Report on the Assessment of Early Warning Systems in the Maldives

August 2005

Asian Disaster Reduction Center

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1. Introduction

1.1 Background

The disaster risk scenario of the Maldives can generally be described as moderate. Nonetheless, its vulnerability to natural disasters was brought to the fore when it was hit by the devastating tsunami of December 26, 2004. The Maldives is also occasionally prone to storms, droughts, heavy rains and high waves caused by cyclones in the Southern Indian Ocean. Given that the Maldives is a nation of islands whose highest elevation is no more than two meters above sea level, the country is at particular risk from rising sea levels associated with climate change.

The small islands (on average 16 hectares), with their flat topography and very low elevation, also suffer from damage to their ecosystems (coral reef), land loss and beach erosion due to sea level rise, changes in air and sea surface temperatures and changes in rainfall patterns. The predominant dependence of the country upon the tourism and fisheries sectors enhances economic and social vulnerability to sea-related hazards.

In response to the UN Flash Appeal for the Maldives, the government of Germany has granted US$ 1,300,000 for a Disaster Risk Management Programme. The key elements of such a program will include the development of early warning systems (TEWS), preparedness planning, disaster management policy development, emergency response capacity enhancement, safe area development, vulnerability assessment and other projects for dealing with the risk of natural hazards. This Disaster Risk Management Programme will also be closely synergized with the National Plans for Environmental Management (NEAP) and Climate Change Adaptation.

Lessons must be learned from the recent tsunami disaster and activities must be initiated that build and strengthen disaster risk management system in this country. An end-to-end review of the existing early warning systems - for the development of a holistic EWS in Maldives - need to be reviewed as part of the preliminary ‘stock-taking’ stage of the DRM Programme

1.2 Rationale for the establishment of a Multi-Hazard Early Warning System

An EWS is the key to minimizing damage in the event of a disaster. Access to information about the probability of a hazard and the extent of damage it could cause is therefore imperative. Such a process requires not only technical and sophisticated warning systems, but also an equally established and politically responsive line of control that could make decisions about evacuation procedures if required. The ability to communicate the threat of a disaster in Maldives is a special concern given the spread of the population over a large number of islands, many of whom have limited communications access.

While the proposed Indian Ocean Tsunami Warning System would take three to five years to develop, a national tsunami warning system (as part of a multi-hazard early warning system) linked with national tropical cyclone and storm surge (high wave) alerts is now being established. An integral component of an EWS will be the provision of community systems for facilitating protective action (evacuation to emergency shelters, movement to high ground) after the communication of alert warnings. An interim arrangement (based on available capacities) will be set up in the Meteorological Department/Emergency Operations Centre (EOC) and will be linked to the warning systems of neighboring countries. Systematic enhancements will also be made to the capacities of the Meteorological Department/EOC and its connections and working relationships with other counterpart agencies, including regional and national organizations. In 1993, a Wave Monitoring Program was conducted by the former Ministry of Public Works and Labor. Efforts to ascertain the current status of that programme and similar initiatives that may have existed need to be undertaken. The participation of Meteorological Department/EOC officials in regional planning and consultation meetings also facilitates the strengthening of an early warning system. A workshop on early warning systems in Male also helps in establishing contacts and developing working relationships with counterpart agencies in the region. In the medium to long-term (two to five years), a more sophisticated national system has to be set up and integrated with the proposed Indian Ocean Tsunami Early Warning System.

1.3 Objectives

Following are the key objectives of the assessment of EWS in the Maldives:

- ✓ To take stock of existing capacities of relevant departments and agencies involved in early warnings in the Maldives: This includes not only the agencies responsible for forecasts and warnings (meteorology and hydrology) but also intermediaries (radio, TV, print media and other communication channels) and end users of early warnings.

- ✓ To identify gaps in the current early warning systems: This includes areas where capacities need to be enhanced, such as the scientific and technical mechanisms, coordination and management of information systems, policy-making procedures and effective information dissemination capabilities.

- ✓ To recommend a set of actions and corresponding resource requirements that need to be undertaken to enhance the effectiveness of early warning systems in the Maldives

1.4 Scope of Assessment

Following are the broad sets of activities that were included in the assessment:

- Review of existing documentation: The assessment team reviewed all existing documentation on early warning and preparedness mechanisms that exist in the Maldives. This included a review of the Wave Monitoring Program established by the Ministry of Public Works and Labor back in 1993.

- Interactions and discussions with the relevant departments and ministries to assess both gaps and needs pertaining to the establishment of an EWS in Maldives: The team held a range of discussions with organizations that include the Meteorological Department, the Telecommunications Authority of Maldives and the Ministries of Information, Home Affairs, Science & Technology and Tourism. These interactions strove to ascertain the capabilities of existing institutions for managing an EWS and also sought recommendations from the various actors on the specific needs pertaining to an EWS in the Maldives.

- Interactions with potential deliverers of early warnings: For an EWS to be successful, efficient information delivery systems are vital. The team held discussions with potential deliverers of the early warnings to gauge their capacities and potential capacities. It was determined that needs to be made to build up capacity at the community level, empower communities to protect themselves, enable communities to acquire basic knowledge on how to recognize the signs of a disaster, and establish systems of communication based on both traditional and modern means. These are all issues that the assessment sought to address.

- Field visits to the areas recently affected by the tsunami: An EWS is as efficient and capable as the people who use it. Training users and the public in the effective use of the tools and systems, as well as continuously raising awareness about the EWS and its importance, are important components of a holistic early warning process. The team assessed the capacities of local communities to respond to early warnings and sought to develop modules to train the end users of an EWS.

1.5 Assessment Team Members

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2. Assessment of the Early Warning System

2.1 Introduction

Natural events, especially storm surges, high waves, strong winds and heavy rains are severe events that have always threatened the livelihoods, industries, communities and social lives of the people of the Maldives. Experts on early warning systems (EWS) were interviewed by researchers who visited various government organizations to learn about disaster management functions at the national level during severe natural events. To identify the specific characteristics of the natural disasters that affect the Maldives, researchers examined historical records and reports regarding natural disasters caused by such severe natural phenomena as cyclones, storm surges, high waves, rough seas, heavy rainfall, strong winds, earthquakes and tsunamis.

EWS experts were carefully interviewed about the daily functions and emergency response capabilities of the Department of Meteorology of the Maldives (DMM), an organization well suited to monitoring natural activities on a 24-hour basis and to launching nationwide disaster management efforts by disseminating early warning messages to national organizations. The consistent monitoring of tides and waves is very important for this country, given its many low lying islands, both from the viewpoint of disaster preparedness against rough sea conditions and the long-term monitoring of water level rise due to global warming. Reports on past disasters were also examined.

The Indian Ocean Tsunami Warning System is scheduled to be established over the next three to five years. This regional center will be well equipped with monitoring systems that include seismometers and tide gauges, and data processing and tsunami assessment systems. Researchers investigated how best to configure a national EWS in the Maldives based on the plans for this system and on the interview surveys they conducted with government officials.

2.2 Activities

The assessment was conducted based on interviews with government authorities and previously published investigation reports. The activities undertaken as part of this project are listed in Table 2-1.

Table 2-1 Activities conducted in the assessment of an early warning system

Date	Time	Activity / Location Visited	Contact Person	Position
June 17	22:00	Arriving in Male’	-	-
June 18	10:00 -	UNDP Recovery Team Office	Ms. Rita Missal	Recovery Officer
	15:00 -	Investigation of related UNDP reports	-	-
June 19	09:00 -	Department of Meteorology, Ministry of Environment and Construction	Mr. Abdulla Algeen	Director
June 20	08:30 -	Department of Meteorology (investigation of past reports)	Ms. Aishath Umar	Administrator
	11:00 -	Ministry of Atolls Development	Mr. Adam Moosa	Director
	12:30 -	National Security Services	Mr. Mohamed Nazim	Major
	13:30 -	Ministry of Communication, Science and Technology	Mr. Farooq Mohamed Hassan	Assistant Director General
	15:00 -	Department of Meteorology (investigation of nation-wide works)	Ms. Aishath Umar	Administrator
June 21	08:40 -	UNDP Recovery Team Office	Mr. Man B. Thapa	Disaster Management Specialist
	10:00 -	Department of Meteorology (investigation of meteorological data)	Ms. Aishath Shimana	Assistant Data Processing Officer
	13:00 -	Construction and Physical Planning Section,. Ministry of Environment and Construction	Mr. Abdul Bari Yoosuf	Deputy Director

Table 2-1 Activities in the assessment for Early Warning System -continued-

Date	Time	Activity / Location Visited	Contact Person	Position
June 22	09:00 -	Male' Municipality	Mr. Ali Hussain Didi	Director General
	10:00 -	Environment Section, Ministry of Environment and Construction	Mr. Ahmed Jameel	Deputy Director
	13:00 -	Ministry of Planning and National Development	Mr. Asim Ahmed	Director
	15:00 -	Department of Meteorology (investigation of meteorological data)	Ms. Aishath Shimana	Assistant Data Processing Officer
	17:30 -	National Meteorological Center, Department of Meteorology (at Hulhule)	Mr. Ali Shareef	Head Meteorologist
	21:00 -	Maldives Airport Corporation Limited and Ministry of Transportation and Civil Aviation	Mr. Ali Hashim	Assistant Managing Director
June 23	09:00 -	Department of Meteorology (investigation of publications on natural disasters)	-	-
June 24	-	Report writing	-	-
June 25	-	Report writing	-	-
June 26	10:00 -	Ministry of Gender, Family Development and Social Security	Mr. Ahmed Shareef	Deputy Minister
	11:00 -	UNDP Recovery Team Office	Mr. Man B. Thapa	Disaster Management Specialist
	12:00 -	Construction Section., Ministry of Environment and Construction	Mr. Mohamed Aslam	Deputy Director (Oceanographer)
	14:00 -	Department of Meteorology (investigation of publications and report writing)	-	-
June 27	09:30 -	National Meteorological Center, Department of Meteorology (at Hulhule)	Mr. Ali Shareef	Head Meteorologist
	12:20 -	Maldives Airport Corporation Limited (at Hulhule)	Mr. Ali Hashim	Assistant Managing Director
	13:30 -	National Meteorological Center, Department of Meteorology (at Hulhule) (Outline of DMM: the forecast, observation, observation equipments and communication systems etc.)	Mr. Ali Shareef Mr. Ahmed Muslim Mr. Ahmed Faisal Mr. Ahmed Shameem	Head Meteorologist Meteorological Forecaster Senior Meteorological Observer Technician Grade 1
June 28	09:00 -	Ministry of Education	Mr. Ibrahim Ismail Ali	Executive Director
	10:30 -	Construction Section, Ministry of Environment and Construction (Inspections of reports in past on the wave and tide monitoring)	Mr. Mohamed Aslam	Deputy Director (Oceanographer)
	14:00 -	Meeting with Arrowcrest Technologies Pte Ltd	Mr. Tham Keang Chung	Director

Table 2-1 Activities in the assessment for Early Warning System -continued-

Date	Time	Activity / Location Visited	Contact Person	Position
June 29	09:00 -	Ministry of Tourism	Mr. Ahmed Salih	Deputy Director
	11:00 -	Meeting with JICA	Ms. Ayako Omura	Project Formulation Adviser
	15:00 -	Department of Meteorology	Mr. Abdulla Algeen	Director
June 30	09:00 -	Television Maldives	Mr. Mohamed Asif	Senior Programme Organiser
	12:00 -	Maldives Police Service	Mr. Ibrahim Khaleel	Chief Inspector
	13:00 -	Health Service, Ministry of Health	Ms. Sheena Moosa	Deputy Director
	16:20 -	UNDP Recovery Team Office	Mr. Man B. Thapa	Disaster Management Specialist
July 01	14:15 -	Department of Meteorology	-	-
	23:15	Leaving Male'	-	-

2.3 Geographical Background

The Republic of Maldives is comprised of a chain of coral atolls extending about 860 km north to south and 80 to 120 km east to west. There are 26 atolls of varying sizes consisting of reefs and reef islands. A total of 1,192 low-lying coral islands (Figure 2-1) have a total land area of approximately 300 km^2. Although the area with the highest elevation is approximately three meters above the mean sea level, about 80% of the nation's total area is less than one meter above the mean sea level. The 26 atolls are grouped into 20 administrative regions. Among the islands, 199 are inhabited and 87 are used as tourist resorts. The total population of the Maldives was reported at about 349,000 in 2005.

The water depth in and around the atolls varies considerably: lagoon waters within the atolls have depths of 30 to 80 m, with the depths increasing as one moves from north to south. At the outer margins of the atolls, the ocean floor drops abruptly to depths of up to 2,000 m or more. Along the inside of the atoll chains, the water is more shallow, with depths of 250 to 300 m. The straits between the east and west atolls are more than 1,000 m deep (Ministry of Environment and Construction, 2004).

2.4 Meteorological Background

The climate in the Maldives is warm and humid, as is typical of tropical regions. Each year there are two monsoon seasons. The south-west monsoon, with its wet winds, creates one rainy season from May to November, and while the north-east monsoon, with its dry winds, creates another from January to March. The annual mean relative humidity ranges from 77-83%, with a high of 90% and a low of 69% in Hulhule according to observation data from the 30-year period 1974-2003. The mean annual air temperature ranges from 27.4-28.8˚C, with the mean annual low and high temperatures in Hulhule at 24.6-26.3˚C and 29.6-31.1˚C, respectively (Figure 2-2). The data on the mean high temperatures by region for 1995 to 2004 shows that the northern region had the highest temperatures, except for 1996 and 1999-2001. The lowest temperatures were recorded in the central region, except for 1997, 2002 and 2003 (Figure 2-3).

Annual rainfall is higher in the southern region and lower in the north. The mean annual precipitation in Male' and Gan is 1,950 mm and 2,292 mm respectively, with sharp variations depending on the time of year (Figures 2-4 and 2-5). In general, there are larger amounts of rainfall during the south-west monsoon period and smaller amounts during the north-east monsoon period. The data showing the amount of annual rainfall over the past 30 years (Figure 2-6) shows noticeable annual variations. The wind rose diagram for Hulhule shows that winds primarily blow from the NW, W-NW, W, W-SW and SW, and less frequently from the N-NW, NE and E-NE (Figure 2-7). The annual mean wind speed ranges from 9-12 knots according to data from Hulhule for 1974-2003 (Figure 2-8). Strong winds hit the Maldives during the early period of the south-west monsoon in May, June and July, and during the latter half of the monsoon period in September and October (Figure 2-9). Gusts of 50-60 knots have also been recorded at Hulhule (Ministry of Environment and Construction, 2004 and Department of Meteorology of Maldives, 2004).

