thailand 0 m
Highest point: Doi Inthanon 2,576 m

Topography

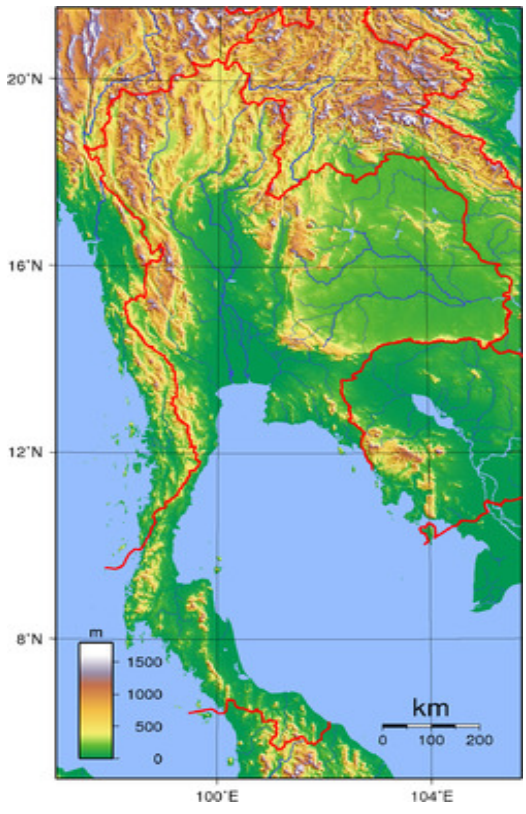
Thailand is divided into four geographical regions: Central Thailand (including Bangkok), Northern Thailand, Northeastern Thailand, and Southern Thailand.

The North Region The North Region is mainly mountainous representing the most heavily forested areas of the country. The region accommodates four north-south flowing rivers namely Ping, Wang, Yom and Nan. Most populated areas in the North are in the alluvial valleys along these rivers. Chiang Mai, the second largest city of Thailand, and Chiang Rai are among the well known cities.

The Northeast Region (Isarn) In terms of areas and population, Isarn is the biggest region of Thailand, one-third of the country's total areas. This region lies atop of Korat Plateau which is bound on the north and east by Mekong River. There are two major rivers, Chi and Mun, which run down to Mekong River.

The Central Region The Central Region (including Bangkok Metropolitan Region is situated in the basin of the Chao Phrya River which runs from north to south and after crossing Bangkok flows to the Gulf of Thailand. This region is often referred as the "rice bowl" of Thailand being the most fertile area of the country.

The South Region The peninsular south consists of the narrow Kra Isthmus that widens into the Malay Peninsula. With a vast area of mountains, the South Region has the highest rainfall in the country. It is connected to the Indian Ocean in the west and to the Pacific Ocean (Gulf of Thailand) in the east.



1.2 Climate information

General Climatic Conditions

The climate of Thailand is under the influence of monsoon winds of seasonal character i.e. southwest monsoon and northeast monsoon. The southwest monsoon which starts in May brings a stream of warm moist air from the Indian Ocean towards Thailand causing abundant rain over the country, especially the windward side of the mountains. Rainfall during this period is not only caused by the southwest monsoon but also by the Inter Tropical Convergence Zone (ITCZ) and tropical cyclones which produce a large amount of rainfall. May is the period of first arrival of the ITCZ to the Southern Part. It moves northwards rapidly and lies across southern China around June to early July that is the reason of dry spell over upper Thailand. The ITCZ then moves southerly direction to lie over the Northern and Northeastern Parts of Thailand in August and later over the Central and Southern Part in September and October, respectively. The northeast monsoon which starts in October brings the cold and dry air from the anticyclone in China mainland over major parts of Thailand, especially the Northern and Northeastern Parts which is higher latitude areas. In the Southern Part, this monsoon causes mild weather and abundant rain along the eastern coast of the part.

The onset of monsoons varies to some extent. Southwest monsoon usually starts in mid-May and ends in mid-October while northeast monsoon normally starts in mid-October and ends in mid-February.

Season

From the meteorological point of view the climate of Thailand may be divided into three seasons as follows:

Rainy or southwest monsoon season (mid-May to mid-October).The southwest monsoon prevails over Thailand and abundant rain occurs over the country. The wettest period of the year is August to September. The exception is found in the Southern Thailand East Coast where abundant rain remains until the end of the year that is the beginning period of the northeast monsoon and November is the wettest month.

Winter or northeast monsoon season (mid-October to mid-February). This is the mild period of the year with quite cold in December and January in upper Thailand but there is a great amount of rainfall in Southern Thailand East Coast, especially during October to November.

Summer or pre-monsoon season (mid-February to mid-May) This is the transitional period from the northeast to southwest monsoons. The weather becomes warmer, especially in upper Thailand. April is the hottest month.

1.3 Demographic data

Official Name: Kingdom of Thailand

Capital (and largest city): Bangkok (Thai : Krung Thep)

Population: 65.9 million (source: National Statistical Office, Ministry of Information and Communication Technology: 2010)

Population density: 127.5 per sq.km. (Source: National Statistical Office.2010)

Languages: Thai, English (secondary language of the elite), ethnic and regional dialects.

Official script: Thai alphabet

Nationality : Thai 75%, Chinese 14%, other 11% Religions : Buddhist 94.6%, Muslim 4.6%, Christian 0.7%,

Life expectancy: Male 69.9 Female 74.9 (source: Report on The 1995-1996 Survey of Population Change, National Statistical Office.)

Major religion: Buddhism

Monetary unit: 1 baht = 100 satangs

1.4 Administrations

Thailand's administrative system is constitutional monarchy with three types of government, central, provincial and local, and composed of 76 provinces.

Type of government: Constitutional monarchy

Head of state: King Bhumibol Adulyadej (Rama IX).

Prime minister: Prime Minister

Administrative Divisions: Thailand has 76 provinces (changwat) and Bangkok municipality. The provinces are divided into 998 districts (amphoe), 8,860 rural administrative subdistricts (tambon) .

Types of government administrations: the central, provincial and local.

Provincial and Local Government: Local government is based on the principles of decentralization and self-government when certain legal conditions are met. Under the 1997 constitution, elected local assemblies and elected or appointed local administrative committees were allowed four-year terms. Central government officials could not serve as local officials. Bangkok is a provincial-level entity with an elected governor and the legislative Metropolitan Administration Council. Supervision of provincial and local government takes place through the Department of Local Administration of the Ministry of Interior.

2.2 Natural hazards in Thailand

Thailand is in a tropical zone which is subject to the influences of monsoons and tropical hurricanes resulting in natural disaster impacts, such as floods, landslides, droughts, wildfires, etc. Summaries of the hazard, vulnerability and disaster risks in Thailand have been extracted from a study prepared by the Asian Disaster Preparedness Center, the Asian Institute of Technology and the United Nations Development Program - "Strengthened Disaster Management Strategies in Thailand", a project of the Royal Thai Government, March 1994, (THA/88/004), are presented in Table 1.1 and Table 1.2 below.

Table 1.1: Relative Risks of Hazards, Vulnerability, Level of Management and Disaster Occurrence in Thailand

Types of Disaster	Hazard	Vulnerability	Management	Disaster Risk
Flood	high	moderate	Moderate	high
Typhoon/Hurricane	high	high	moderate	moderate
Earthquake	low	low	poor	moderate
Landslide	moderate	low	poor	moderate
Drought	high	moderate	moderate	moderate
Fire	high	moderate	moderate	moderate
Explosion	high	moderate	poor	high
Accident	high	moderate	poor	high
Epidemics	low	low	moderate	low
Pests	moderate	low	poor	moderate
Civil Unrest	low	low	poor	moderate
Refugee migration	moderate	Low	moderate	moderate

Thailand is faced with natural and man-made hazards such as flood, landslides, urban fire, bush fire, windstorm, drought, thunderbolt-induced disaster, hailstorm and disease epidemic. Among these, flood, tropical cyclone, drought, and fire are at high level of intensity.

Table 1.2: Rank Order of Risk of Disasters in Thailand

Type of Disasters	Subjective Rank	Numeric Weight
Flood	high	2.39
Accident	high	2.37
Explosive	high	2.34
Typhoon	moderate	2.31
Drought	moderate	2.24
Fire	moderate	2.20
Land slide	moderate	2.15
Earthquake	moderate	1.97
Civil Unrest/Refugee Influx	moderate	1.87
Pests	moderate	1.77
Epidemic	low	1.63

The occurrences of natural disaster in Thailand are subject to seasonal cycle such as cold spell, drought, flood, landslide and storm.

Table 1.3 Disaster Seasoning Calendar

Type of Disaster	Disaster/Event	Periods of Time (month)
Natural	1. Cold spell 2. Drought 3. Flood 4. Landslide 5. Tropical Cyclone 6. Earthquake 7. Storm surge	October – January January – May October – November and June – September October – November and June – September March – May Year – round surveillance October – November
Natural/human induced	1. Forest fire	Year – round surveillance Northern region April – May Northeastern region November – May Central region, Eastern region, Southern region } March - May

Source: Implementation Handbook 2009, Department of Disaster Prevention and Mitigation

2.1 Natural Hazards likely to affect the country

Looking into the past major disasters happening in Thailand, it was not only the 2004 Indian Ocean Tsunami that came to devastate the country. Long before that Thailand experienced other major natural disasters as well. These include Typhoon Gay in 1989 that hit a southern province of Chumporn, claiming almost 500 lives, and landslide in a northern part of country in 2001 where 131 people perished.

Flood, landslide, forest fire, wind damage, drought, lightening, hail and epidemics are the major disasters. Flood is by far the worst disasters in Thailand. Between 2002 and 2010 flood killed more than 1,000 people and brought damage and loss in economic terms more than 40 billion Baht. It out numbers the damage caused by all other disasters combined during the period.

Landslides occur frequently in Thailand due to the influence of monsoon rain. In most cases, landslide would occur in the northern and southern parts of the country which are mountainous. The table below provides information of large scale landslide events taken place over the past four decades.

Although drought does not pose danger to human life but it does cause a great damage to the economy and livelihood of the people especially in rural areas. Occasionally, Thailand experienced tropical storms.

Thailand suffers quite often from these disasters; the occurrences of which are becoming more often and more severe than before. The table below concludes the detail of natural disaster occurrence in Thailand during 2005 – 2010.

Table 1.4 Thailand's Disaster Situation Summary in 2010

year	Disaster type	Frequency	Killed	Injured	Total affected	Damaged (Baht)	Damaged (USD)
2010	**Flood**	**7**	**266**	**1,665**	**13,485,963**	**16,338,772,341**	**536,577,088**
	Drought	n/a	0	0	4,077,411	1,415,223,466	46,476,961
	Cold Spell	n/a	0	0	10,609,301	n/a	n/a
	Storm	2,192	30	174	407,271	198,845,340	6,530,244
	Fire	1,903	29	83	8,912	1,283,787,066	42,160,494
2009	**Flood**	**5**	**53**	**22**	**8,881,758**	**5,252,613,976**	**172,499,637**
	Drought	n/a	0	0	17,353,358	108,346,716	3,558,184
	Cold Spell	n/a	0	0	10,588,881	n/a	n/a
	Storm	1,348	24	26	360,154	207,373,975	6,810,311
	Fire	5,127	83	312	6,549	817,334,839	26,841,866
2008	**Flood**	**6**	**113**	**16**	**7,921,127**	**7,601,796,302**	**249,648,482**
	Drought	n/a	0	0	13,298,895	103,900,841	3,412,178
	Cold Spell	n/a	0	0	9,554,992	n/a	n/a
	Storm	1,995	15	30	242,944	227,549,741	7,472,897
	Fire	1,696	30	92	8,392	1,424,889,050	46,794,385
2007	**Flood**	**13**	**36**	**17**	**2,326,179**	**1,687,865,982**	**55,430,738**
	Drought	n/a	0	0	16,754,980	198,304,732	6,512,470
	Cold Spell	n/a	0	0	5,910,339	n/a	n/a
	Storm	2233	10	71	245,619	234,547,154	7,702,697
	Fire	1,901	45	156	9,761	875,791,793	28,761,635
2006	**Flood**	**6**	**446**	**1,462**	**6,050,674**	**9,627,418,620**	**316,171,383**
	Drought	n/a	0	0	11,862,358	495,275,738	16,265,213
	Cold Spell	n/a	0	0	2,303,703	n/a	n/a
	Storm	1,883	29	39	142,849	92,244,108	3,029,363
	Fire	1,734	37	66	9,708	1,083,845,622	35,594,273
2005	**Flood**	**12**	**75**	**0**	**2,874,673**	**5,982,283,276**	**196,462,504**
	Drought	n/a	0	0	11,147,627	7,565,861,139	248,468,346
	Cold Spell	n/a	0	0	3,742,793	n/a	n/a
	Storm	1,313	13	0	61,429	148,871,750	4,889,055
	Fire	1,559	48	68	23,250	931,191,005	30,580,985

(1 USD = 30.45 Baht)

Source: Department of Disaster Prevention and Mitigation (DDPM)

2.2 Recent major disasters

2011: Severe flooding occurred during the 2011 monsoon season in Thailand. Beginning at the end of July triggered by the landfall of Tropical Storm Nock-ten, flooding soon spread through the provinces of Northern, Northeastern and Central Thailand along the Mekong and Chao Phraya river basins. In October floodwaters reached the mouth of the Chao Phraya and inundated parts of the capital city of Bangkok. Flooding persisted in some areas until mid-January 2012, and resulted in a total of 815 deaths (as of JAN. 17, 2012) (with 3 missing) and 13.6 million people in 4 regions affected. Sixty-five of Thailand's 77 provinces were declared flood disaster zones, and over 20,000 square kilometers (7,700 sq mi) of farmland was damaged. The disaster has been described as "the worst flooding yet in terms of the amount of water and people affected."The World Bank has estimated 1,425 billion baht (US$ 45.7 Bn) in economic damages and losses due to flooding, as of 1 December 2011. Most of this was to the manufacturing industry, as seven major industrial estates were inundated by as much 3 meters (10 feet) during the floods.

Figure 3.1: Flood in 2011

2010: In 2010 the impacts of tropical storms together with the influence of the active monsoon trough lying over Thailand has brought losses and damages to the country, particularly in the sector of agriculture, fishery, tourism, and to overall activities of the people. During the year 2010, Thailand was affected by the influence of 2 main tropical storms, namely Tropical Storm Mindulle (22-28 August 2010) and Tropical Depression (31 October – 2 November). Besides the influences from Typhoon related disaster, this year Thailand was also suffered from the flooding crisis from the vigorous monsoon clouds poured heavy rainfall over Thailand which occurred in over 51 provinces of Thailand. More than 8.9 million people and 2.6 households had been affected by flooding since the flood hit on October 10, 2010. The death toll has reached 257 in 29 provinces and the economic loss was estimated to be more than USD 1.5 Billion.

The Tropical Storm "Mindulle" was moving over the East of Donghoi, Viet Nam. On August 24, 2010 the monsoon then increased its intensity as Severe Tropical Storm and expanded across Thailand, Lao PDR, Cambodia and Viet Nam. The effects of Midulle caused heavy rainfall and flood in the north and northeastern parts of Thailand until September 15, 2010. The total affected areas covered more 39 provinces and affected over million populations. For 712 people were evacuated and there were 2 deaths due to the flood.

The estimated damages were over USD 185 million with damages to 87,000 hectare of agricultural areas, more than 57,000 livestock, 5,881 roads, 186 bridges, 44 schools, and 80 mines.

In the beginning of October 2010 the low pressure area, moving over Southern, Central, Eastern part coupled with South East Monsoon has caused damage to 19 provinces, 94 districts, 716 sub-district, 5,474 villages, 545,447 households and 1,694,199 persons.

Those provinces include 1 province in Northern part (Nakornsawan); 9 in Northeastern part (Nakornratchasima, Chaiyaphum, Srisakes, Surin, Khonkaen, Kalasin, Mahasarakham, Roi Et and Ubonratchathani; 9 Central Provinces (Chainart, Singburi, Angthong, Suphanburi, Pra NakhonSi Ayutthaya, Lopburi, Saraburi, Nonburi and Pathumthani). It is estimated that 6,316,156 rai of farmland (2,497,210 acres) are destroyed.

In addition, on October 31, 2010 the Tropical Depression moved into the Gulf of Thailand over the Southern part of Thailand, causes heavy rainfall and flooding which affected in 12 provinces, 133 districts, 874 sub-districts, 6,197 villages, 609,511 households and 1,932,405 persons. There were 78 casualties in 8 provinces, 1,499 injuries. The estimated losses were USD 104 million.

Figure 3.2: Flood in 2010

2004: December 2004's Tsunami: the Most Catastrophic Disaster in Thai

At 07.58 a.m., of 26 December 2004, the massive earthquake magnitude of 9.0, the strongest in the world since 1964, struck deep under the Indian Ocean off the west coast of Sumatra, Indonesia, and triggered the cataclysmic tidal wave that slammed on the Andaman coastal provinces, southern Thailand. The catastrophic incident devastated 6 provinces namely, Phuket, Trang, Phang Nga, Krabi, Ranong and Satun.

Right after the tsunami waves ebbed, the relief activities were immediately and continuously activated. It is widely accepted that Thailand had led an effective relief efforts and response immediately on the day of tsunami strike. As the consequence, Thailand had achieved the rapid success in relief operation within a few months later. The key factors in the effectiveness of relief response can be delineated as follows;

- The synergy of Thai people from all walks of life to provide all kinds of assistance to their suffered countrymen.
- The close and integrated collaboration and cooperation among the civil, military, police, NGOs, charitable foundations, civil defence volunteers etc.
- The influx of endless support and humanitarian assistance from international communities, organizations, NGOs near and far.

The Royal Thai Government, private sector and NGOs, have continuously launched restoration activities to enhance livelihoods and rebuild the environments of the affected people and areas following the initial phase of rescue and humanitarian relief. Simultaneously, has conducted preparedness activities so as to reduce the vulnerability and increase the resilience in the tsunami hit communities. The international communities, NGOs and United Nations mechanisms also continue to endlessly support Thailand in these humanitarian assistance activities.

2007: Cyclone Lekima hit Thailand between 4 and 6 October 2007 killed 17, affected 1,552,936, and whose total loss was US$ 30.8 million.

2008: Cyclone Mekkahla hit between 31 September and 1 October 2008. The cyclone caused torrential rains which killed 32, affected 2,864,484 and whose total loss was US$ 21.6 million.

Figure 3.3: Tsunami in Thailand

3. Disaster Management system

3.1 Disaster Management Law , Legal system, legal framework

3.1.1 The Disaster Prevention and Mitigation Act 2007:

The Disaster Prevention and Mitigation Act 2007 (DPM Act) has replaced the old and outdated 1979 Civil Defense Act and the 1999 Fire Prevention and Suppression Act. Entering into force on 6 November 2007,

It stipulates the Department of Disaster Prevention and Mitigation (DDPM) as the core government department in handling national disaster management work. Also it authorizes local governments to take responsibility of disaster management in their respective areas, in line with the Provincial Plan.

The Disaster Prevention and Mitigation Act 2007 (DPM Act) has 4 prominent features, including

1) Introducing 3 main policy - making and planning bodies including National, Provincial and Bangkok Metropolitan,
2) Having Prime Minister or an designated Deputy Minister as the National Commander,
3) Empowering Department of Disaster Prevention and Mitigation (DDPM) as the core government agency in handling national disaster management work, and
4) Authorizing local governments to take responsibility of disaster management in their respective areas, in line with the Provincial Plan.

According to the new DPM Act, disaster can be classified into 3 categories namely:
1) Man-made and natural disasters;
2) Disaster resulted from air raid during wartime; and
3) Disaster resulted from sabotage or terrorist attack.

Government Organization Ministerial Statuette, Meteorological Department, Ministry of Information and Communication Technology 2002

In the first section, the Meteorological Department was designated to take responsibility in

field of meteorological management, including monitoring and reporting on weather and natural phenomena, accurately and rapidly forecasting and warning natural disaster, to meet the most benefit of socio-economic, agricultural and industrial side, as well as to protect the loss and damage of people, private and government sectors from natural disaster.

Government Organization Ministerial Statuette, Water Resource Department, Ministry of Natural Resources and Environment 2002

In section 3, the Water Crisis Protective Center, Water Resource Department, has empowered in take action in

(1) Analyzing and pointing the risky areas resulting from water;
(2) Recommending guideline and master plan for water resource management.

In terms of policy making, there are 3 levels:
1) National, which is chaired by the Prime Minister or a designated Deputy Minister
2) Provincial, which is chaired by Provincial Governor
3) Bangkok Metropolitan Administration level, which is chaired by the Bangkok Governor.

Each of three policy - making organs is composed of the committee as follows:
1) The National Disaster Prevention and Mitigation Committee (NDPMC)
2) The Provincial Disaster Prevention and Mitigation Committee
3) The Bangkok Metropolitan Administration Committee

The National Disaster Prevention and Mitigation Committee (NDPMC): Members of the committee come from various Ministries relevant to disaster management, i.e. Ministry of Interior, Ministry of Defense, Ministry of Agriculture and Cooperatives, Ministry of Transportation and Communications, Ministry of National Resources and Environment, Ministry of Information, Communication and Technology, Ministry of Public Health, Ministry of Finance, and so on. The Prime Minister or designated Deputy Prime Minister is a chairperson, and Director-General of Department of Disaster Prevention and Mitigation (DDPM) is the secretariat of the committee. The Committee has prominent tasks and responsibilities for proposing the policy to formulate the National Disaster Prevention and Mitigation Plan, and effectively integrating the development on disaster prevention and mitigation mechanism among government agencies, local administrations, and other relevant private sectors.

The Provincial Disaster Prevention and Mitigation Committee: The Provincial Governor as the Provincial Director is, according to the Act, responsible for disaster prevention and mitigation in the province area. The responsibilities include appointment of the Provincial Disaster Prevention and Mitigation Committee, which come from representatives from other provincial disaster management agencies. The Secretariat of the provincial committee is the Chief of Disaster Prevention and Mitigation Provincial Office. Their main duty of the provincial committee is to formulate the provincial disaster management plan under the guideline of national plan.

The Bangkok Metropolitan Administration Committee*:* Just the same as Provincial Director, Bangkok Metropolitan Governor as the Bangkok Director is responsible for disaster prevention and mitigation in Bangkok and to be the person to appoint the Bangkok Metropolitan Committee composing of delegates from government agencies including Bangkok Metropolitan, DDPM, Universities, and public charities and communities in Bangkok. The Committee has powers in drafting the Disaster Prevention and Mitigation Plan for Bangkok which shall be consistence to the National Disaster Prevention and Mitigation Plan, and other handling the disaster management related activities.

3.1.2 Disaster Prevention and Mitigation Plan

Department of Disaster Prevention and Mitigation (DDPM) as the Secretariat of the National Disaster Prevention and Mitigation Committee (NDPMC), has the responsibility to devise the National Disaster Prevention and Mitigation Plan. This is to be done by conferring with relevant government agencies, local administrations, and private sectors.

Once the National Plan is approved, it will be used as a master plan, upon which the provincial and Bangkok Metropolitan Administration will be based. The national plan will be in service

for the period of 3 years. DDPM is to make sure that the new plan for the next 3 years is ready for use accordingly.

According to the National Disaster Prevention and Mitigation Act 2007, the three - level plan shall have substantial parts as shown in the following table.

National plan	Provincial Plan	BMA Plan
(1) Guide lines, measures and adequate budget to support disaster prevention and mitigation operations systemically and continuously	(1) The setting up of Special Command Center when ever disasters strike, that center shall be constructed and has authorities to command and oversee disaster prevention and mitigation operations and activities	(1) establishment of command center where disaster occurred for construction and authorization for disaster prevention and mitigation operation
(2) Guide lines and methods for providing aids and mitigate the impacts of disasters in both short and long term, together with evacuation procedures of effected people, government services, and other local administrations, supports effected people on their public health, public utilities and communication system	(2) Plan and procedures for local administrations for procuring tools, equipments, materials, hardware and vehicles in disaster prevention and mitigation operations	(2) plan and process to procure materials , tools , equipment, and vehicle for disaster prevention and mitigation
(3)Relevant government agencies and local administrations shall proceed all operations under (1) and (2), and shall seek for availability and mobility of fund	(3) Plan and procedures for local administrations for procuring an early warning system and other equipments to inform people and communities on incoming disasters	(3) plan and process to procure signaling devices or others for notifying the occurrence and expectation of a disaster
(4)Preparedness perspectives on support personnel, equipments and other materials to deploy upon disaster prevention and mitigation operations, and capacity building of those personnel and other people shall be included	(4) Operation plan for disaster prevention and mitigation at local administrations	(4) Bangkok Disaster Prevention and Mitigation Action Operation Plan
(5) Guide line on fixing, recovery and restoration to community right after disaster	(5) Cooperation plan to other relevant public charities.	(5) Coordination Plan with Public Charity Organizations in Bangkok

3.1.3 National Civil Defense Plan 2005

This is another core disaster management plan that serves as the master plan for agencies responsible in disaster management in providing guidelines or formulating their operational plans. The Plan has been developed from the same plan yearly 2002 by the authorized National Civil Defense Sub-committee to improve plan. The plan will be reviewed and updated by DDPM every three year before proposed for approval by the National Disaster Prevention and Mitigation Committee. Two main components of the plan involve disaster prevention and mitigation, and the other is Civil Defense for Security (Rear-Area Protection). The details of each component are as follows:

Disaster Prevention and Mitigation Components: comprises 3 parts:

Part I: Civil Defence Master Plan: This part comprises 9 chapters, including

(1) Disaster Cycle and Civil Hazard Situation
(2) Objectives, Scope and Principles of Civil Defence
(3) Establishment of Civil Defence Commanding Unit
(4) Civil Defence Preparedness
(5) Disaster Response
(6) Coordination of Civil Defence Operation
(7) Rehabilitation
(8) Communications and
(9) Evaluation

Part II: Civil Defence Procedure in Disaster Management: This part comprises 11 chapters:

(10) Objectives and Principles of Implementation
(11) Flood, Tropical Cyclone and Mudslide Prevention and Mitigation
(12) Fire Prevention and Mitigation
(13) Earthquake and Building Collapse Prevention and Mitigation
(14) Drought Prevention and Mitigation
(15) Forest-Fire Prevention and Mitigation
(16) Chemical and Hazmats Prevention and Mitigation
(17) Cold Spell Prevention and Mitigation
(18) Communication and Transportation Accident Prevention and Mitigation
(19) Animal Epidemics Prevention and Mitigation
(20) Agricultural Pests and Diseases Prevention and Mitigation, and

Part III : Related Laws and Regulations

Civil Defense for Security (Rear-Area Protection) Component

This component comprises 6 chapters:

(1) Civil Defence for Security
(2) Disaster Prevention and Mitigation during War-Time (Rear-Area Protection)
(3) Sabotage Prevention and Suppression
(4) Prevention and Mitigation of Disaster Resulted from Landmine and Torpedo
(5) Air-Raid Disaster Prevention and Mitigation
(6) Civil Unrest Prevention and Suppression

3.2 Structure of Disaster Management

Disaster Prevention and Mitigation Act B. E. 2550 (2007) has explicitly prescribed and explicated disaster management arrangement that encompasses the types of disaster, policy guideline, operating procedure as well as coordinating procedure as illustrated in chart 1.1 :

(1) The Prime Minister is a chairman of National Disaster Prevention and Mitigation Committee. In case of extreme large – scale disaster the Prime Minister has been empowered to command National Commander, Director, state agency, and local administration organization to handle disaster situation.

(2) National Disaster Prevention and Mitigation Committee, which is chaired by the Prime Minister or the entrusted Deputy Prime Minister is obligated to lay down a policy for the formulation of National Disaster Prevention Mitigation Plan and integrate the development of disaster management system. Department of Disaster Prevention and Mitigation as the Secretariat of National Disaster

Prevention and Mitigation Committee has been tasked to formulate the aforesaid plan in conjunction with relevant government agencies including the representatives from local administration organization.

(3) The National Safety Council of Thailand is the main body responsible for formulating the accident – related policy and developing safety mind. Department of Disaster Prevention and Mitigation as well functions as the Secretariat of National Safety Council of Thailand.

(4) All disaster operations related command, order and management at national, provincial/Bangkok Metropolis and local levels must precede according to the Act as illustrated in chart 1.1

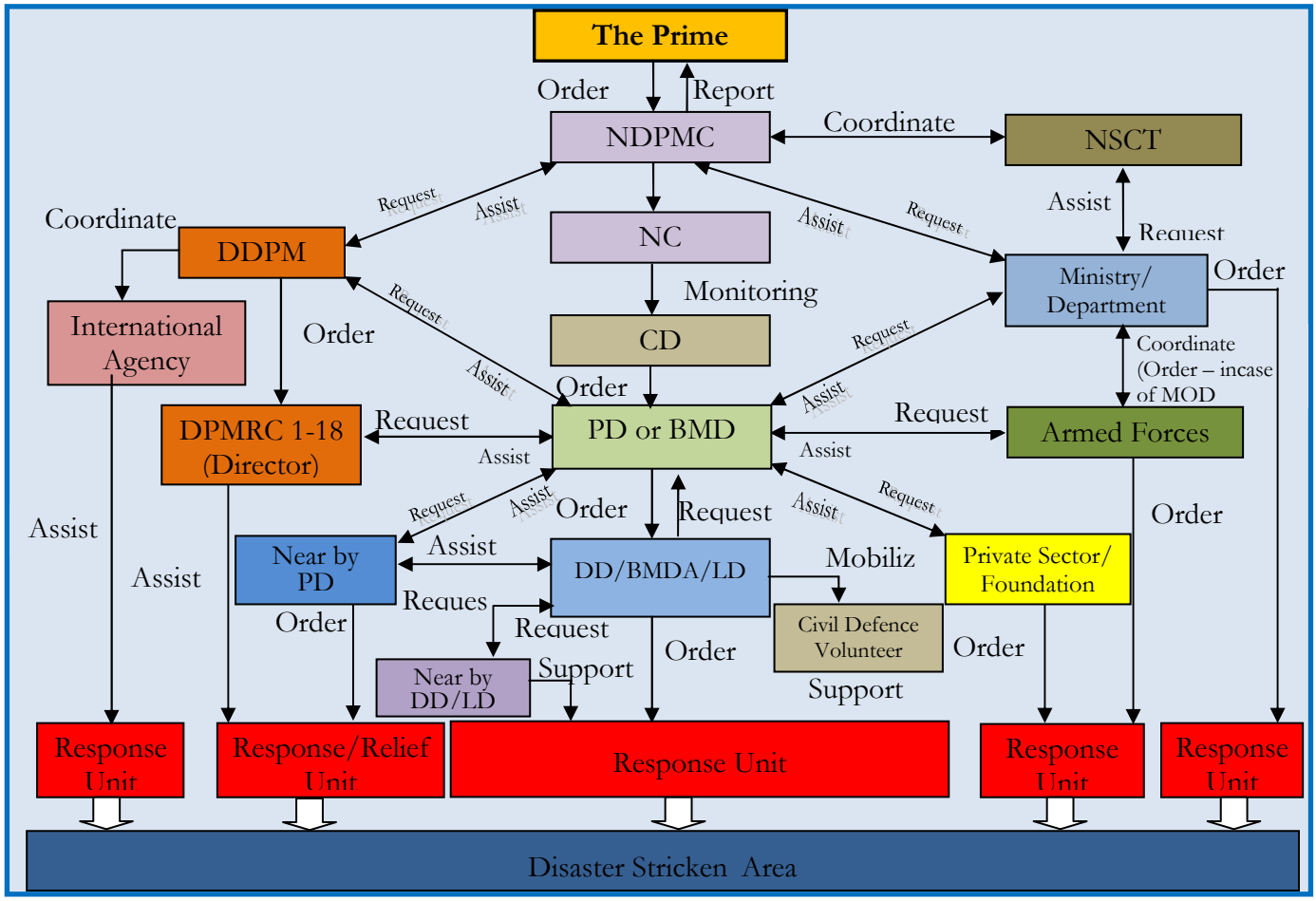


Chart 1.1 Current Disaster Management Arrangements in Thailand

Table 1.5: Component of National Disaster Prevention and Mitigation Committee and its roles

National Disaster Prevention and Mitigation Committee and its roles	
Committee Members	Mission
1. Chairman: - Prime Minister or Deputy Prime Minister as assigned 2. Vice Chairman 1 - Minister of Ministry of Interior; Vice Chairman 2 - Permanent Secretary - Ministry of Interior 3. Committee: - Permanent Secretary - Ministry of Defence; - Permanent Secretary - Ministry of Social Development and Human Security; - Permanent Secretary - Ministry of Agriculture and Cooperatives; - Permanent Secretary - Ministry of Transportations; - Permanent Secretary - Ministry of Natural Resources and Environment; - Permanent Secretary - Ministry of Information and Communication Technology; - Permanent Secretary - Ministry of Public Health; - Director of the Bureau of the Budget; - Commander-in-Chief of the Royal Thai Police; - Supreme Commander; - Commander-in-Chief of the Royal Thai Air Force; - Commander-in-Chief of the Royal Thai Army; - Commander-in-Chief of the Royal Thai Navy; - Secretary-General National Security Council; - and not more than five qualified persons appointed by the Cabinets as committee members. 4. Secretary: The Director General, DDPM, 5. Assistant Secretary: 2 DDPM Officers	1. Establish the National Disaster Prevention and Mitigation Policy for establishing the master plan. 2. Approve the National Disaster Prevention and Mitigation Plan before submission to the cabinet. 3. Integration and develop the Disaster Prevention and Mitigation Plan of government agencies, local government agencies and private agencies. 4. Provide advice, consultation and support the implementation of Disaster Prevention and Mitigation's mission 5. Regulate the rules of remuneration, compensation and any expenses of the Disaster Prevention and Mitigation implementation 6. Perform other missions as mentioned in this Act or other Acts or assigned by the Cabinet.

3.3 National Safety Council of Thailand (NSCT)

Apart from National Civil Defence Committee, Thailand has another disaster management related mechanism which has highlighted its tasks and responsibility on man-made disaster management only, that is "The National Safety Council of Thailand" (NSCT). The NSCT has been established in 1982 on the ground of the problem of road traffic accidents in Thailand which annually resulted in the tremendous loss of lives, properties and national economy. Later on, its responsibilities have been extended to cover the prevention of chemical accident, occupational accident, accident in home and public venues, considering preventive measure of fire in high-rise building, accident prevention in subway tunnel construction, providing education of safety etc.

3.4 National Disaster Warning Center

The National Disaster Warning Center was established under the Order of the Office of the Prime Minister. It is to protect lives and properties of Thai people and foreign visitors by setting up the National Warning Center as soon as possible.

The major task of the National Disaster Warning Center is to detect earthquake and to analyze seismic data to determine the possibility of a Tsunami generation before issuing notification messages to the public and related authorities and rescuers for evacuation of people into safe places. This is to prevent the loss of people's lives and properties as much as possible. From now on, the National Disaster Warning Center will be developed, upgraded of its early warning system and extended its telecommunication networks to be able to cope with multi-hazards disasters apart from Tsunami. Now, NDWC had transferred to be under of the Ministry of Information and Communication Technology

3.5 Implementing Mechanism Arrangement

The following implementing mechanisms will be established to undertake disaster management responsibilities.

3.5.1 National Command Headquarters

The power and duty of National Command Headquarters are to direct, control, oversee, supervise, and coordinate disaster operations undertaken by Emergency Operations Centers of all levels. The Headquarters is headed by the Minister of Ministry of Interior as National Commander and other functioning staffs which comprise permanent secretary for Ministry of Interior as the Deputy National Commander, director general of Department of Disaster Prevention and Mitigation as the Central Director, the representatives from every government agency, public enterprise and the designated private entity. The main administration staffs of the headquarters will be the personnel from Department of Disaster Prevention and Mitigation.