Sea currents in the region around the Maldives are strongly affected by the monsoon. The currents flow westward during the north-east monsoon period, and eastward during the south-west monsoon period. The tidal current flows eastward during high tide and westward during low tide. Swells and wind waves are generally stronger in April to July during the south-west monsoon period, when swells are generated by cyclones and storm surges. For example, some swells reached Male' and Hulhule in 1987, generating high waves three meters high (Ministry of Environment and Construction, 2004).

2.5 Seismological Background

Situated on the Indo-Australian Plate, the Maldives is tectonically very stable and aseismic. It is located far away from such tectonically active and high-seismicity regions as northern India, Burma, the Andaman Sea, western Sumatra and the Carlsberg Oceanic Ridge. The aseismic nature of the area around the Maldives is clearly evident (Figure 2-10).

Some inhabitants of the country, however, have reported feeling tremors. Although they occur very infrequently, seismic events have been felt by people across a wide area and on many islands. These seismic activities are not caused by nearby seismic events, but by the relatively large events that have occurred in western India and the Sumatra regions, according to the inspections of the USGS website by the Department of Meteorology of the Maldives (DMM). While the number of tremors in the Maldives has typically been quite low, at only one to two events every year, the DMM reports that three tremors were felt between the M 9.0 Sumatra Earthquake on December 26, 2004 (including the main quake itself) and May 5, 2005. According to the observations of the DMM, the perceptible tremors were not very strong and were short-period quakes, unlike the tremors of long-period, low-frequency earthquakes. They also were of short duration, usually lasting less than 20 seconds. Since the December 26, 2004 event, DMM officials have been keeping records of all perceptible earthquakes in the Maldives.

Given the tectonic situation of the nation, the possibility of strong ground motion caused by a large earthquake near the Maldives is very low. In 2000, the World Meteorological Organization (WMO) noted that the event of most concern to the nation would be a tsunami resulting from an earthquake off of Sumatra. This, of course, this turned out to be absolutely correct. Regions around the Maldives, however, are subject to considerable seismic activity, especially regions north, west, southwest, and south of the country (Figure 2-11).

Figure 2-12 shows seismic events with a magnitude of 6.0 or greater and at a depth of less than 100 km in the Indian Ocean region. The M 9.0 event on December 26, 2004 and the M 8.4 event on March 28, 2005, the largest shock since the December quake, occurred off the west coast of northern Sumatra and off of southern Sumatra, respectively. Both triggered large tsunami waves in the Indian Ocean. Even before these events, large earthquakes greater than M 7.0 had consistently occurred in the region off the west coast of northern Sumatra, and also in the regions around northern and southern Sumatra and the Nicobar Islands. The largest event prior to the M 9.0 quake in 2004 was the M 8.0 earthquake that occurred on June 5, 2000 in south Sumatra.

Two earthquakes of magnitude 7.0 or greater have occurred in regions relatively close to the Maldives. The first was a M 7.6 event on December 1, 1983 in the Chagos Archipelago region, about 500 km south of the Maldives, which triggered a tsunami. The other was a M 7.6 event on July 16, 2003 in the Carlsberg Ridge region, about 400 km southwest of the Maldives. Far southeast of the nation, two major events of M 7.2 and M 7.8 occurred in the southern part of the Indian Ocean, far south - southwest of Sumatra. The former occurred on January 23, 1949 and the latter on June 18, 2000. The 2000 quake triggered a tsunami. A M 8.0 event also occurred on January 26, 2001 in western India, far north of the Maldives. These eight earthquakes are displayed in Figure 2-12. This figure includes old reports about destructive earthquakes that struck the Maldives in 1729 and 1730 (see Table 2-2: Earthquakes in the next section).

Common sense dictates that a major earthquake could suddenly occur in a region that has not been seismically active in the past. Seismic activity west of Sumatra is still continuing (Figures 2-13 and 2-14), and the chain of seismically active segments in western Sumatra could potentially generate large events in the future. There are no clear reports from the past about earthquakes having hit the Maldives, but attention should continue to be paid to the possibility of tsunamis generated from the active seismic zone around Sumatra. Attention should also be paid to the possible occurrence of major future events in western India and in the waters west and southwest of the Maldives, the waters of the oceans lying south of the Maldives, and the Carlsberg Oceanic Ridge Zone, which has a high level of seismic activity.

2.6 Historical Records of Natural Disasters

Researchers examined the historical records of natural disasters in the Maldives kept by several government organizations, but no systematic records were found. To facilitate the evaluation of natural disasters and meticulous risk management, organizations and research groups should strongly encourage each island/atoll to collect information on and descriptions of historical disasters. Historical records on natural disasters in this section are compiled in Table 2-2: Storms, Earthquakes and High Waves. This information is mainly based on publications produced by the Asian Development Bank and Ministry of Planning and Environment (1993) and the Ministry of Home Affairs, Housing and Environment (2001).

Although the natural disaster records are incomplete, the Maldives is generally considered to have been fortunate in terms of its natural disaster experience, as it has not been very severely affected by such disasters in the past. However, three major disaster risks need to be noted: climate change, which is causing sea levels to rise, storm surges, and tsunamis. Researchers frequently heard the adage: "Calamity in the Maldives comes from the sea."

Sea level rise resulting from global warming is the great fear of this country, given that it is a chain of low-lying islands. Shore erosion is common on the islands and the nation's vulnerability to natural phenomena, especially to waves, increases every year.

Strong winds and rough seas are common almost year round in the Maldives, especially during the south-west monsoon (May to November) and the low-pressure conditions it creates. These occur for a longer time in the north than in the south. The magnitudes and frequencies of disasters caused by winds and waves are moderate to low as compared with the other nations and regions of the world. However, rough seas interrupt sea transportation and wind waves wash away houses situated near the coast on several islands every year. Heavy rainfall causes flooding and storm surges destroy structures. In addition, the flooding caused by high tides damages houses, roads, and trees near the coastline.

Some areas experience frequent flooding as a result of high waves or heavy rainfall. This damage occurs mainly in the southern region and mostly in April and December, the interim periods between the north-east and south-west monsoons. Fuvahmulah Island experienced nine such events between 1977 and 1989. Damage to agriculture, trees, houses, structures, and ships, as well as beach erosion, are common results of high waves and flooding.

As described in the previous section, there is little risk of a major earthquake occurring near the Maldives. However, reports do exist of destructive earthquakes in 1729 and 1730 in the eastern region. On December 26, 2004, a magnitude 9.0 earthquake occurred off the west coast of northern Sumatra, Indonesia. The event generated widespread giant tsunami waves in the Indian Ocean, causing disasters throughout Asia. The tsunami traveled across the Indian Ocean and reached the Maldives at 9:20 am, about three hours after the earthquake occurred. Almost all the islands in the Maldives were affected by flooding, and waves of about 1 m to 3.7 m in height lashed onto the islands. The tsunami demolished many houses and livelihoods, and left thousands homeless. As many as 8,352 people were displaced. According to the field inspections by the Japanese Survey Team (Fujima et al., 2005), the maximum height of the inundation waves was 3.7 m while the maximum runup wave height was 4.7 m. Aftershocks of the M 9.0 earthquake continue even today. On March 28, 2005, a M 8.4 earthquake, the largest since the M 9.0 event last year, occurred in the area slightly south of northern Sumatra. Tsunami waves measuring several tens of centimeters were observed in the Maldives, but they did not cause any damage.

2.7 Wave and Tide Monitoring

Systematic measurements of tides and waves have been very valuable and of great importance for the Maldives, which is prone to wave and tide-related disasters. Long-term measurements of tides and waves in the Male' region provided measurements of the sea level for the 15 months from March 1988 to June 1989 and measurements of waves and seiches[1] for about one year from June 1988 to June 1989 (Ministry of Public Works and Labour, 1989).

These measurement efforts were triggered by wide-scale flooding in April 1987. A similar abnormal sea level rise occurred in June-July 1988. The most plausible reasons for both of these incidents of sea level rise

[1] **Seiche:** Resonant oscillations of the water in bays or lakes whose periods depend on the size and depth of the body of water in which they occur. These are usually induced by strong earthquakes, sudden changes of wind-direction or fluctuations in the atmospheric pressure.

were spring tides that occurred during the full moon which, in addition to creating off-shore swells, generated waves two to three meters high. Wave and tide measurements have been conducted using three tide gauges (float-operated), two waverider systems (buoys) and one pressure transducer set up in shallow reefs. The tide gauges were set up in Male', Hulhule and an island inside the Male' Atoll, and a pressure cell was installed at a depth of 3 m on the coast of Male'. The waveriders were installed off the south of Hulhule island and off the outer shore of an island inside the Male' Atoll.

Detailed data analyses have been conducted to obtain statistical predictions of wave heights based on the collected data and the water level probabilities at the measurement sites. The measurements and analytical results identified the ordinary features of and variations in the wave heights, periods, arriving directions and current speeds of tides and waves. Measurement results also included information on other phenomena such as wind waves, swells and seiches at measurement sites. For example, the constitutions of tides, including strong semidiurnal tides, were analyzed and a wave frequency analysis conducted using a pressure cell and waverider showed sharp peaks at about 10-11 seconds. These measurements enabled researchers to determine the mean sea level at Male'. They also confirmed the spectral peak period distribution of waves of up to 15 seconds, indicating the presence of long-period swells.

Previous data analysis efforts provided information on the characteristics of waves and tides at measurement sites, but no unusual wide-scale events affecting many islands or atolls simultaneously have been observed due to the limited period during which they were monitored. The observed results were not used to analyze the relationships between the variations in water levels and wave heights, or to analyze meteorological phenomena such as monsoon changes, passage of cyclones, active low circulations and strong winds. For these, long-term measurements of waves and tides are essential. Such measurements, if taken continuously over a longer period, would enable researchers to calculate the predominant period, the propagation of swells from the open ocean, the power of waves by frequency, and the mean sea level. They also would provide information that is essential for determining what facilities are needed for tide and wave mitigation policies, and would facilitate objective assessments of sea level rise due to global warming. Continuous monitoring at the fixed stations nationwide should continue to be conducted using tide gauges and wave meters not only for the purpose of conducting long-term evaluations of tide and wave changes, but also for analyzing and predicting wind waves and rough sea conditions caused by meteorological events.

The report issued by the Ministry of Public Works and Labour (1989) concludes with recommendations emphasizing the following two points. The first recommendation expresses the importance of long-term continuous monitoring of tides, waves, currents, seiches and swells across a wide region from north to south in the Maldivian Archipelago. This is indeed necessary to analyze the wide-scale phenomena occurring in all parts of the archipelago. The second recommendation expresses the simultaneous measurements of daily tide variations for at least one month at each atoll. These results will enable researchers to make accurate correlations between the results of tide gauges installed at various locations throughout the islands (Ministry of Public Works and Labour, 1989).

Wave observations also have been conducted during field surveys for the construction of seawalls around Male' island. Monitoring was conducted for one year between October 1, 1991 and September 30, 1992, including short-period measurements of one week or one month in 1991 at several coastal locations around the island. Bore hole examinations were conducted in coastal areas. Data on the height and direction of waves has been analyzed, and has revealed sharp variations by coastal area and wave period (Japan International Cooperation Agency, 1992).

Tide gauge stations have been installed in the Maldives under the supervision of the TOGA Project by the Sea Level Center at the University of Hawaii, USA. The tide stations were installed in three locations where the DMM has meteorological offices; the National Meteorological Center (Hulhule Meteorological Office) in 1987, the Gan Meteorological Office in 1987 and the Hanimaadhoo Meteorological Office in 1991. These stations have been upgraded with advanced systems, such as dual floating tide gauges with digital data loggers and satellite-based data transmission systems. The tide gauges are maintained by the DMM. Photo 2-1 shows the tide gauge system operating in Hulhule. Although there is no system for continuously monitoring tides/water levels in real time at the DMM, the data is sent monthly from the DMM to the University of Hawaii on floppy disk, and is also sent directly via the DCP (Data Collection Platform) of a geostationary meteorological satellite for analysis and processing. The DMM receives the data and annual tide predictions and shares the results with the public via daily weather forecasts.

2.8 Department of Meteorology of the Maldives

Meteorological services were established in the Maldives in the early 1940s. Work at the national level has been conducted by different government offices since that time. Both the items observed and the frequency of observance, as well as the distribution of data, were limited when the services were first provided. Due to the importance of meteorological services for the country, the Meteorological Center was created on August 1, 1974 and the Department of Meteorology was established on July 1, 1980. The center was renamed the National Meteorological Center (NMC) on August 1, 1980. The NMC operates 24 hours a day and issues daily weather forecasts, aviation forecasts, weather warnings and marine forecasts to the public. There are five Meteorological Offices, including the NMC, that conduct meteorological observations for weather forecasts.

Under the Executive Head of Meteorology (Deputy Minister of Environment and Construction), the Director of the DMM heads the Administrative Headquarters (AH) in Male', the National Meteorological Center (NMC, VRMM) in Hulhule and four Meteorological Offices extending southward from Hanimaadhoo (VRMH) in the north to Kadhdhoo (VRMK), Kaadedhdhoo (VRMT) and Gan (VRGN) (Figure 2-15). The total number of DMM staff including the Executive Head and the Director is 102. There are 32 staff members at AH, 27 at the NMC, eight at VRMH, six at MVMK, five at VRMT and 22 at VRGN. The AH has five sections: Meteorological Administration, Climate Data, Technical Support, Oceanography and Geology. Meteorologists, forecasters, observers and laborers are stationed at each facility according to the grade of each Meteorological Office. The NMC and the other four Meteorological Offices conduct surface meteorological observations and store their own data (Table 2-3). Observation data from the four offices is then sent to the NMC through a data modem over the national telephone network.

In addition to its meteorological observations, the DMM maintains tide gauge stations at three Meteorological Offices as described in the previous section. Upper-air observations are conducted at one of those stations (Table 2-3). Photo 2-2 shows views of the NMC building and observation field. Photo 2-3 shows six pieces of meteorological observation equipment: analog and digital thermometers, a digital barometer, a rain gauge, a wind system and a sunshine recorder. Views of the Climate Data Section of the AH and the Observatory Room at the NMC are shown in Photo 2-4.

The DMM has been linked to the RTH (Regional Telecommunication Hub designated by WMO) New Delhi via the Internet-based Global Telecommunication System (GTS) to send and receive meteorological data and information containing earthquake information and tsunami warnings from the PTWC and the Japan Meteorological Agency (JMA, more on this organization below). Observation data, meteorological charts and other meteorological information can be obtained at the NMC via the GTS for daily weather forecasts.