3.5.2 Local Command Center

This category of center includes :

(1) Tambon Administration Organization Command Center is headed by chief executive of tambon administration organization (TAO) as the Director, other functioning staffs of the center comprise TAO clerk as the Deputy Local Director, sub - district headman, village headman and the representatives from private sector located within tambon jurisdiction. This first response mechnism is responsible for disaster operations within tambon jurisdiction.

(2) Municipality Command Center is headed by the mayor as Director; other functioning staffs of the center comprise municipal Clerk as the Deputy Director, chiefs of different divisions of municipality and the designated private sector's representatives. This first response mechanism is responsible for disaster operations within its jurisdiction.

(3) Pattaya City Command Center is headed by Pattaya City mayor as the Director, other functioning staffs of this center comprise Pattaya City clerk as the Deputy Director, chiefs of different divisions of Pattaya City office and the designated private sector's representatives. This first response mechanism is responsible for disaster prevention and mitigation operations within its jurisdiction.

(4) District Command Center is headed by district chief as the District Director, other functioning staffs of this center comprise district clerk, chiefs of different divisions of district office, representatives of the local administration organization and private sector located in district jurisdiction. The main function of this center is to carry out disaster operations within the district jurisdiction and to assist the provincial disaster operations.

(5) Bangkok Metropolitan District Command Center is headed by each Bangkok Metropolitan District Director as the Bangkok Metropolitan Assistant Director. This center is responsible for conducting disaster operations within district jurisdiction as well as assisting Bangkok Metropolitan Director. All officials of divisions and sectors of Bangkok Metropolitan district office and the representatives from public sector within its jurisdiction are the functioning staffs of this center. In addition, this center is obliged to assist Bangkok Metropolitan Administration in managing a disaster within Bangkok Metropolitan jurisdiction.

(6) Provincial Command Center is headed by provincial governor as the Provincial Director, and deputy provincial governor whom entrusted by provincial governor including chief executive of provincial administration organization are Deputy Provincial Directors. The functioning

staffs comprise the chiefs of different government offices located in the province and the representatives from designated public and private enterprises.

(7) Bangkok Metropolitan Command Center is headed by Bangkok Metropolitan governor as the Bangkok Metropolitan Director, and a permanent secretary for Bangkok Metropolitan Administration as the Bangkok Metropolitan Deputy Director. This center is responsible for disaster operations within Bangkok Metropolitan jurisdiction.

Tasks of Local Command Center

(1) Direct, control, perform and coordinate disaster management activities within the area under responsibility.

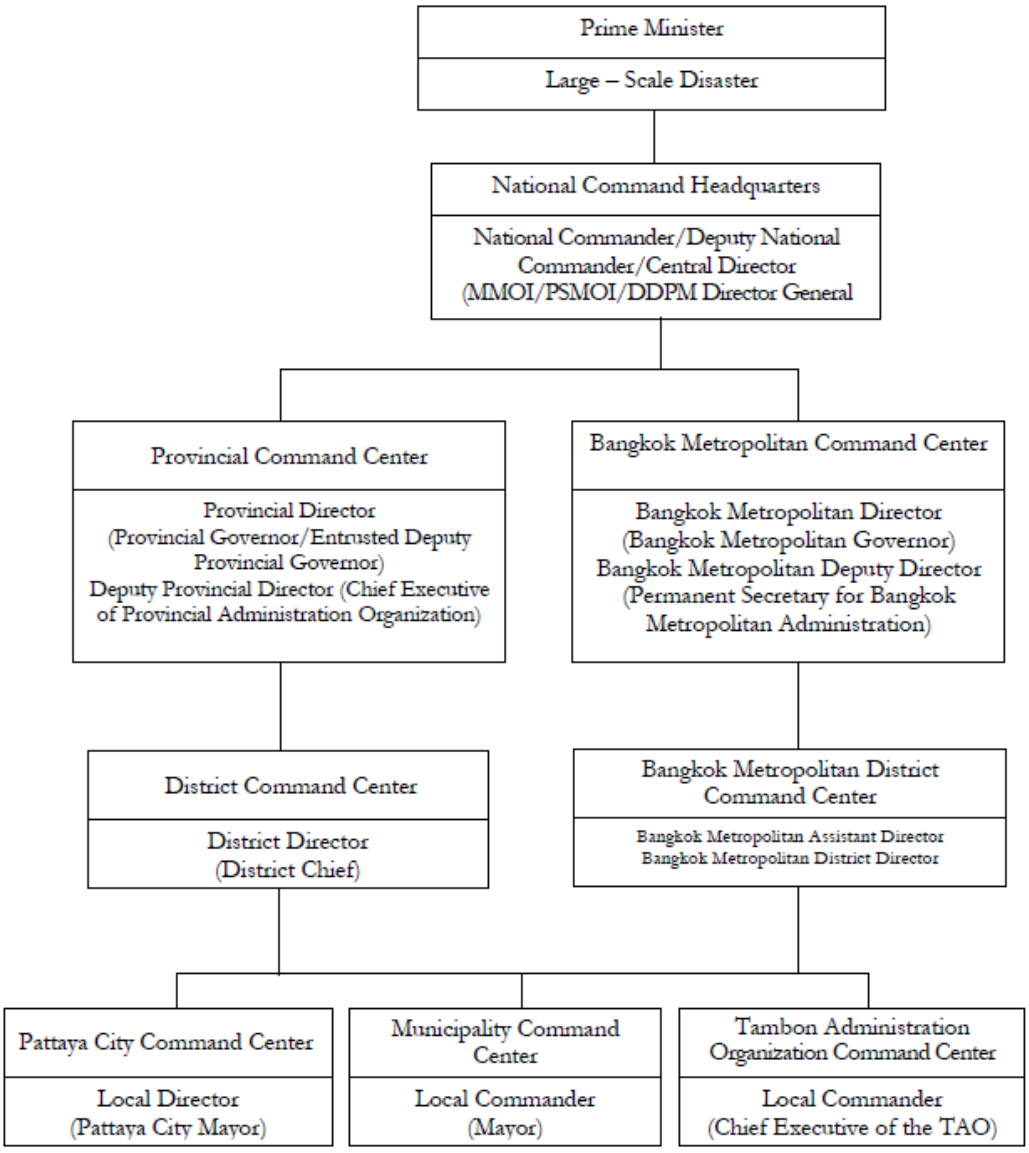
(2) Provide support to adjacent and other Command Centers upon request.

(3) Coordinate with government agencies and other relevant public enterprises located in the area under responsibility including private sector for cooperation on disaster management.

When a disaster occurs or is imminent in area under responsibility, the respective Command Center is obliged to establish Emergency Operations Center to provide assistance to the people in short notice.

The structure of implementing mechanism arrangement is illustrated in chart 1.2

Chart 1.2 Implementing Mechanism Arrangement



3.6 Priority on disaster reduction management

Priority on disaster risk management

Thailand urgently needs to reform disaster management systems and mechanisms as follows:

1) *Public Awareness and Education.* Improve public safety of every sector particularly those who are living with risk by enhancing people's understanding of the threats posed by various types of disasters.

2) *Materializing Early Warning Systems*: Following the catastrophic tsunami disaster in 2004, Thailand took immediate action to establish National Disaster Warning Center, which covers the warning of both natural and man-made disasters.

3) *Establishing More International Disaster Management Networks:* Thailand needs to enhance the country's disaster management capacity and efficiency through the mobilization of technical assistance from foreign countries, particularly from developed and advanced countries.

4) *Effective Damage Assessment*: Remote Survey technology must be introduced to effectively assess the damages caused by large scale disaster. The staff of the agencies concerned needs to be trained to enhance their capacity in applying satellite images to assess the damage.

5) *Application of Community-Centered Approach*: Local Authority and community are in the front line in the event of disaster occurrence, consequently, they are the most vulnerable and effected. It is indispensable to enhance their potentials in responding to disasters, and to equip them with awareness and preparedness.

6) *Highlight on Preventive Approach*: The new approach of disaster management has shifted its focus from "assistance" or "relief" to "prevention". In this regard, risk reduction to be vigorously taken into account. So as to reduce the risk, both structural and non-structural measures should be materialized, thus, the cost of risk reduction will yield invaluable rate of return when compared with the cost of disaster damage.

7) *The Focus on Prevention:* Proactive disaster management can reduce the damage and impact substantially.

8) *The Focus on Public Participation*: The past disaster management in Thailand had underlined the roles of government agencies and simply ignored private sectors, non – government organization, communities and even the public. Unfortunately, there has been a lack of cooperation among agencies concerned. This is a real challenge for DDPM to bring these stakeholders together.

9) *The Focus on Unity in Management:* The application of the Incident Command System (ICS) will demonstrate unity in management.

10) *The Focus on Efficient Communication*: The efficient communication system consists of the major system and the reserved system, which are vital for disaster management.

11) *The Focus on Human Resource Development:* Human resource development is a key factor for disaster management.

12) *Livelihood Rehabilitation*: Livelihood rehabilitation activities such as community development, vocational training, improving the standards of living should be immediately materialized to normalize disaster victims' means of living.

3.7 Department of Disaster Prevention and Mitigation

Department of Disaster Prevention and Mitigation (DDPM), according to the Bureaucrat Reform Act 2002, has been formed by different organizations responsible for disaster prevention and mitigation as follows:

(1) Civil Defence Division of Department of Provincial Administration;

(2) Department of Accelerated Rural Development;

(3) Department of Social Welfare, Department of Community Development; and

(4) Office of National Safety Council

According to Article 11 of Disaster Prevention and Mitigation Act B.E.2550, DDPM is mandated to be central government agency under the umbrella of Ministry of Interior to undertake the work on disaster prevention and mitigation at a national level. Aside its Head Office in Bangkok, DDPM has thoroughly 76 DDPM provincial offices, and 18 regional centers. The locations of DDPM regional centers namely;

1) Disaster Prevention and Mitigation Regional Center, Zone 1 Pathum Thani

2) Disaster Prevention and Mitigation Regional Center, Zone 2 Suphan Buri

3) Disaster Prevention and Mitigation Regional Center, Zone 3 Prachin Buri

4) Disaster Prevention and Mitigation Regional Center, Zone 4 Prachuap Kiri Khab

5) Disaster Prevention and Mitigation Regional Center, Zone 5 Nakhon Ratchasima

6) Disaster Prevention and Mitigation Regional Center, Zone 6 Khon Kean

7) Disaster Prevention and Mitigation Regional Center, Zone 7 Sakhon Nakhon

8) Disaster Prevention and Mitigation Regional Center, Zone 8 Kamphaeng Phet

9) Disaster Prevention and Mitigation Regional Center, Zone 9 Phitsanulok

10) Disaster Prevention and Mitigation Regional Center, Zone 10 Lampang

11) Disaster Prevention and Mitigation Regional Center, Zone 11 Surat Thani

12) Disaster Prevention and Mitigation Regional Center, Zone 12 Songkhla

13) Disaster Prevention and Mitigation Regional Center, Zone 13 Ubon Ratchathani

14) Disaster Prevention and Mitigation Regional Center, Zone 14 Udon Thani

15) Disaster Prevention and Mitigation Regional Center, Zone 15 Chaing Rai

16) Disaster Prevention and Mitigation Regional Center, Zone 16 Chainat

17) Disaster Prevention and Mitigation Regional Center, Zone 17 Chanthaburi

18) Disaster Prevention and Mitigation Regional Center, Zone 18 Phuket

In 2004, Disaster Prevention and Mitigation Academy (DPMA) has been established and 6 campus in Prachinburi, Songkhla, Chiang Mai, Khon Kaen, Phuket, Phitsanulok which is currently conducting training for its own staffs, some government stakeholders and private organization.

DDPM's responsibility:

1. Materializing disaster and civil emergency prevention and warning Systems and creating preparedness in all areas.
2. Directing and implementing disaster and civil emergency mitigation activity systematically, rapidly, equitably and thoroughly.
3. Procurement of materials, equipments, and vehicles, indispensable for disaster prevention, mitigation, suppression and for relief operation.
4. Rehabilitation of damaged public utilities, physical and mental recuperation of disaster victim, and restoration of livelihood. All these activities are carried out on thorough, equitable and rapid basis, and be in harmony with the needs of the victims.
5. Mainstreaming and collaborating disaster prevention and mitigation system, programme, the implementation evaluation with other national and international agencies.

Disaster Management in DDPM's main activities

Disaster Management comprises 3 phases as follow;

1. Preparedness Phase: DDPM has supported the provinces to carry out preparedness related activities as follow;

(1) Formulating disaster prevention plan.
(2) Training the officials and Civil Defence Volunteer.
(3) Educating the general public.
(4) Procuring equipments, vehicles and other amenities and safety temporary shelters.
(5) Conducting annual drills and exercise in different levels.

2. Prevention and Mitigation Phase: In the event of disaster or the potential disaster, DDPM will implement the following activities.

(1) Early warning: After receiving the information of potential disaster from Department of Meteorological and Department of Mineral Resources, DDPM will immediately relay to the risk province to further warn the people of the hazard or evacuate the people.

(2) Directing Unit: The National Committee will set up "Operation Center" to manage disaster

(3) Providing relief operation to the affected people thoroughly and rapidly.

(4) Coordinating: In the event of large-scale disaster, DDPM will coordinate with all agencies concerned to mobilize relief efforts to affected areas.

(5)Telecommunication: The Director of National Committee is authorized to utilize all telecommunication facilities in the affected areas. DDPM will coordinate with telecommunication concerned agencies to provide the substitute facilities in case the telecommunication system in the affected area broke down.

(6) Public Relations: At national level, DDPM is responsible for disseminating the disaster related information to the public continuously to protect the life and property of the citizens. Moreover to alert the possibility of disaster just before a strong tremor is expected to strike as "a warning"

3. Recovery Phase: DDPM is responsible for

(1) Providing relief to affected people: Provincial/District/Local authorities assess the damages and losses and enlist the affected persons. DDPM will carry out to pay cash compensation the victims.

(2) Clean-up: DDPM will coordinate with all agencies concerned to mobilize the equipments to conduct clean-up activities.

(3) Long-term Rehabilitation: DDPM is responsible for coordinating with all agencies concerned to collect all relevant information on long-term rehabilitation projects and further submit for cabinet's approval

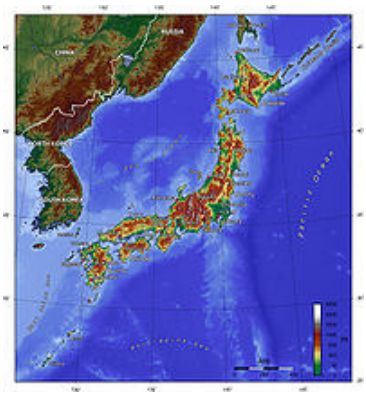
4. Budget Size on National Level

Year	THB	USD(ml)	JPN(ml)
2003	1,066,412,900	35.02	2,797
2004	1,312,578,500	43.10	3,443
2005	1,685,362,700	55.34	4,421
2006	2,437,850,700	80.06	6,395
2007	1,948,805,800	64.00	5,112
2008	2,184,972,800	71.75	5,734
2009	2,315,783,900	76.05	6,074
2010	2,541,163,000	83.45	6,666
2011	2,541,163,300	83.45	6,666
2012	3,918,637,000	128.69	10,279

Source: DDPM (1 USD = 30.45 THB, 100JPN= 38.12 THB)

Chapter 3 Disaster Management System in Japan

3.1 General Information



Japan is an island nation in East Asia. Located in the Pacific Ocean, it lies to the east of the Sea of Japan, People's Republic of China, North Korea, South Korea and Russia, stretching from the Sea of Okhotsk in the north to the East China Sea and Taiwan in the south. The characters that make up Japan's name mean "sun-origin", which is why Japan is sometimes referred to as the "Land of the Rising Sun".

Japan consists of forty-seven prefectures, each overseen by an elected governor, legislature and administrative bureaucracy. Each prefecture is further divided into cities, towns and villages.

Japan has a total of 6,852 islands extending along the Pacific coast of Asia. The main islands, from north to south, are Hokkaidō, Honshū, Shikoku and Kyūshū. The Ryūkyū Islands, including Okinawa, are a chain to the south of Kyūshū. Together they are often known as the Japanese Archipelago. About 73 percent of Japan is forested, mountainous, and unsuitable for agricultural, industrial, or residential use. As a result, the habitable zones, mainly located in coastal areas, have extremely high population densities. Japan is one of the most densely populated countries in the world.

The islands of Japan are located in a volcanic zone on the Pacific Ring of Fire. They are primarily the result of large oceanic movements occurring over hundreds of millions of years from the mid-Silurian to the Pleistocene as a result of the subduction of the Philippine Sea Plate beneath the continental Amurian Plate and Okinawa Plate to the south, and subduction of the Pacific Plate under the Okhotsk Plate to the north. Japan was originally attached to the eastern coast of the Eurasian continent. The subducting plates pulled Japan eastward, opening the Sea of Japan around 15 million years ago. Japan has 108 active volcanoes. Destructive earthquakes, often resulting in tsunami, occur several times each century. The 1923 Tokyo earthquake killed over 140,000 people. More recent major quakes are the 1995 Great Hanshin earthquake and the 2011 Tōhoku earthquake, a 9.0-magnitude quake which hit Japan on March 11, 2011, and triggered a large tsunami.

A major feature of Japan's climate is the clear-cut temperature changes between the four seasons. In spite of its rather small area, the climate differs in regions from a subarctic climate to a subtropical climate. The side of the country which faces the Sea of Japan has a climate with much snow in winter by seasonal winds from the Siberia. Most of the areas have damp rainy season from May to July by seasonal winds from the Pacific Ocean. Japan is frequently visited by typhoons from July to September.

3.2 Disaster Management in Japan

Natural Hazards in Japan

Japan is located in the circum-Pacific mobile zone where seismic and volcanic activities occur constantly. The number of earthquakes and distribution of active volcanoes is quite high. The geological formation with plate boundaries of the Pacific plate, the Philippine Sea plate, the Eurasian plate, and the North American plate make Japan an earthquake-prone country. Also because of its geographical, topographical, and meteorological conditions, it is subject to other frequent natural disasters such as typhoons, torrential rains, and heavy snow.

Every year there is a great loss of people's lives and properties in Japan due to natural disasters. Numerous large-scale typhoons and earthquakes caused extensive damage and thousands of casualties in the past. However, with the progress of society's capabilities to address disasters and the mitigation of 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 remarkable declining tendency.

The disaster management system has been developed and strengthened following the bitter experiences of large-scale natural disasters and accidents.

3.3 Recent Major Disasters in Japan

3.3.1 Great East Japan Earthquake/ Tsunami (March 2011)

The **2011 earthquake off the Pacific coast of Tohoku**, also known as the **2011 Tōhoku earthquake** or the **Great East Japan Earthquake**, was a magnitude 9.0 (M_w) 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 Tōhoku and the hypocenter at an underwater depth of approximately 32 km (20 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 Tōhoku'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.

The Japanese National Police Agency has confirmed 24,000 people as dead or missing as of April 2011 across eighteen prefectures, as well as over 125,000 buildings damaged or destroyed. The earthquake and tsunami caused extensive and severe structural damage in Japan, including heavy damage to roads and railways as well as fires in many areas, and a dam collapse. Around 4.4 million households in northeastern Japan were left without electricity and 1.5 million without water. 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. Residents within a 20 km (12 mi) radius of the Fukushima I Nuclear Power Plant and a 10 km (6.2 mi) radius of the Fukushima II Nuclear Power Plant were evacuated. In addition, the U.S. recommended that its citizens evacuate up to 80 km (50 mi) of the plant.

Early estimates placed insured losses from the earthquake alone at US$14.5 to $34.6 billion. The Bank of Japan offered ¥15 trillion (US$183 billion) to the banking system on 14 March in an effort to normalize market conditions. The overall cost could exceed US$300 billion, making it the most expensive natural disaster on record. The earthquake moved Honshu 2.4 m (8 ft) east and shifted the Earth on its axis by estimates of between 10 cm (4 in) and 25 cm (10 in).

3.3.2 Great Hanshin-Awaji Earthquake (January 1995)

On 17 January 1995, an earthquake with a 7.3 magnitud e on the Richter scale occurred at Awaji Island of Hyogo Prefecture in Western Japan. It killed 6,434 people; injured 43,792; destroyed 104,906 houses; half destroyed 144,274 houses; and partially destroyed 390,506 houses. The fires that broke out because of the earthquake burned down an area of 835,858 square meters.

Restoration Process and Efforts Toward "Creative Reconstruction"

Despite difficult conditions, including severed traffic networks and paralyzed urban functions, steady restoration took place through the dedicated efforts of those involved and with generous assistance from around the world. In only six days following the Earthquake, provisional supply of electricity was restored, with water and gas reconnected in three months.

The Priority Three-Year Reconstruction Plan was implemented to press forward the urgently needed reconstruction of living quarters for the victims, and also the restoration of industries and infrastructure such as roads, harbors, and railways. In addition, the Great Hanshin-Awaji Earthquake Reconstruction Plan (Hyogo Phoenix Plan) was formulated with the aim of achieving "creative reconstruction" over a period of ten years. The Phoenix Plan called for not only mere restoration but also the creation of urban communities that meet the needs of the increasingly aging society and Japan's highly maturing economy.

With the extent of restoration in housing, industries, and urban infrastructure accomplished thus far, the quantitative targets set in the Priority Three-Year Reconstruction Plan were successfully achieved. On January 17, 2005, the 10th Great Hanshin-Awaji Earthquake Memorial Service was held in the presence of Their Majesties The Emperor and Empress of Japan.

Hyogo continues to exert its utmost efforts to support disaster-hit elderly citizens to regain their self-reliance, create sources of communal vitality, and establish safe and secure communities.

3.3.3 Typhoon No. 23 (TOKAGE) (October 2004)

On 20 October 2004, Typhoon No. 23 landed on Japan and caused floods and landslides triggered by record-breaking torrential rain and high wave. Ninety-five (95) people were killed; 555 injured; 909 houses were totally destroyed; more than 18,000 houses were damaged; and about 55,000 were inundated.

Natural Disasters in Japan from 1900 to 2011

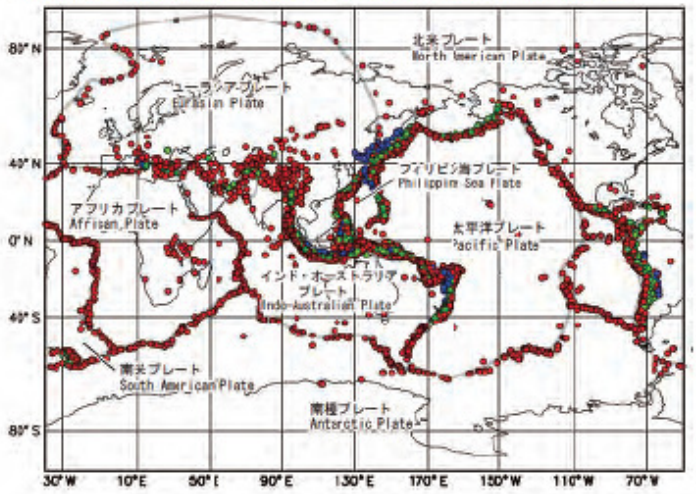
		# of Events	Killed	Total Affected	Damage (000 US$)
Drought	Drought	1	–	–	–
	ave. per event		–	–	–
Earthquake (seismic activity)	Earthquake (ground shaking)	43	161796	951578	146841400
	ave. per event		3762.7	22129.7	3414916.3
	Tsunami	14	40780	560127	212821000
	ave. per event		2912.9	40009.1	15201500
Epidemic	Bacterial Infectious Diseases	2	1	534	–
	ave. per event		0.5	267	–
	Viral Infectious Diseases	1	–	2000000	–
	ave. per event		–	2000000	–
Extreme temperature	Heat wave	3	242	18300	–
	ave. per event		80.7	6100	–
Flood	Unspecified	31	12814	7015269	268300
	ave. per event		413.4	226299	8654.8
	Flash flood	1	21	25807	1950000
	ave. per event		21	25807	1950000
	General flood	12	197	99266	1814000
	ave. per event		16.4	8272.2	151166.7
	Storm surge/coastal flood	2	34	384143	7440000
	ave. per event		17	192071.5	3720000
Mass movement wet	Avalanche	1	13	–	–
	ave. per event		13	–	–
	Landslide	20	989	25706	210000
	ave. per event		49.5	1285.3	10500
Storm	Unspecified	24	1890	192814	453500
	ave. per event		78.8	8033.9	18895.8
	Local storm	6	27	100499	363000
	ave. per event		4.5	16749.8	60500
	Tropical cyclone	109	32500	7512095	53055500
	ave. per event		298.2	68918.3	486747.7
Volcano	Volcanic eruption	15	515	99979	132000
	ave. per event		34.3	6665.3	8800
Wildfire	Forest fire	1	–	222	–
	ave. per event		–	222	–

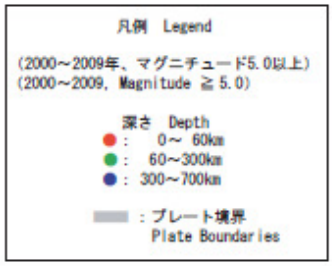
Created on: Sep-1-2011. - Data version: v12.07
Source: "EM-DAT: The OFDA/CRED International Disaster Database
www.em-dat.net - Université Catholique de Louvain - Brussels - Belgium"

3.4 Disaster Management System in Japan

Japan is located in the Circum-Pacific mobile Belt where seismic and volcanic activities occur constantly. Although the country covers only 0.25% of the land area on the planet, the number of earthquakes and active volcanoes is quite high. Also, because of geographical, topographical and meteorological conditions, the country is subject to frequent natural disasters such as typhoons, torrential rains and heavy snow.

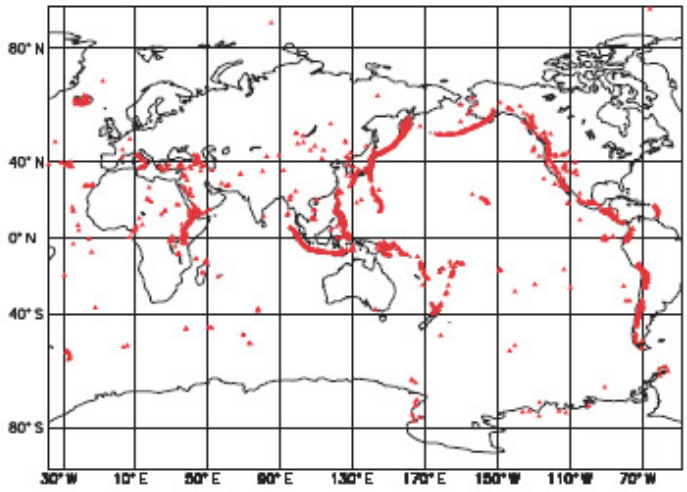
世界の震源分布とプレート
World Geographical Distribution of Hypocenters and Plates





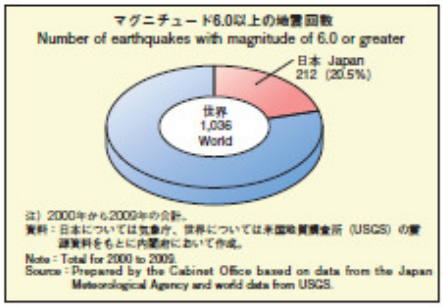
資料：米国地質調査所（USGS）の震源データをもとに気象庁において作成。
Source : Prepared by the Japan Meteorological Agency based on data from USGS.

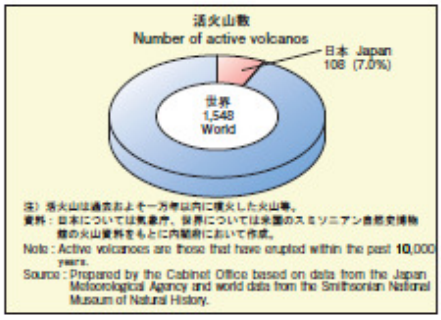
世界の主な火山
Principal Volcanoes in the World



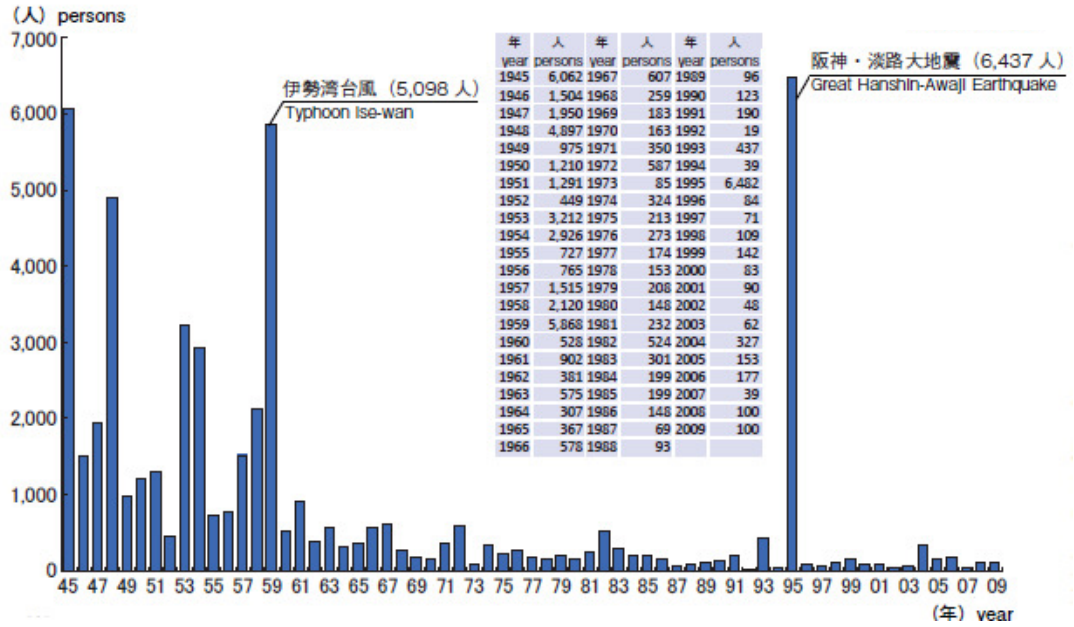
注）火山は過去おおむね一万年間に活動のあったもの。
Note : The volcanoes shown are those that have been active within the past 10,000 years.
資料：米国のスミソニアン自然史博物館の火山データをもとに気象庁において作成。
Source : Prepared by the Japan Meteorological Agency based on data from the Smithsonian National Museum of Natural History.

世界の災害に比較する日本の災害
（地震回数、活火山数）
Comparison of Natural Hazards in Japan and Other Parts of the World (Earthquakes and Volcanoes)





Every year there is a great loss of people's lives and property in Japan due to natural disasters. Up until the 1950s, numerous large-scale typhoons and earthquakes caused extensive damage and thousands of casualties. However, with the progress of society's capabilities to address disasters and the mitigation of 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.



year	persons	year	persons	year	persons
1945	6,062	1967	607	1989	96
1946	1,504	1968	259	1990	123
1947	1,950	1969	183	1991	190
1948	4,897	1970	163	1992	19
1949	975	1971	350	1993	437
1950	1,210	1972	587	1994	39
1951	1,291	1973	85	1995	6,482
1952	449	1974	324	1996	84
1953	3,212	1975	213	1997	71
1954	2,926	1976	273	1998	109
1955	727	1977	174	1999	142
1956	765	1978	153	2000	83
1957	1,515	1979	208	2001	90
1958	2,120	1980	148	2002	48
1959	5,868	1981	232	2003	62
1960	528	1982	524	2004	327
1961	902	1983	301	2005	153
1962	381	1984	199	2006	177
1963	575	1985	199	2007	39
1964	307	1986	148	2008	100
1965	367	1987	69	2009	100
1966	578	1988	93		

Figure 3.1: The Number of Deaths and Missing Persons in Disasters

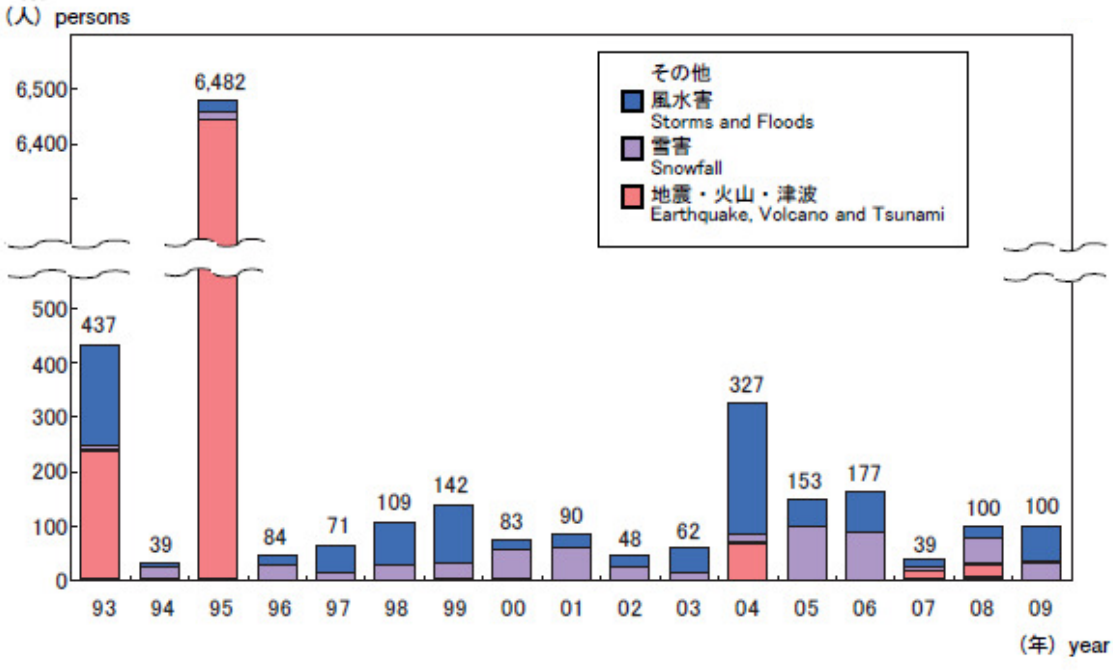


Figure 3.2: The Number of Deaths and Missing Persons by Type of Disaster

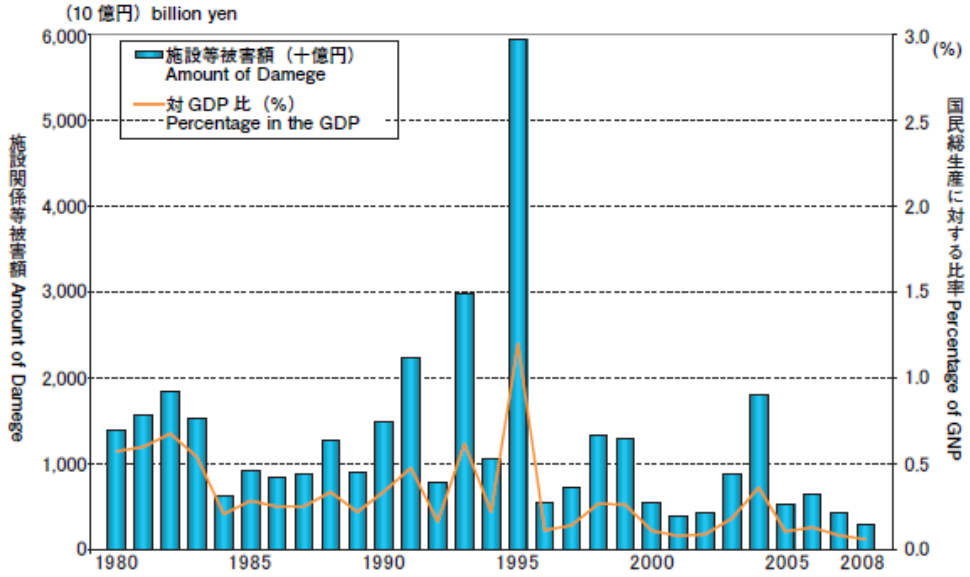


Figure 3.3: Amount of Damage to Facilities Due to Disaster

Source: Prepared by the Cabinet Office based on data from related ministries.