The DMM provides information for daily weather forecasts, such as wind and sea conditions, rainfall, wave heights, tide levels and observation results from the previous day. The forecasts are disseminated to the public twice a day through such mass media outlets as TV, radio, cable TV and newspaper, which receive the information from the NMC via telephone or fax. The daily forecast is delivered to the Office of the President. Aviation forecasts are conducted as necessary. Seismic activity around the world is checked on the USGS website. Tsunami Watch Information issued by the JMA and PTWC, the support systems operating until an Indian Ocean Tsunami Warning System is established, are distributed to the DMM through GTS, fax and the Internet. This information is distributed nationwide by the DMM.

The DMM has been planning to establish new services in the areas of marine meteorology, seismology and oceanography to facilitate the issuance of warnings related to natural events in the future. Recommendations regarding the establishment of new services in the areas of marine meteorology and seismology have been issued based on detailed surveys conducted by the WMO (WMO, 1999; WMO, 2000). The new services have not yet been implemented, but the DMM has been investigating plans for strengthening its operations. Since the severe damage caused by the sudden onslaught of giant tsunami waves on December 26, 2004, the DMM has been assigned the task of disseminating early warnings on severe natural events.

2.9 Existing International Tsunami Early Warning Systems

(1) National Tsunami Warning System in Japan

Japan has been struck by many disastrous earthquakes and tsunamis throughout its history. The major difference between the Maldives and Japan is their tectonic situations. Japan is located on plate boundaries prone to frequent large earthquakes whose strong tremors and related tsunamis cause significant loss of life and property. Major earthquakes occur not only offshore, but also inland. When earthquakes are followed by tsunamis, the epicenters are often within 100-200 km of the Japanese coastline. In several cases, the rupture zones associated with major earthquakes have extended into coastal areas. This means that tsunami waves can reach the coast within several tens of minutes and sometimes even within several minutes of a major earthquake. The quick dissemination of tsunami warnings is therefore very important for the successful evacuation of residents and effective disaster management.

The Japan Meteorological Agency (JMA) is the governmental authority responsible for the surveillance of natural phenomena, the dissemination of warnings for severe weather, typhoons, wave heights, earthquakes, tsunamis and volcanic eruptions, as well as for the archiving and publication of nationwide observation data. Tsunami warnings are also issued by the JMA in close cooperation with the Pacific Tsunami Warning Center (PTWC) when tele-seismic events with the potential to generate tsunamis occur in the Pacific Ocean.

The accurate and prompt determination of the hypocenters and magnitudes of earthquakes is absolutely essential for the accurate evaluation of the threat and potential magnitude of a related tsunami, as well as for the quick dissemination of tsunami warnings. The JMA has a nationwide seismological observation network and a telemeter system for transmitting on-line and real-time seismic wave data to six District Tsunami Warning Centers including the JMA Headquarters. It also has a computer system capable of determining the hypocenter and magnitude of an earthquake and evaluating the potential tsunami threat and the magnitude of an impending tsunami based on tsunami simulation models, as well as systems for disseminating tsunami information and conveying it to the relevant institutions.

When major earthquakes occur in and around Japan, earthquake and tsunami information is first issued to the prefectural governors, then transmitted to the heads of municipalities from their respective prefectures, and finally announced to the public. This information is also simultaneously transmitted directly by the JMA to designated government offices, the Coast Guard, police and fire stations, the mass media, and others. The JMA first provides seismic intensity information (to identify the region with the largest tremor intensities), followed by tsunami warnings (coastal regions are informed of the approximate tsunami arrival time and wave height expected) and earthquake information (on the location of the hypocenter, the magnitude and distribution of areas with the highest intensity tremors). The goal is to issue each of these pieces of information within two minutes, three minutes and five minutes, respectively, after an earthquake occurs.

(2) Pacific Ocean Tsunami Warning System

Major earthquakes have occurred in the marginal regions of the Pacific Ocean, such as the regions off the Aleutian Islands, Alaska, Japan, Indonesia, Chile, Mexico, and other locations. These events have frequently generated giant tsunami waves that have caused severe damage not only in the nations where they originated, but also in neighboring countries. The 1960 M 9.5 Chilean Earthquake even caused severe tsunami damage in Japan, even though the countries are located on opposite sides of the Pacific Basin.

In 1965, the Intergovernmental Oceanographic Commission (IOC) established the ICG/ ITSU (International Co-ordination Group for the Tsunami Warning System in the Pacific (TWSP)) and the ITIC (International Tsunami Information Center). The Pacific Tsunami Warning Center (PTWC) has been hosted by the US to operate a tsunami warning system and a system for monitoring seismicity and sea levels in the Pacific Basin in coordination with 40 member states. When a major earthquake strikes, the PTWC quickly determines its, hypocenter and magnitude. The tsunami potential is then evaluated based on the magnitude and the sea level in the Pacific region. When necessary, tsunami warnings are issued to member states.

(3) Interim Indian Ocean Tsunami Warning System Operated by the PTWC and the JMA

The establishment of a tsunami warning and mitigation system in the Indian Ocean is being promoted as part of a project of the IOC/UNESCO. This project is expected to take three to five years to complete. Until this system is established, the PTWC and the JMA are operating interim tsunami warning services in the Indian Ocean region using existing seismological and water-level networks and facilities. The warning messages are issued to the nations and organizations that would be impacted by a tsunami in the Indian Ocean.

The JMA and the PTWC follow similar procedures for disseminating tsunami warnings. The following describes the procedures followed by the JMA. When an earthquake larger than M 6.5 occurs in or around the Indian Ocean region, the JMA determines its hypocenter and magnitude using the wave patterns provided by its own data as well as seismic wave data collected from the IRIS website. The potential for a tsunami in the Indian Ocean region is then evaluated based on the empirical relations between the magnitude and tsunami grade. Information including the time of the occurrence, the location and magnitude is then disseminated. If necessary, Tsunami Watch Information is issued by the JMA through the GTS (Global Telecommunication System), fax and the Internet. Tsunami Watch Information does not provide information on when the tsunami waves will reach the shore. Tsunami wave monitoring is conducted using the tide gauge data collected via the Internet and is based on variations in the sea level. This information is obtained through the DCP function of the GMS. The goal is to disseminate this information within 30 minutes of an earthquake. The relevant countries and organizations receive and use tsunami warning messages from both the JMA and the PTWC.

2.10 Current Early Warning System in the Maldives

The Maldives is administered by its ministries at the national level, by five regional offices and 20 atoll offices at the regional level, and by island offices at the local level. This is an effective structure for transmitting warnings from the national level to the island residents. The ministries are in charge of such public facilities as hospitals, schools, tourism facilities and fisheries on each island, and this should facilitate the urgent communication of information from the national level to the local/public level. To disseminate information from the national level to the public, the DMM disseminates warnings through such mass media outlets as TV, cable TV, radio, websites and newspapers. However, there is no fixed system for transmitting emergency information from the DMM throughout the national government.

After the great tsunami disaster of December 26, 2004, the National Disaster Management Center (NDMC) was established to facilitate the coordination of disaster response efforts nationwide. The NDMC is the center for emergency response, relief and recovery efforts. The Ministries of Defense, National Security Services and Planning and National Development should be the main players in keeping this center operating.

Efforts are being made to reinforce the NDMC so that it can exist as a permanent organization, and a plan is being prepared for the flow of emergency messages related to natural events (National Security Services, 2005, Figure 2-16). For effective national disaster management, organizations and systems need to be established that can exhibit leadership and take responsibility for addressing important national issues. An effective emergency response requires that current natural phenomena can be correctly assessed and that decisions can be made in a short time. This will then facilitate prompt decisions regarding such issues as the efficient transmission of warnings and the urgent sharing of alerts, emergency communications between responsible institutions and organizations, the urgent transmission of warnings to regional, atoll and island authorities, and the urgent evacuation of residents.

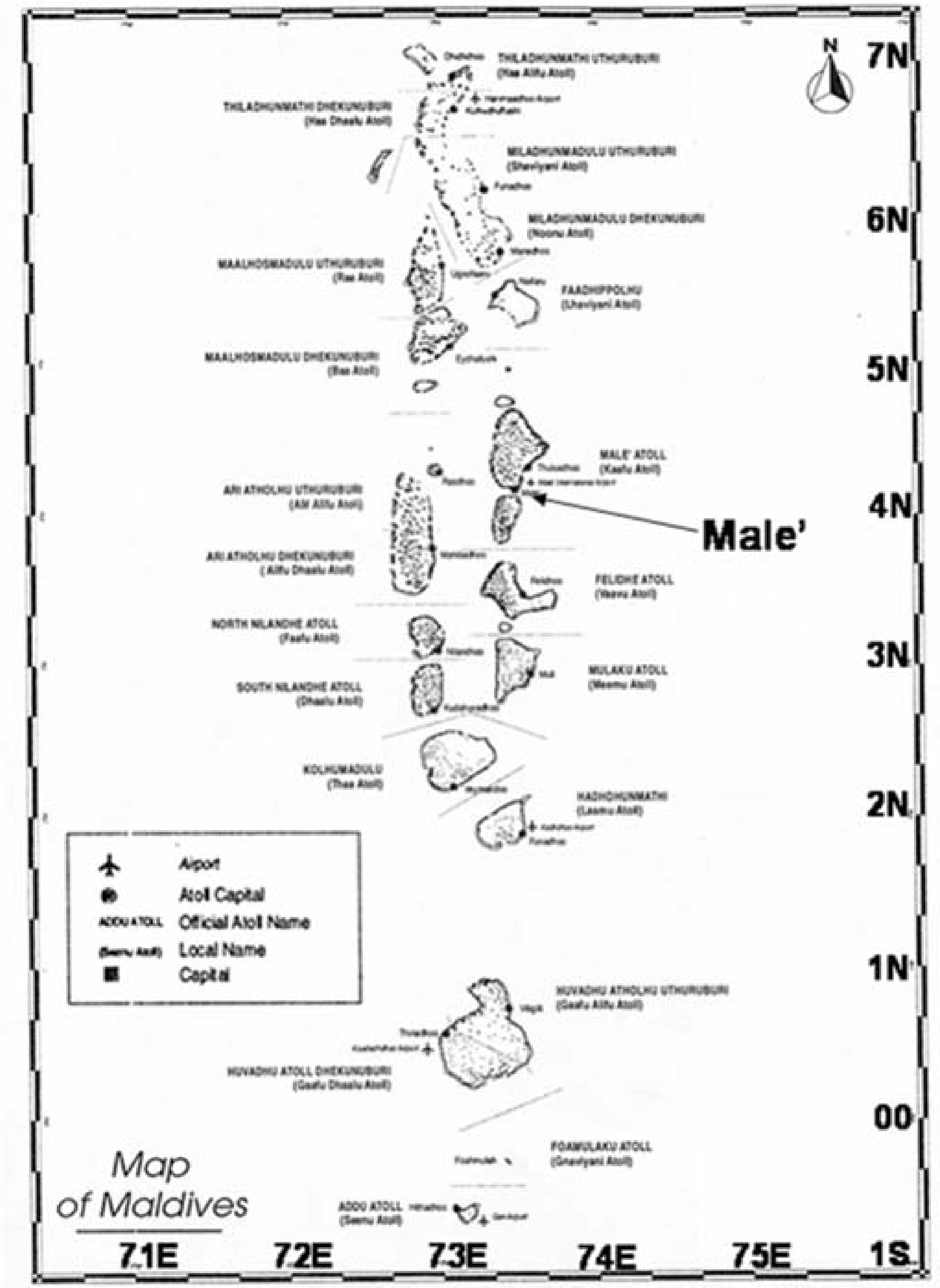


Figure 2-1 Map of Maldives
(Ministry of Planning and National Development (2005): National Recovery and Reconstruction Plan)

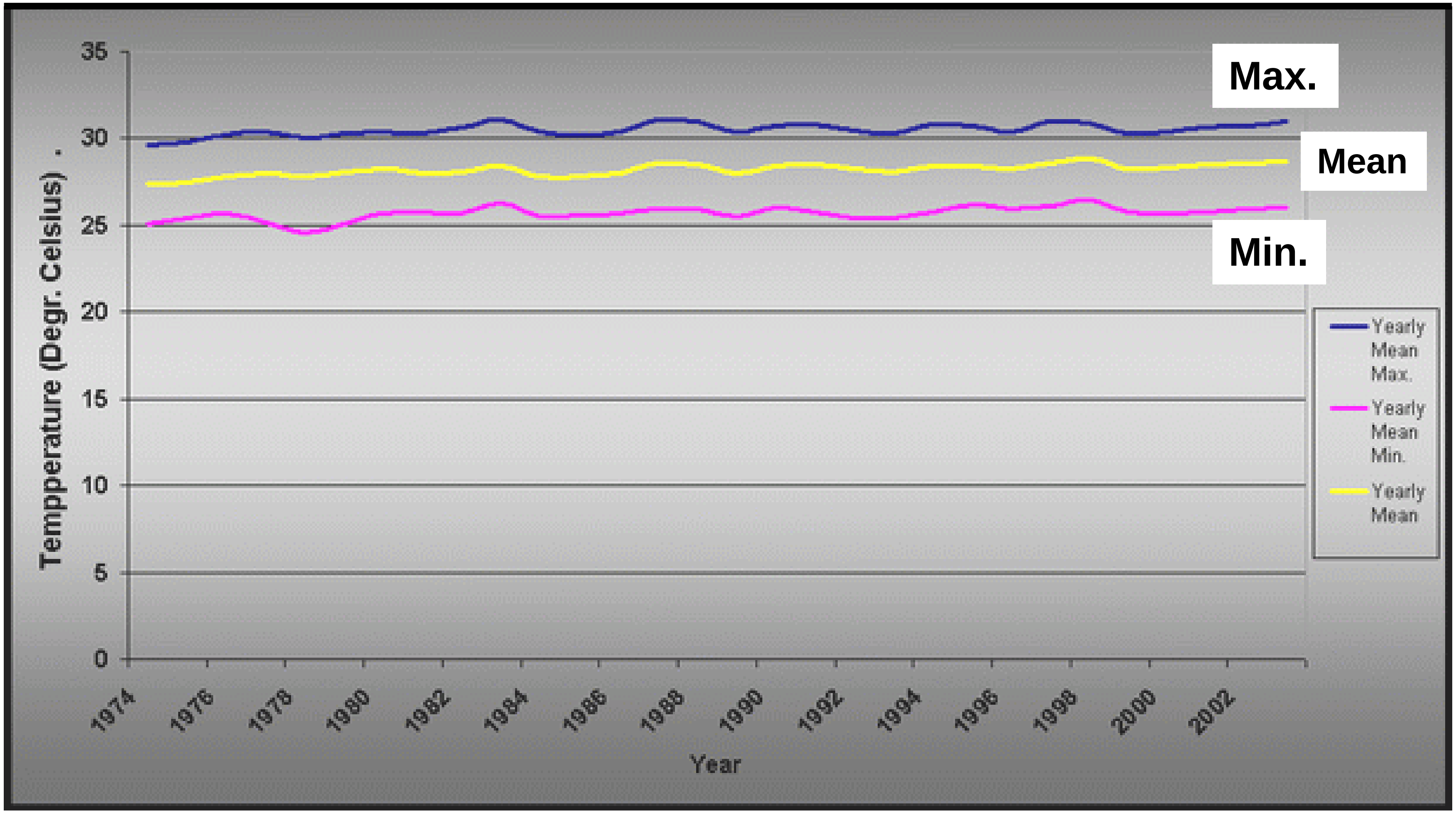


Figure 2-2 Annual Air Temperature for Hulhule, 1974 to 2003 (Department of Meteorology (2004): Met. Data 2003)

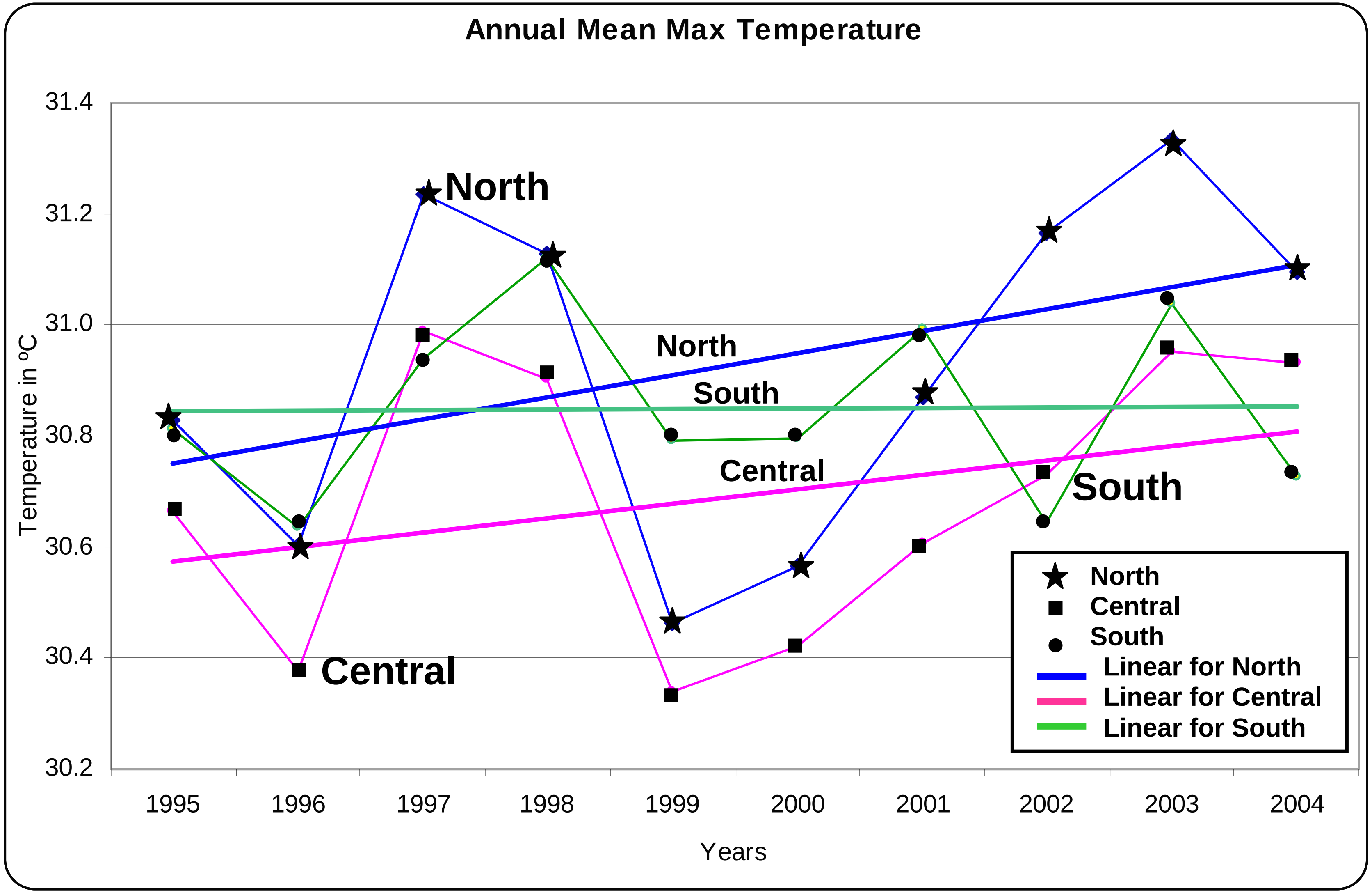
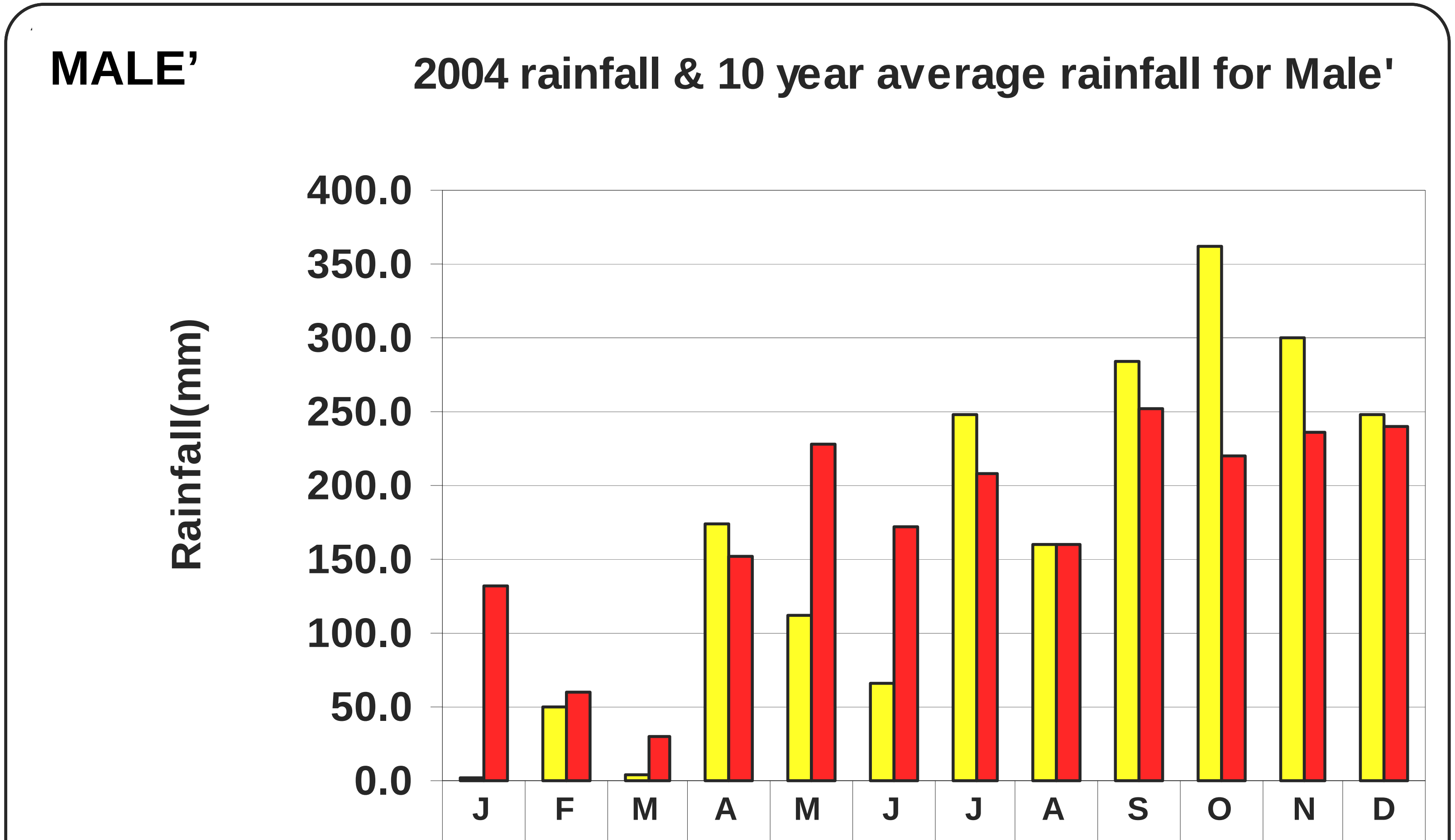
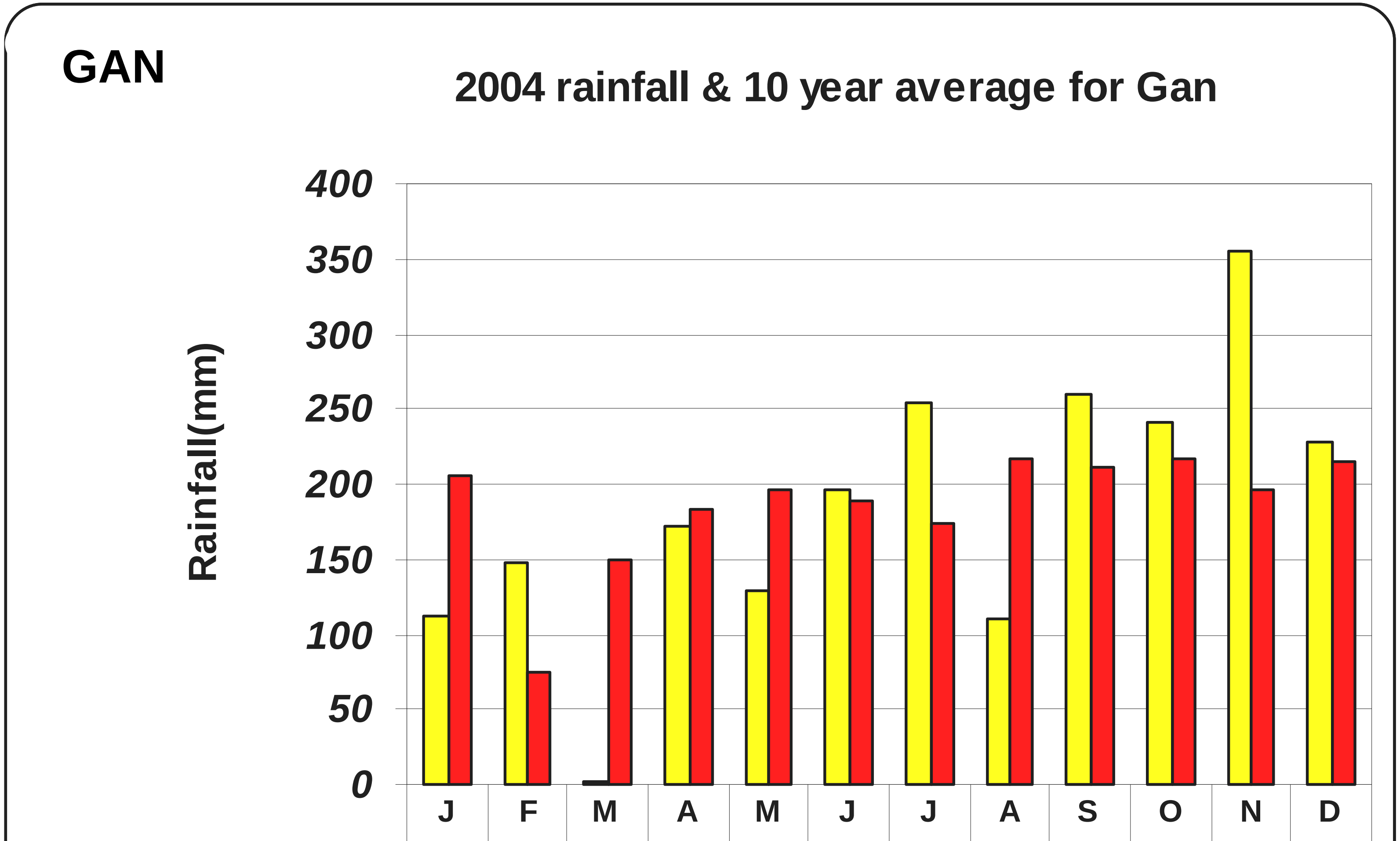


Figure 2-3 Annual Mean Maximum Air Temperature, 1995 to 2004 (Department of Meteorology (2005): Monsoon Report 2004)



	J	F	M	A	M	J	J	A	S	O	N	D
2004 rainfall-Male	2.7	49.4	4.5	175.0	112.7	66.5	248.7	159.6	283.4	361.2	300.8	249.0
10 year average	132.9	60.4	29.2	151.1	227.8	171.1	208.5	159.4	251.5	220.3	235.0	240.9

Figure 2-4 2004 Rainfall and 10 Year Mean Rainfall for Male' (Department of Meteorology (2005): Monsoon Report 2004)



	J	F	M	A	M	J	J	A	S	O	N	D
2004 rainfall-Gan	113	148	1.7	172	130	197	254	110	260	241	355	228
10 year average	205.7	74.5	150.4	183.0	196.7	188.5	174.7	217.6	211.5	217.2	197.0	215.6

Figure 2-5 2004 Rainfall and 10 Year Mean Rainfall for Gan (Department of Meteorology (2005): Monsoon Report 2004)