In spite of such efforts, in 1995, more than 6,400 people dies of the Great Hanshin-Awaji Earthquake Also in 2009, some 100 people died or went missing due to storms, flooding or heavy snowfall. There is also a high probability of the occurrence of large-scale earthquakes in the coming decades. As such, natural disasters remain a menacing threat to the safety and security of the country.

Figure 3.4: Hanshin-Awaji Earthquake

Table 3.1: Major Disaster in Japan since 1945

年月日 Date	災害名 Disaster	死者・行方不明者数 Number of Dead and Missing	年月日 Date	災害名 Disaster	死者・行方不明者数 Number of Dead and Missing
昭和 20.1.13	三河地震 (M6.8)	2,306 人	昭和 49.5.9	伊豆半島沖地震 (M6.9)	30 人
1945	Mikawa Earthquake		1974	Izu-hanto-oki Earthquake	
昭和 20.9.17 ~ 18	枕崎台風 (広島、西日本)	3,756 人	昭和 51.9.8 ~ 14	台風第 17 号及び 9 月豪雨 (全国 (特に香川, 岡山))	171 人
1945	Typhoon Makurazaki		1976	Typhoon 17 and Torrential Rains	
昭和 21.12.21	南海地震 (M8.0)	1,443 人	昭和 52.1.	雪害 (東北, 近畿北部, 北陸)	101 人
1946	Nankai Earthquake		1977	Heavy Snowfall	
昭和 22.8.14	浅間山噴火 (群馬県)	11 人	昭和 52.8.7 ~ 53.10.	有珠山噴火	3 人
1947	Mt. Asama Eruption		1977	Mt. Usu Eruption	
昭和 22.9.14 ~ 15	カスリーン台風 (東北以北)	1,930 人	昭和 53.1.14	伊豆大島近海地震 (M7.0)	25 人
1947	Typhoon Catherine		1978	Izu-Oshima-kinkai Earthquake	
昭和 23.6.28	福井地震 (M7.1)	3,769 人	昭和 53.6.12	宮城県沖地震 (M7.4)	28 人
1948	Fukui Earthquake		1978	Miyagi-ken-oki Earthquake	
昭和 23.9.15 ~ 17	アイオン台風 (四国~東北 (特に岩手))	838 人	昭和 54.10.17 ~ 20	台風第 20 号 (全国 (特に東海, 関東, 東北))	115 人
1948	Typhoon Ion		1979	Typhoon 20	
昭和 25.9.2 ~ 4	ジェーン台風 (四国以北 (特に大阪))	539 人	昭和 55.12. ~ 56.3.	雪害 (東北, 北陸)	152 人
1950	Typhoon Jane		1980	Heavy Snowfall	
昭和 26.10.13 ~ 15	ルース台風 (全国 (特に山口))	943 人	昭和 57.7. ~ 8.	7, 8 月豪雨及び台風第 10 号 (全国 (特に長崎, 熊本, 三重))	439 人
1951	Typhoon Ruth		1982	Torrential Rains and Typhoon 10	
昭和 27.3.4	十勝沖地震 (M8.2)	33 人	昭和 58.5.26	日本海中部地震 (M7.7)	104 人
1952	Tokachi-oki Earthquake		1983	Nihon-kai-chubu Earthquake	
昭和 28.6.25 ~ 29	大雨 (前線：九州, 四国, 中国 (特に北九州))	1,013 人	昭和 58.7.20 ~ 29	梅雨前線豪雨 (山陰以東 (特に島根))	117 人
1953	Torrential Rains		1983	Torrential Rains	
昭和 28.7.16 ~ 24	南紀豪雨 (東北以西 (特に和歌山))	1,124 人	昭和 58.10.3	三宅島噴火	–
1953	Torrential Rains		1983	Miyake Is. Eruption	
昭和 29.5.8 ~ 12	風雪 (低気圧：北日本, 近畿)	670 人	昭和 58.12. ~ 59.3.	雪害 (東北, 北陸 (特に新潟, 富山))	131 人
1954	Storm damage		1983	Heavy Snowfall	
昭和 29.9.25 ~ 27	洞爺丸台風	1,761 人	昭和 59.9.14	長野県西部地震 (M6.8)	29 人
1954	Typhoon Toyamaru		1984	Nagano-ken-seibu Earthquake	
昭和 32.7.25 ~ 28	諫早豪雨	722 人	昭和 61.11.15 ~ 12.18	伊豆大島噴火	–
1957	Torrential Rains		1986	Izu-Oshima Is. Eruption	
昭和 33.6.24	阿蘇山噴火	12 人	平成 2.11.17 ~	雲仙岳噴火	44 人
1958	Mt. Aso Eruption		1990	Mt. Unzen Eruption	
昭和 33.9.26 ~ 28	狩野川台風	1,269 人	平成 5.7.12	北海道南西沖地震 (M7.8)	230 人
1958	Typhoon Kanogawa		1993	Hokkaido-nansei-oki Earthquake	
昭和 34.9.26 ~ 27	伊勢湾台風	5098 人	平成 5.7.31 ~ 8.7	平成 5 年 8 月豪雨 (全国)	79 人
1959	Typhoon Ise-wan		1993	Torrential Rains	
昭和 35.5.23	チリ地震津波	142 人	平成 7.1.17	阪神・淡路大震災 (M7.3)	6,437 人
1960	Chile Earthquake Tsunami		1995	Great Hanshin-Awaji Earthquake	
昭和 38.1.	昭和 38 年 1 月豪雪 (北陸, 山陰, 山形, 滋賀, 岐阜)	231 人	平成 12.3.31 ~ 13.6.28	有珠山噴火	–
1963	Heavy Snowfall		2000	Mt. Usu Eruption	
昭和 39.6.16	新潟地震 (M7.5)	26 人	平成 12.6.25 ~ 17.3.31	三宅島噴火及び新島・神津島近海地震	1 人
1964	Niigata Earthquake		2000	Miyake Is. Eruption and Niijima and Kozushima Is. Earthquake	
昭和 40.9.10 ~ 18	台風第 23, 24, 25 号 (全国 (特に鹿島, 兵庫, 福井))	181 人	平成 16.10.20 ~ 21	台風第 23 号 (全国)	98 人
1965	Typhoons 23, 24, 25		2004	Typhoon 23	
昭和 41.9.23 ~ 25	台風第 24, 26 号 (中部, 関東, 東北, 特に静岡, 山梨)	317 人	平成 16.10.23	平成 16 年 (2004 年) 新潟県中越地震 (M6.8)	68 人
1966	Typhoons 24,26		2004	Niigata-ken-Chuetsu Earthquake	
昭和 42.7. ~ 8.	7, 8 月豪雨 (中部以西, 東北南部)	256 人	平成 17.12. ~ 18.3	平成 18 年豪雪 (北陸地方を中心とする日本海側)	152 人
1967	Torrential Rains		2005	Heavy Snowfall	
昭和 43.5.16	十勝沖地震 (M7.9)	52 人	平成 19.7.16	新潟県中越沖地震 (M6.8)	15 人
1968	Tokachi-oki Earthquake		2007	Niigata Earthquake	
昭和 47.7.3 ~ 15	台風第6, 7, 9号及び7月豪雨全国 (特に北九州, 島根, 広島)	447 人	平成 20.6.14	岩手・宮城内陸地震 (M7.2)	23 人
1972	Typhoons 6,7,9 and Torrential Rains		2008	Iwate-Miyagi Inland Earthquake	

注) 死者・行方不明者について, 風水害は 500 人以上, 雪害は 100 人以上, 地震・津波・火山噴火は 10 人以上のもののほか, 災害対策基本法による非常災害対策本部又は緊急災害対策本部等政府の対策本部が設置されたもの。

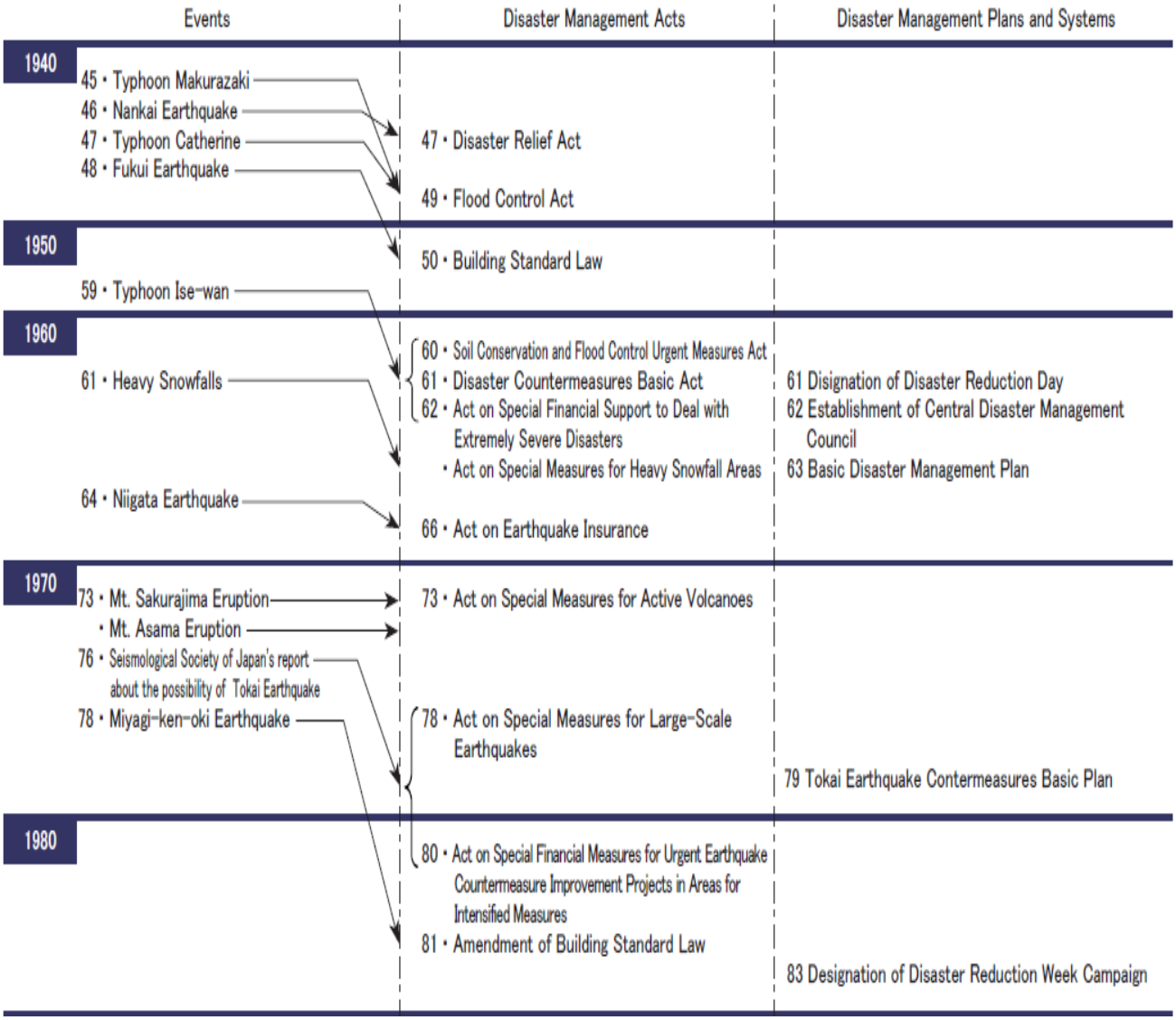
資料：気象年鑑, 理科年表, 消防庁資料, 兵庫県資料

Note: Data includes storms or floods in which 500 or more people were killed or reported missing, snow disasters in which 100 or more people were killed or reported missing and earthquakes, tsunami and volcanic eruptions in which 10 or more people were killed or reported missing. The data also includes disasters for which Major or Extreme Disaster Management Headquarters was established based on the Disaster Countermeasures Basic Act.

Sources: Kisho Nenkan, Rikanenpyo, data from Fire and Disaster Management Agency, and data from Hyogo Prefecture.

3.5 Progress in Disaster Management Laws and Systems

In Japan, the disaster management system has been developed and strengthened following the bitter experiences of large-scale disasters and accidents.



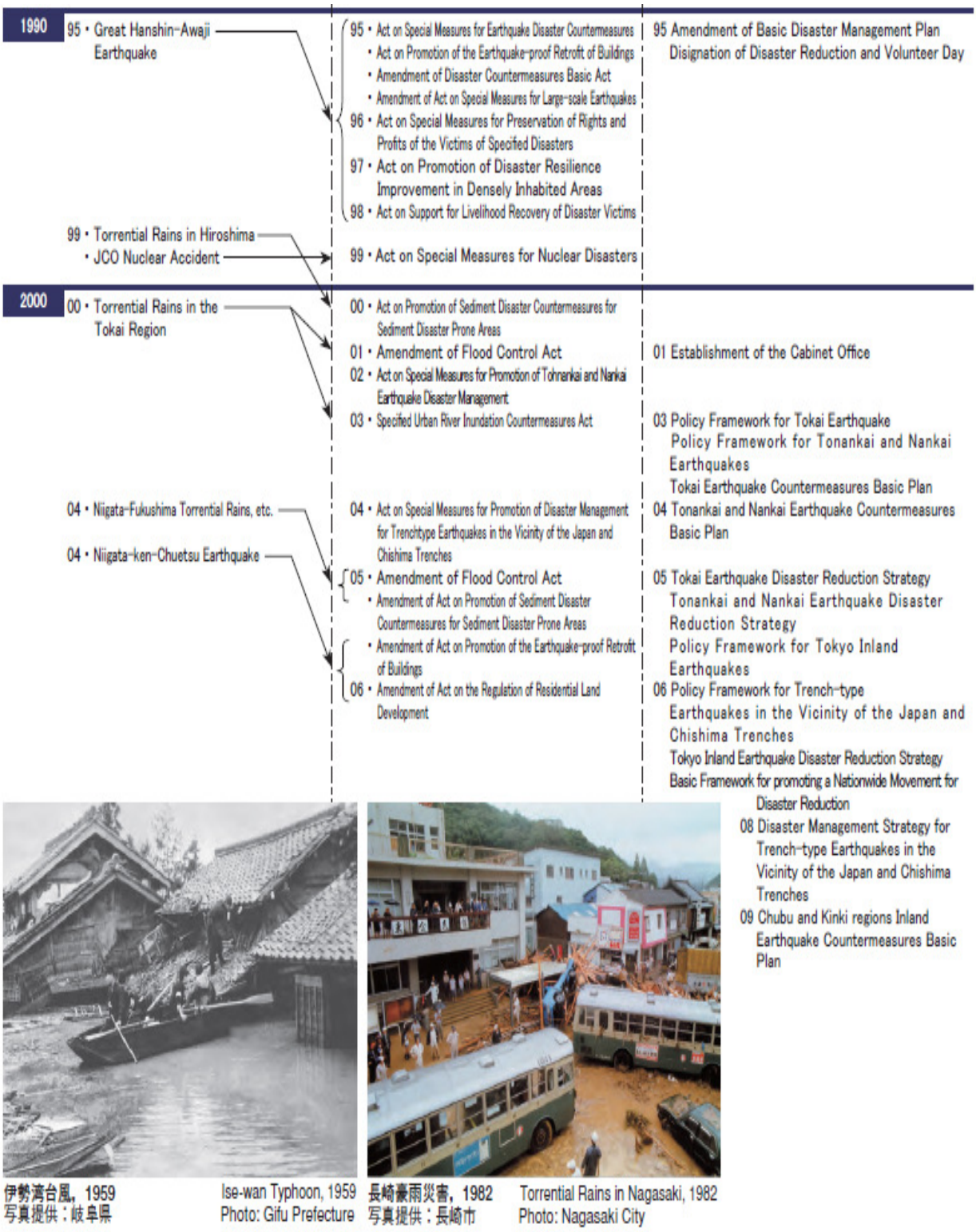


Figure 3.5: The experiences of large-scale natural disasters and accidents

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

Basic Acts

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

Disaster Prevention and Preparedness

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

Disaster Emergency Response

1) Disaster Relief Act (1947)
2) Fire and Disaster Management Organization Act (1947)
3) Japan Coast Guard Act (1948)
4) Fire Services Act (1948)
4) Flood Control Act (1949)
3) Police Act (1954)
3) Self-Defense Forces Act (1954)

Disaster Recovery and Reconstruction

1) Forest National Insurance Act (1937)
2) Act on Temporary Treatment of Rental Land and Housing in Cities (1946)
3) Agriculture Disaster Compensation Act (1947)
4) Act on Interim Measures for Subsidizing Recovery Projects for Agriculture, Forestry and Fisheries Facilities Damaged Due to Disasters (1950)
5) Small-Medium Business Credit Insurance Act (1950)

6) Act on National Treasury Share of Expenses for Recovery Projects for Public Civil Engineering Facilities Damaged Due to Disasters (1951)
7) Public Housing Act (1951)
8) Fishing Boat Damage Compensation Act (1952)
9) Railway Improvement Act (1953)
10) Act on National Treasury Share of Expenses for Recovery of Public School Facilities Damaged Due to Disasters (1953)
11) Act on Interim Measures for Financing Farmers, Woodsmen and Fishermen Suffering from Natural Disasters (1955)
12) Airport Act (1956)
13) Small-scale Business Equipment Installation Financial Support Act (1956)
14) Act on Special Financial Support to Deal with Extremely Severe Disasters (1962)
15) Fisheries Disaster Compensation Act (1964)
16) Act on Earthquake Insurance (1966)
17) Act on Special Financial Measures for Group Relocation Promotion Projects for Disasters Mitigation (1972)
18) Act on Payment of Solatia for Disasters (1973)
19) Act on Special Measures for Reconstruction of Disaster-stricken Urban Areas (1995)
20) Act on Special Financial Measures for Reconstruction of Jointly Owned Buildings in Disaster-stricken Areas (1995)
21) Act on Special Financial Measures for Preservation of Rights and Profits of Victims of Specified Disasters (1996)
22) Act on Support for Livelihood Recovery of Disaster Victims (1998)
23) The Japan Finance Corporation Act (2007)

3.6 Establishment of Comprehensive Disaster Management System: Disaster Countermeasures Basic Act

To protect national land as well as citizens' lives, livelihoods, and property from natural disasters is a national priority. The turning point for strengthening the disaster management system came after the immense damage caused by the Ise-wan Typhoon in 1959, and led to the enactment of the Disaster Countermeasures Basic Act in 1961, which formulates a comprehensive and strategic disaster management system. The disaster management system has been further strengthened following the lessons learned from large-scale disasters such as the Great Hanshin-Awaji Earthquake.

Japan's disaster management system addresses all of the disaster phases of prevention, mitigation and preparedness, emergency response as well as recovery and rehabilitation. With clear roles and responsibilities of the national and local governments, the relevant stakeholders of the public and private sectors cooperate in implementing various disaster countermeasures.

Main Contents of the Disaster Countermeasures Basic Act

1) Definition of responsibilities for disaster management
2) Disaster management organizations
3) Disaster management planning system
4) Disaster prevention and preparedness
5) Disaster emergency response
6) Disaster recovery and rehabilitation
7) Financial measures
8) State of Disaster Emergency

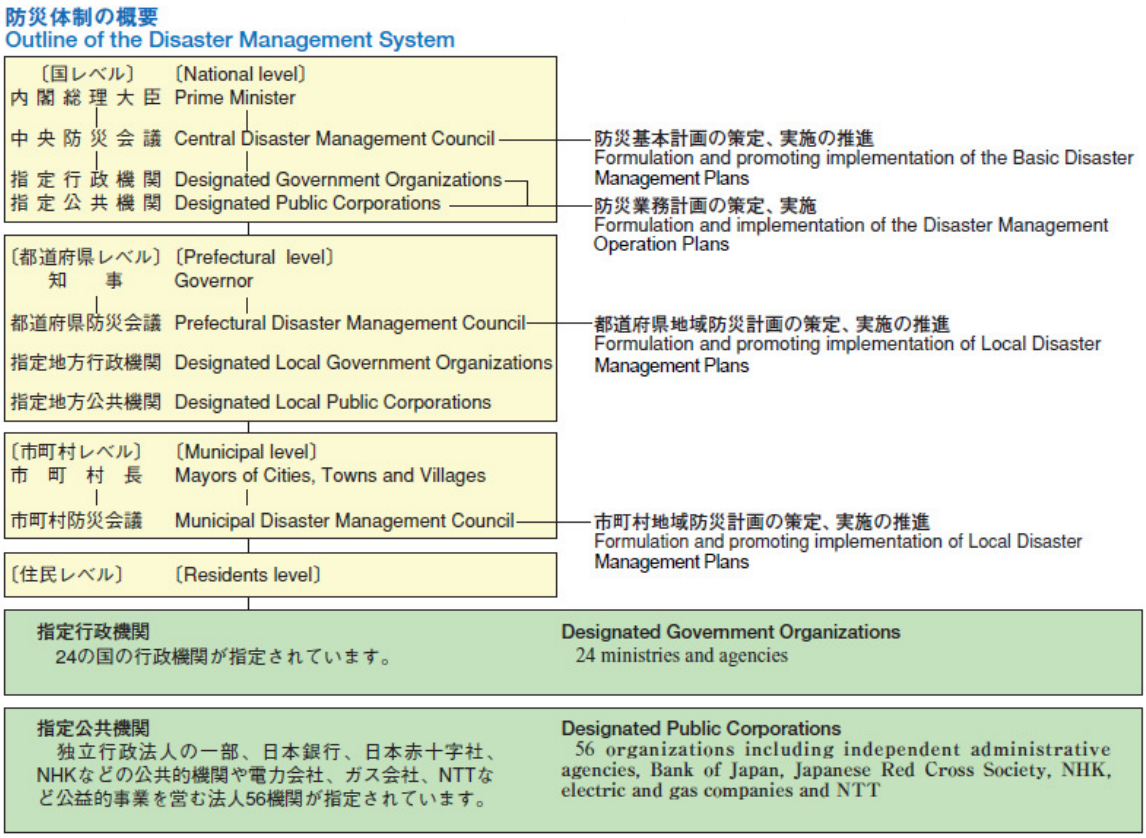


Figure 3.6: Outline of the Disaster Management System

3.7. Basic Legal Frameworks of Disaster Management in Japan

In 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 including Disaster Countermeasures Basic Act (1961) which is the cornerstone of legislation of disaster management which set out the basic for measures for disaster risk reduction, emergency response, post-disaster recovery and reconstruction. It was formulated in 1961, after the happening of Typhoon Ise-wan in 1959 that caused more than 5,000 fatalities. Following acts are the other relevant acts associated with disaster countermeasures Basic Act (1961);

- Erosion Control Act (1897), Disaster Relief Act (1947), Building Standard Law (1950)
- Landslide Prevention Act (1958), River Act (1964), and Act on Special Measures for Large-scale Earthquakes (1978).

(1) Erosion Control Act 1897:

To clearly define the responsibilities of the national and local governments and other public organizations to take necessary measures for preventing sediment-related disaster from the generation and discharge of unstable sediment due to natural events, such as heavy-rain induced landslides and river-bed erosion, to ensure a sound environment and maintain the function of river in flood control and water use, and thus to contribute to the conservation of the national land and the stability of the people‘s livelihood.

(2) Disaster Relief Act 1947:

The purpose of this law is to allow the national government to take necessary emergency relief measures in case of disaster in cooperation with local municipal governments, the Japan Red Cross, and other relevant organizations. Distribution of foods and drinking water, Supply of clothing,

bedding, and other basic necessities, Medical and natal care, Rescue of disaster victim , Emergency repairs of housing subject to disaster, Distribution and/ or loan of funding, equipment, and materials required to maintain livelihoods, Distribution of school supplies , Interment and other matters as specified by government ordinance.

(3) Building Standard Law 1950:

In Article 39 of the law, the municipal government is allowed to designate the area with considerable risk due to tsunami, storm surge, and flood and so on as disaster prone areall by its local ordinance. And it shall be determined in the above ordinance that necessary items for disaster Prevention in the disaster prone area such as prohibition against building a residence or restriction concerning to build a building.

(4) Land slide Control Act 1958:

To provide the measures for preventing landslides or slag heap collapses to avoid or mitigate damage from those hazards, and thus to contribute to the conservation of the national land and the stability of the people‘s livelihood.

(5) River Act 1896:

The law is to clearly define the responsibilities of the national and local governments and other public organizations to take necessary measures for comprehensive river management, through which disaster due to floods and storm surges will be prevented, rivers will be in proper use, the regular functions of river water will be maintained, and river environment will be improved and conserved, which will contribute to the conservation and development of the national land, and thus ultimately to enhance public welfare. This law specifies the administration’s responsibilities about river management.

3.8 Mission of the Cabinet Office

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 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 disaster, as well as conduct overall coordination.

Additionally, taking into account the lessons learned from the Great Hanshin-Awaiji Earthquake, the Cabinet Secretariat system was also strengthened, including 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.

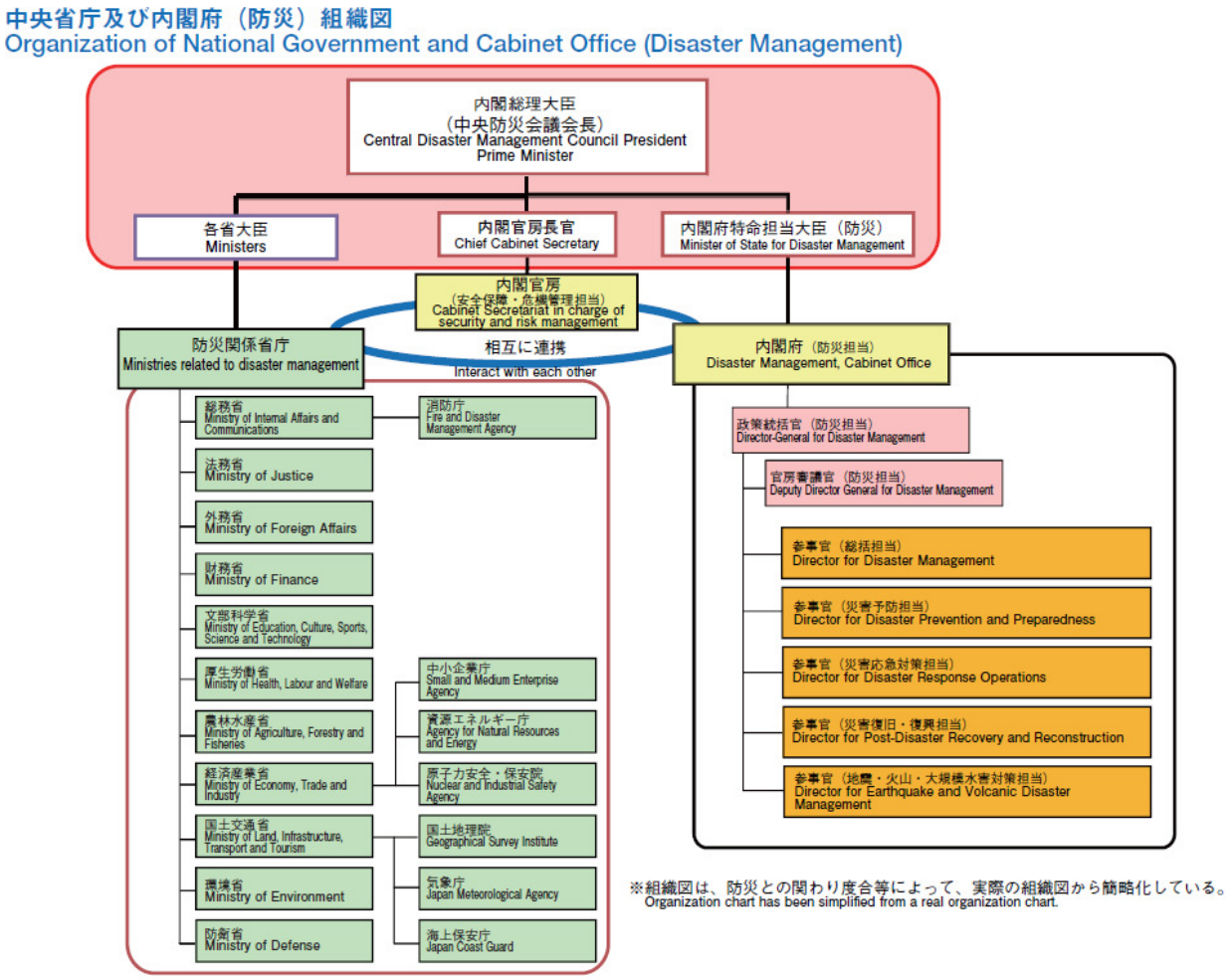


Figure 3.7: Organization of National Government and Cabinet Office (Disaster management)

3.9 Central Disaster Management Council

The Central Disaster Management Council is one of the councils that deal with crucial policies of the Cabinet, and is established in the Cabinet Office based on the Disaster Countermeasures Basic Act. The council consists of the Prime Minister, who is the chairperson, Minister of State for Disaster Management, all ministers, heads of major public institutions and experts. The council promotes comprehensive disaster countermeasures including according to requests from the Prime Minister or Minister of State for Disaster Management.

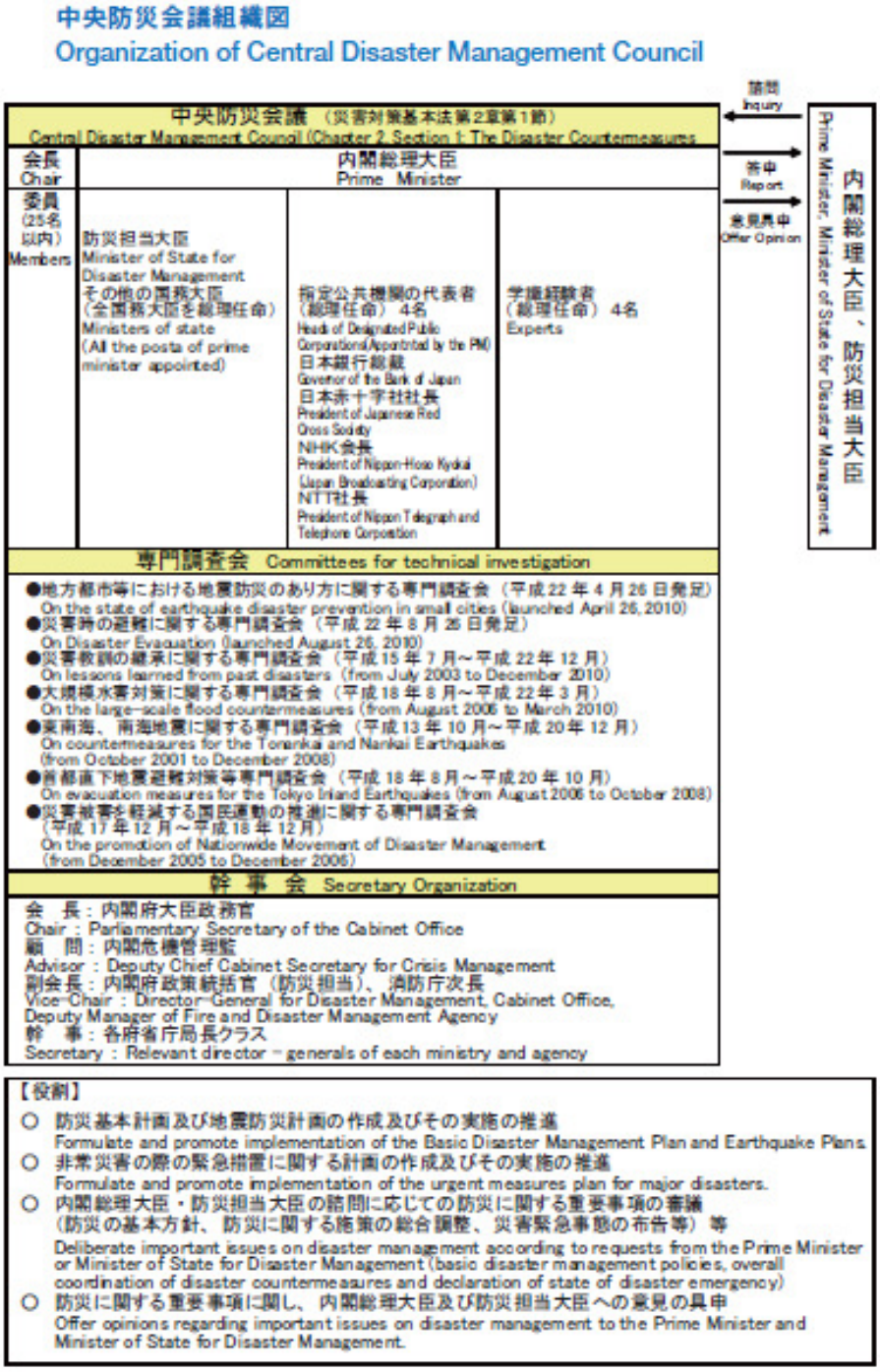


Figure 3.8: Organization of Central Disaster Management Council

3.10 Disaster Management Planning System

Disaster Management Planning System

1) Basic Disaster Management Plan: This plan is a basis for disaster reduction activities and is prepared by the Central Disaster Management Council based on the Disaster Countermeasures Basic Act.

2) Disaster Management Operation: This is a plan made by each designated government organization and designated public corporation based on the Basic Disaster Management Plan.

3) Local Disaster Management Plan: This is a plan made by each prefectural and municipal disaster management council, subject to local circumstances and based on the Basic Disaster Management Plan.

Basic Disaster Management Plan

The Basic Disaster Management Plan states comprehensive and long-term disaster reduction issues such as disaster management related systems, disaster reduction projects, early and appropriate disaster recovery and rehabilitation, as well as scientific and technical research.

The plan was revised entirely in 1995 based on the experience of the Great Hanshin-Awaji Earthquake. It now consists of various plans for each type of disaster, where tangible countermeasures to be taken by each stakeholder such as the national and local governments, public corporations and other entities are described for easy reference according to the disaster phases of prevention and preparedness, emergency response, as well as recovery and rehabilitation.

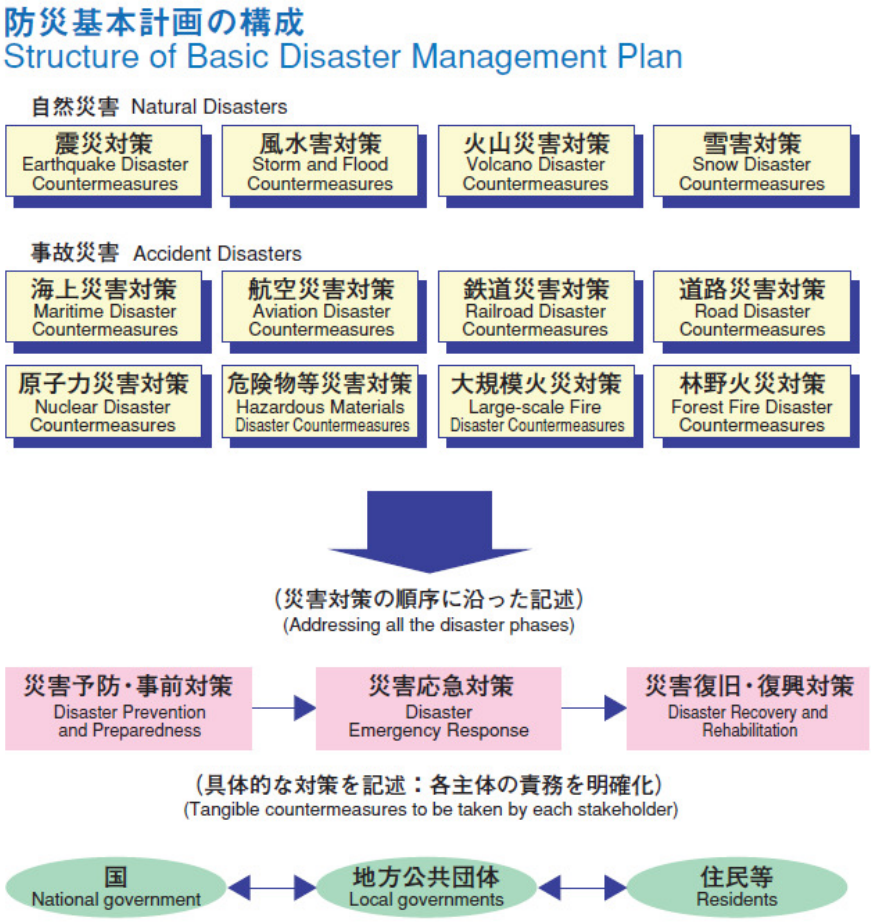


Figure 3.9: Structure of Basic Disaster Management Plan

Table 2.2: History of Basic Disaster Management Plan

防災基本計画の策定・修正経緯
History of Basic Disaster Management Plan

年 Year	内　容 Contents
昭和38年 1963	作成 Initial plan drawn up
昭和46年 1971	地震対策、石油コンビナート対策等に係る修正 Revision for earthquake countermeasures and petrochemical complex countermeasures
平成7年 1995	自然災害対策編の全面的な修正 Overall revision of Natural Disaster Countermeasures
平成9年 1997	事故災害対策編の追加 Addition of Accident Disaster Countermeasures
平成12年 2000	原子力災害対策編の全面的な修正 Overall revision of Nuclear Disaster Countermeasures
	省庁再編に伴う修正 Revision parallel with reorganization of ministries and agencies
平成14年 2002	風水害対策編、原子力災害対策編の修正 Revision of Storm and Flood Countermeasures and Nuclear Disaster Countermeasures
平成16年 2004	震災対策編の修正 Revision of earthquake countermeasures
平成17年 2005	自然災害対策に係る各編の修正 Revision of Natural Disaster Countermeasures
平成19年 2007	防衛庁の防衛省へ移行に伴う修正 Part corrections pertaining to the natural disaster
平成20年 2008	各編の修正 Each Chapter Review

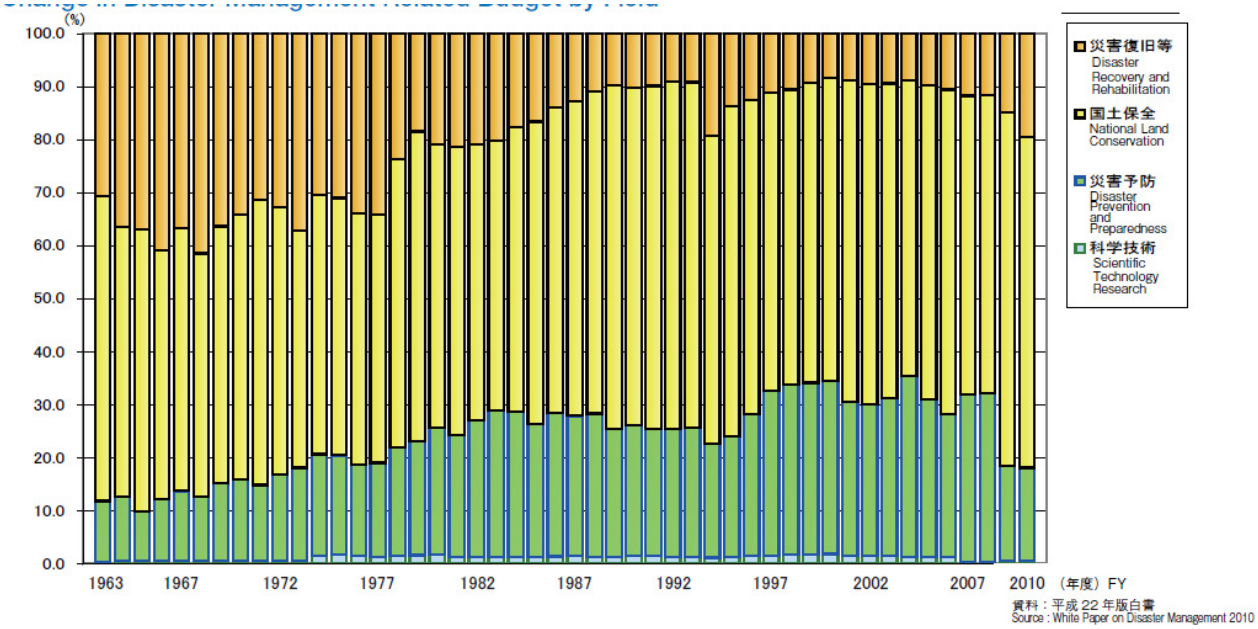


Figure 3.10: Change in Disaster Management Related Budget by Field

3.11 Disaster Management Structure

Disaster Management of Japan is categorized into 3 levels including national, regional and municipal level. The significance of each level is delineated as follows:

1) National Level: The Prime Minister is the National Commander through the National Disaster Management Council, and the designed government organizations (23 ministries and agencies), and designated public cooperation (63 organizations including independent administrative agencies, Bank of Japan, Japanese Red Cross Society, NHK, electricity and gas companies and NTT). In this connection, the national council is responsible for formulation and promoting the implementation of the Basic Disaster Management Plan. Meanwhile, the other two designed agencies of government and public cooperation are responsible for formulation and implementation of the Disaster Management Operation Plan.

2) Prefectural Level: The Governor is the commander ordering via the Prefectural Disaster Management Council, and designed government organization and public corporations in local. The prefectural council will conjunctionally work with the mentioned designed agencies to formulate and promote the implementation of Local Disaster Management Plan.

3) Municipal Level: In this level, the Mayor of City, Town and Village is the commander, as the same of Governor in prefectural level, will take function through Municipal Disaster Management Council to formulate and promote the implementation of Local Disaster Management Plan.

3.12 Disaster Management Related Budget

The national budget for disaster management is approximately 1.2 trillion yen (Initial budget 2010FY). The percentage for each field is: i) Scientific Technology Research, 0.6%:ii) Disaster Prevention and Preparedness, 17.5%, iii) National Land Conservation, 62.4%; and iv) Disaster Recovery and Rehabilitation, 19.5%)

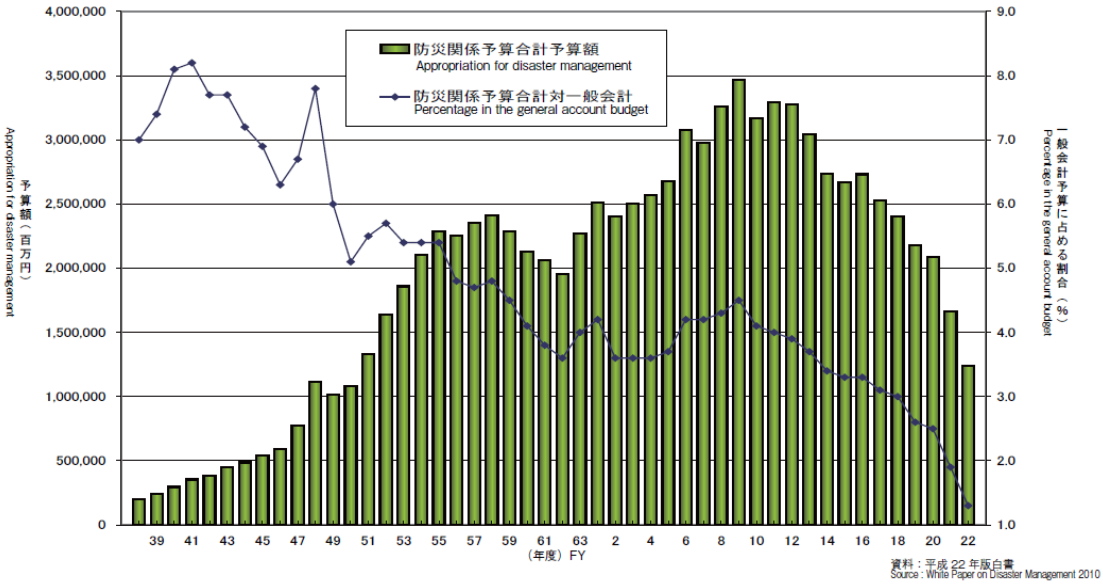


Figure 3.11: Change in Disaster Management Related Budget

3.13 Earthquake Disaster Countermeasures.

(1) Earthquake Disasters in Japan

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 earthquake prone. More than 20% of the world's earthquakes (magnitude 6 or greater) have occurred in or around Japan.

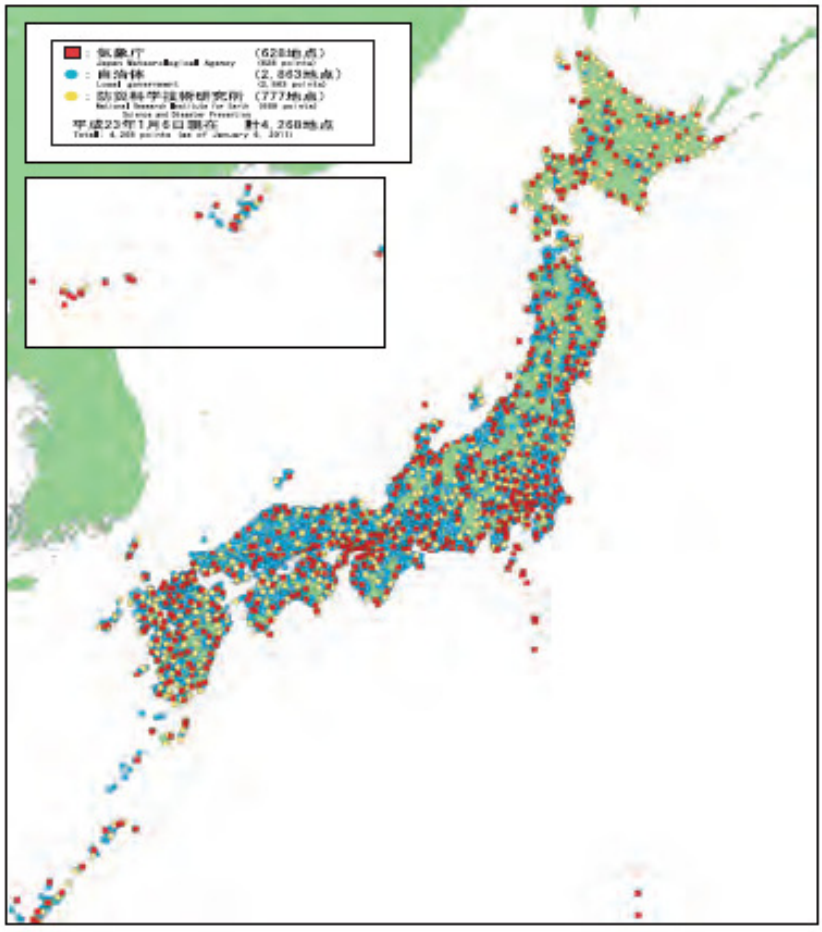
Japan is well acquainted with the massive inter-plate earthquakes produced by plate subduction (such as the Great Kanto Earthquake of 1923) and the inland crustal earthquakes caused by plate movements (such as the Great Hanshin-Awaji Earthquake of 1995)

(2) Observation system

In order to constantly monitor seismic activity, the Japan Meteorological Agency ((JMA) and other relevant organizations install and maintain seismometers that are used for estimating the location of the epicenter and magnitude of an earthquake as well as for tsunami warnings, and seismic intensity meters that measure the intensity of ground motion, in numerous places nationwide. As soon as an earthquake occurs in or around Japan, the JMA analyzers P-wave at seismometers placed close to the hypocenter. If an earthquake of intensity 5 or greater is forecasted, Earthquake Early Warning (EEW) information is issued. Within about two minutes, it issues a seismic intensity information report for earthquakes of intensity 3 or greater, and within about five minutes issues an earthquake information report indicating the epicenter and magnitude of the earthquake and the seismic intensity in the municipalities where strong shaking was observed.

震度観測点

Seismic Intensity Observation Points



(3) Outline of Countermeasures against Large-scale Earthquakes

It has been pointed out with a great sense of urgency that Japan can be struck by large-scale earthquakes in the next few decades, in areas such as Tokai, Tonankai, Nakai, the Japan and Chishima Trenches, and directly below Tokyo and the Chubu and Kinki regions.

Regarding trench-type earthquakes, based on the related laws and regulations, appropriate actions where various countermeasures need to be strengthened, the reinforcement of observation

systems, and the formulation of a plan of action by relevant government organizations and private corporations. In addition, preparations such as improvements in evacuation sites and firefighting facilities are being promoted based on laws specifying special financial measures.

With regard to each large-scale earthquake, including the Tokyo Inland Earthquake, the Central Disaster Management Council has conducted examinations to clarify the characteristics of the earthquake, estimate the damage and identify necessary countermeasures. The following set of plans and strategies for each large-scale earthquake are now being developed: the "Policy Framework," a master plan 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 the actions to be taken by related organizations. It is necessary to keep working on countermeasures nationwide, as has been witnessed by the examples of the major earthquakes of Hanshin-Awaji and Niigata-ken-Chuetsu, because such a disaster can occur anywhere in Japan. Committee on Earthquake Disaster Reduction in Local Cities is examining possible countermeasures.

(4) Countermeasures against Tokai Earthquake

Strain on the earth's crust along the Suruga Trough has been building up for approximately 160 years, ever since the Ansei-Tokai Earthquake in 1854. Therefore, it is believed that there is a high possibility of a Tokai Earthquake occurring.

A Tokai Earthquake is the only earthquake at present with a possibility of being predicted just before it occurs. The areas for intensified measures against earthquakes (160 municipalities in eight prefectures as of April 2010) were designated under the **Act on Special Measures for Large-scale Earthquakes**, where the observation system has been reinforced and the earthquake response system in the case of a prediction report being announced has been developed.

Data presumed to be effective for earthquake prediction are monitored in real-time by the **Japan Meteorological Agency**. Upon detecting any abnormality in the data, observation, caution and prediction information regarding an earthquake in the Tokai region will be announced. The Prime Minister will then issue a warning declaration based on the earthquake prediction report and implement necessary measures including establishment of the Earthquake Disaster Warning Headquarters.

The Central Disaster Management Council drew up the **"Earthquake Countermeasures Basic Plan"** containing basic policies for actions to be taken in response to a warning declaration based on the act, and relevant organizations have their own plans accordingly. When relevant local governments carry out urgent projects to improve facilities for mitigating possible damage caused by the Tokai Earthquake based on their own plans, special measures will be taken such as increasing national government subsidies and fiscal measures for the local governments based on the **Act on Special Financial Measures for Urgent Earthquake Countermeasure Improvement Projects in Areas for Intensified Measures."**

Regarding countermeasures against Tokai Earthquake, the Central Disaster Management Council reviewed the probable epicenter area in 2001, and the areas forintensified measures were expanded in 2002, based on various observation data and scientific expertise accumulated over the past quarter of a century following the enactment of the **Act on Special Measures for Large- scale Earthquakes.**

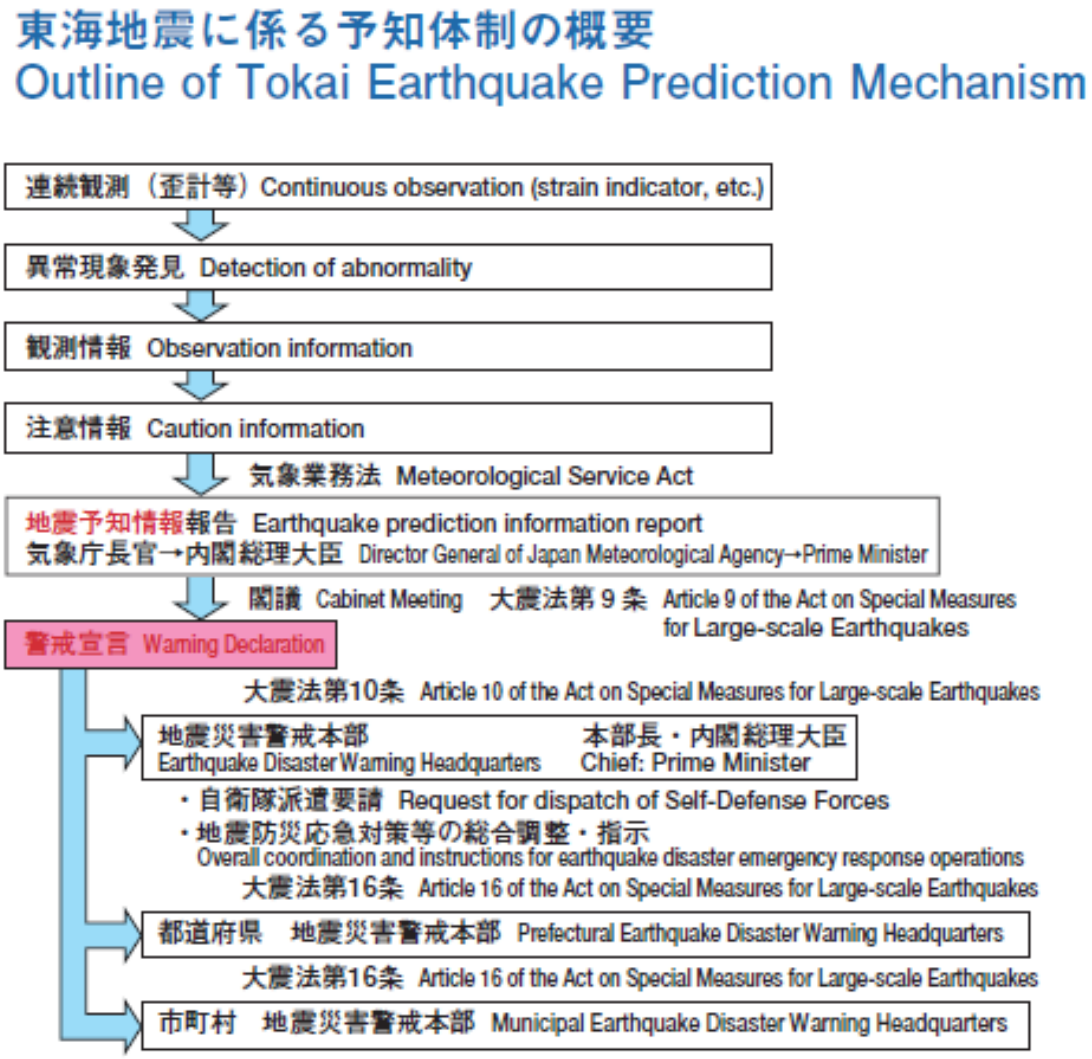
Furthermore, the Central Disaster Management Council published the outcome of its damage estimation in 2003, which made it clear that there may be extreme and wide-area damage including about 9,200 people killed in the case of no forewarning.

In the same year, the council also decided the **"Policy Framework for Tokai Earthquake,"** containing such main issues as implementation of urgent earthquake-resistant construction measures, reinforcement of community capabilities against disasters, and **establishment of a tangible disaster management system in the case of a warning declaration.**

Based on this policy framework, the Tokai Earthquake Disaster Reduction Strategy was formulated in 2005. These guidelines set clear goals: a 50% reduction in the number of deaths and the value of economic losses from earthquakes in the region and an increase in the number of earthquake-resistant homes to 90% of the housing stock, within 10 years.

Furthermore, the **"Guidelines for Tokai Earthquake Emergency Response Activities"** were formulated in 2003 (revised in 2006), and the activities of each disaster management related organization

were determined in terms of each level, such as at the time of caution information, warning, declaration and disaster occurrence. Based on these guidelines, a detailed plan of action was formulated for units engaged in search and rescue, firefighting and medical activities when a warning declaration is made or an earthquake suddenly occurs.



(5) Countermeasures against Tonankai and Nankai Earthquakes

Tonankai and Nankai Earthquakes with a magnitude of 8 or greater have occurred at intervals of 100 to 150 years. Most recently, the Tonankai Earthquake and Nankai Earthquake occurred in 1944 and 1946, respectively, and therefore it is anticipated that the next ones will occur in the first half of this century. The Central Disaster Management Council announced a damage estimate in 2003 after examining the possible epicenter zone, strength of tremors and distribution of tsunami wave height. It said that the maximum number of deaths could be approximately 18,000, of which about 8,600 may be attributable to tsunamis.

In the same year, the council established **the "Policy Framework for Tonankai and Nankai Earthquakes,"** the contents of which included establishing the tsunami disaster management system and wide-area disaster management support system, and promoting the planned urgent prevention countermeasures as the main items.

Additionally, based on the **Act on Special Measures for Promotion of Tonankai and Nankai Earthquake Disaster Management,** the countermeasures promotion areas for the Tonankai and Nankai Earthquakes were designated in 2003 (21 prefectures and 403 municipalities as of April 2006) . **The" Tonankai and Nankai Earthquake Countermeasures Basic Plan"** was also drafted in 2004.

The relevant organizations have their own plans accordingly.

In 2005, the Central Disaster Management Council drafted the **"Tonankai and Nankai Earthquake Disaster Reduction Strategy,"** which sets forth an overarching goal of halving the estimated deaths and economic loss within a 10-year period, as well as the strategic targets to create a tsunami hazard map in all the relevant municipalities in the same period. In 2006, **the "Guidelines for Tonankai and Nankai Earthquake Emergency Response Activities"** were drafted. In 2007, a plan was drafted to decide specific details of such activities, based on the 2006 Guidelines.

(6) Countermeasures against Trench-type Earthquakes in the Vicinity of the Japan and Chishima Trenches

There have been many large-scale earthquakes of M7 or M8 scale occurring in the vicinity of the Japan Trench, extending in the oceanic areas from off of Eastern Chiba to Sanriku, and in the vicinity of the Chishima Trench, extending from the areas off Sanriku, Tokachi and Etorofu Island. There are many types of earthquakes in this area, such as the Meiji-Sanriku Earthquake Tsunami in 1889, which caused enormous damage from a giant tsunami, and the Miyagi-ken-oki Earthquake, which occurs at intervals of approximately 40 years. The Central Disaster Management Council chose eight of these earthquakes as subject matter for strengthening disaster countermeasures and examined the strength of tremors and distribution of tsunami wave height, and announced the estimated damage in 2006. In the same year, the council established the **"Policy Framework for Trench-type Earthquakes in the Vicinity of the Japan and Chishima Trenches,"** focusing on issues such as the promotion of tsunami disaster countermeasures, the construction of towns capable of withstanding tremors, and addressing problems unique to snowy or cold areas. Additionally, based on the **Act on Special Measures for Promotion of Disaster Management for Trench-type Earthquakes in the Vicinity of the Japan and Chishima Trenches,** the countermeasures promotion areas for these earthquakes were established (5 prefectures and 119 municipalities included as of April 2006), and the **"Countermeasures Basic Plan for Trench-type Earthquakes in the Vicinity of the Japan and Chishima Trenches"** was drafted. The relevant organizations have their own plans based on the basic plan.

These measures were followed by the drafting of the **"Guidelines for Emergency Response Activities in the Countermeasures for Trench-type Earthquakes in the Vicinity of the Japan and Chishima Trenches" in 2007** and the **"Disaster Management Strategy for Trench-type Earthquakes in the Vicinity of the Japan and Chishima Trenches" in 2008.**

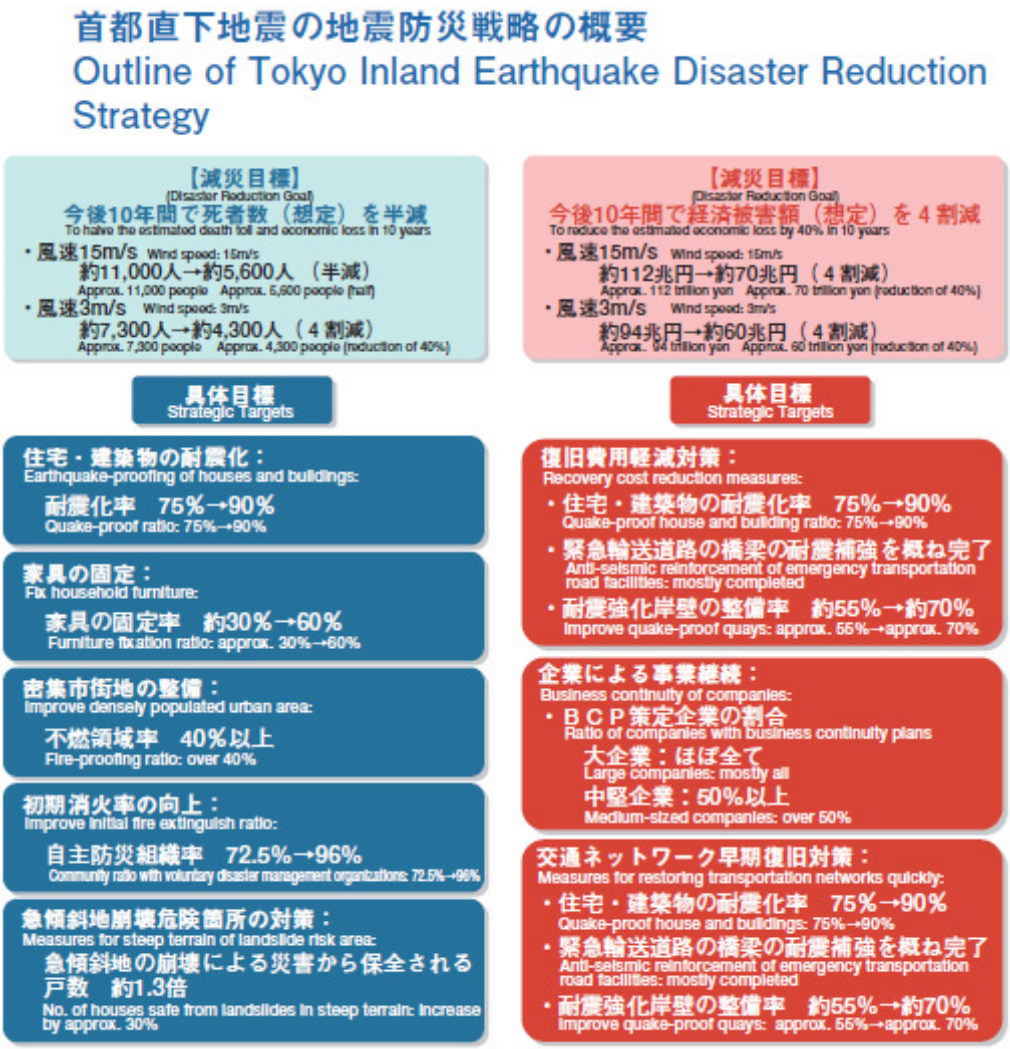
(7) Countermeasures against Tokyo Inland Earthquakes

It is believed that in the capital area (Tokyo), massive trench-type earthquakes with a magnitude of 8 or greater, like the Great Kanto Earthquake (1923), will occur at intervals of 200-300 years. Additionally, it is presumed that several Tokyo Inland Earthquakes of M7 scale will occur before a M8 scale earthquake, and the imminent possibility of such an event in the first half of this century has been pointed out.

Many types of Tokyo Inland Earthquakes are assumed due to various possible epicenters and the complicated mechanism of the occurrence. The Central Disaster Management Council has carried out damage estimations for 18 types of Tokyo Inland Earthquakes, and assumed extensive damage including a death toll of approximately 11,000 people, total collapse of 85,000 buildings and a maximum economic loss of 112 trillion yen in the earthquake with an epicenter in the northern part of Tokyo Bay (assumed scale of M7.3).

In 2005, the Council established the P**olicy Framework for Tokyo Inland Earthquakes**, with the main items being to secure the continuity of the capital functions and countermeasures to reduce massive damage. In 2010, this policy framework was revised to include specific measures to handle large numbers of evacuees or travelers unable to return to their homes. Additionally, in 2006, the council drafted the **Tokyo Inland Earthquake Disaster Reduction Strategy**, with general goals of halving the death toll and reducing the economic loss by 40%, as well as strategic goals such as increasing the proportion of earthquake-resistant houses and buildings to 90% of total housing stock and increasing the fixed furniture rate to 60% within 10 years.

That same year, the Council also drafted the **Guidelines for Tokyo Inland Earthquake Emergency Response Activities**. Plans specifying specific activities were then drawn up on the basis of these guidelines.



(8) Countermeasures against Chubu and Kinki regions inland earthquakes

It is thought highly probable that earthquakes will strike the Tonankai and Nankai regions in the first half of this century. Seismologists believe a broad area of central Japan from Chubu to Kinki has entered an active period, raising the risk of increased seismic activity. Based on past examples, seismic activity in inland western Japan regions tend to both presage and follow earthquakes in the Tonankai and Nankai regions.

In the Chubu and Kinki regions, which are densely urbanized, the damage from a large-scale earthquake would be extremely extensive. When the Central Disaster Management Council drafted estimates of probable damage from five types of earthquake in the Chubu region and eight in Kinki, it concluded that an earthquake in the Uemachi fault zone would cause horrific devastation: an estimated 42,000 deaths, almost a million collapsed buildings and economic damage of 74 trillion yen. The toll from a major tremor in the Sanage- Takahama fault zone could reach 11,000 dead, 300,000 collapsed buildings and economic damage of 33 trillion yen.

To prepare for such a disaster, in 2009 the Central Disaster Management Council launched **the Chubu and Kinki regions Inland Earthquake Countermeasures Basic Plan**. This scheme seeks chiefly to grapple with the unique challenges of minimizing harm in the event of a major quake in Chubu

or Kinki, including disaster countermeasures in areas of dense concentrations of wooden homes and steps to minimize damage to cultural assets.

(9) Earthquake-proofing of Houses and Buildings

More than 80% of the casualties in the Great Hanshin-Awaji Earthquake were caused by building collapse. Similarly, damage estimates assume that building collapse will be the cause of a large number of deaths in future large-scale earthquakes. Unfortunately, it is estimated that some 21% of existing residences are insufficiently earthquake-resistant, as they were built before 1981, when stricter earthquake-resistant building codes were introduced. Also, about 30% of schools and 40% of hospitals lack adequate earthquake-resistant construction.

In view of this situation, the Central Disaster Management Council drafted the "Urgent Countermeasures Guideline for Promoting the Earthquake-resistant construction of Houses and Buildings" in 2005, which stipulates that earthquake-resistant construction throughout the country should be urgently and strongly enforced in close cooperation with related ministries as a national priority.

In line with this, the Act on Promotion of the Earthquake-proof Retrofit of Buildings was amended to strengthen measures such as the development of a promotion plan for improving earthquake-resistant construction by local governments. Additionally, the subsidy system that provides financial support to promote earthquake-resistance diagnosis and retrofit has been expanded, and tax reduction measures to promote earthquake-resistant retrofit of residences and commercial buildings have been established.

The Cabinet Office has released the "Map of Weak Subsurface Layers Nationwide," indicating weakness against earthquake tremors in 1km2 blocks throughout Japan. It has also summarized a method for each municipality to produce an "Earthquake Disaster Hazard Map" that indicates subsurface layer weakness in 50m2 blocks and the danger of building collapse, and is working on disseminating this method.

(10) Tsunami Countermeasures

Surrounded by water on all sides with long andcomplex coastlines, Japan is highly vulnerable to earthquake-generated tsunamis. In reality, there has been severe damage caused by various tsunamis in the past, including the Meiji-Sanriku Earthquake Tsunami (1896), Nihon-kai-Chubu Earthquake (1983), and Hokkaido Nansei-oki Earthquake (1993).

In addition to local tsunamis generated by earthquakes near the coast, Japan has also suffered major damage from the onslaught of distant tsunamis generated by open-sea earthquakes. In 1960, a tsunami generated by the Chile Earthquake crossed the Pacific Ocean and reached the shores of Japan about 22 hours later, killing 142 people.

When a tsunami is expected to cause coastal damage, the Japan Meteorological Agency issues a tsunami warning or advisory within 2-3 minutes after the earthquake and then follows up with announcements about the estimated height and arrival time of the tsunami. The information is transmitted immediately to disaster management organizations and media outlets, and further forwarded to residents and maritime vessels.

Tsunami countermeasures, such as expediting the announcement/transmission of tsunami forecasts and improving coastal embankments (tidal embankments) and tide prevention gates, have been carried out. The Cabinet Office, in cooperation with relevant ministries has prepared guidelines for the creation of a tsunami hazard map and the designation/development of tsunami evacuation buildings by local governments, and is working on disseminating the guidelines.

(11) Volcano Disaster Countermeasures

(1) Volcano Disasters in Japan

Japan is a highly volcanic country. Poised on the Circum-Pacific Volcanic Belt or "Ring of Fire," the Japanese islands are home to 108 active volcanoes – 10% of the Earth' total. In the past, eruptions and others volcanic activity have caused heavy damage. In three recent examples, the eruptions of Usuzan and Miyakejima in 2000 and Kirishimayama (Shinmoedake) in 2011 caused thousands of residents to flee their homes.

The phenomena associated with volcanic eruptions are extremely varied, and once a volcano begins to erupt there is often little time to evacuate. Naturally, authorities place the greatest emphasis on protecting against the most life-threatening situations, such as volcanic cinders, pyroclastic flows, snowmelt and volcanic mudflows. The most important approaches to protecting residents' lives

against volcanic disasters are the accurate reading of the precursors to volcanic eruptions, broadcasting of appropriate information, and wide-area networks to ensure rapid and orderly evacuation in the event of an eruption.

(2) Continuous Monitoring of Volcanoes and Broadcasting of Eruption Alert

JMA deploys a network of seismometers, telephoto cameras and angle meters ranged around 47 volcanoes throughout Japan (selected by the **Coordinating Committee for Prediction of Volcanic Eruptions**, an organization of academics and related government agencies), and monitors the volcanoes continuously, 24 hours a day. If an eruption affecting the caldera periphery or populated areas is predicted, an eruption warning is issued. For a group of 29 of these volcanoes (as of February 2011) that are especially close to populated areas, five volcano alert levels are assigned according to the status of volcano activity, each clearly connected to a specific set of disaster countermeasures: Evacuate; Prepare to Evacuate; Entry Restricted, and so on.

(3) Volcano Disaster Management Councils, Volcano Hazard Maps, Evacuation Plans

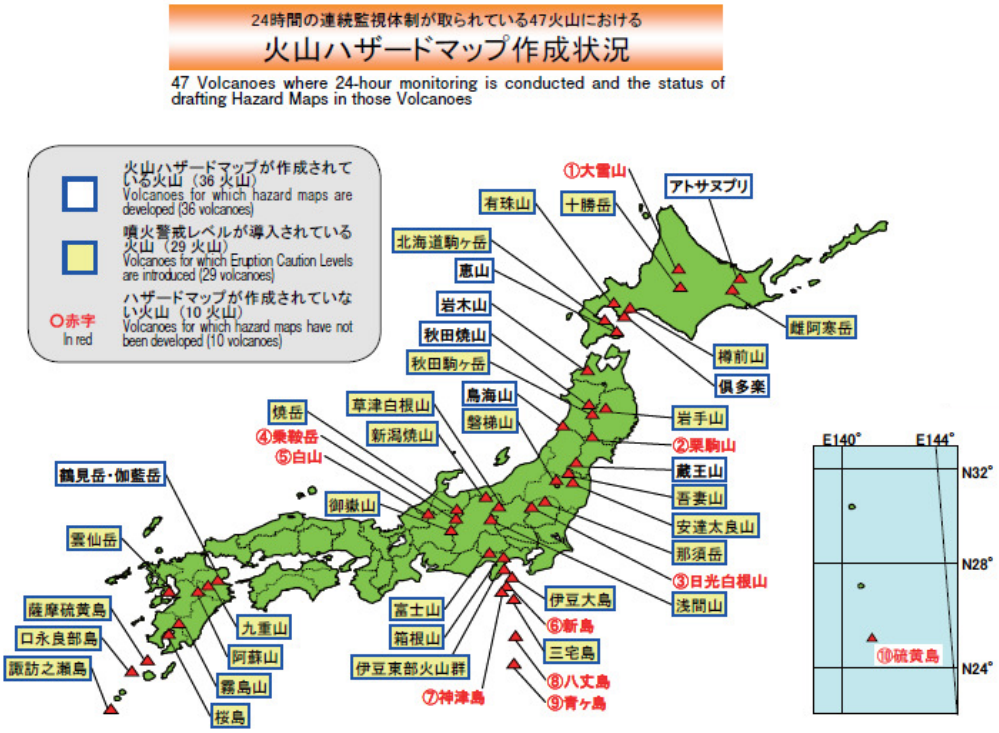
Based on the Policy on Volcano Management Related to Evacuation in the Event of Eruption, compiled in March 2008 by the Cabinet Office, the following actions are being taken.