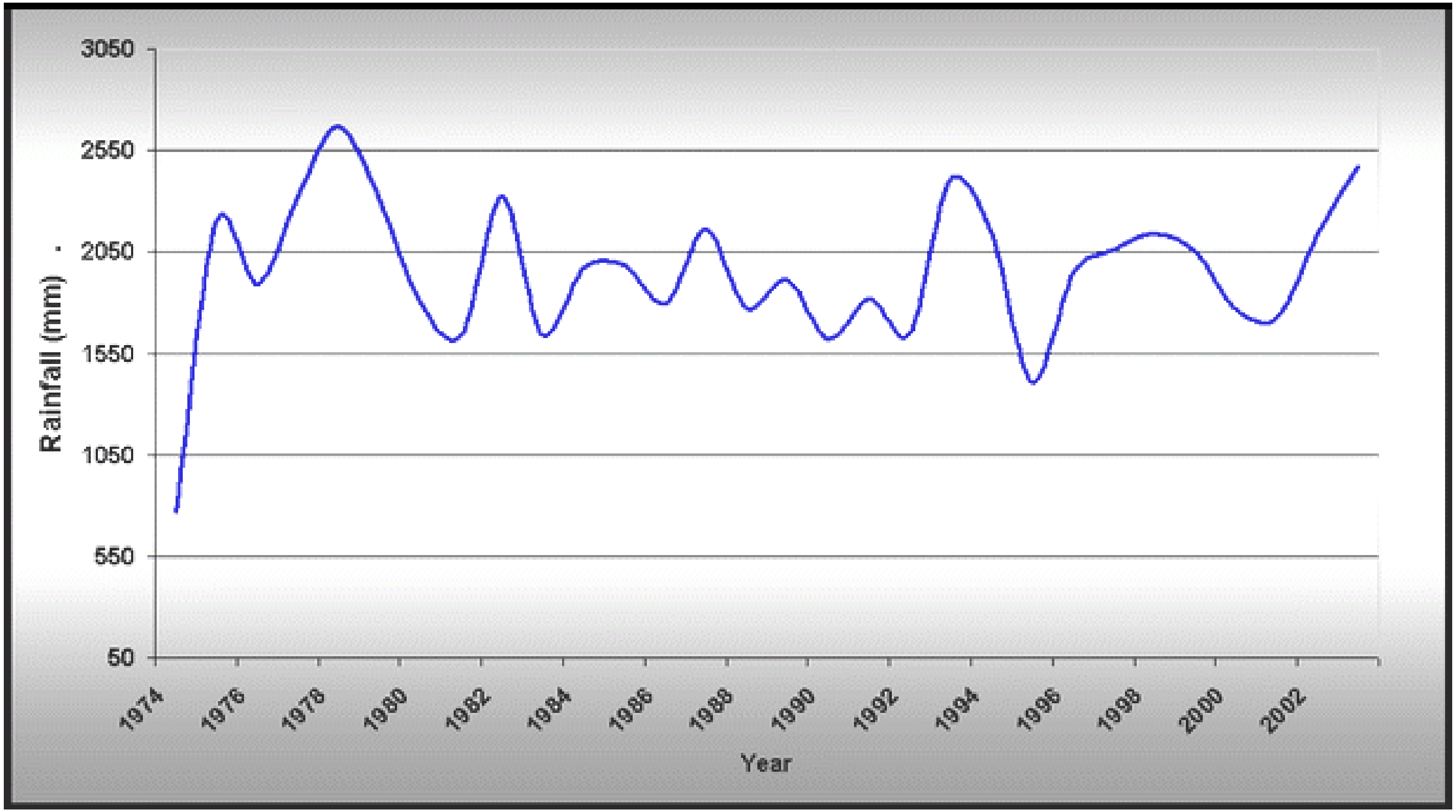


Figure 2-6 Yearly Rainfall for Hulhule, 1974 to 2003 (Department of Meteorology (2004): Met. Data 2003)

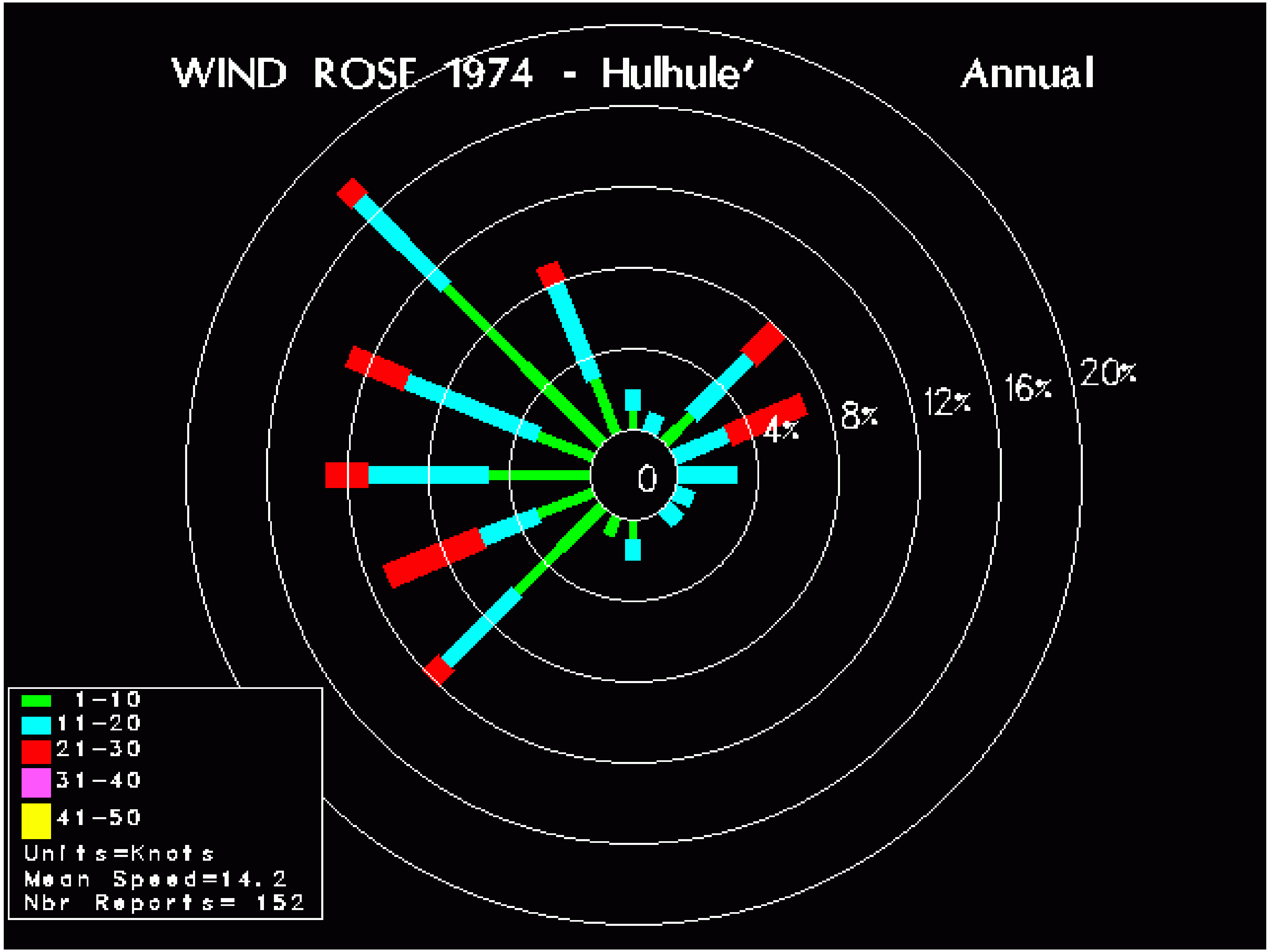


Figure 2-7 Wind Rose for Hulhule, 1974 to 2003 (Department of Meteorology (2004): Met. Data 2003)

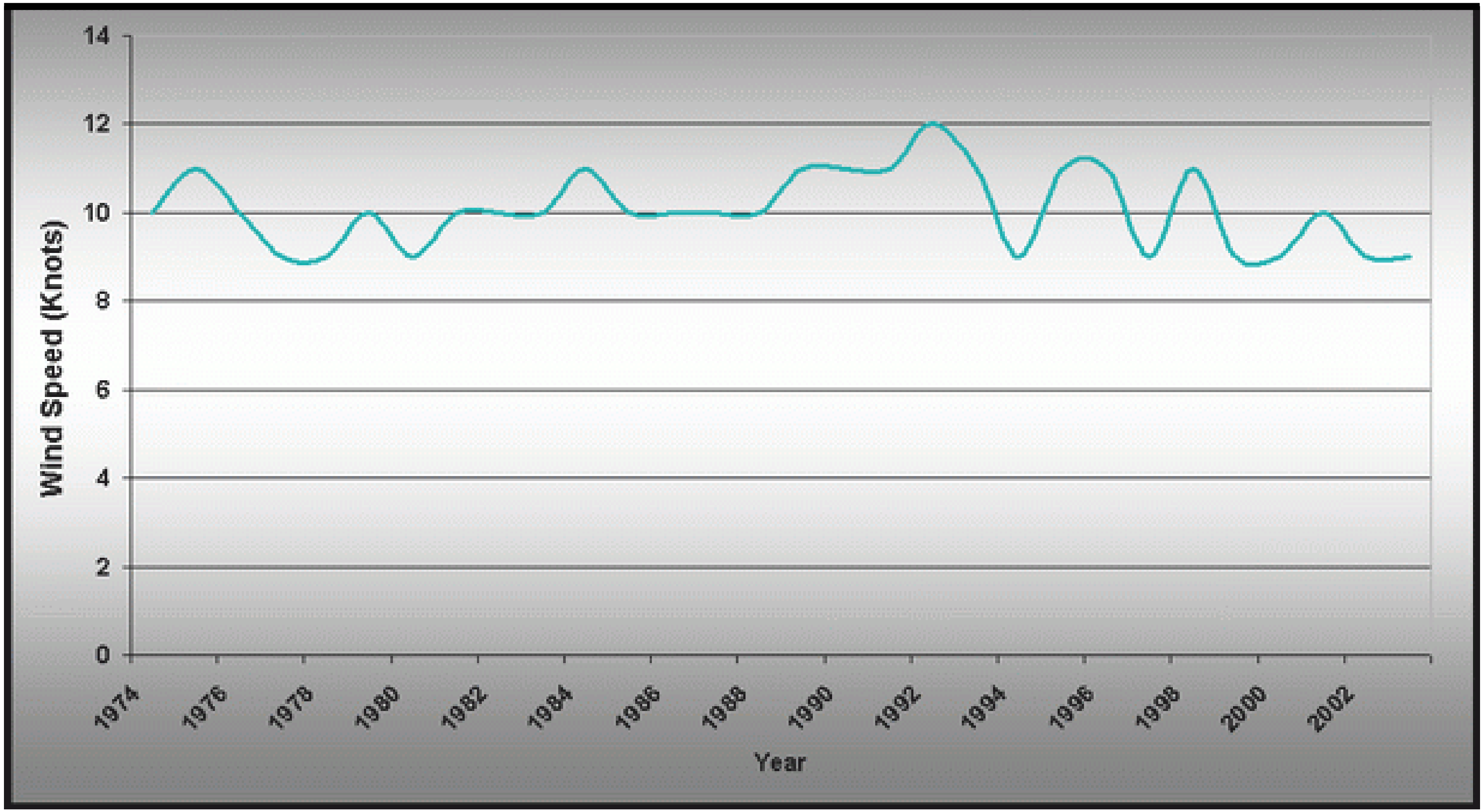


Figure 2-8 Yearly Mean Wind Speed for Hulhule, 1974 to 2003 (Department of Meteorology (2004): Met. Data 2003)

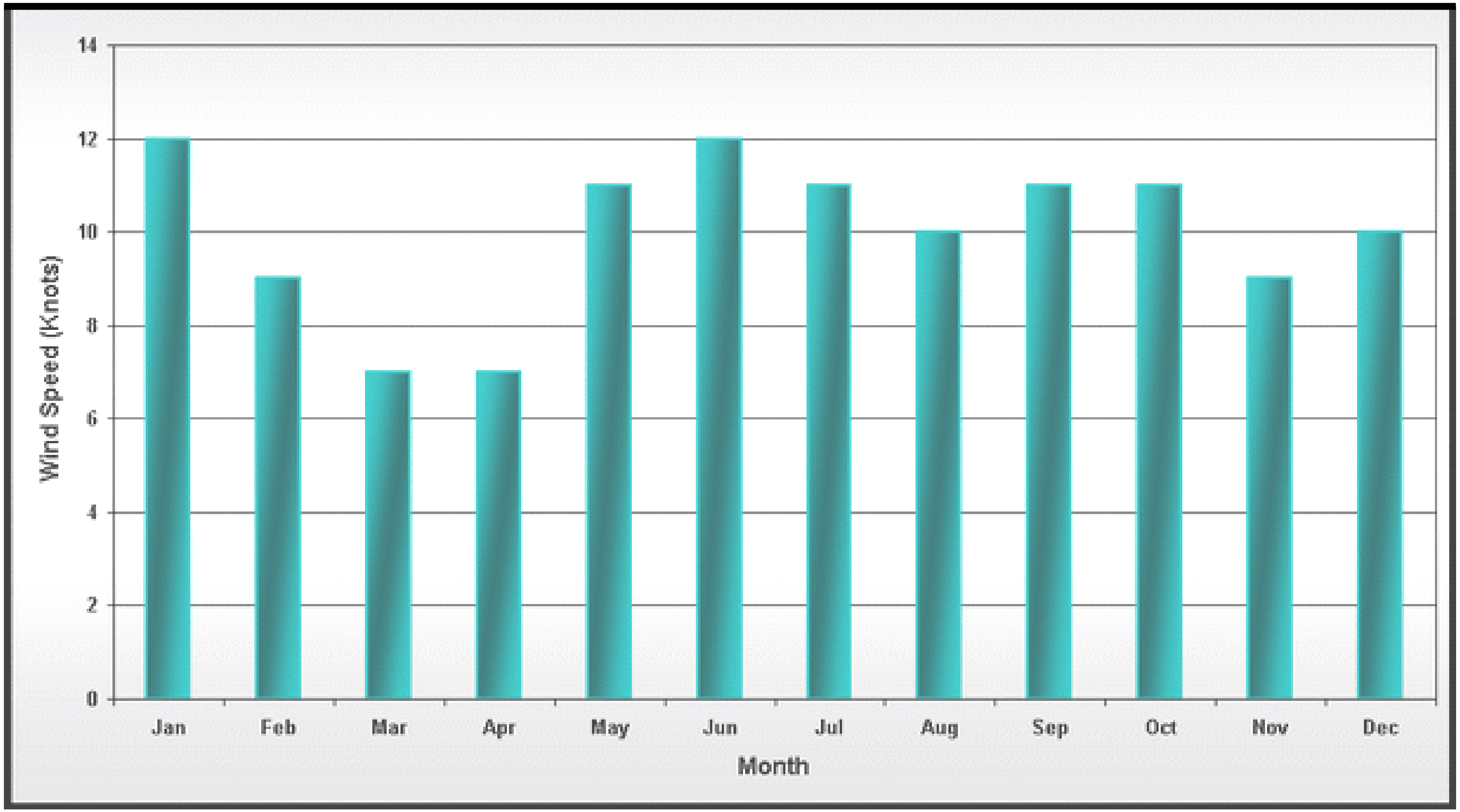


Figure 2- 9 Monthly Mean Wind Speed for Hulhule, 1974 to 2003 (Department of Meteorology (2004): Met. Data 2003)