1) Volcano Disaster Management Councils, a wide-area coordinating framework consisting of various volcano- related government agencies, are established at 24 volcanoes. Core groups, consisting of prefectural and local government officials, meteorological observatory personnel, the Sabo (Soil Erosion Control) Department, and volcanologists, lead the activities of the Volcano Disaster Management Councils.

2) Based on a variety of eruption scenarios, the Volcano Disaster Management Councils **draft volcano hazard maps** pointing out areas at risk of dangerous eruption phenomena for 40 volcanoes.

3) The Volcano Disaster Management Councils promote **the drafting of specific and practical evacuation plans**. These plans specify when to begin evacuation, areas likely to require evacuation, and evacuation routes and methods.

Preparing hazard maps for 47 continuously monitored volcanoes



(4) Measures based on the Act on Special Measures for Active Volcanoes

In areas that are, or have the potential to be, especially hard-hit by volcanic phenomena, special measures are implemented under the **Act on Special Measures for Active Volcanoes**. These measures include the provision of facilities based on designation of areas requiring emergency provision of refuge facilities and areas requiring removal of volcanic ash. As of February 2011, measures based on this law have been implemented in the areas around Sakurajima, Asosan, Usuzan, Izu-ooshima, Tokachidake, Unzendake, Miyakejima and Kirishimayama.

噴火警報等と噴火警戒レベル
Eruption Alarm and Eruption Caution Level

警報の呼び方 Types of alarms	対象範囲 Targeted areas	噴火警戒レベル Eruption Caution Level	キーワード Key words	
噴火警報 Eruption Alert	居住地域及びそれより火口側 Residential areas and the areas closer to a crater	レベル5 Level 5	避難 Evacuation	
		レベル4 Level 4	避難準備 Preparation for evacuation	
火口周辺警戒 Alarm for the vicinity of a crater	火口から居住地域近くまでの広い範囲の火口周辺 Wide areas near a crater including areas close to residential areas	レベル3 Level 3	入山規制 Limited access	
	火口から少し離れた所までの火口周辺 Areas around a crater and their vicinity	レベル2 Level 2	火口周辺 Limited access to the areas around a crater	
噴火予報 Eruption Forecast	火口内等 Inside a crater	レベル1 Level 1	平常 Normal	

(12) Storm and Flood Countermeasures

(1) Storm and Flood Disasters in Japan

Japan is prone to a variety of water and wind-related disasters including flooding, landslides, tidal waves and storm hazards, owing to meteorological conditions such as typhoons and active weather-front systems and geographical conditions such as precipitous terrains and steep rivers, as well as settlement conditions in which many of the cities are built on river plains. One-half of the population is concentrated in possible inundation areas, which account for about 10% of the national land.

Although there has been a large reduction in the area inundated by floods owing to soil conservation and flood control projects over many years, the amount of general assets damaged in flooded areas has increased in recent years. Additionally, as a long-term trend, there is an increasing tendency of downpours throughout the country.

(2) Observation System

The Japan Meteorological Agency observes meteorological phenomena that cause storm and flood disasters using the **Automated Meteorological Data Acquisition System (AMeDAS)**, which automatically measures rainfall, air temperature and wind direction/speed, weather radar, and geostationary meteorological satellites. These are used to announce forecasts and warnings to prepare against disasters (weather warnings and advisories for individual municipalities began in May 2010).

The rainfall and the water levels in rivers are observed by the Ministry of Land, Infrastructure, Transport and Tourism and prefectural governments utilizing visual observation methods, mechanical observation equipment, and a wireless telemeter system that transmits automatically observed data from remote locations. **Flood forecasts and water level information are provided utilizing the Internet and mobile phones.**

(3) Comprehensive Storm and Flood Countermeasures

In order to reduce damage caused by severe weather disasters, structural measures such as improving rivers, dams and sewage systems, and non-structural measures such as preparing hazard maps and providing disaster information, must be promoted in an integral manner.

As non-structural countermeasures, the warning and evacuation systems of the possible inundation areas and landslide prone areas have been developed in accordance with the **Flood Control Act and the Act on Promotion of Sediment Disaster Countermeasures for Sediment Disaster Prone Areas**. Both laws were amended in 2005 to intensify measures including the familiarization of hazard maps and the identification of a method to disseminate disaster information to facilities caring for those who require assistance at the time of a disaster like elderly people in the municipal disaster management plans.

Based on the Flood Control Act, some 368 rivers subject to flood warning and 1,488 rivers subject to water-level notifications are designated. Of these, inundation risk areas are currently designated and published for 1,768 rivers and streams (as of February 2010). Moreover, municipalities that include such areas are encouraged to prepare and disseminate flood hazard maps. Currently some 1,137 municipalities are doing so (as of February 2010).

(4) Countermeasures against Large-scale Floods

In light of a rising trend in heavy downpours in recent years, a strong need exists to fortify measures for rapid, effective evacuation and relief, in anticipation of large-scale flood disasters. The Central Disaster Management Council published a series of disaster scenarios in 2008, detailing the anticipated damage in the event of a number of possible cases. These included heavy downpours causing destruction of the fortified weirs along the banks of the Tonegawa and Arakawa Rivers in the Tokyo metropolitan area. At worst, such a catastrophe could leave up to 2,600 people dead and another 1.1 million people stranded. To minimize the damage in such an event, the Central Disaster Management Council is moving forward with the formation of a network for countermeasures against flood disasters.

(13) Snow Disaster Countermeasures

(1) Storm and Flood Damage in Japan

Japan is a bow-shaped archipelago filled with steep mountain ranges. When cold winds blow in from Siberia in winter, the warm current flowing up the eastern coast from the south brings heavy snowfalls to the Sea of Japan side of the country. Among the seasonal problems that result every year are falls by people removing snow from their roofs, avalanches, and obstruction of traffic and city functions due to snow accumulation.

In the winter of 2005–06, ferocious winds brought tremendous snowfalls to every part of the Sea of Japan coastline. Many people were injured from falls as they cleared snow from their roofs, while others were pinned by snow falling from rooftops or even by collapsing roofs. The death toll reached 152the second-worst total for snow-related deaths since the end of World War II. Fatal accidents continued in subsequent years, with 47 people perishing in the winter of 2006–07, 21 in 2007–08 and 56 in 2008–09.

(2) Outline of Snow Disaster Countermeasures

Measures are being taken to prevent accidents that result in injury, **improve the avalanche warning system,** and remove snow for securing road traffic networks at the time of heavy snowfall.

Against avalanches, comprehensive measures including avalanche prevention projects for protecting communities, risk communication efforts about dangerous locations among residents, and improvement of the warning and evacuation system, are taken.

Furthermore, as heavy snowfall areas account for approximately half of the national land, based on the Act of Special Measures for Heavy Snowfall Areas, measures have been introduced to

secure traffic and communications, protect agricultural and forestry industries, and improve living environmental facilities and national land conservation facilities.

In recent years deaths from snow removal operations, especially removal of snow from roofs, have grown numerous, and a disproportionate number of the fatalities have been people 65 years and over. The Cabinet Office has responded by advising on how to avoid accidents while clearing snow, and conducting public-awareness campaigns through various related organizations and agencies, particularly municipal governments.

3.14 Disaster Reduction Awareness Enhancement and Disaster Knowledge Dissemination

(1) Promotion of Efforts for Disaster Reduction

In order to reduce disaster damage, there must be close combination of self–help efforts rooted in the awareness of people and companies; mutual-help efforts of various community-based stakeholders; and public-help efforts made by the national and local governments.

To deploy efforts wherein individuals, families, communities, corporations and other various groups and entities participate in continuous activities and investments for mitigating disaster damage, in 2006 the **Central Disaster Management Council published a Basic Framework for a Nation-wide Movement for Disaster Reduction - Actions with Added Value to Security and Safety.**

(2) Disaster Reduction Week Campaign

The national government has designated September 1st of each year as Disaster Reduction Day, and the period from August 30th to September 5th as Disaster Reduction Week. A variety of events such as the Disaster Reduction Fair, various seminars, disaster reduction drills and exercises, and disaster management poster contests are held throughout the country to disseminate disaster knowledge.

（3）Disaster Education

Disaster education in schools is important for learning necessary disaster knowledge from childhood. It is therefore taught in various school curriculums. Social education at community level including town-watching and hazard-mapping programmes in which residents participate are also important. The Cabinet Office promotes disaster education including through sharing good examples of disaster education programs.

3.15 Improvement of Environment for Disaster Reduction Volunteer Activities

The Great Hanshin-Awaji Earthquake launched an enormous outpouring of volunteer assistance activity, from both within and outside the afflicted areas. In the following disasters, large numbers of volunteers have rushed to aid and comfort the victims and assist in the reconstruction and restoration of disaster-stricken regions.

The government has designated each January 17 “Disaster Reduction and Volunteer Day,”and the week from January 15 to January 21“Disaster Reduction and Volunteer Week.”During this one-week period, seminars, lectures, exhibitions and other events are held to promote the spread of volunteer and autonomous disaster reduction activities when disasters occur. These events take place throughout Japan, with the close cooperation of local governments and other related entities.

To provide a supportive environment for disaster reduction volunteer activities, the Cabinet Office provides information volunteers can use in their efforts, as well as facilities for the exchange of information and views. The Cabinet Office also provides local government receiving volunteer assistance with information and expertise, and promotes wide-area collaboration among disaster management volunteer activities when disasters strike.

3.16 Disaster Reduction Activities of Corporations

In response to disasters, corporations are required to secure the safety of their customers and employees, and continue their business activities which contribute to mitigate social and economic difficulties in disaster situation. The Cabinet Office promotes the enhancement of disaster reduction activities of corporations.

(1) Promotion of Business Continuity Plans of Corporations

When earthquakes and other disasters cause enterprise activity to stagnate, the impact affects not only individual companies, but also employment levels and the overall economy of the stricken region. Through trade and commerce with businesses in other areas, the economic damage can affect other regions as well. In this context, promoting the drafting and implementation of business continuity plans (BCPs) is extremely vital. By outlining a management strategy for ensuring the continuation of business in the event of a disaster, BCPs can ensure the stability of Japan's society and economy while creating an image of reliability for Japanese companies abroad.

In 2005 the Japanese government, through a special committee of the Central Disaster Management Council, drew up and began circulating a set of "business continuity guidelines."The government set a target of convincing "virtually all large companies and 50% of medium-sized companies" to draft BCPs (as stipulated in Earthquake Disaster Management Strategies and New-growth Strategy and Plans). In this way Japan's central government has played a critical role in encouraging the drafting and implementation of BCPs in the private sector.

(2) Encouraging the Evaluation of Corporate Disaster Reduction Activities

For private enterprises, recognizing the role of companies in the event of a disaster (ensuring the safety and security of employees, preventing secondary disasters, maintaining business continuity, contributing to and living in harmony with local communities) and working to promote disaster management activities is of crucial importance.

To encourage companies to engage in disaster management activities, markets and local communities must give appropriate recognition to enterprises that take an active part in these activities.

The government is disseminating information for this purpose. It has prepared a self-evaluation table entitled "Business Measures for Disaster management," as well as "Disclosure on Disaster management Measures: Explanations with Examples." Using an evaluation system based on the items in the self-evaluation table, the Development Bank of Japan (DBJ) has developed a lending facility with a rating system for operations that promote disaster management. The DBJ is implementing this system as an incentive to encourage companies to conduct disaster management activities.

Chapter 4 Early Warning System in Japan

4.1 MINISTRY OF LAND, INFRASTRUCTUE, TRANSPORT AND TOURISM

The MLIT conducts disaster management policy at national level in relation to flood and sediment disasters as well as town development with regard to safety for both natural and man-made disasters. Alongside with other phases of emergency management the ministry also actively involved in response phase and to this end Disaster Prevention Center was established.

Disaster Prevention Center established in the MLIT performs the following functions:

- Mobilizing leaders, staff members and related department members
- Observing and distributing meteorological information, site images, etc.
- Collecting and sharing information (integrating damage information)
- Exchanging information with ministers' offices, other ministries and agencies, local departments, etc.
- Providing information to the public
- Regional assistance, assistance to local governments

In order to achieve the "zero victim" goal in the face of increasingly intense floods and localized heavy rains caused by climate change, flood forecast centers (provisional name) will be established in regional development bureaus to strengthen risk management measures in, for example, monitoring floods and providing information to municipal governments, the mass media, etc. Flood forecast centers are to perform such tasks as climate change monitoring, flood risk evaluation and the development of an advanced flood prediction system. To the end following activities are implemented:

✧ Collection of point data (e.g. rainfall amounts, water levels and water quality)

Rain observation by ground gauges and *telemetry system* – the data obtained by telemeters are consolidated in one site, such as a regional bureau and a prefectural office, through the linking station. Then, they are sent to each office to update the real-time flood prediction calculations.

✧ Collection of area data (rainfall amounts)

Radar rain gauges have been installed at 26 locations throughout the country. The information of 1-km mesh resolution is updated every half an hour and available on the Internet. The radar data are calibrated using the ground data.

✧ Collection of image data.

CCTV Network - Ministry of Land, Infrastructure and Transport, Regional Development Bureaus and River Offices have real-time access to 3,900 CCTV images available on IP (Internet protocol) network. CCTV images are used for developing disaster control plans. Fiber-optic network - River Bureau and Road Bureau have jointly laid fiber optics network lines with the total length of 12046 km (as of 2006). River information systems developed by individual regional development bureaus have been integrated into a national river information system. Regional development bureaus can customize the system according to their requirements.

4.2 Japan Meteorological Agency

JMA is the key body in prediction major natural hazards such as earthquakes, tsunamis, typhoons and volcano eruptions while MLIT is for flood and sediment disasters and cooperation with them is essential for municipalities and other disaster response organizations. It must be noted that application of latest technologies for disaster warning and communication by JMA had greatly improved disaster response system in Japan. In addition, state lifeline agencies, railway companies, NHK has established quick information sharing with JMA and other relevant bodies as well as response mechanism within respective fields of activity.

Massive numbers of voluntary response organizations and people involved in voluntary disaster response shows high level of disaster awareness and social responsibility for disaster reduction in the country. During disaster times acting in collaboration with the professional responders, voluntary teams demonstrate remarkable efforts in psychological support of the affected people and provided basic utilities.

The existing Early warning system, although, has been form during relatively short time period put in place sophisticated mechanism which enables Japan to mobilize forces and resources and respond in a comprehensive manner any large-scale disasters promptly, considerably decreasing damage and loss. Comprehensively elaborated coordination enables to relevant bodies take concerted actions to increases response efficiency. In turn hierarchical supervision granting response bodies with great independence keeps accountability of them high.

JMA is semi-autonomous agency of the MLIT. Besides, function as central weather service agency of Japan, the agency has established comprehensive surveillance and awareness providing mechanism with regard to earthquake, typhoon and volcano hazards. Regarding flood forecast Director-General of Japan Meteorological Agency (JMA) In the event of the imminence of a flood or storm surge, the Director-General of JMA informs the Minister of Land, Infrastructure, Transport and Tourism and the prefectural governors concerned of the present state.

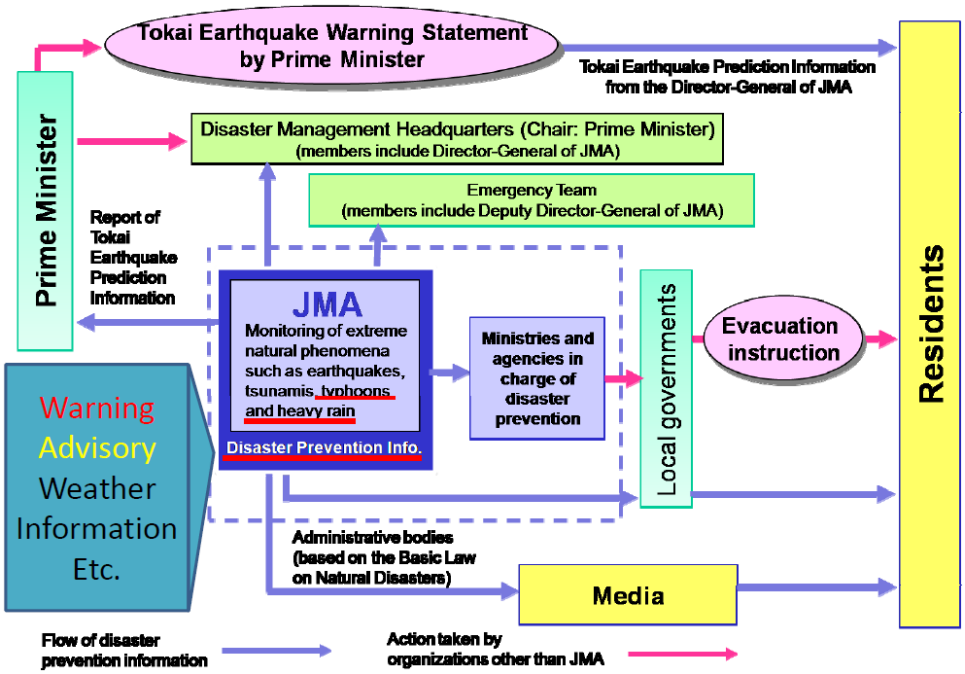


Figure 4.1 The role JMA in Disaster Management System of Japan

MLIT informs, jointly with the Director-General of JMA, for a class A river (excluding designated sections), the prefectural governors concerned of

- ✧ water level or discharge if the possibility of flooding is deemed high or
- ✧ water level or discharge, or the flood hazard area and the flood water depth if flooding has already occurred.

Prefectural governors communicate the information received as described above to the flood protection managers and stage gauge managers.

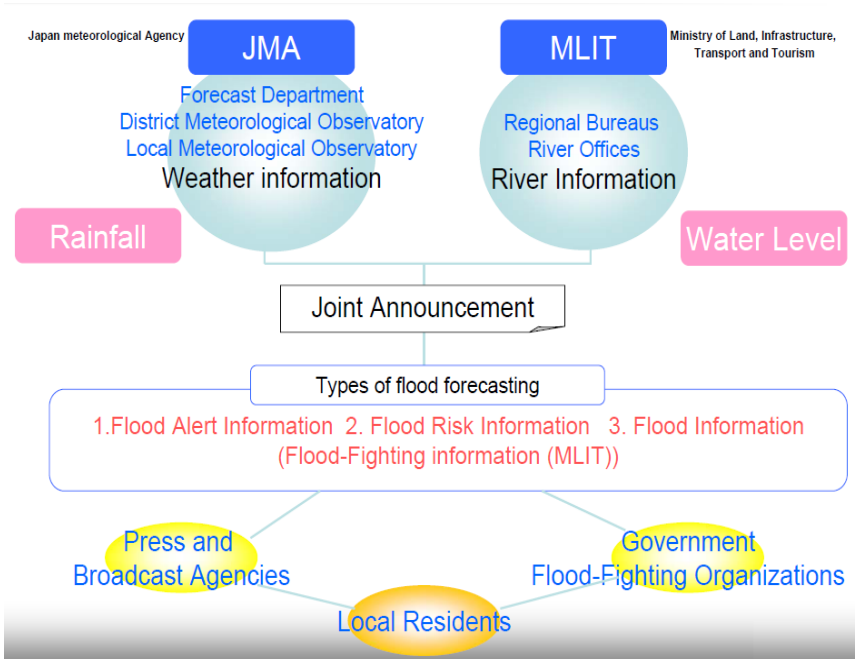
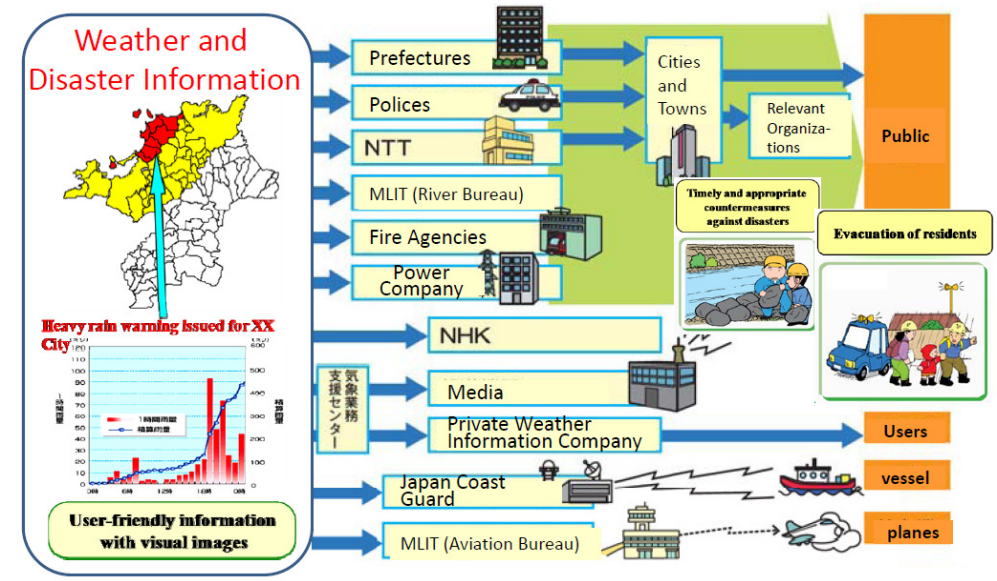


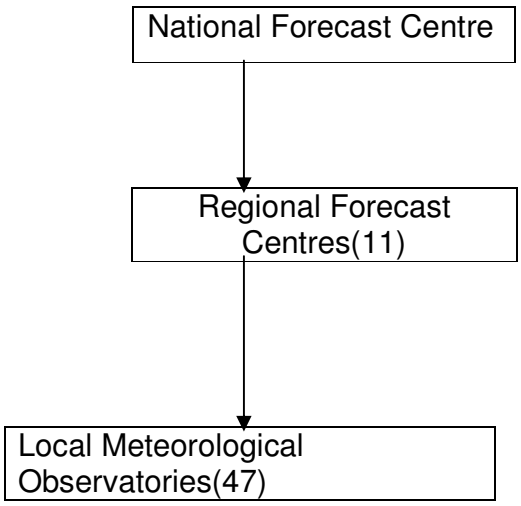
Figure 4.2 Joint flood warning by MLIT and JMA



Japanese Meteorological Agency is playing the major role in forecasting natural disasters through its advanced monitoring network including satellites. The whole role of activities implements with the following goals in compliance with the Act of Ministry and meteorological services act,

- Prevention and mitigation of natural disasters.
- Safety of transport.
- Development and prosperity of industry.
- Improvement of public welfare.

Framework of Forecast Operation (JMA)



JMA's Meteorological Services

1. Space-based Observation
2. Upper-air Observation
3. Radar Observation
4. Surface Observation
5. Ocean Observation
6. International Data Exchange

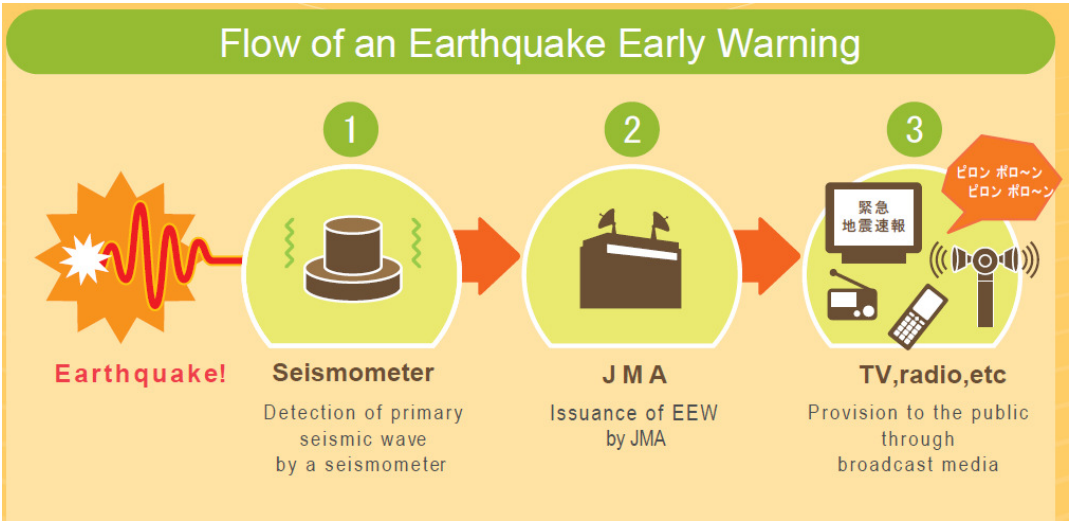
LMO is responsible for issuance of information on weather disaster prevention such as warnings/advisories for each prefecture.

Main Objective of Local Meteorological Observatories:

Disaster Forecasting to save lives

- Collecting weather and EQ data
- Analysis and Prediction of Weather
- Issuing Warnings and Meteorological Information

4.3 Utilization of Earthquake Early Warning Information



Earthquake Early Warning (EEW) information announces the estimated hypocenter and magnitude of an earthquake as well as the estimated arrival time of the S-wave (the principal shock) of the earthquake and seismic intensity in each area. This information is made possible by detecting the P-wave near the epicenter and immediately processing the data since there is a difference in the speed of the P-wave, which arrives faster, and the principal shock, which arrives later and causes more severely destructive phenomena. In the case of a large-scale ocean trench-type earthquake, there may be a time lag (several seconds to several tens of seconds) between the issuance of the EEW information and the start of severe shaking (when the S-wave arrives). This can be a critical time to be used for mitigating damage by stopping trains and elevators, extinguishing flames or crawling under tables.

The issuance of EEW information by the Japan Meteorological Agency (JMA) began in October 2007. The JMA initiated the service to provide earthquake warning as mandated under a 2007 revision of the **Meteorological Service Act**.

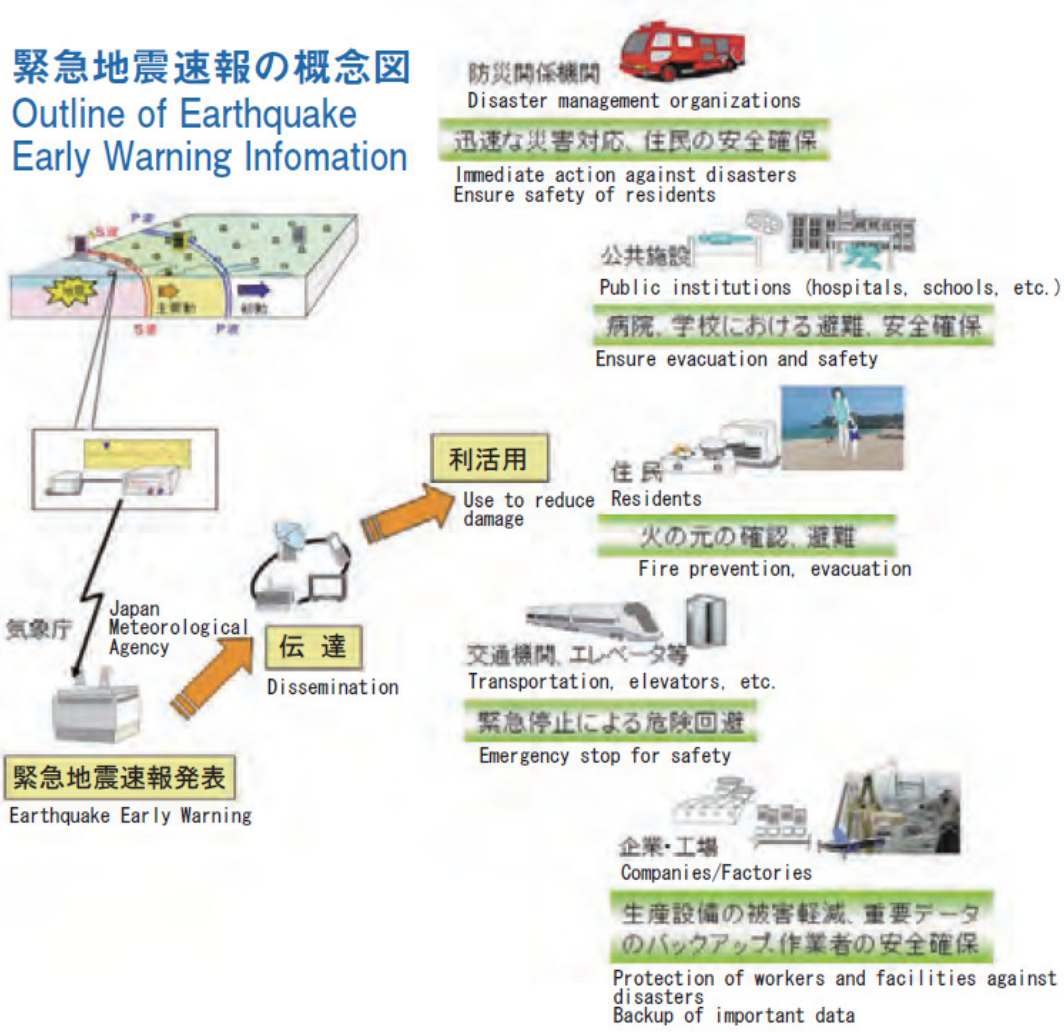


Figure 4.2: Outline of Earthquake Early Warning Information

4.4 Observing, Forecasting and Warning of Disaster Risks

Observation systems that can accurately detect disaster risks in real-time have been progressively improved for establishing early warning systems, supporting the early evacuation of residents and response activities of disaster management organizations, and thereby reducing disaster damage. Organizations involved in disaster reduction, especially the JMA, use 24-hour systems to carefully monitor various natural phenomena and weather conditions.

In addition to announcing observed information related to natural phenomena, the JMA issues a wide range of forecasts, warnings and advisories regarding earthquake-generated tsunamis and severe weather events such as heavy rain.

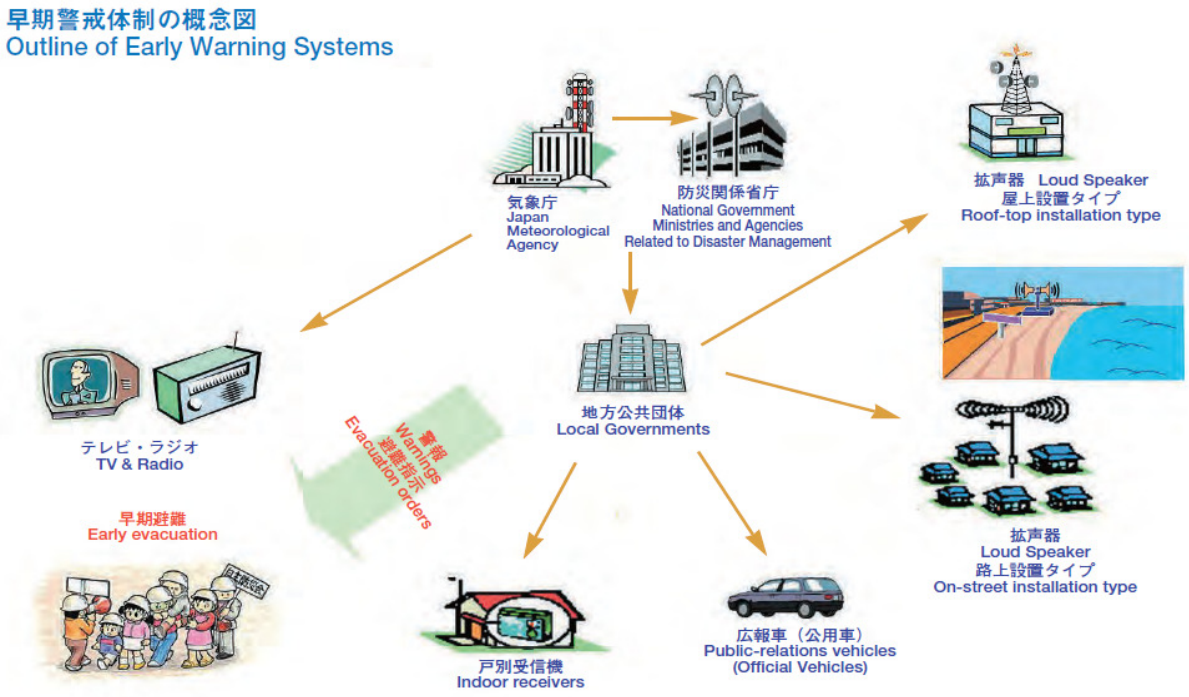


Figure4.3: The Outline of Early Warning Systems

4.5 Information and Communication Systems

The development of a quick and accurate communications systems is essential for the effective use of disaster early warning information. For this purpose an online system has been built, linking the JMA with disaster management organizations of the national and local governments and media organizations.

Disaster management organizations have also been developing radio communications networks exclusively for disasters: the Central Disaster Management Radio communications System, which connects national organizations; the Fire Disaster Management Radio Communications System, which connects firefighting organizations across the country; and prefectural and municipal disaster management radio communications systems, which connect local disaster management organizations and residents.

The Cabinet Office has established the Central Disaster management Radio Communications System to link with designated government organizations, designated public corporations and local disaster management organizations, providing communications by telephone, fax, data transmission, TV conferencing and transmission of pictures of disaster situations from helicopters.

Furthermore, to provide backup for terrestrial communications, services such as a satellite mobile telephone communications system for municipal governments have been launched in 2011.

Simultaneous wireless communications systems using outdoor loudspeakers and indoor radio receivers are used to disseminate disaster information to residents. Tsunami and severe weather warnings are widely provided to citizens via TV and radio broadcasts.

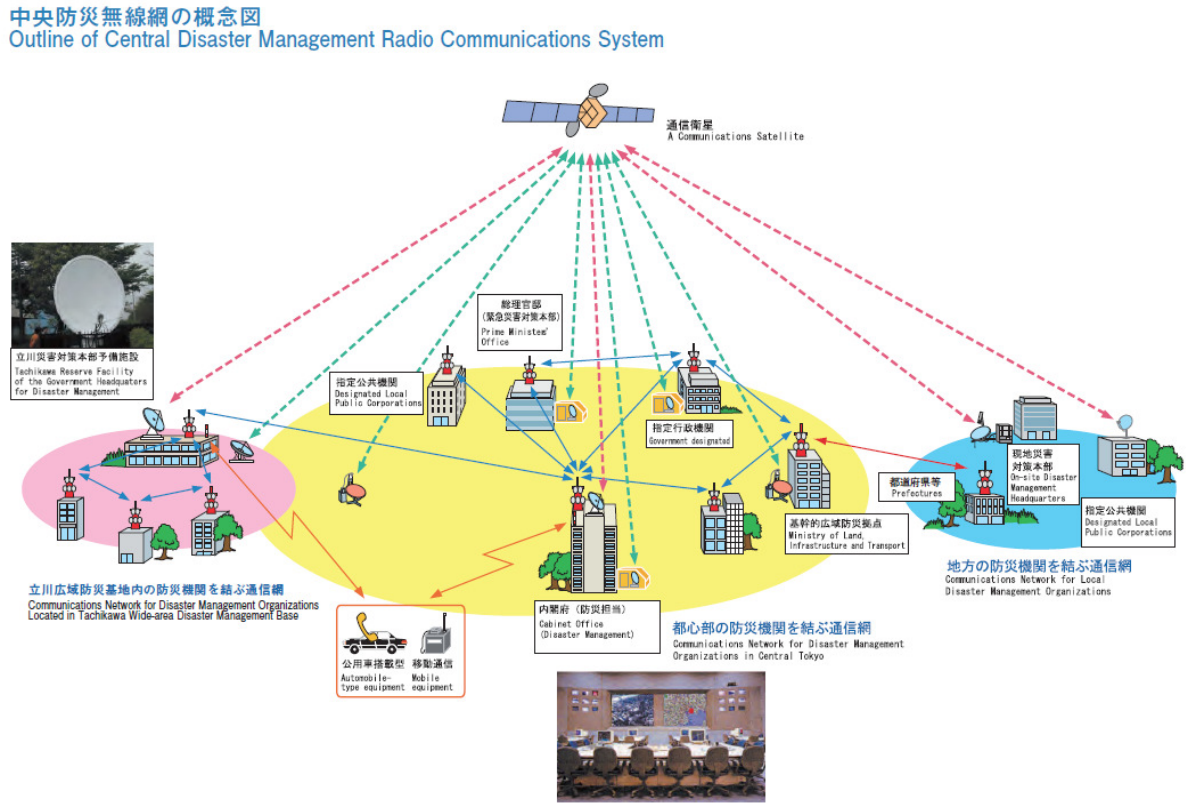


Figure4.4: The Outline of Central Disaster Management Radio Communications System

4.5.1 How to use warnings and Information for Disaster Prevention.

Japan is one of the most earthquake-prone countries in the world, and has repeatedly suffered serious damage caused by earthquakes and tsunamis.

What would happen if there were no earthquake/tsunami information when a tremor hits? The absence of information on areas that are at risk of tsunami strikes or subject to strong shaking would delay evacuation and emergency response by disaster prevention agencies, and may result in extensive damage.

The Japan Meteorological Agency (JMA) promptly issues warnings and information on earthquakes and tsunamis to mitigate disasters and protect life and property.

Examples:

●In the event of large earthquakes, JMA announces earthquake alerts before strong tremors arrive **(Earthquake Early Warnings).**

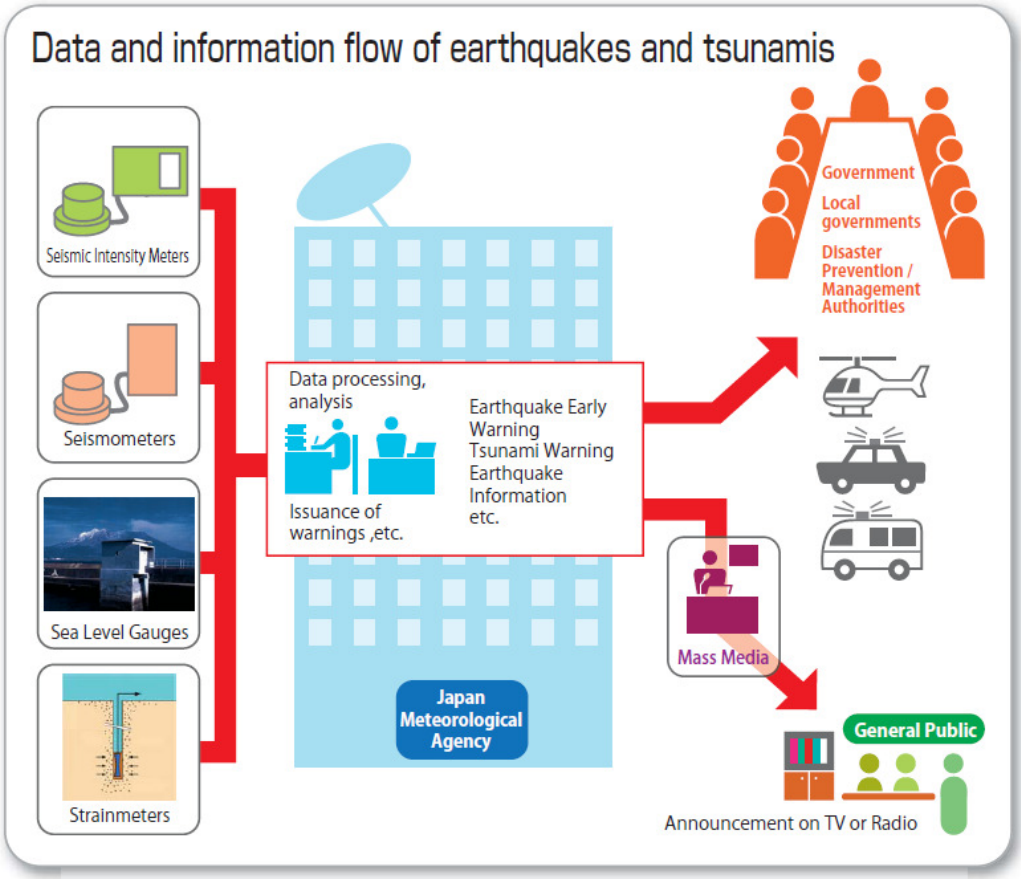
●In the event of large earthquakes in ocean areas, JMA announces estimated tsunami heights and their arrival times in advance **(Tsunami Warnings/Advisories).**

●In the event of earthquakes, JMA announces hypocenter, magnitude and where strong shaking has been felt **(Earthquake Information).**

To utilize above information, it is very important to understand the announcements made by JMA and to have a certain level of awareness in regard to earthquakes and tsunamis.

There is brochure explained about various types of information and warnings and outlines JMA's monitoring network. Basic facts about earthquakes and tsunamis are also included.

The resource aims to help people understand the various types of information issued by JMA to prevent and mitigate disasters caused by earthquakes and tsunamis.



4.5.2 Earthquake&Tsunami Warnings/Information in Japan

1) Earthquake and Tsunami Warnings

When JMA anticipates damage from an earthquake, it issues warnings and forecasts using observed data.

JMA has two kinds of warnings on earthquakes: one is an Earthquake Early Warning, which predicts strong motion, and the other is a Tsunami Warning, which predicts tsunamis. The Agency also issues public advisories and forecasts if the expected level of damage is below the criteria for these warnings to be issued.

2) Earthquake Early Warnings

Earthquake Early Warnings (EEWs) are warnings (or forecasts) of strong motion to be issued several seconds to several tens of seconds before its arrival.

If the estimated seismic intensity is above 5-lower, an EEW is issued to areas where the estimated seismic intensity is 4 or greater through media such as TV and radio.

The main benefit of EEW is that they are issued before the arrival of strong shaking. Strong tremors caused by earthquakes strike suddenly. However, notice of their arrival several seconds to several tens of seconds in advance allows people to take action to protect themselves, such as promptly moving away from windows and shelves or taking cover under a sturdy table. As there are only a few moments before strong tremors arrive, after the issuance of EEW there may be no time to consider how to react on hearing EEW; this makes it important to carry out emergency response drills so that appropriate action can be taken as soon as a warning is given. In areas close to the focus of the earthquake, however, an EEW may not be transmitted before the tremors hit and errors of ±1 or so may be included in the estimated scismic intencity of EEW.

It should be noted that there are such limits to the accuracy of EEW.

◆ Example of an EEW broadcast image (NHK)

◆ EEW

Criterion	Contents	Examples of responses to EEW
Predicted seismic intensity is 5-lower or greater.	Names of areas where seismic intensity is predicted to be 4 or greater	Provided through various media (e.g., TV and radio) to the general public.

3) Tsunami Warnings/Advisories and Tsunami Information

Tsunamis are one of damaging phenomena caused by earthquakes. If a tsunami strikes a coastal area, it can cause death or serious injury to people and damage to buildings.

When an earthquake occurs, JMA estimates whether a tsunami has been generated. If a disastrous tsunami is expected in coastal regions, JMA issues a Tsunami Warning/Advisory for each region (66 individual regions are defined to cover all coastal areas of the country).

Tsunami Warnings/Advisories are categorized into three levels – Tsunami Warning (Major Tsunami), Tsunami Warning (Tsunami) and Tsunami Advisory –according to the estimated tsunami height. JMA also issues information on tsunami details such as estimated arrival time and height. If no damage is expected, a Tsunami Forecast is issued.

Warnings/Advisories may be changed or updated based on observed tsunami heights.

◆ Tsunami Warnings/Advisories

Category		Indication	Action to be taken
Tsunami Warning	Major Tsunami	Tsunami height is expected to be 3 meters or more.	Leave coastal areas immediately and evacuate to a safe place.
	Tsunami	Tsunami height is expected to be up to 2 meters.	
Tsunami Advisory		Tsunami height is expected to be about 0.5 meters.	Leave coastal areas and do not engage in fishing or swimming activities.

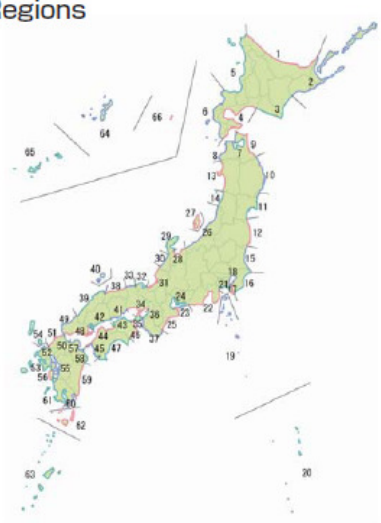
Tsunami Forecast

Forecast of changes in sea level	Indication
No tsunami is expected	A "No tsunami is expected" message is added to the Earthquake Information.
Expected height of sea level change less than 0.2 m.	No damage is expected as changes in sea level will be less than 0.2 m.
Slight sea level changes may still occur after Tsunami Advisory cancellation.	Pay attention when engaging in fishing, swimming or other activities, as changes in sea level may still occur for the time being.

Tsunami Information

Tsunami-related messages	Indication
Tsunami Information (forecast of height and arrival time of initial wave)	Forecasts of the height and arrival time of the initial wave are provided for each forecast region.
Tsunami Information (arrival time of tsunami and high tide)	Information on the estimated time of high tide and forecasts of tsunami arrival times at several points are provided.
Tsunami Information (tsunami observations)	Arrival times and tsunami heights observed at tsunami observation stations are provided.

Tsunami Forecast Regions



Number	Tsunami Forecast Regions	Number	Tsunami Forecast Regions	Number	Tsunami Forecast Regions
1	OKHOTSK SEA COAST OF HOKKAIDO	23	PACIFIC COAST OF AICHI PREF.	45	BUNGO STRAIT COAST OF EHIME PREF.
2	EASTERN PART OF PACIFIC COAST OF HOKKAIDO	24	ISE BAY AND MIKAWA BAY	46	TOKUSHIMA PREF.
3	CENTRAL PART OF PACIFIC COAST OF HOKKAIDO	25	SOUTHERN PART OF MIE PREF.	47	KOCHI PREF.
4	WESTERN PART OF PACIFIC COAST OF HOKKAIDO	26	NIIGATA PREF.,EXCEPT SADOGASHIMA ISLAND	48	SETONAIKAI COAST OF YAMAGUCHI PREF.
5	NORTHERN PART OF JAPAN SEA COAST OF HOKKAIDO	27	SADOGASHIMA ISLAND	49	JAPAN SEA COAST OF YAMAGUCHI PREF.
6	SOUTHERN PART OF JAPAN SEA COAST OF HOKKAIDO	28	TOYAMA PREF.	50	SETONAIKAI COAST OF FUKUOKA PREF.
7	MUTSU BAY	29	NOTO AREA, ISHIKAWA PREF.	51	JAPAN SEA COAST OF FUKUOKA PREF.
8	JAPAN SEA COAST OF AOMORI PREF.	30	KAGA AREA, ISHIKAWA PREF.	52	NORTHERN PART OF SAGA PREF.
9	PACIFIC COAST OF AOMORI PREF.	31	FUKUI PREF.	53	WESTERN PART OF NAGASAKI PREF.
10	IWATE PREF.	32	KYOTO PREF.	54	IKI ISLAND AND TSUSHIMA ISLANDS
11	MIYAGI PREF.	33	NORTHERN PART OF HYOGO PREF.	55	ARIAKE SEA AND YATSUSHIRO SEA
12	FUKUSHIMA PREF.	34	SETONAIKAI COAST OF HYOGO PREF.	56	AMAKUSA NADA COAST OF KUMAMOTO PREF.
13	AKITA PREF.	35	SOUTHERN PART OF AWAJI ISLAND	57	SETONAIKAI COAST OF OITA PREF.
14	YAMAGATA PREF.	36	OSAKA PREF.	58	BUNGO STRAIT COAST OF OITA PREF.
15	IBARAKI PREF.	37	WAKAYAMA PREF.	59	MIYAZAKI PREF.
16	KUJUKURI AND SOTOBO AREA, CHIBA PREF.	38	TOTTORI PREF.	60	EASTERN PART OF KAGOSHIMA PREF.
17	UCHIBO AREA, CHIBA PREF.	39	SHIMANE PREF.,EXCEPT OKI ISLANDS	61	WESTERN PART OF KAGOSHIMA PREF.
18	TOKYO BAY	40	OKI ISLANDS	62	TANEGASHIMA AND YAKUSHIMA AREA
19	IZU ISLANDS	41	OKAYAMA PREF.	63	AMAMI ISLANDS AND TOKARA ISLANDS
20	OGASAWARA ISLANDS	42	HIROSHIMA PREF.	64	OKINAWA ISLANDS
21	SAGAMI BAY AND MIURA PENINSULA	43	KAGAWA PREF.	65	MIYAKOJIMA AND YAEYAMA AREA
22	SHIZUOKA PREF.	44	SETONAIKAI COAST OF EHIME PREF.	66	DAITOJIMA AREA

4) Earthquake Information

JMA issues predictive information such as Tsunami Warnings/Advisories and Earthquake Early Warnings as well as earthquake information based on the results of observations.

◆ Earthquake Information issued by the JMA

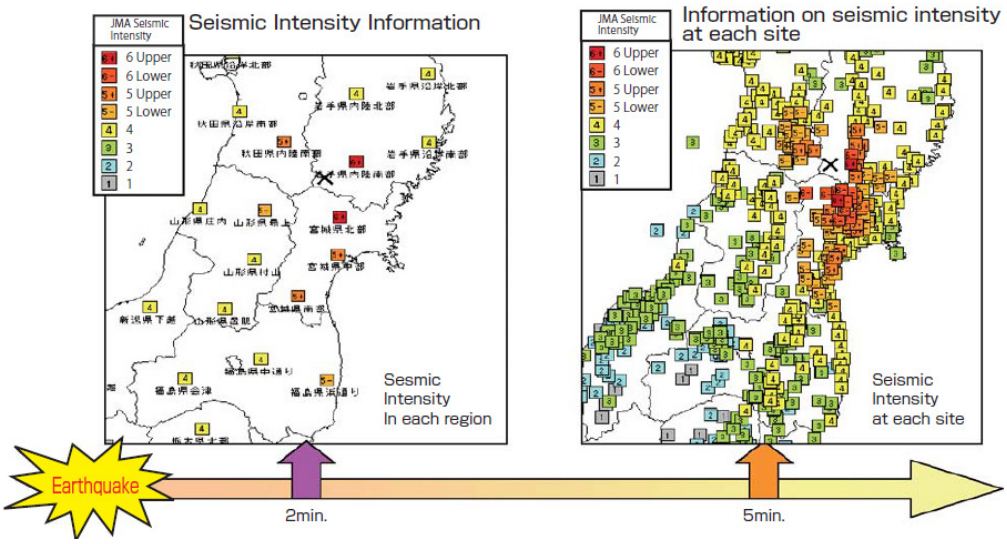
Title	Content and timing of issue
Seismic Intensity Information	Occurrence of an earthquake Regions with seismic intensity of 3 or greater (Issued within two minutes of earthquake occurrence)
Earthquake Information	Earthquake hypocenter and magnitude Remark – either "No threat of tsunami" or "Sea levels may change slightly, but no danger is expected." (Issued when no tsunami forecast is announced.)
Earthquake and Seismic Intensity Information	Earthquake hypocenter and magnitude Cities/towns/villages with seismic intensity of 3 or greater, and those with estimated seismic intensity of 5-lower or greater with no reports from seismic intensity meters
Information on seismic intensity at each site	Earthquake hypocenter and magnitude Sites with seismic intensity of 1 or greater
Information on the number of earthquakes	Number of earthquakes with seismic intensity of 1 or greater (Issued if earthquakes occur repeatedly.)
Shake Map(Estimated Seismic Intensity Distribution Map)	Estimated Seismic Intensity Distribution Map based on seismic intensity data (Issued when seismic intensity is 5-lower or greater.)

Seismic Intensity Information and Information on seismic intensity at each site

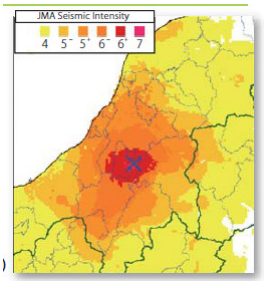
When seismic intensity is 3 or greater, JMA issues Seismic Intensity Information within two minutes to allow emergency action to be taken.

The seismic intensities are disseminated to disaster management organizations and are used as a trigger for their emergency operation. They are also broadcast to the public by TV, radio and other media. For example, the Cabinet Secretariat will call a meeting of the designated emergency response team in the event of a quake with seismic intensity of 6-lower or greater.

◆ Issuance of Seismic Intensity Information and Information on Seismic Intensity at each site (The Iwate-Miyagi Nairiku Earthquake in 2008)



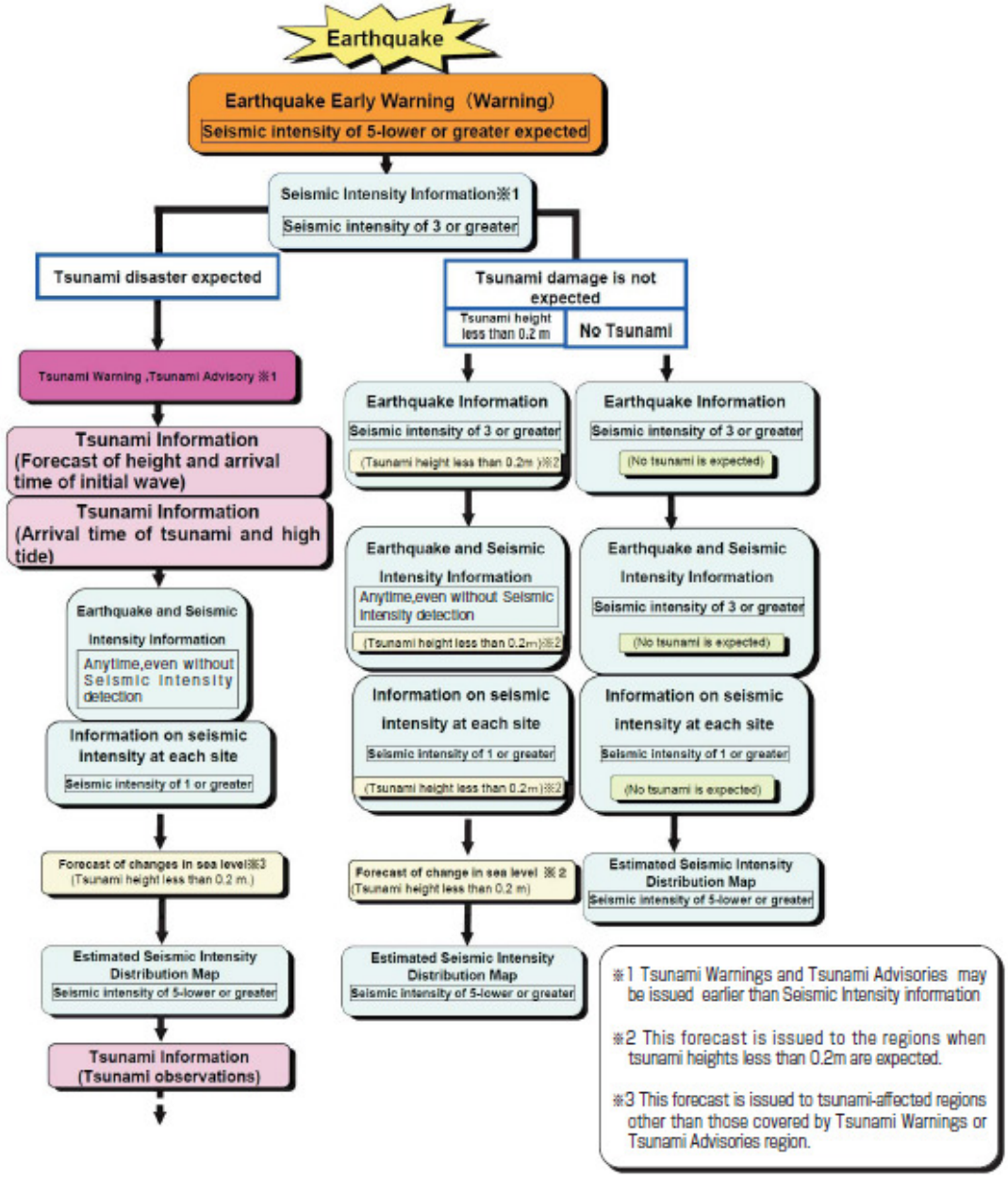
Shake Map (Estimated Seismic Intensity Distribution Map



To enable prompt emergency measures to be taken by disaster management authorities, JMA analyzes seismic intensity taking into account the surface geology for each grid space, and draws an Estimated Seismic Intensity Distribution Map that shows estimated seismic intensity in places without seismic intensity meters. As the analyzed values have a margin of error, users should focus on the extent and distribution of strong ground motion areas rather than the respective estimated value for each grid.

Estimated Seismic Intensity Distribution Map The Mid Niigata prefecture Earthquake in 2004)

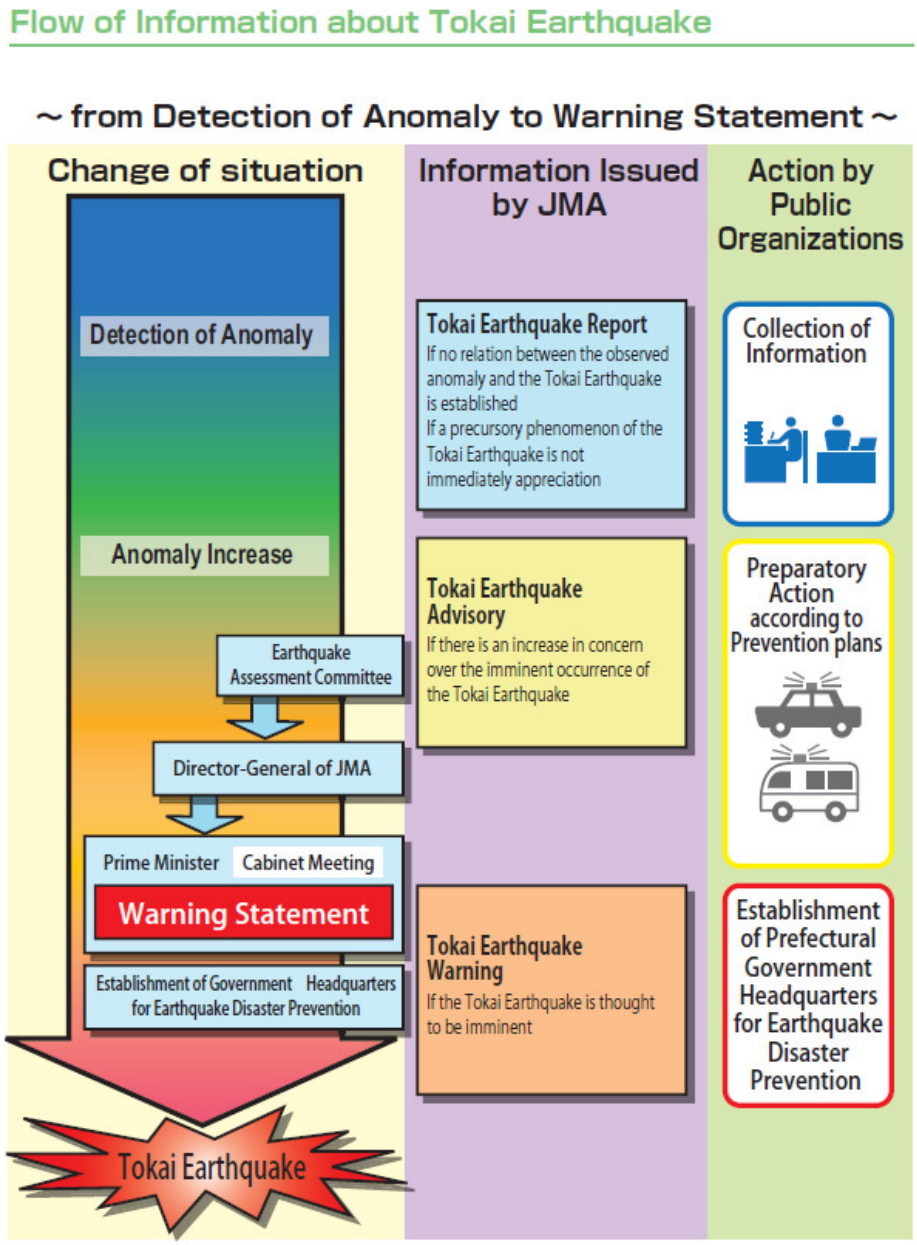
Flow of issuance of information on tsunamis and earthquakes



5)Tokai Earthquake Prediction and Information

Information about Tokai Earthquake

In Japan, a large-scale earthquake with a magnitude of around 8 (referred to as the Tokai Earthquake) is widely expected to hit the Tokai region in the near future. In order to predict the occurrence of the Tokai earthquake, JMA has developed a seismic and crustal deformation observation network throughout the region in conjunction with related organizations, and observes data coming from them on around-the-clock basis (see p.16). If anomalous data are detected, JMA issues Information on the Tokai Earthquake bulletins to allow preparatory action and emergency measures for earthquake disaster prevention. These are categorized into three types:Tokai Earthquake Report, Tokai Earthquake Advisory, and Tokai Earthquake Warning .



6) Information on Large Earthquakes and Tsunamis

Prompt Report of Occurrence of a Large Earthquake（News Release）

When a large earthquake occurs, JMA issues a rompt Report of Occurrence of a Large Earthquake and Tsunami (hypocenter, magnitude, possibility of tsunami, areas of strong motion, historical earthquake activity around the hypocenter). If there is possibly serious damage, the Agency announces information on the earthquake and issues important notices to the public through the news media (News Release).

Press conference

<Prompt Report about a Large Earthquake>
- Hypocenter and magnitude
- Possibility of tsunami
- Areas of strong motion
- Historical earthquake activity

<News Release>
(when there is possibly serious damages)
In addition to the prompt report,
- Prospect of aftershock activity (see below)
- Characteristics of earthquake derived from data analysis
- Results of mobile observations

Notes: English versions of the Prompt Report and Information on the prospect of aftershock activity are not available on the website as of April, 2009.

Prospect of Aftershock Activity

When a large earthquake occurs, a sequence of smaller earthquakes usually follows it. The largest earthquake is called the mainshock, while the smaller ones are referred to as aftershocks. In the event of a large earthquake, JMA announces the prospect of aftershocks to the public to enable appropriate measures to be taken.

<Example content of a report on the prospect of aftershock activity>

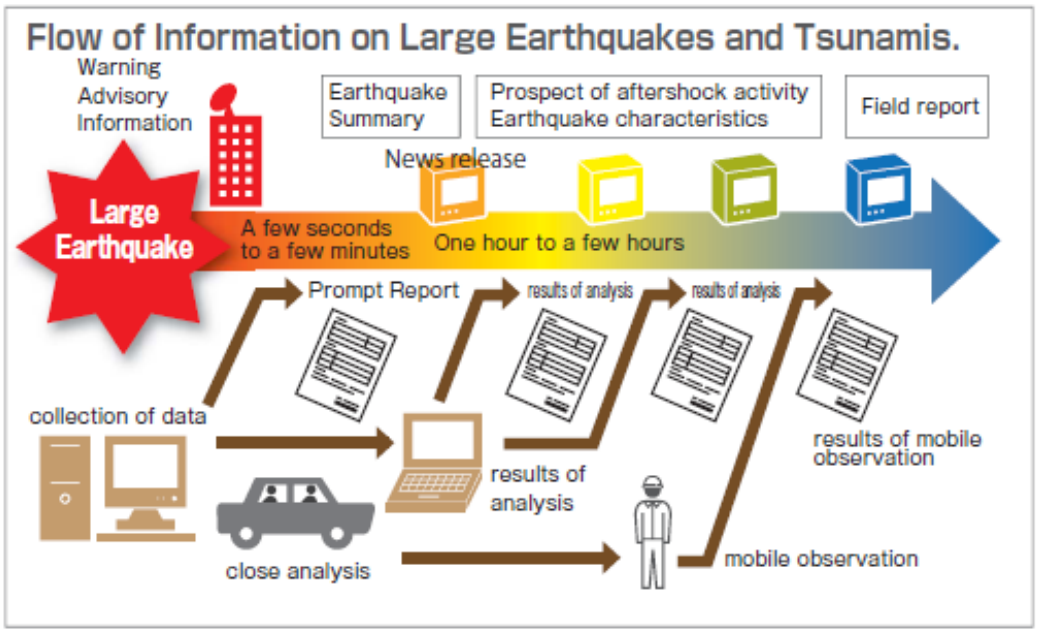
★Comparison of the quake with previous ones
Example…「今回の地震の余震活動は、過去の事例に比べて、極めて活発な部類に属します。」
The level of earthquake activity is very high compared with previous occurrences.

★Current status of aftershocks
Example…「余震活動は時間の経過とともに減衰しているものの、一時的に活発化しています。」
The frequency of aftershocks will decrease over time, but may sometimes increase.

★Aftershock vigilance period
Example…「今後１週間程度は」
A week from the present time

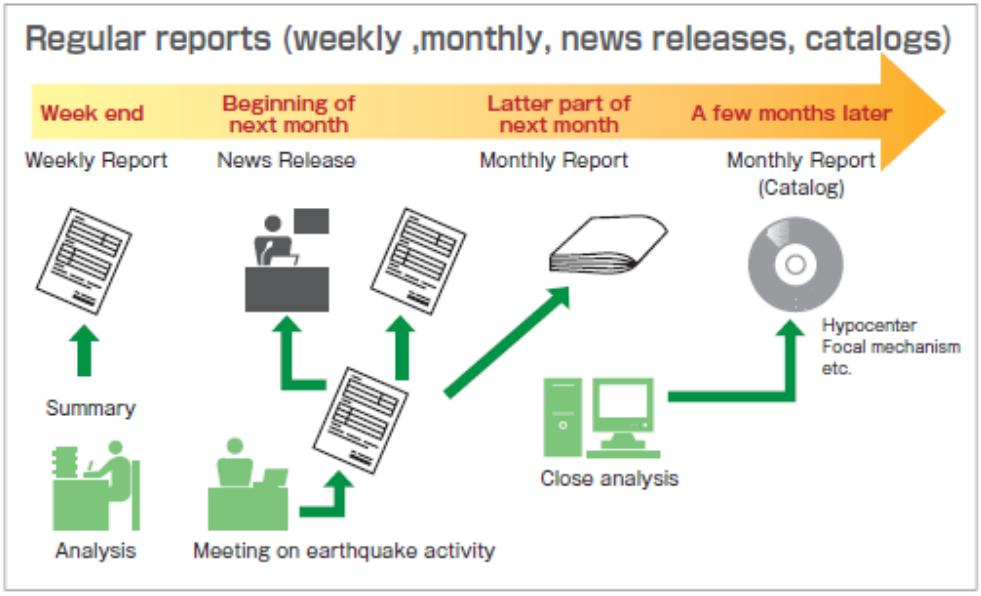
★Expected seismic intensity of aftershocks
Example…「震度６弱、ところによっては震度６強の揺れとなる余震が発生するおそれがあります。」
Large earthquakes with strong shaking and a seismic intensity of 6-lower or 6-upper may occur.

★Things to be careful of
Example…「本震によって強い揺れとなった地域では、余震によって家屋の倒壊や土砂崩れなど、さらに被害が拡大するおそれがありますので、やむを得ない事情がない限り危険個所には立ち入らないなど厳重な警戒が必要です。」
Pay attention to landslides and building collapse as a result of aftershocks.



Regular reports on earthquake activity

JMA announces summary of earthquake activities on a weekly and monthly basis. Weekly and monthly reports are published on the JMA website. In addition, the Agency issues the monthly summary as news releases to the public in the beginning of the month.

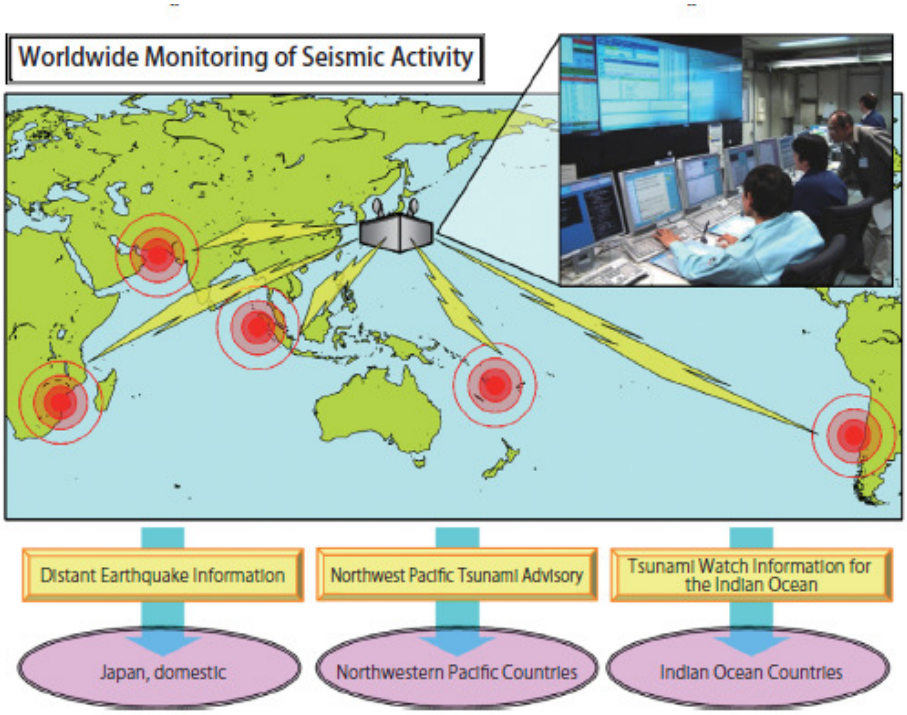


Distant Earthquake Information and International Tsunami Advisories

JMA monitors seismic activity not only around Japan but also worldwide. If a tsunami generated by a distant earthquake is expected to hit the Japanese coast and possibly cause disastrous conditions, JMA issues Tsunami Warnings/Advisories in the same way as for local tsunamis. When a

major earthquake occurs somewhere far from Japan, the Agency issues Distant Earthquake Information to the public.

Tsunamis spread ocean-wide regardless of the borders of countries, and can cause serious damage in multiple coastal areas. In order to protect human life and property against tsunami hazards, we must work together with overseas related organizations. Within a worldwide framework for a tsunami warning system, countries exchange observational data and information to enable earthquake/tsunami detection and measures against expected tsunamis as early as possible. Japan has a wealth of experience and knowledge on tsunamis, and JMA, in such an international partnership role, plays a major part in contributing to tsunami disaster management measures in other countries. When a large earthquake occurs in the Sea of Japan, the northwestern Pacific region or the Indian Ocean, the Agency analyzes the related observation data and quickly provides International Tsunami Advisories to the countries in each region. These advisories contain information on the earthquake and the possibility of tsunamis, and are used in the recipient countries for the implementation of emergency action such as nationwide tsunami warnings and official evacuation.