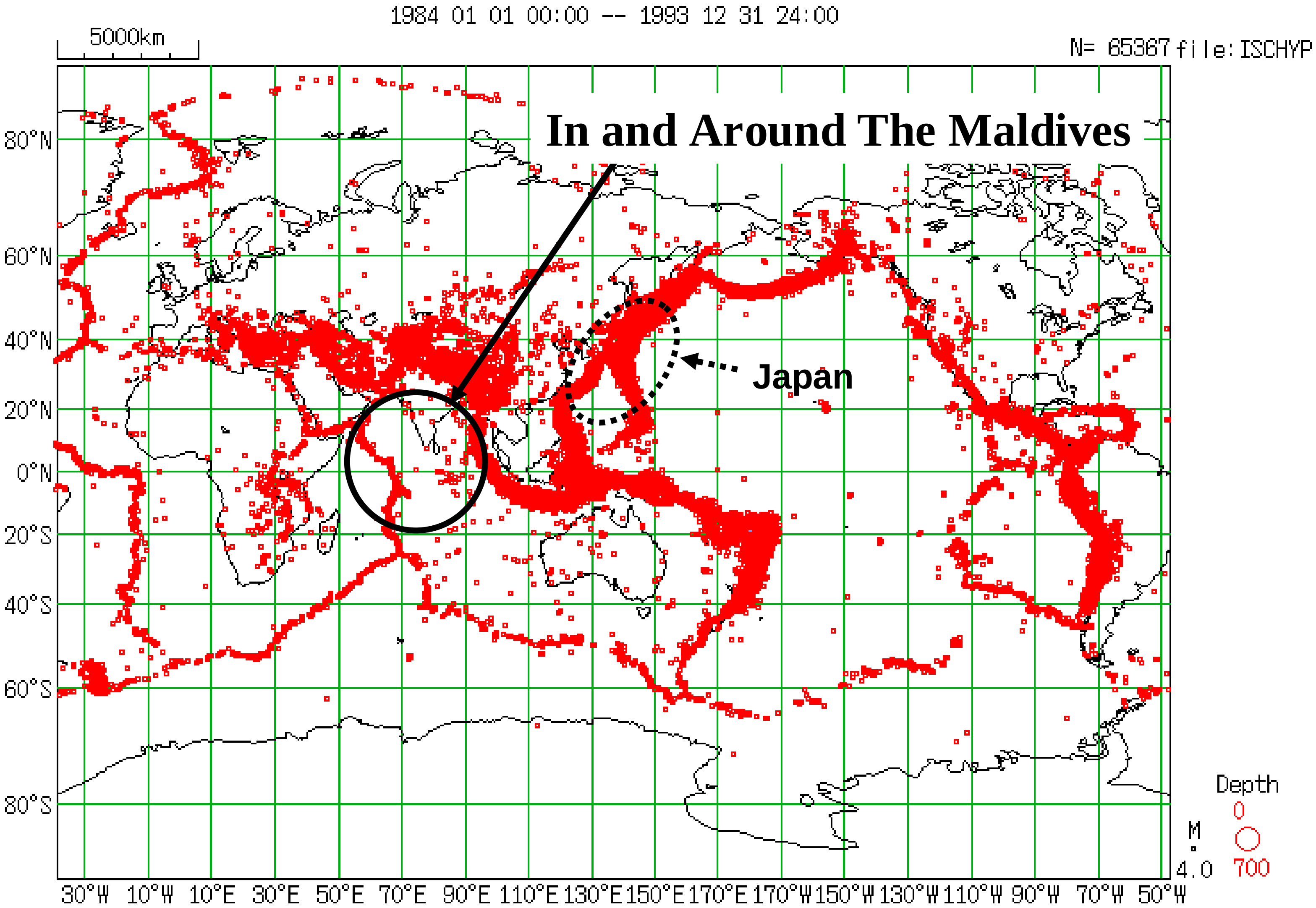


Figure 2-10 Seismicity Worldwide, 1984 to 1993 (after the USGS Catalogue. Prepared by M. Kiyomoto)

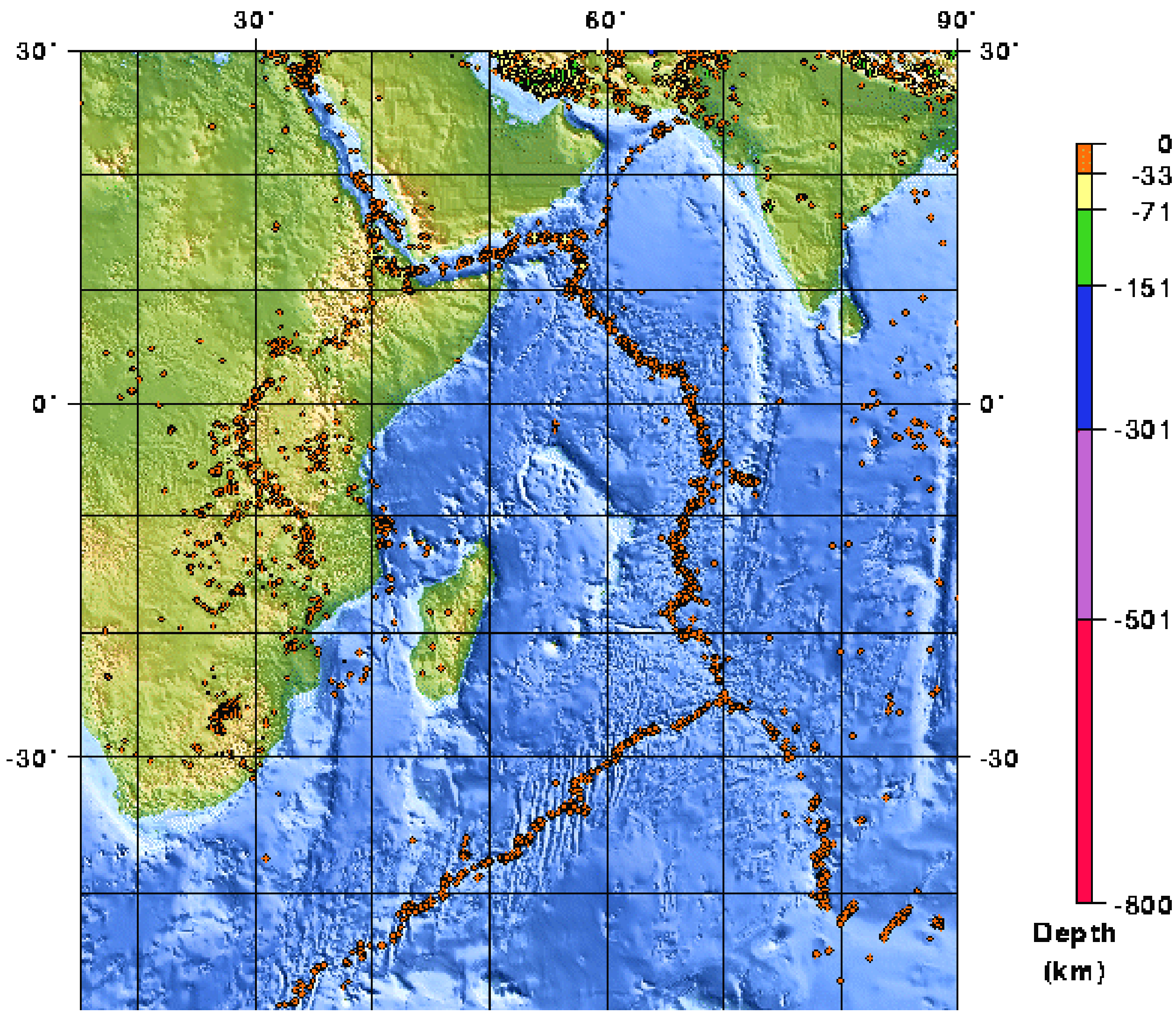


Figure 2-11 Seismic Activity in the West Indian Ocean (USGS Website)

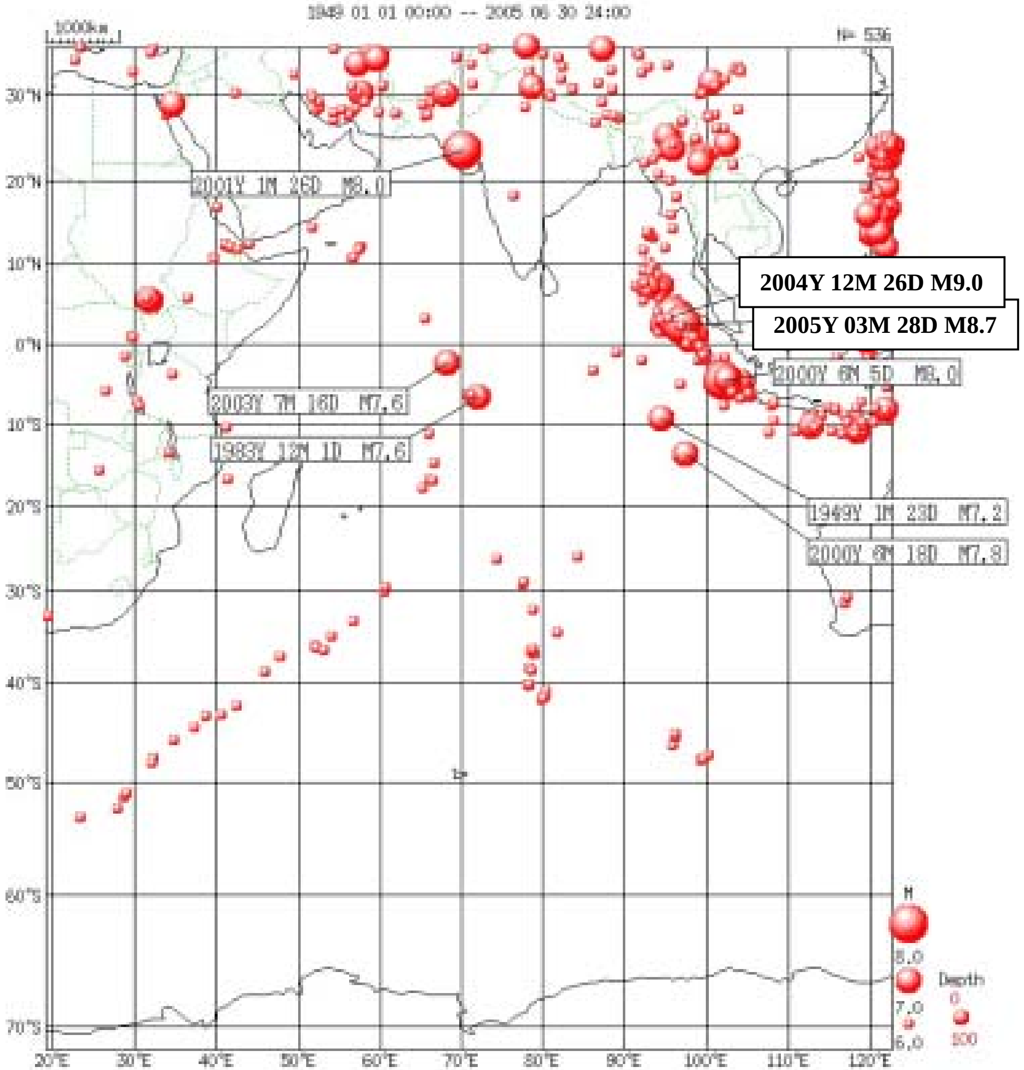


Figure 2-12 Earthquakes greater than M 6.0 and shallower than 100 km in the Indian Ocean Region, January 1949 to June 2005
(From the USGS Catalogue. Prepared by M. Kiyomoto)

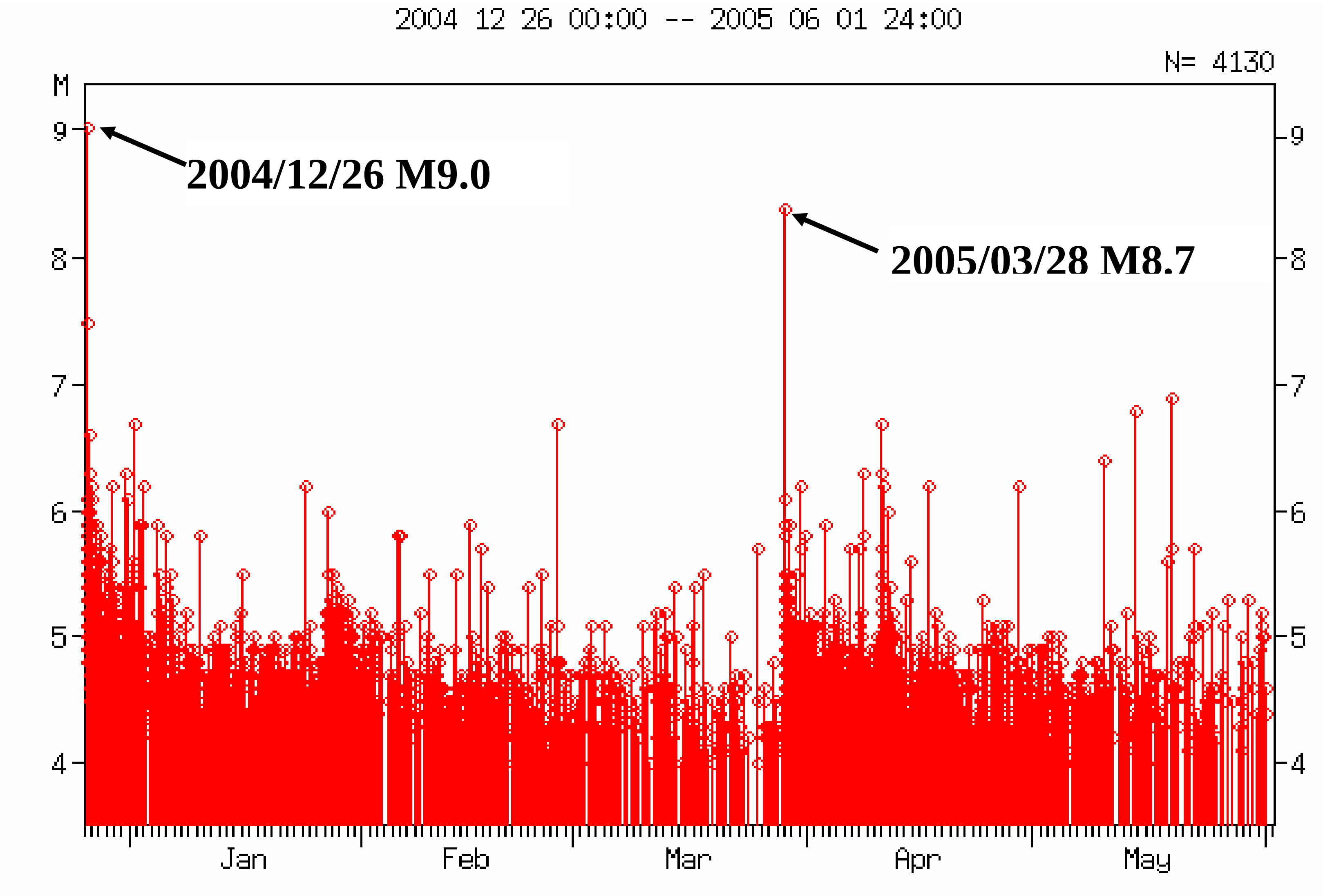


Figure 2-13 Time Variation of Seismic Activity off the West Coast, Northern Sumatra (From the USGS Catalogue. Prepared by M. Kiyomoto)