Earthquake and Tsunami Monitoring

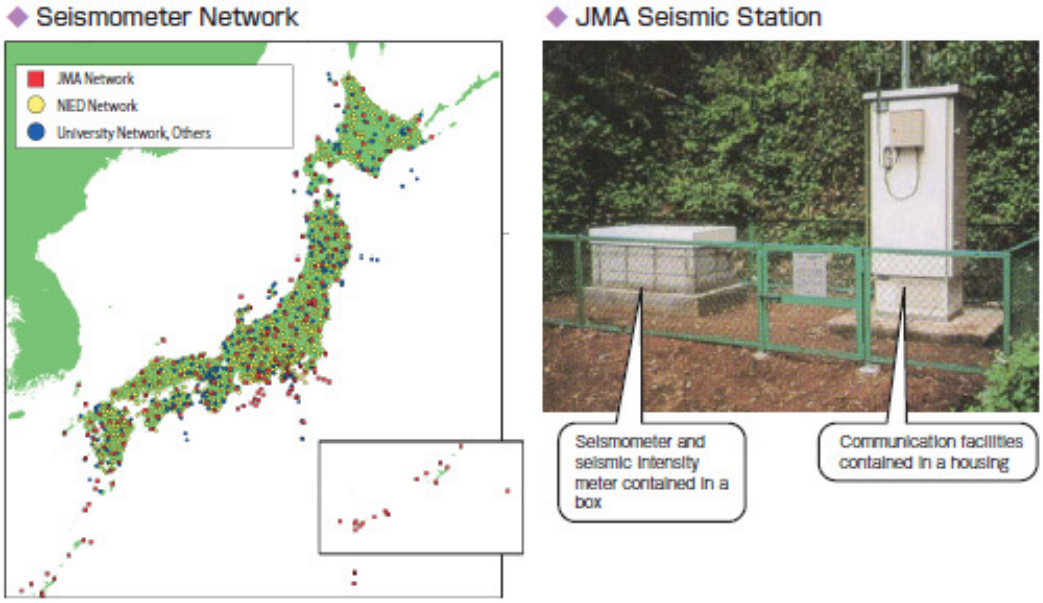
JMA collects real-time data from seismometers, seismic intensity meters, gauge stations and other instruments to monitor earthquakes and tsunamis around the clock. When an earthquake causes serious damage, the Agency dispatches the JMA Mobile Observation Team (JMA-MOT) to assess the situation.

Seismometer Network

When an earthquake occurs, it is important to know its location and magnitude. To achieve this, we need to observe its waves and analyze its hypocenter and magnitude; an instrument used to observe earthquake waves is called a seismometer.

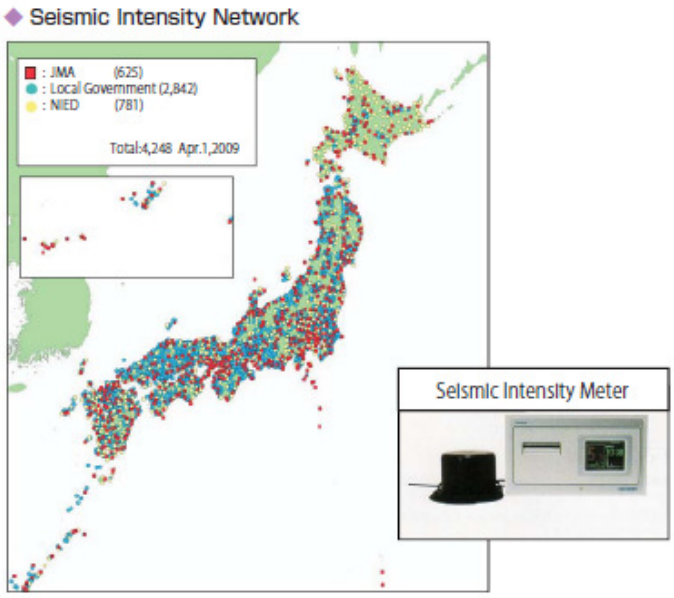
JMA operates a seismic network consisting of about 200 seismometers and collects seismic waveform data in real time around the clock. The Agency also uses seismometers belonging to the National Research Institute for Earth Science and Disaster Prevention (NIED), and issues Earthquake Early Warnings, Tsunami Warnings / Advisories and Earthquake Information.

JMA also collects and analyzes seismic data from NIED, universities and related institutes in order to conduct comprehensive assessment of seismic activity for the promotion of research activities in cooperation with the Ministry of Education, Culture, Sports, Science and Technology (MEXT). The products of this analysis are shared with the relevant organizations.



Seismic Intensity Network

A seismic intensity meter is an instrument that measures and records the seismic intensity of ground motion. JMA has installed about 600 seismic intensity meters throughout the country, and also collects seismic intensity data from another 3,600 stations (as of Apr. 1, 2009) operated by local governments and the National Research Institute for Earth Science and Disaster Prevention (NIED). These data are used for Earthquake Information issued by JMA.



Tsunami Monitoring Network

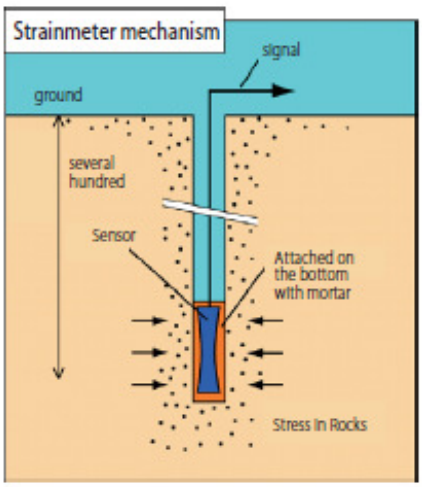
When tsunamis are observed, JMA issues tsunami observation information including observation points, tsunami heights and expected times of arrival. The Agency operates about 70 tidal gauge stations and also collects real-time sea-level data from stations operated by the Ports and Harbors Bureau (Ministry of Land, Infrastructure, Transport and Tourism), the Geographical Survey Institute and the Japan Coast Guard. Currently, JMA issues tsunami information using data from about 170 stations.

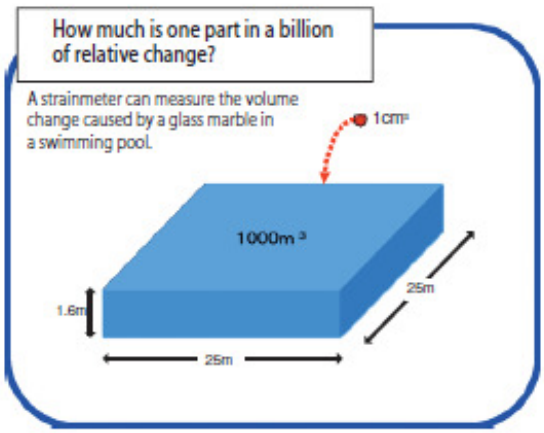
◆ Stilling-well Type Gauge Station

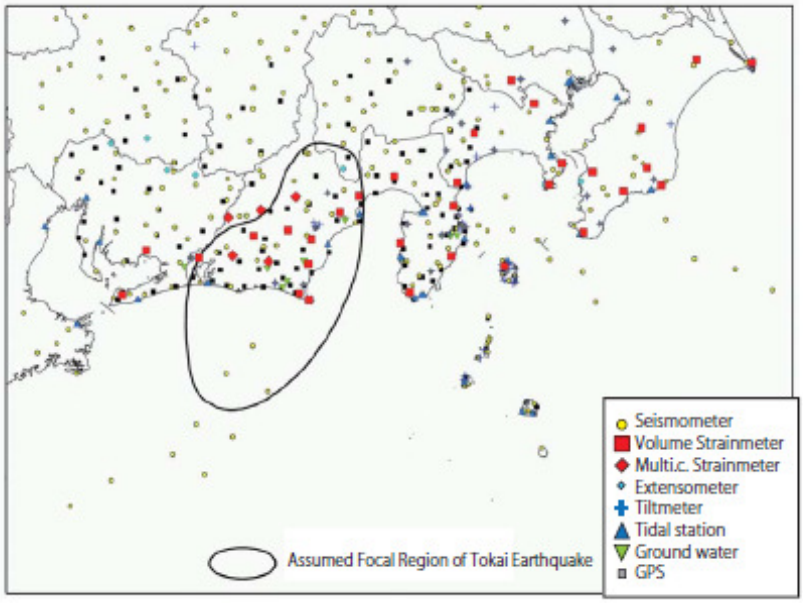
◆ Acoustic Type Gauge Station

Observation systems for the Tokai Earthquake

Various kinds of instruments, including seismometers, strainmeters and GPS equipment, are installed in and around the assumed focal region of Tokai Earthquake (see the figure below). The observational data in collaboration with related institutes are continuously transmitted to JMA. Strainmeters play an important role in detecting potential pre-slip movement that may be a precursor to the Tokai Earthquake. They measure very minute expansions and contractions in underground rock. A cylindrical sensor is set at the bottom of a borehole several hundred meters in depth. A strainmeter can detect a relative change of one part in a billion of crustal expansion or contraction. This is equivalent to measuring the volume change caused by a glass marble in a swimming pool.





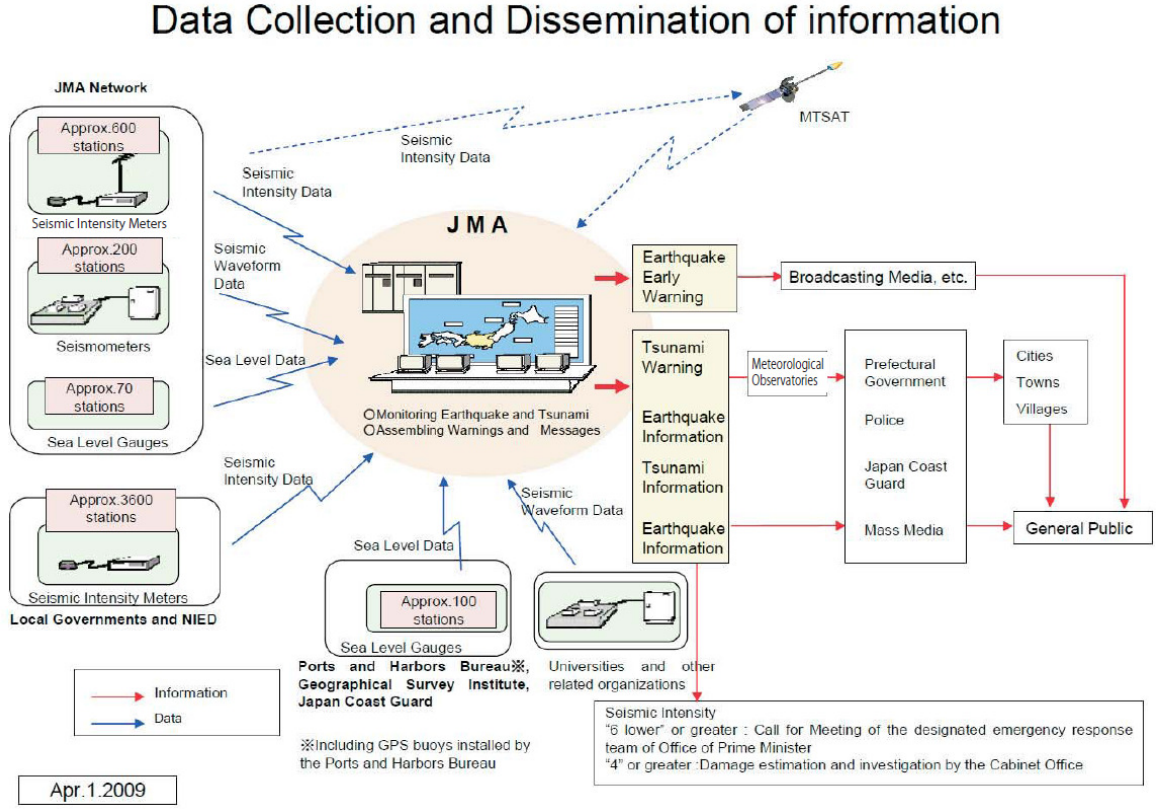


These observations are maintained under joint cooperation effort with the Geographical Survey Institute, Japan Coast Guard, the University of Tokyo, Nagoya University, National Research Institute for Earth-Science and Disaster Prevention, Advanced Industrial Science And Technology, Shizuoka Prefecture and others.

A Data Collection and Processing System for Assured Communication

JMA monitors seismic activity and issues Warnings/Advisories and information on a 24-hour basis. To provide these resources urgently and precisely, JMA needs to collect various seismic data and analyze them quickly. To this end, the Agency operates a comprehensive system called EPOS (the Earthquake Phenomena Observation System). This is responsible for issuing Earthquake Early Warnings, Tsunami Warnings/Advisories, Earthquake Information and Information on the Tokai Earthquake.

Warnings/Advisories and information issued by JMA are transmitted to disaster management authorities, local governments and the broadcasting media over a nationwide computer network immediately. Disaster management authorities and local governments take action to mitigate disasters based on these resources. Such action is also announced to the public through the media and the Internet.



Basic knowledge about earthquake and tsunami

Earthquakes and Shaking

What is an earthquake? When people feel the ground shake, they exclaim, "It's an earthquake!" Strictly speaking, what they are feeling is ground motion caused by an earthquake. As a technical term, ground motion is used to distinguish this movement from the earthquake itself. An earthquake is a destructive slip movement inside a rock plate deep under the ground. We call the plane of this movement a fault , and the point at which a destructive slip movement starts is called the hypocenter.

Such destructive slip movements cause vibration that propagates in every direction. Since vibration travels in a wave formation, its movement is called a seismic wave. When the vibration reaches the ground surface, people become aware of earthquake motion. Thus, not all places on the surface of the ground shake at the same time. Locations closer to the hypocenter shake first, while distant areas shake later.

Seismic waves

Seismic waves can be either primary waves (P-waves) or secondary waves (S-waves). S-waves propagate more slowly than P-waves, but have a high amplitude and cause damage. P-waves travel at about 7 km/s (25,200 km/h), while S-waves move at about 4 km/s (14,400 km/h). At a point 50 km from the hypocenter, for example, a P-wave will arrive at about 7 seconds after the start of the quake, and an S-wave will arrive at about the 13-second point.

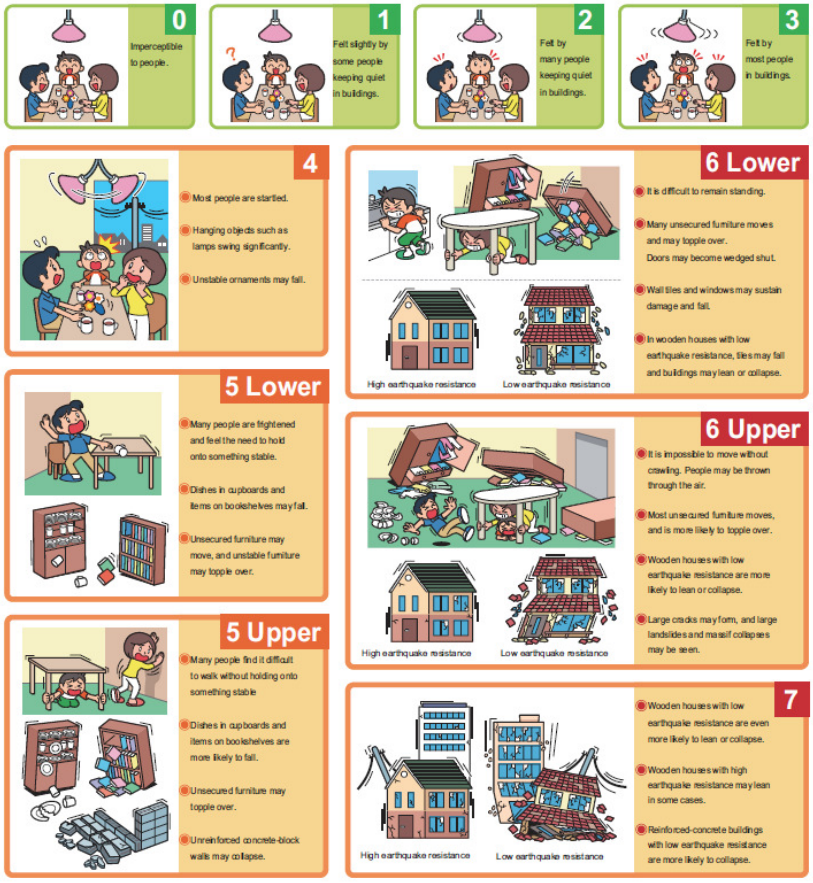
Catching seismic waves

How can we find out where an earthquake occurs ? Vibration propagates as a wave, so the farther a point is from the hypocenter,the later the wave arrives. As a result, if we can pinpoint where

earthquake motion appears first among many monitoring sites (seismometers),the hypocenter can be assumed to near that site. In fact, hypocenters are located by considering the subterranean structure (i.e., the structure of the earth s crust) and comparing differences in the appearance times of P-waves and S-waves.

Seismic Intensity and Magnitude

Seismic intensity and magnitude are easily confused because both have similar values. In this section, we explain the difference between them. Seismic intensity describes the scale of the ground motion at a particular location. It varies with the distance from the epicenter and the surface geology at each point. JMA s seismic intensity scale has 10 degrees (0 (imperceptible), 1, 2, 3, 4, 5-lower, 5-upper, 6-lower, 6-upper, 7). Magnitude is a numerical value that represents the scale of a fault slip underground. Large earthquakes have high magnitude.

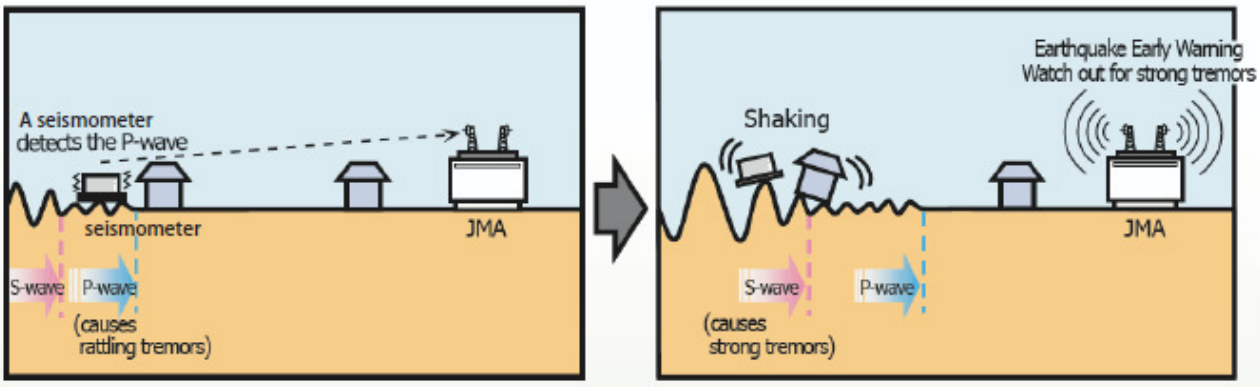


◆ Summary of JMA Seismic Intensity Scale Tables

Principle of Earthquake Early Warnings

Earthquake Early Warnings (EEWs) are issued slightly after an earthquake occurs. They are not earthquake predictions which tell us occurrence of earthquake in advance.

As soon as an earthquake occurs, the EEW system uses seismometers located near the epicenter to calculate the hypocenter, magnitude and P-wave data detected by the area that will be subjected to strong shaking, and provides a first announcement. EEWs are transmitted promptly. A sophisticated observation system to detect seismic waves quickly, technology that enables forecasting from very weak shaking and communication technology for prompt dissemination are the elements that enable JMA to issue EEWs.



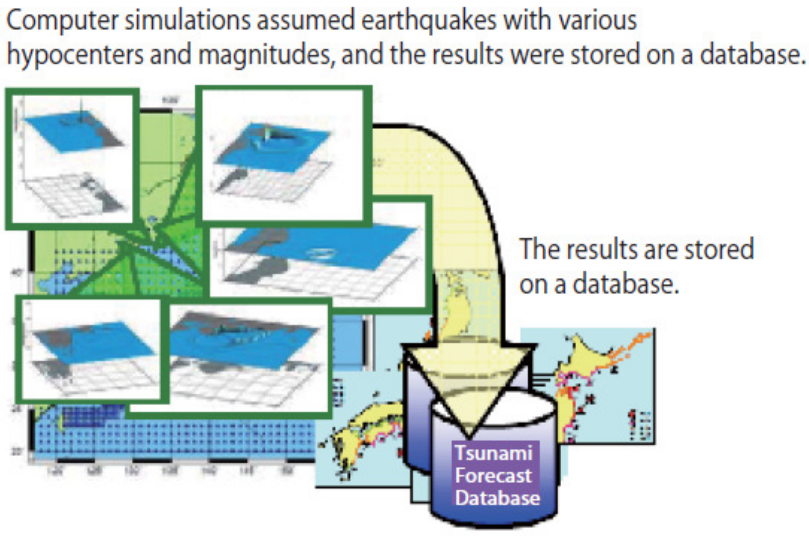
Tsunamis

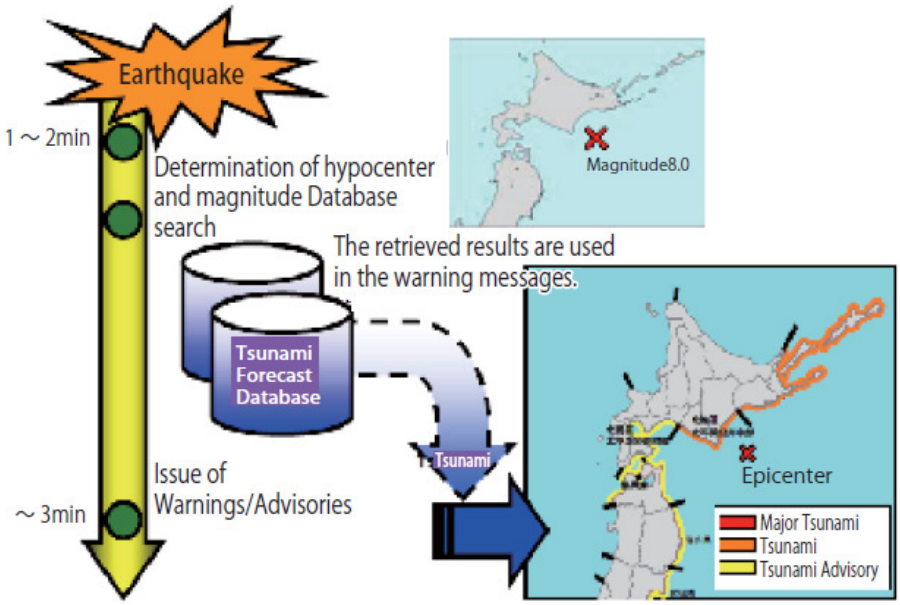
When large earthquakes occur in ocean areas, the sea floor rises or sinks. Accordingly, massive amounts of water on the sea floor also move up or down, and this movement spreads out in all directions in the ocean. The resulting waves are called tsunamis. Tsunami waves become slower as the sea becomes shallower. As a result, trailing waves catch up with those ahead near the coast, and the tsunami grows much higher. Even if a tsunami does not seem very high in offshore areas, it can turn into a big wave near the coast. If you feel an earthquake in a coastal area or if a Tsunami Warning is issued, evacuate immediately to high ground. Under no circumstances should you go to the seashore to see the tsunami.

Method of Tsunami Warning

When a large earthquake occurs in a sea area, JMA issues a Tsunami Warning/Advisory. A numerical simulation technique is used to estimate tsunami potential and propagation. After an earthquake occurs, Tsunami Warnings/Advisories must be issued immediately to enable evacuation before the wave strikes coastal areas.

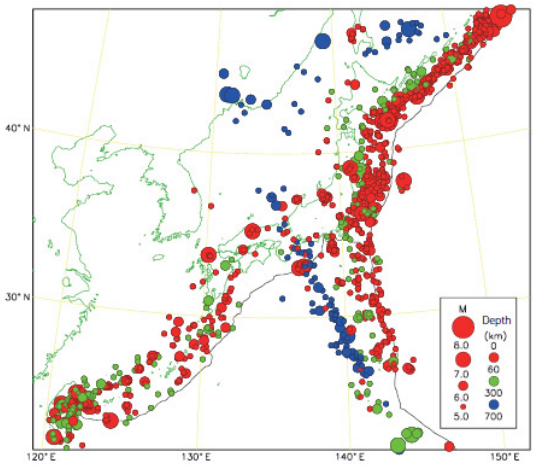
To enable immediate issuance of Tsunami Warnings/Advisories, JMA has conducted computer simulation of tsunamis with earthquake scenarios involving various locations and magnitudes, and the resulting information on tsunami arrival times and heights is stored on a database. If a large earthquake occurs, the operation system quickly calculates its hypocenter and magnitude, searches the tsunami database referring to these calculations, and selects the closest-matching results from the database. Using the estimated height of the tsunami for each coastal region, JMA issues a Tsunami Warning/Advisory.





Earthquakes around Japan

Around Japan, oceanic plates called the Pacific Plate and the Philippine Sea Plate subduct beneath the continental plates (the North American Plate and the Eurasian Plate) several centimeters annually. These plate movements cause forces to act in various directions around the country, which is the reason behind the extremely high seismic activity in the area. Around Japan, therefore, oceanic plates subduct beneath continental plates. These continental plates are dragged down as a result, and strain energy is accumulated. When this strain exceeds a certain level, it causes the continental plates to jump up, and tremors known as interplate earthquakes occur. Conversely, tremors generated by strain forces within a plate are called intraplate earthquakes. They occur in subducting plates and shallow underground areas of continental plates. Compared to interpolate earthquakes, intraplate earthquake occurring in shallow underground areas are relatively small, but can cause serious damage if they occur directly below populous areas.



Distribution of earthquakes around Japan from 1998 to 2008 (data from the Japan Meteorological Agency)

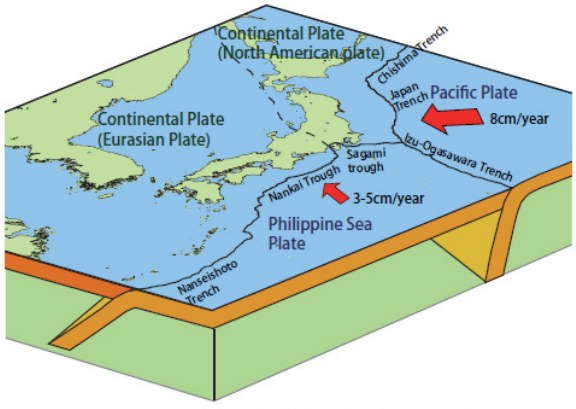
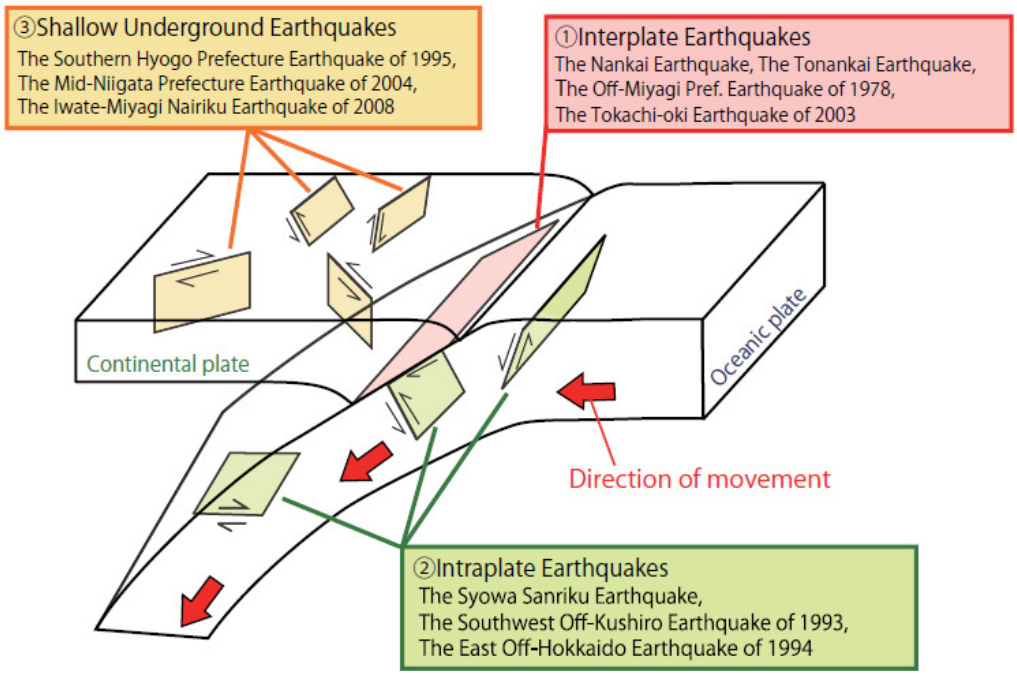


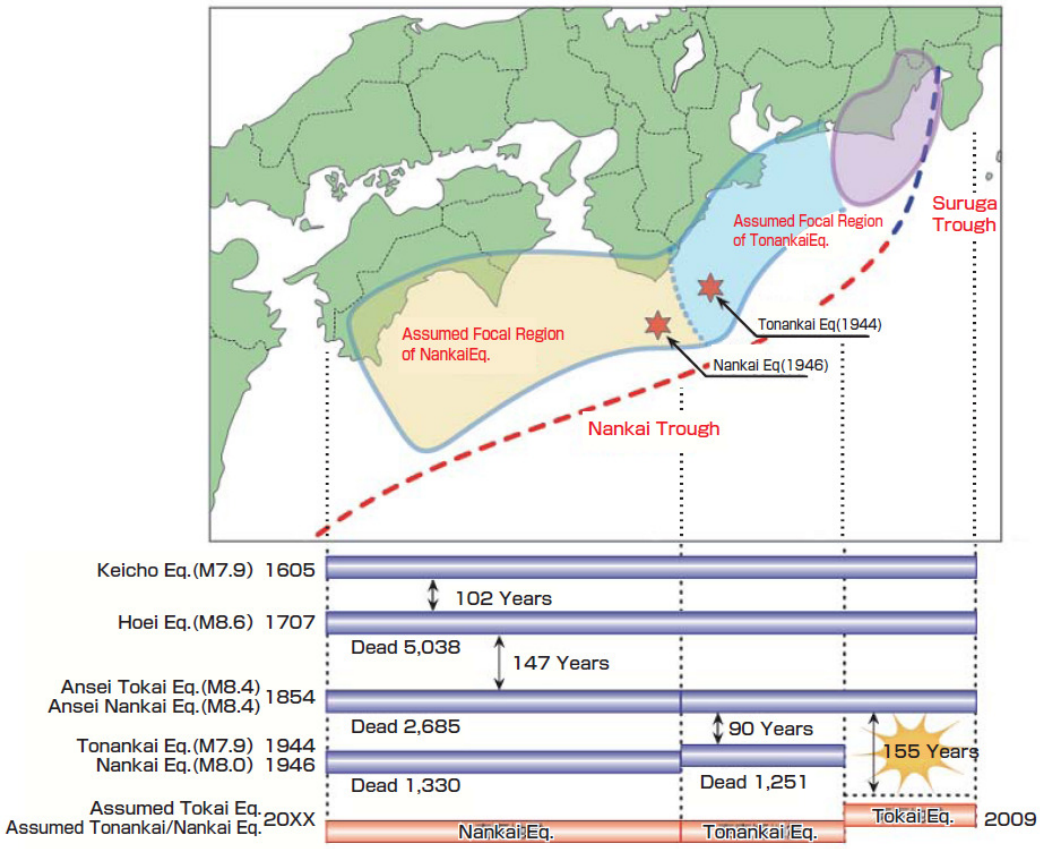
Plate Tectonics around Japan



The Tokai Earthquake

The Tokai Earthquake is expected to occur in the near future along the trench near Suruga Bay, and is considered to be as large as M8-class. Large earthquakes of this magnitude have occurred historically every 100 –150 years in the area from the Suruga Trough in Suruga Bay to the trough off Shikoku Island, and are known as Tonankai/Nankai Earthquakes. However, when the last Tonankai Earthquake (1944, M7.9) and Nankai

Earthquake (1946, M8.0) occurred, the crust along the Suruga Trough did not move. Since the trough (in region E of the figure below) has remained motionless for more than 150 years, the Tokai Earthquake is widely expected to occur in the near future.



How is it possible to predict the Tokai Earthquake?

In relation to the Tokai Earthquake, a pre-slip phenomenon (see the figure below) is expected just before the quake itself, and observation systems are in place to detect this slip. If it actually takes place and is successfully detected, JMA will issue warning information on the Tokai Earthquake. However, there is a possibility that the pre-slip could be too slight to be detected by the sensors, so it cannot be said with certainty that the Tokai Earthquake will be predicted.

Why it is thought possible to predict the Tokai Earthquake scientifically

●It is expected to be accompanied by precursory phenomena.

●Observation systems are in place to detect these phenomena.

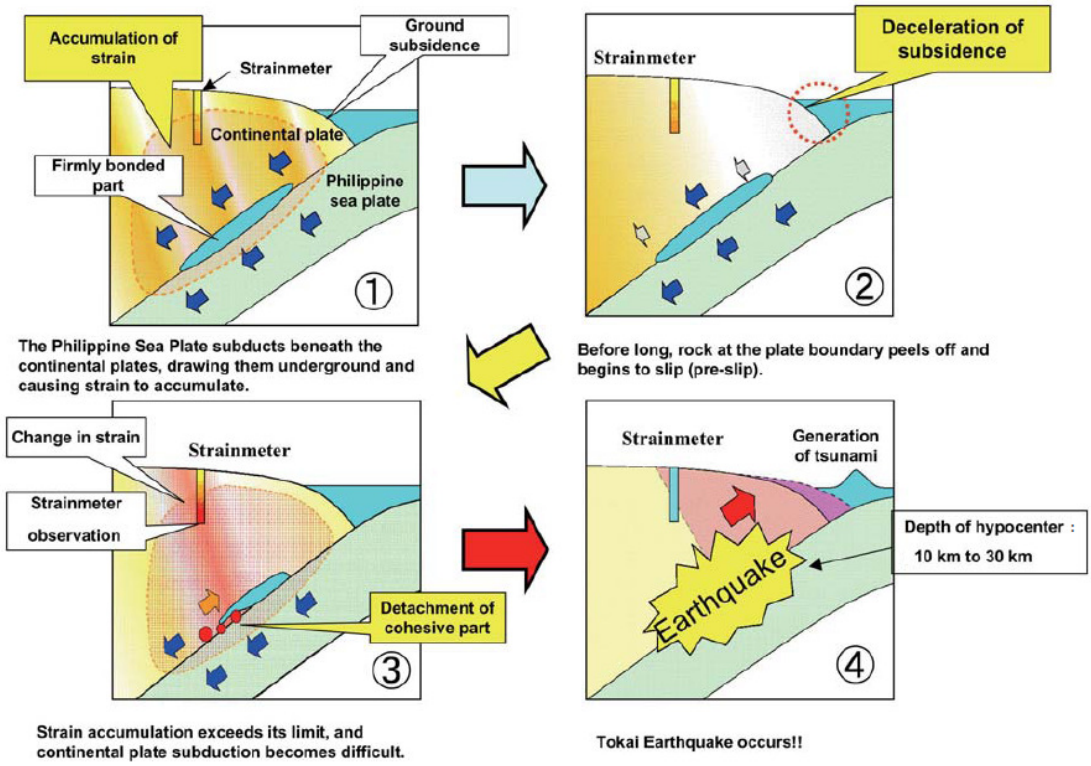
●There are guidelines on deciding based on the pre-slip model whether detected anomalous phenomena are precursory in nature or not.

Tokai Earthquake Generation Scenario

The Tokai Earthquake is expected to occur with the following sequence:①Accumulation of strain, ② Deceleration of subsidence, ③ Pre-slip, ④ Occurrence of Tokai Earthquake .Pre-slip is a phenomenon where part of the hypocentral region (the hard bonded plate boundary in the case of the Tokai Earthquake) peels off and begins to slip.