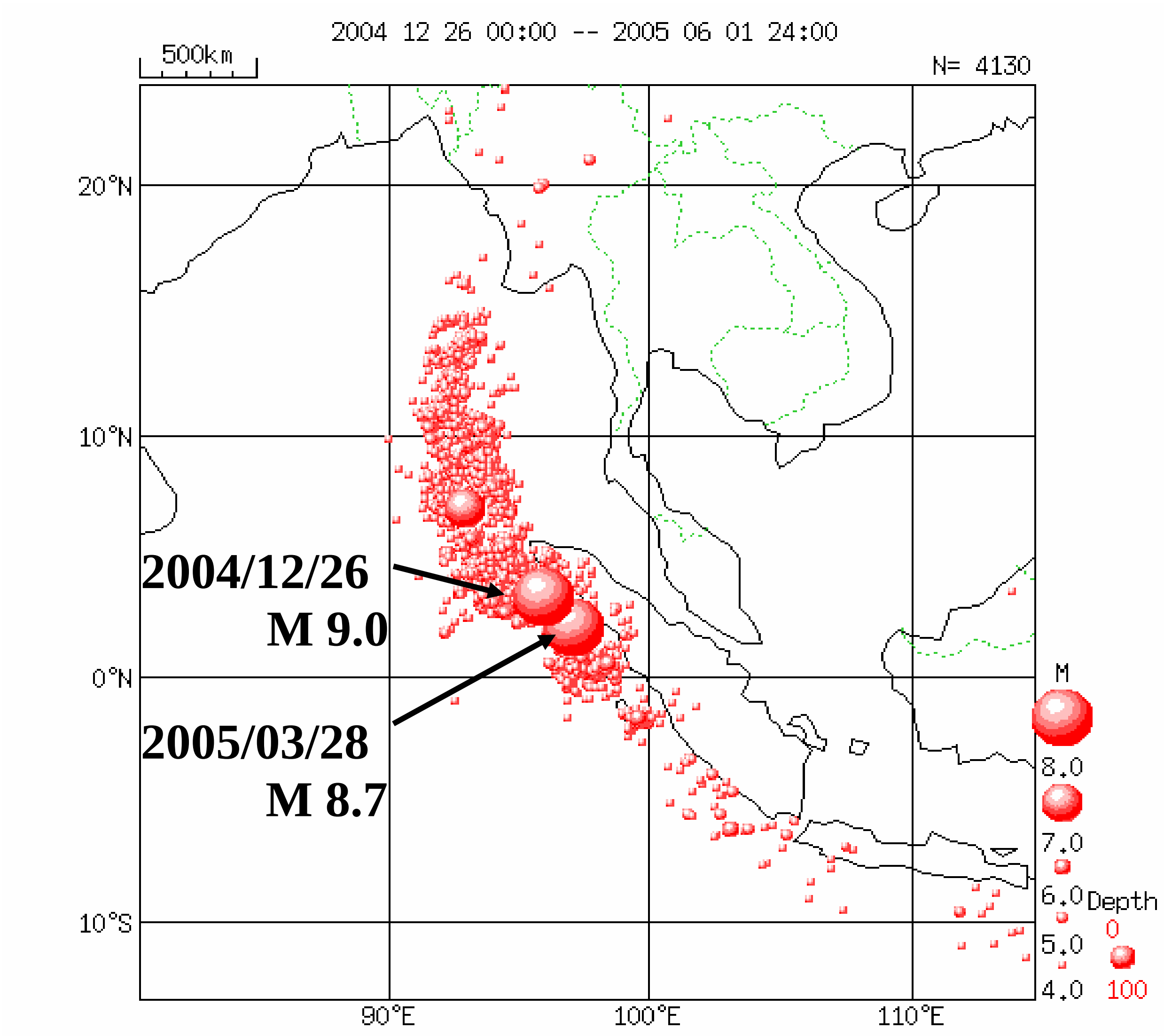


Figure 2-14 Epicentral Distribution of Seismic Activity off the West Coast, Northern Sumatra
(From the USGS Catalogue. Prepared by M. Kiyomoto)

Table 2-2 Historical Records of Natural Disasters in the Maldives: Storms

Date	Remarks
In the Past	The northern part of the Maldives was struck by cyclones in the distant past. Several islands were damaged by cyclone-driven storms. About 18 islands in the northern atolls were abandoned after being devastated by storms (Maniku, 1990).
October 1733	A cyclone devastated and flooded many islands, particularly among the northern atolls, with great loss of life and property (Bell, 1940).
1742	A tornado struck Male' from the west, and more than 110 coconut trees were toppled (Bell, 1940).
7 June 1752	Male' was affected by a severe storm which blew from the southwest.
7 May 1812	Storm devastated a number of islands in the northern Maldives. The storm reached as far south as Kuredhoo.
9 October 1819	Male' was affected by a storm which blew from the west.
1819	A great storm burst upon Male' from the west. Many trees were blown down. In the Palace Enclosure, 12 buildings fell (Bell, 1940).
29 December 1819	Storm affected islands south of Maalhosmadulu.
1820	A tornado struck the Maldives. Many islands of the Tiladummati and Miladummadulu Atolls and one or two islands in the Malosmadulu Atoll were devastated. More than 30 *odifahuru* were wrecked and many people drowned. More than 33 islands were temporarily uninhabitable.
8 December 1821	Storm devastated many islands south of Miladhummadulu.
1898	Thulhaadhoo was affected by a storm during the south-west monsoon.
25 December 1923	"Bodu Vissara" struck Male'. Strong winds blew overnight from a southwesterly direction. Heavy rains started in the morning and the winds became less violent by about 9 am. But the winds hipped up again with the arrival of another storm from the northwest at about 10 am. Several houses and trees fell and large areas of Male' were flooded. The winds subsided by about 2 pm. Four vessels in Male' harbor were lost.
9 January 1955	Storm laid waste to many islands from the southern point of Miladhummadulu.
3 November 1978	The strongest gust of 62 kt was recorded in Huluhule.
23 June 1987	Storms occurred that were localized to only a few islands (Maniku, 1990). A large number of islands (24 islands in four atolls) were affected by such "freak storms" (Maniku, 1990).
25 June 1987	More islands (29 islands in nine atolls) were added to the above list.
30 May 1991	A cyclone-driven storm struck the southern atolls. Atmospheric pressure fell to 997 hPa and the maximum squally winds reached 90 kt (DoM, 2001; WMO, 1993). Most parts of the country were affected, as 4,081 houses in 13 atolls were damaged (SAAC, 1992).
2000	The resort island of Bolifushi was hit by a freak storm, lasting about 12 hours and causing significant damage.

Table 2-2 Historical Records of Natural Disasters in the Maldives: Earthquakes

Date	Remarks
1 August 1729	Destructive earthquake occurred in the east (Bell, 1940).
1729	Statement by Bell (1940); Much of Henvareu Ward of Male' was destroyed by fire. An earthquake was felt throughout the islands.
16 July 1729 - 16 July 1730	Footnote of Bell (1940); Two destructive earthquakes occurred in the east on August 1, 1729 and March 12, 1730.
12 March 1730	Destructive earthquake occurred in the East (Bell, 1940).
21 September 1730	Earthquake (Bell, 1940) (Not mentioned in the *Tariku*).
29 September 1730	Earthquake (Bell ,1940) (Not mentioned in the *Tariku*).
October 1730	Earthquake (Bell, 1940) (Not mentioned in the *Tariku*).
1759	A great fire occurred in Henveru Avaru. It was preceded by an earthquake (Bell 1940).
26 December 2004	The worst natural disaster in the history of the Maldives. The tsunami struck the Maldives at 09:02 am. The M 9.0 earthquake off the west coast of northern Sumatra, Indonesia, caused a maximum runup wave height of about 4.7 m at Fonadhoo and inundation waves as high as about 3.7 m at Hulhumale (Fujima et al. 2005). Most of the islands throughout the nation were affected by at least about 1 m high tsunami waves. 13 islands were totally evacuated. As many as 82 persons, including 4 foreigners, were killed and 26 persons are still missing. Over 15,000 people lost their homes and were displaced. Tsunami waves destroyed houses, public utilities such as hospitals and schools, the transportation and communication infrastructure, seawalls, harbor facilities and more. The tremors were felt across a wide region. The capital of Male' was struck by tsunami waves of heights above MSL (Mean Sea Level) of 1.96 m, 1.36 m, 2.16 m and 1.36-1.46 m along its west, north, east and south coasts, respectively. About 60% of the total area of the capital island was inundated but the functions of the capital were not seriously disturbed, in spite of damage sustained by ships and harbor facilities. Seawalls installed around the capital in 2002 were clearly effective in reducing the peak heights of tsunami waves and the damages they caused. About 70% of Hulhule Island, home of the international airport, was inundated by tsunami waves and the runway was closed for 10 hours. Tsunami waves also struck other atolls, causing severe damage to houses, ships, infrastructural components and so on.
28 March 2005	M 8.4 earthquake occurred off the west coast of northern Sumatra, Indonesia. This was the largest shock since the M 9.0 event on December 26, 2004. Tremors were felt across a wide area. Tsunami heights recorded at Hanimaadhoo, Hulhule and Gan stations were 40 cm, 18 cm and 10 cm, respectively. No damage was reported in the Maldives.

Table 2-2 Historical Records of Natural Disasters in the Maldives: High Waves

Date	Remarks
10-12 April 1987	High waves due to an abnormal rise in the sea level caused wide-scale flooding that damaged a number of islands in the central part of the nation. Harbors, buildings, structures and coastal areas in Male' were destroyed by high waves and massive flooding. Damage also occurred in Hulhule.
June, July and September 1988	High waves due to an abnormal rise in the sea level damaged houses, structures and coastal areas. High waves and wide-scale flooding was reported on some islands in the southern atolls.

Note:

Data mainly from:

Asian Development Bank and Ministry of Planning and Environment (1993): Disaster Preparedness and Mitigation in the Republic of the Maldives (by Campbell, J. R.).

Ministry of Home Affairs, Housing and Environment (2001): First National Communication of the Republic of Maldives to the United Nations Framework Convention on Climate Change.

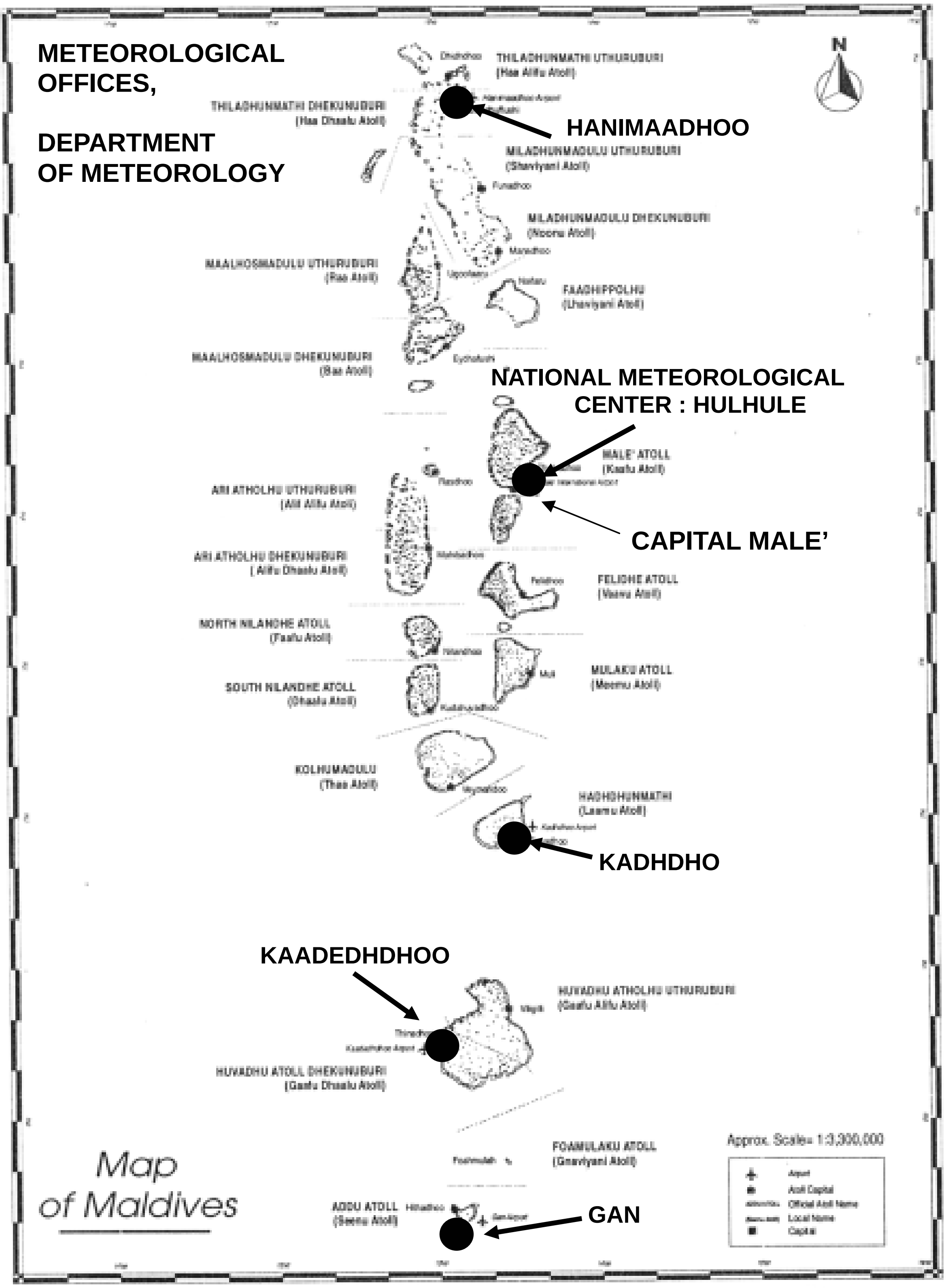


Figure 2-15 Distribution of Meteorological Offices

Table 2-3 Meteorological Offices of the Department of Meteorology of the Maldives