The key to predicting the Tokai Earthquake is the detection of signs of pre-slip. JMA monitors unusual movement that may accompany pre-slip using strainmeters to predict its occurrence.

◆ Tokai Earthquake Generation and Pre-slip Scenario



6. Earthquake Early Warning

What is an Earthquake Early Warning? (緊急地震速報 (Kinkyu Jishin Sokuho) in Japanese)

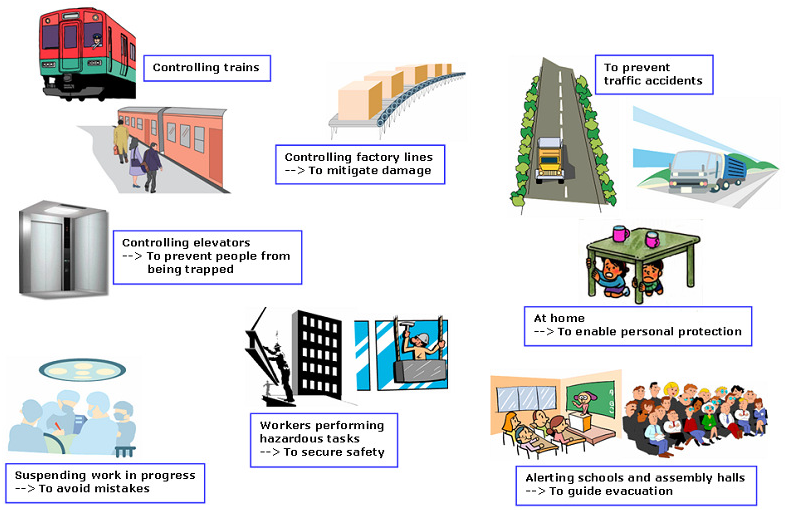
The Earthquake Early Warning system provides advance announcement of the estimated seismic intensities and expected arrival time of principal motion. These estimations are based on prompt analysis of the focus and magnitude of the earthquake using wave form data observed by seismographs near the epicenter. The Earthquake Early Warning 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 Earthquake Early Warning system provides advance announcement of the estimated seismic intensities and expected arrival time of principal motion.

When a major earthquake occurs, the following information is broadcasted through wireless loudspeaker:

Earthquake Early Warning		A major earthquake is about to occur. A major earthquake is about to occur.
Earthquake and Tsunami Information	Seismic intensity of 4 or more	An earthquake with a seismic intensity of □□ has occurred. Please turn off the gas and extinguish all fire sources. Please turn on the TV or radio and stay calm.
	Large Tsunami Warning	A Large Tsunami Warning has been issued. For those near the ocean, please evacuate to high ground.
	Tsunami Warning	A Tsunami Warning has been issued. For those near the ocean, please evacuate to high ground.
	Tsunami Advisory	A Tsunami Advisory has been issued. For those near the ocean, please be careful.
	The Tokai Earthquake Warning Declaration	A Tokai Earthquake Warning Declaration has just been issued. Please pay attention to the information on TV or radio.
	The Tokai Earthquake Advisory Information	A Tokai Earthquake Advisory Information has just been issued. Please pay attention to the information on TV or radio.

Examples of Response to an Earthquake Early Warning



Chapter 5 Early Warning System in Thailand

5.1 National DRR Institutions

The Thai Government altered its approach to disaster management in 2002 and shifted from an emphasis on relief and rehabilitation to a more proactive integration of mitigation and preparedness. The Bureaucratic Reform Act of 2002 restructured the institutional arrangements and resulted in new roles for state agencies and the creation of the Department of Disaster Prevention and Mitigation (DDPM) under the Ministry of Interior. Brief descriptions of key government organizations in EWS and DRR are given below

The National Disaster Warning Center (NDWC) was established in May 2005 under the Office of the Prime Minister's Secretariat and is responsible for end-to-end multi-hazard warnings including earthquakes and tsunamis. A cabinet resolution dated 3 April 2007 transferred the NDWC to the Office of the Minister of Information and Communication Technology (ICT). The NDWC was later transferred again to the Thai Meteorological Department of the Ministry of ICT by the government of former Prime Minister Surayud Chulanont. The major task of the NDWC is to detect earthquakes and to analyse seismic data to determine the possibility of a tsunami generation before issuing notification messages to the public, related authorities and rescuers for evacuation of people to safe places. The NDWC is currently upgrading its EWS, extending its telecommunications network to ultimately issue multihazard warnings with a special emphasis on floods.

The Department of Disaster Prevention and Mitigation (DDPM), established in 2002 under the Ministry of Interior, is the main agency for disaster management coordination and serves as the Secretariat to the National Disaster Prevention and Mitigation Committee (NDPMC). It resulted from the consolidation of various departments with disaster management programmes such as the Accelerated Rural Development Department. The DDPM's description of duties includes studying, analysing, researching and developing information technology systems for prevention, warning and disaster mitigation. The DDPM is also responsible for mobilizing, awareness raising, and arranging training and exercises in disaster prevention and mitigation. The DDPM is not in charge of structural measures to prevent the occurrence of disasters or to mitigate their effect. In 2004, the DDPM set up a Disaster Prevention and Mitigation Academy with training offered in several locations. The DDPM engages in continuous capacity development of its departments, receiving technical support from UNDP and the Japanese and German governments, among others.

The Thailand Meteorology Department (TMD) under the Ministry of ICT monitors meteorological and seismic instruments throughout the country, and weather satellites as well as telemeters in Thailand's 25 river basins, providing daily, weekly and monthly forecasts.

The Department of Mineral Resources (DMR) covers all major functions affiliated with the development of mineral, petroleum and groundwater resources. In October 2002, the DMR was moved to the newly established Ministry of Natural Resources and Environment. The DMR undertakes geological mapping, research and training. With 1,000 geologists to cover the entire county, the DMR joins forces with other agencies, particularly the DDPM. The DMR also contributes significant resources in staff time and ICT applications to the NDWC.

The Department of Water Resources (DWR) was established in 2002, under the Ministry of Natural Resources and Environment, as the main agency for formulating management plans as well as monitoring, coordinating and implementing water resources conservation and rehabilitation measures. It is also the lead agency for flood control and mitigation in the river basins in the country and formulates 'river basin organization' as part of its strategy. The Department is responsible for setting up a water crisis management centre.

The Royal Irrigation Department (RID), Ministry of Agriculture and Cooperatives, has a long history of development interventions and is responsible for water provision, storage, maintenance and allocation. It participated in the design, construction and operation of major water

projects for Bangkok. It carries out initiatives relevant to DRR including the development of a sustainable water usage plan, forecasting of water storage and drainage systems to prevent flood and drought disasters, and launching of publicity campaigns for water use.

Hydrographic Department of the Royal Thai Navy (HDRTN) provides services for navigational safety, defence and country development, and is responsible for the survey and production of navigational charts, marine forecasting, and navigational procurement and maintenance. Routine inspection, calibration and maintenance of sea-level stations are the responsibility of the Royal Thai Navy.

5.2 The National Disaster Warning Center (NDWC)

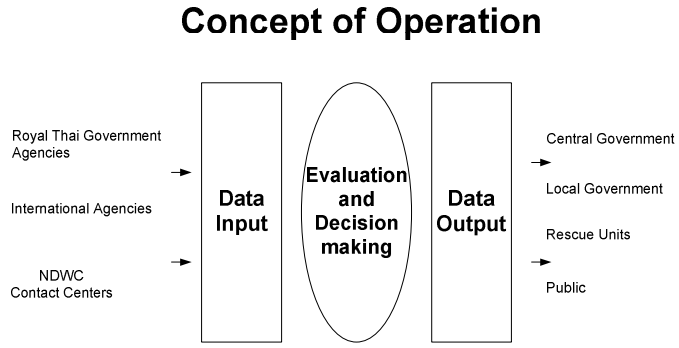
Role and Responsibility

NDWC is responsible for end-to-end multi-hazards including earthquake and tsunami :

1) Receiving data
2) Analysis
3) Dissemination of Warning Message
4) Coordinating and Planning
5) Supervising the Preparedness and Response, and the recovery.

Fig. 5.1 NDWC Logo

NDWC and other departments, such as Department of Disaster Prevention and Mitigation (DDPM), Thai Meteorological Department (TMD), Department of Mineral resources (DMR) and Thai army together developed the handbook called the concept of operation for an early warning system. The concept of operation consists of input, evaluation and decision and output. For earthquake and tsunami warnings, NDWC gets input and information from seismic networks, of course form both inside and outside of Thailand, such as Thai Meteorological Department, Royal Thai Navy, Electricity Generating Authority of Thailand (EGAT), Thai Royal Irrigation Department, Pacific Tsunami Warning Center (PTWC) in Hawaii, U.S.A., Japan Meteorological Agency (JMA) in Japan and etc. This information is then analyzed by NDWC experts before making the decision, there is a tsunami or not. If there is, NDWC first have to check with the Hydrographic Department of the Royal Thai Navy which uses tide gauges to detect sea level change located at the Similan Island and to confirm tsunami generation. Then the warning messages will be sent out to VIPs, rescue units and to the public by Short Message Service (SMS), electronic mail (e-mail), and FAX for example. The warning messages will be announced simultaneously through warning tower, radio stations and the Television Pool of Thailand. In addition, NDWC provides a call center to serve 24 x 7 to provide information if somebody wants to monitor the situation.



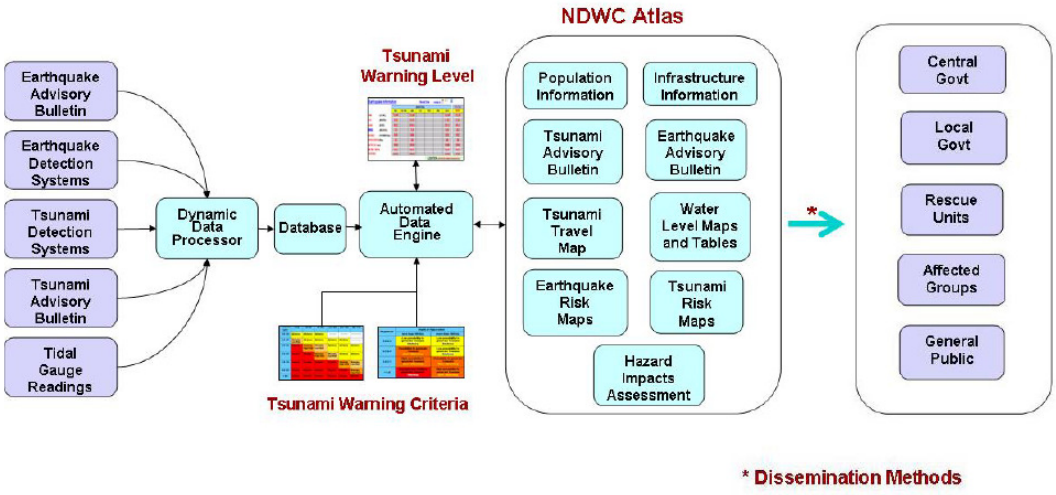
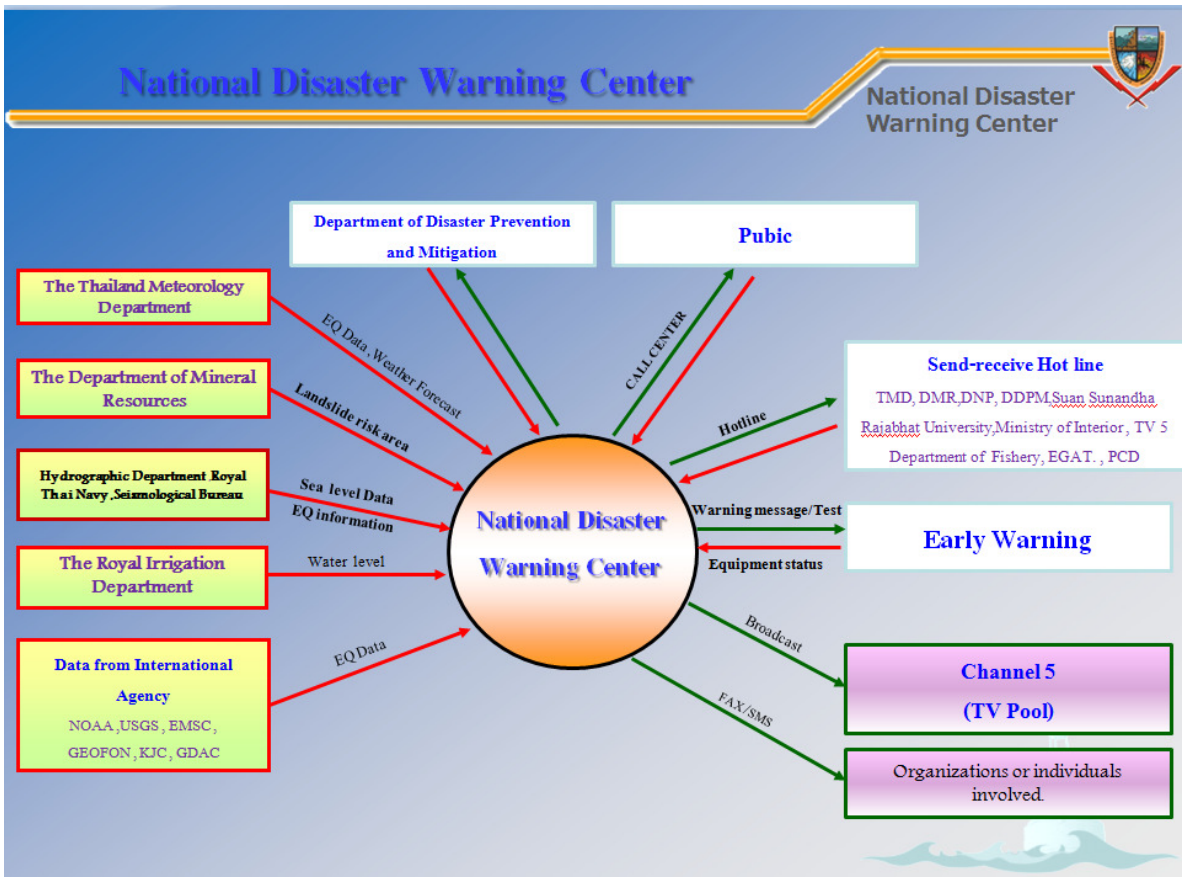


Fig. 5.2 the Concept of Operation



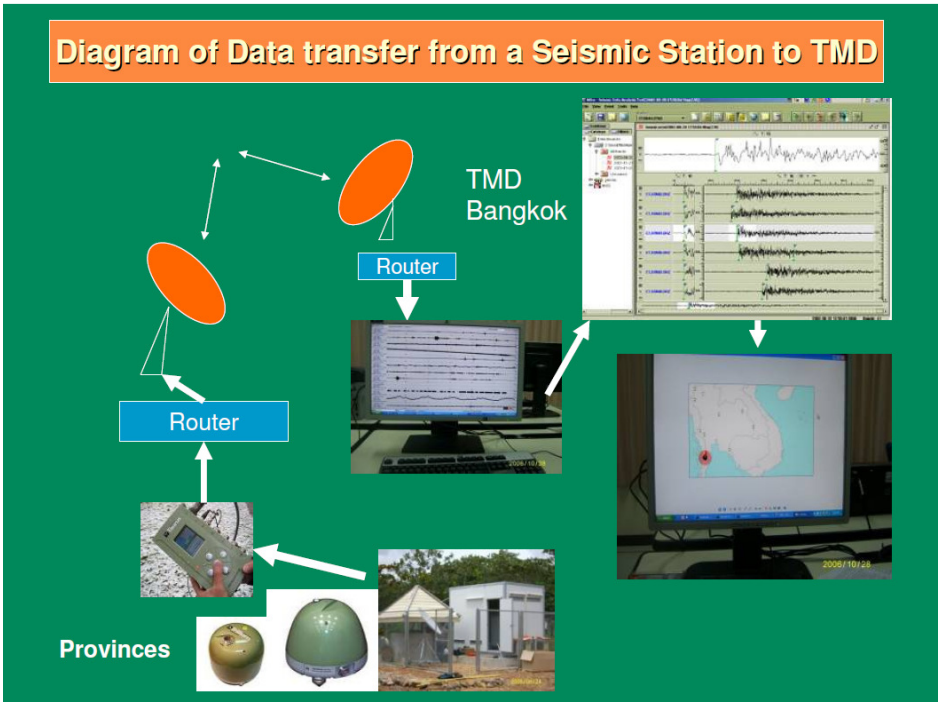


Fig. 5.3 the Concept of Operation

5.3 Inter-agency mechanisms

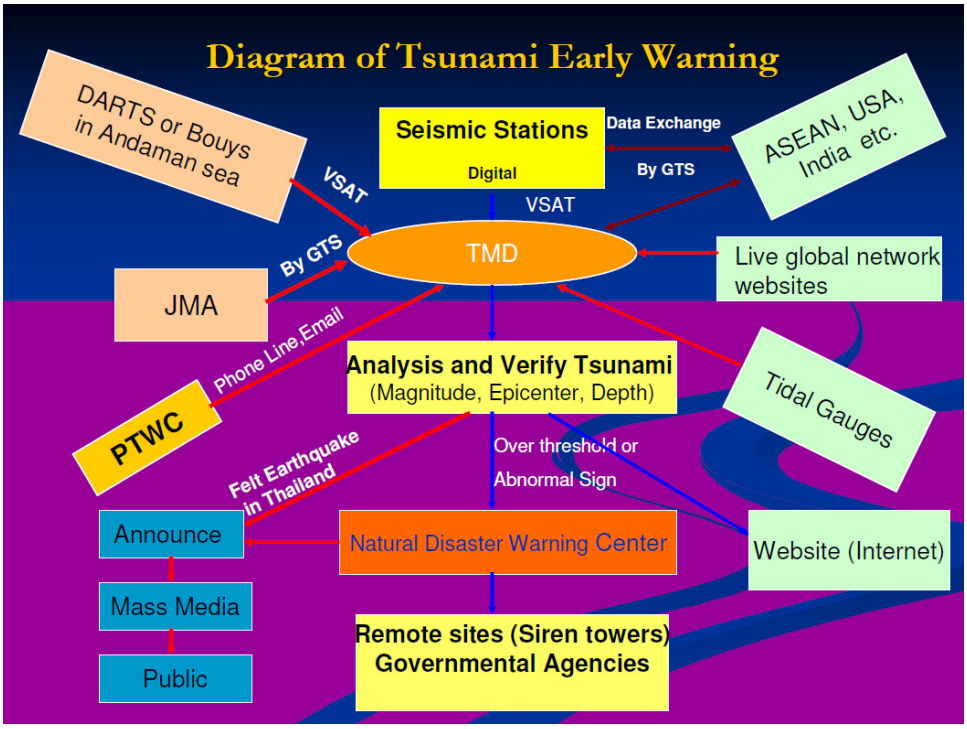
The National Early Warning Committees. Representatives of the departments within NDWC form a National Early Warning Committee to make a decision as to when a warning should be issued. The Committee on National Disaster Warning Administration deals with technical advice to improve the speed of the operation of the NDWC. The Committee on Policy of the National Disaster Warning System formulates guidelines, policies, measures and plans pertaining to the management of the national disaster warning system for the Cabinet. It also coordinates these with commissions, appointed by law or a cabinet resolution, that have intersecting duties and responsibilities. Other committees are the Steering Committee – Committee on the Study of Disaster Early Warning System and Sub-Committee on the National Disaster Warning Center Administration.

5.4 Monitoring and Warning System

Thailand is making significant progress towards strengthening hazard monitoring and disaster EWS. While investments in information and communication technology have already improved the reception of warning information from regional and international monitoring networks, more needs to be done to improve transfer and exchange of relevant information within the country, across agencies, and to and from remote and vulnerable areas.

The Thai Meteorological Department (TMD), which is the main recipient and provider of hazard data to national counterparts, requires further capacity strengthening to process input information and issue more timely warnings. Due to a combined impact from climate change, environmental degradation and changes in land use, disasters – floods, landslides and droughts in particular – are on the increase. Setbacks caused by these disasters threaten to overtake the pace of development. Monitoring and early warning capacities at local levels are not ready to deal with these challenges and require urgent capacity development, particularly in vulnerable communities.

Diagram of Tsunami Early Warning by TMD

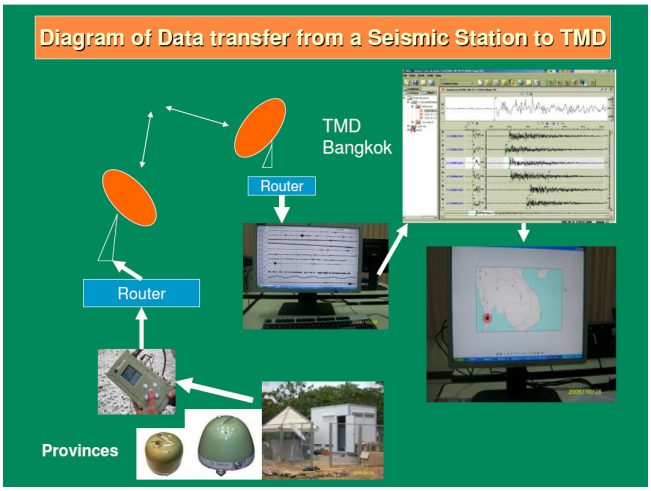


Tsunami Warning Criteria		
Magnitude	Depth of Hypocenter	
	less than 100 km.	more than 100 km.
5.0 - 6.4	Low possibility to generate Tsunami Advisory	Low possibility to generate Tsunami Advisory
6.5 - 6.9	Possibility to generate Tsunami Alert / Watching	Low possibility to generate Tsunami Advisory
7.0 - 7.7	High possibility to generate Tsunami Alert / Watching	Possibility to generate Tsunami Alert / Watching
> 7.8	Very high possibility to generate Tsunami Warning	High possibility to generate Tsunami Alert / Watching

Seismic Network in Thailand

Generally to face with earthquake disaster or establish for tsunami warning system in the country , several measures of earthquake-tsunami prevention and mitigation including early warning need to have high efficiency input and good results from reliable standard class of seismic monitoring system and from the latest technology of digital data and real time telecommunication . Seismological tasks, Geological works and Earthquake engineering research mainly utilize these data and information as well. Consequently Seismological Bureau, Thai Meteorological Department established an Automatic Earthquake Monitoring System to serve all the need of raw ground motion data, sea level changes, displacement and analyzed seismic data for the public interest and multi users. The system consists of 40 seismic stations, 26 accelerograph stations, 9 tidal gauge stations, 4 GPS stations. The operational works are 24/7 basis to continuously monitor, watch and disseminate of relevant information, messages and warning regarding to earthquake and tsunami hazard.

Generally earthquake prevention and mitigation measures are dealed with several agencies both in governmental and private sectors that responsible to plan , operate, monitor, research and implement in advance for operational procedure of pre events , during events, or after events in order to attain the last goal of safety and wealthy of people. This Seismological Bureau WEB site is initially one of the line to serve this objective for all users and people to directly access data, information and warning including basic knowledge of seismology and tsunami. Furthermore it will reveal that earthquake phenomenon are normal natural events that occurred everyday. Even though luckily, Thailand is not in the active area but it is not mean that Thailand is safe for earthquake and tsunami disaster. Then to face with these disasters the best scientific preparing in advance must be performed to gain sustainable safety and mitigation.



Royal Irrigation Department (RID) and **Water Resource Department (DWR)** of Thailand are responsible for water management. **DWR**'s main functions relates to water policy, planning and strategy. **RID** is responsible for water source development, water management, including flood and drought relief, especially in floodplains and downstream watershed, whereas **DWR** takes care of natural rivers and steep-slope upstream watershed.

The Royal Irrigation Department (**RID)** RID implements strategies for flood prevention and relief. The Aims are to decrease the loss of lives and property especially in urban and agricultural areas. The Water Watch and Monitoring System for Warning Centre (WMSC) was set up to monitor flood situations on a 24 hourly basis. There is also collaboration with other related organizations to plan flood prevention. Local flood protection systems were set up in important economic areas where severe floods may occur. In addition, early warning systems using various technologies were established. This includes a telemetry and flood forecasting system for water management.

The RID to date has installed and operated about 208 telemetric stations in 13 of 25 river basins in Thailand. In addition, 555 manual river gauges and 2,294 manual rain gages were installed and operated all over country. As part of the local flood warning system, DWR has developed and installed early warning systems in 458 villages of the total 2,370 villages in Thailand and included with automatic flood-warning sirens are being operated.

Flood Forecasting and Warning System for protecting in 25 basins are being developed. For this system, To mitigate and reduce the risk of floods, the flood warning system is carefully managed in the following process.

First, telemetry system is used as a method for flood forecasting in different river basins covering nearly the whole country.

Second, the forecasting situation is then announced to public with different ways like website or radio broadcasting or networks. For network mentioned above it means regional offices which take part in communicating in the local areas with other methods or media.

Third, after flooding situation, pumping for water drainage has to be prepared in order to reduce the height of water level or inundated areas.

Department of Mineral Resources (DMR) DMR has established local warning networks or self-protection networks in risk areas. The networks include local people working for their communities or villages as volunteers. They were trained to have knowledge on landslide behavior and how to observe the upstream warning signs. During the monsoon season they will be the guards at check points or at the foot of mountains where they can clearly see stream water. When they detect signs of landslide development such as distinct rumbling sound, they will warn other people in risk areas downstream. Moreover, DMR established the Geohazards Operation Center in Bangkok to monitor

landslide activity and to coordinate with the local networks and relevant agencies. When heavy rain is approaching landslide prone areas, the center will disseminate landslide watch bulletin and inform the networks through television, radio, facsimile and mobile phone. The local networks can also call the center to get more information and the real time situation from their areas. Furthermore, the center coordinates closely with the Thai Meteorological Department (TMD) concerning rainfall prediction and with the Department of Disaster Prevention and Mitigation (DDPM) and provincial governors on landslide management. DDPM and Governors who have authority in disaster management are also alert to support villages in risk areas.

5.5 Dissemination and Communication

In Thailand, gaps include the lack of formalization of institutional roles in multi-hazard early warning. Responsibilities for information exchange across government, with civil society and the media, as well as for informing the general public, require clear centre(s) of authority and standard operating procedures (SOP). Current confusion over government roles and inadequate cooperation amongst various information holders and providers threatens to undermine the credibility of warnings with the media and the public. Due to a lack of general awareness and understanding, central and provincial authorities are nervous to issue warnings that may prove to be false and expose them to criticism and public outrage. There is a lack of decision support systems that could help to avoid overcautious and inefficient cross-checking of data.

This includes the need for real time connections rather than reliance on the Internet. In general, information and communication systems are not yet up to international standards for efficient exchange of data. The dissemination system relies largely on a system of warning towers but the additional use of non-technical means and the involvement of social networks are required to reach all at risk.

Chapter 6 Conclusion

People-centered early warning systems empower communities to prepare for and confront the power of natural hazards. However, the efficiency of such systems is to be measured in terms of lives saved and reduction in losses, which is directly related to the execution of an anticipated response by the people and institutions once a warning is issued.

The four elements of people centered Early Warning Systems

A complete and effective, people-centered early warning system – EWS – comprises four inter-related elements, spanning knowledge of hazards and vulnerabilities through to preparedness and capacity to respond. Good governance is encouraged by robust legal and regulatory frameworks and supported by long term political commitment and integrated institutional arrangements. Major players concerned with the different elements should meet regularly to ensure that they understand all of the other components and what other parties need from them.

Effective early warning systems require strong technical foundations and good knowledge of the risks. But they must be strongly people centered – with clear messages, dissemination systems that reach those at risk, and practiced and knowledgeable responses by risk managers and the public. Public awareness and education are critical; in addition, many sectors must be involved. Effective early warning systems must be embedded in an understandable manner and relevant to the communities which they serve.

Risk Knowledge. Risk assessment and mapping will help to set priorities among early warning system needs and to guide preparations for response and disaster prevention activities.

Warning Service. A sound scientific basis for predicting potentially catastrophic events is required. Constant monitoring of possible disaster precursors is necessary to generate accurate warnings on time.

Communication and Dissemination. Clear understandable warnings must reach those at risk. For people to understand the warnings they must contain clear, useful information that enables proper responses. Regional, national and community level communication channels must be identified in advance and one authoritative voice established.

Response Capability. It is essential that communities understand their risks; they must respect the warning service and should know how to react. Building up a prepared community requires the participation of formal and informal education sector.

JAPAN

As one of the public corporations designated for disaster management under the Disaster Countermeasure Basic Act, NHK plays the key role in disaster broadcasting and emergency .JMA is the key body in prediction major natural hazards such as earthquakes, tsunamis, typhoons and volcano eruptions while MLIT is for flood and sediment disasters and cooperation with them is essential for municipalities and other disaster response organizations. It must be noted that application of latest technologies for disaster warning and communication by JMA had greatly improved disaster response system in Japan. In addition, state lifeline agencies, railway companies, NHK has established quick information sharing with JMA and other relevant bodies as well as response mechanism within respective fields of activity.

- **Crucial collaboration with JMA and MLIT** - JMA is the key body in prediction major natural hazards such as earthquakes, tsunamis, typhoons and volcano eruptions while MLIT is for flood and sediment disasters and cooperation with them is essential for municipalities and other disaster response organizations.

- **Comprehensive mechanism of emergency broadcasting by national television** –Close collaboration with JMA and established automated emergency warning, huge facilities and equipments in its disposal NHK plays central role in disaster broadcasting and emergency warning.

- Massive numbers of voluntary response organizations and people involved in voluntary disaster response shows high level of disaster awareness and social responsibility for disaster reduction in the country. During disaster times acting in collaboration with the professional responders, voluntary teams demonstrate remarkable efforts in psychological support of the affected people and provided basic utilities.

- The existing Early warning system, although, has been form during relatively short time period put in place sophisticated mechanism which enables Japan to mobilize forces and resources and respond in a comprehensive manner any large-scale disasters promptly, considerably decreasing damage and loss. Comprehensively elaborated coordination enables to relevant bodies take concerted actions to increases response efficiency. In turn hierarchical supervision granting response bodies with great independence keeps accountability of them high.

-Changes and advancements driven by previous large-scale disasters -based on the lessons of previous national disasters system has undergone both organizational changes and enhancements. Large-scale natural disasters in recent decades, such as, Isewan Typhoon, Great Hanshin-Awaji Earthquake have influenced currents disaster response system in Japan. The system has undergone some organizational changes, new disaster response forces – DMAT, and disaster response mechanisms – ex, Phoenix System and Emergency Medical Information System in Hyogo Prefecture – has been introduced and integrated.

- Multilevel emergency response – Depending on the scale of disaster emergency response is conducted on local ,prefectural and national levels.

- Effective lifeline crisis management system – recent disasters proved high level of emergency response preparedness and capabilities by lifeline – electricity and gas – providers. integration of advanced technologies for disaster prediction, control and resilience and comprehensive collaboration with other relevant bodies are the key reasons

THAILAND

Although the Department of Disaster Prevention and Mitigation is a major organization in charge of disaster management, other public organizations are also actively involved in this important task.

Provinces and local governments also have emergency management offices. The Provincial Office of Disaster Prevention and Mitigation is responsible for emergency management at the provincial level . Thailand now has 75 provincial offices of disaster prevention and mitigation across the country. The tasks and responsibilities of these offices and centers are basically similar. However, the organizational structure can a bit vary dependent on the nature, priority, and management strategy of each province.

There has been an increasing awareness in the national Government regarding emergency management. Thailand also has a good legal foundation for emergency management. Both the Disaster Prevention and Mitigation Act 2007 (B.E. 2550) and the National Disaster Prevention and Mitigation Plan 2010-2014 (B.E. 2553-2557) can be used as the framework and guideline for emergency management. These two pieces of legislation can help related agencies work to achieve their goals in preventing and mitigating the impacts of disasters. The improvement in communication system/network can be sources for improving emergency management system as well.

Weakness

- The framework for disaster management in Thailand adopts a multi-stakeholder approach with the involvement of many institutions at the national, provincial and local levels. However, this is not altogether complete, with some gaps and some overlaps.

- Management system at national, provincial and local levels is not clear and unity. It causes problem on coordination and create inefficient works for government agencies, state enterprises, private agencies and other respected agencies.

-The new institutions such as DDPM and NDWC have disaster management as their role responsibilities, and the various long-standing departments and technical agencies that have some role in different phases of the disaster management cycle.

-Having too many laws and regulations confines work management

The causes for Early warning problem are

1) inadequate political commitment,
2) weak coordination among various actors,
3) Lack of public awareness and lack of public participation in the development and operation of early warning systems.
4) Lack of decision support systems that could help to avoid overcautious and inefficient cross-checking of data.
5) The need for real time connections rather than reliance on the Internet
6) Insufficient budget allocation of DRR
7) One way communication of Early warning, No feedback evaluation from community
8) Warning Message understood and trusted but do not know how to respond.

Thailand Challenges and Future Plan

- Development of multi-stakeholder partnerships and citizen participation
- Improvement of information sharing and management
- Promotion of education and public awareness
- Integration of disaster reduction concepts into development planning
- Promoting continuous efforts among the government and various stakeholders on public awareness and preparedness
- Strengthen partnership of Government and Private Sector
- Develop a comprehensive policy and legal framework to cover EWS in structural and operational detail, and define roles and responsibilities of governmental and nongovernmental actors.
- Develop a mechanism for assigning resources to cover the needed inputs.
- Ensure feedback into the EWS development process by sharing results from evaluations of EWS activities and outputs of workshops.
- Enhance the critical role of the media in the dissemination of early warning messages.
- Analyze the effectiveness of warning messages by using feedback from the community.
- Enhance data reliability and interagency data sharing by assessing and prioritizing needs for each organization participating in the system to improve access to real time data and to provide effective analysis to decision makers.
- Develop a Warning alerts and messages that are geographically-specific to ensure warnings are targeted to those at risk only.
- Enhance technology to support interagency data sharing by assessing and prioritizing the needs of each participating organization to improve access to real time data and provide a reliable analysis to decision makers.
- Prepare early warning guide or handbooks that collect all the currently fragmented pieces of information in a practical format for use by government staff, communities, NGOs, media and the private sector.
- Strengthen communication networks, particularly to and from and within communities,
- Also strengthen and map feedback communications from relevant agencies and communities
- Support development of media partnerships in EWS, such as with the NDWC and at local levels.
- Set up Mister Warning in communities and Disaster Warning Network
- Design standard and practical guidebook for community leaders.
- Create warning system in communities
- Strengthen participation skills for disaster management with planning skill, creating network, giving knowledge and disseminating information.
- Provide trainings to situation commanders, operation staff, community leaders, planners, and general people
- Improve database system and risk maps for risk areas/communities
- Enhancing and improving on local wisdom for disaster warning
- Cooperate warning system from respected agencies
- Connect early warning system from respected agencies
- Improve overall disaster forecast system
- Connect disaster information system from respected agencies
- Evaluate and improve the responsibilities and authorities of government agencies periodically
- Add knowledge on disasters into educational curriculum of primary to university levels

including community level and all management levels

- Strengthen people's participation in planning and networking. Encourage them to use museum for disseminating information on disasters
- Build up coopration with mass media such as television, newspaper and radio for building culture on safety and flexible community
- Strengthen early warning system - Create standard guidebook, set up method and steps to be guidelines for community leader used for emergency response after receiving warning alarm.

Although continuing safety campaigns have been utilized, Thai people still pay less attention to the impact of disaster and the way to prevent it to happen. Thailand should continually build the safety culture and educate the public about disasters. The lack of integration among national agencies responsible for disaster management can sometimes lead to fragmented action/effort which can mitigate the effectiveness and efficiency of disaster management. Thailand should find a more effective way to integrate these national agencies.

Disaster risk management is a multi-sectorial and cross-cutting issue. Early warning as an essential element of risk management can be successful if all related sectors in local, national, regional and global level work together effectively. Working together requires common objectives and vision, strategic directions, integrated and harmonized approach, and commitment by all actors.