Station Name	Location	Functioning	Observation Equipment
National Meteorological Center (Hulhule)	No. 43555 (VRMM) 4.19°N 73.53°E	Surface meteorology and tide observation: Every hour, 24 hours a day. Issues daily weather forecast, aviation forecasts, weather warnings and marine forecasts.	Wind system, barometer, digital barometer, thermometers, rain gauge, sunshine recorder, SADIS, Satellite Imagery Receive (internet), tide gauge
Gan	No.43599 (VRGN) 0.69°S 73.16°E	Surface meteorology and tide observation: Every hour, 24 hours a day. Upper air observation: Once a day. Observation data is sent to the NMC.	Wind System, barometer, thermometers, rain gauge, sunshine recorder, tide gauge, radiosonde system
Hanimaadhoo	No.43533 (VRMH) 6.75°N 73.17°E	Surface meteorology and tide observation: Every hour from 5:00 AM - 5:00 PM and every 3 hours from 5:00 PM - 5:00 AM. Data is sent to the NMC. Daily synoptic and aviation report (8:00 AM - 5:00 PM).	Wind system, barometer, thermometers, rain gauge, sunshine recorder, tide gauge
Kadhoo	No.43577 (VRMK) 1.86°N 72.10°E	Surface meteorology observation: Every hour from 5:00 AM - 5:00 PM and every 3 hours from 5:00 PM - 5:00 AM. Data is sent to the NMC. Daily basic surface and aviation report (8:00 AM - 5:00 PM).	Wind system, barometer, Thermometers, rain gauge
Kaadedhdhoo	No.43588 (VRMT) 0.49°N 72.1°E	Surface meteorology observation: Every hour 5:00 AM - 8:00 PM. Data is sent to the NMC. Daily synoptic and aviation report (8:00 AM - 5:00 PM).	Wind system, barometer, Thermometers, rain gauge

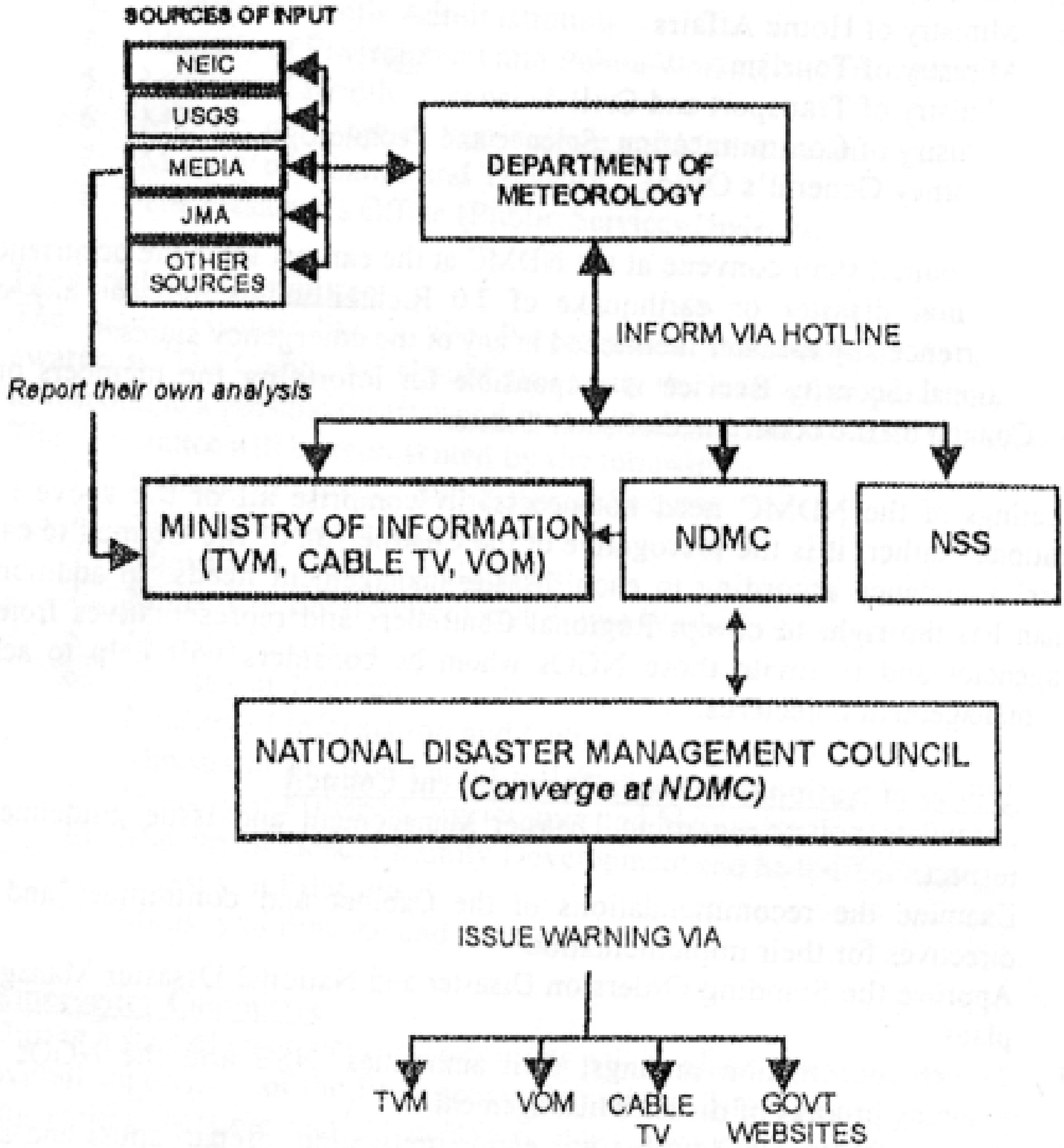


Figure 2-16 Alert and Warning Flow Chart for Natural Disasters (DRAFT)
(The National Security Service, 2005)

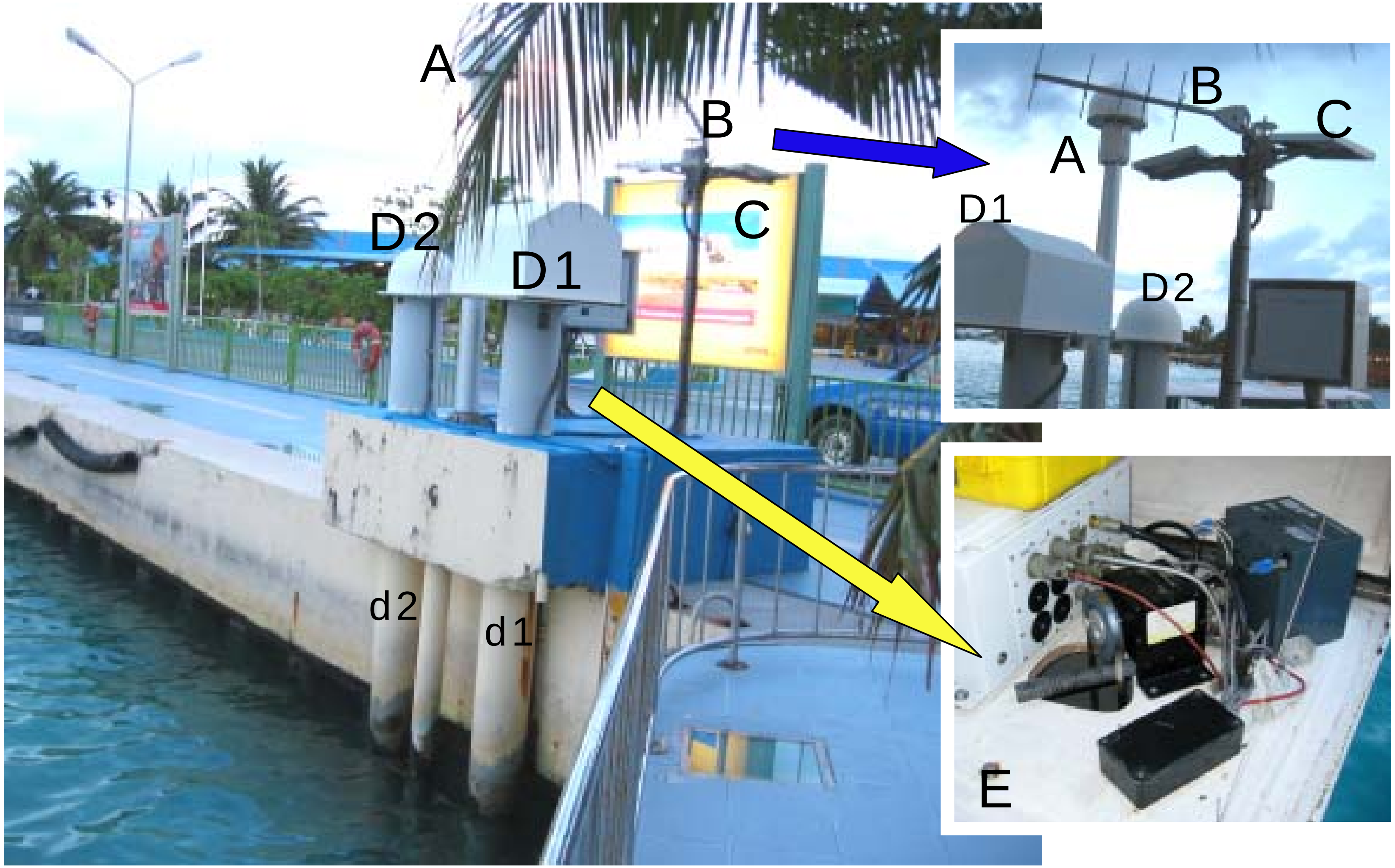


Photo 2-1 Tide gauge system in Hulhule
A and B: Antennas for GPS and satellite transmission. C: Solar-cell panel.
D1 and D2: Transducer cases of floats installed in two pipes (d1 and d2). E: The transducer system inside case D1.

Photo 2-2 Complete view of the building (left) and observation field (right) of the National Meteorological Center in Hulhule

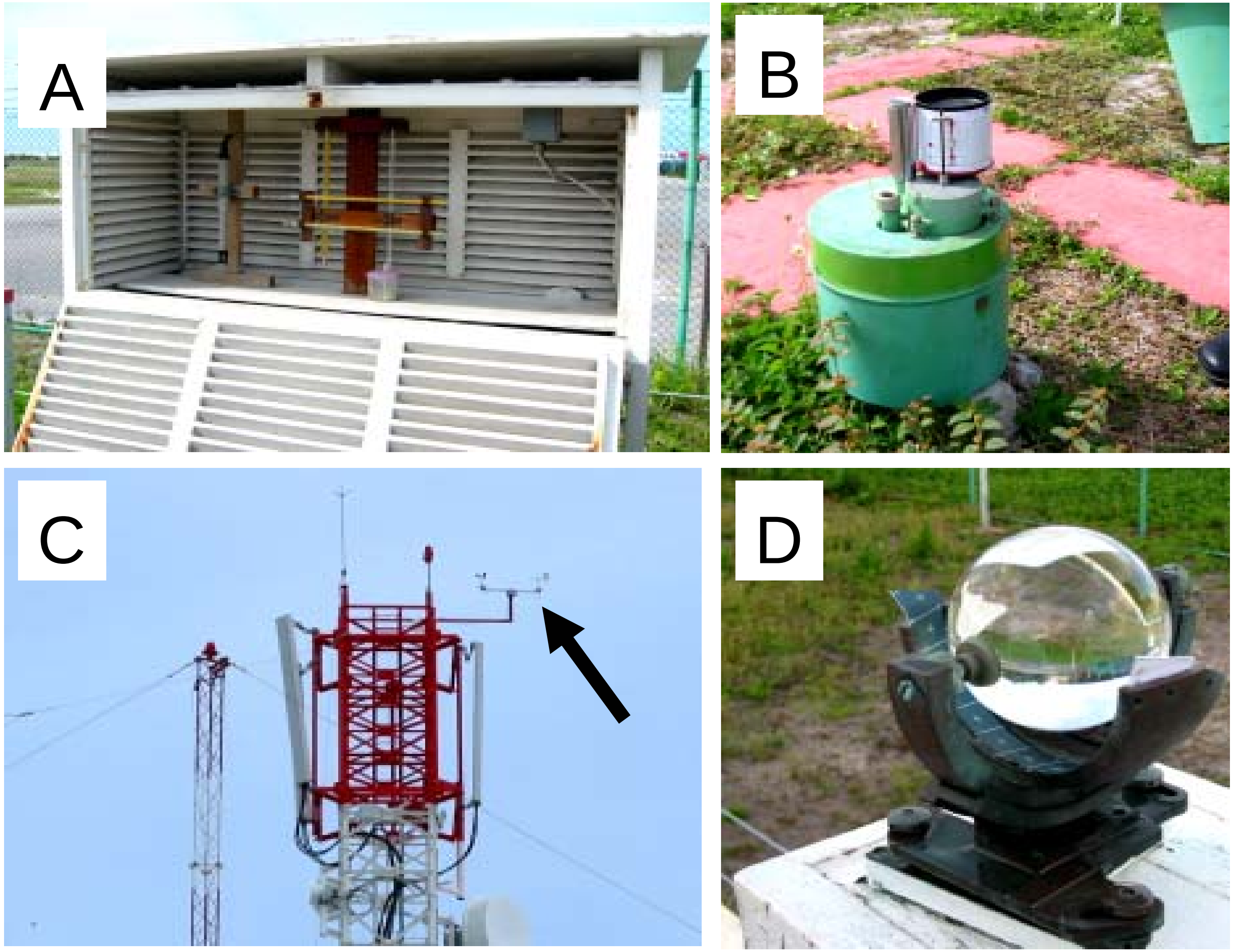


Photo 2-3 Examples of meteorological equipment at the NMC
A: Thermometers (middle and left) and a digital barometer (right) installed in a box.
B: Rain gauge. C: Wind system installed on a tower. D: Sunshine recorder.

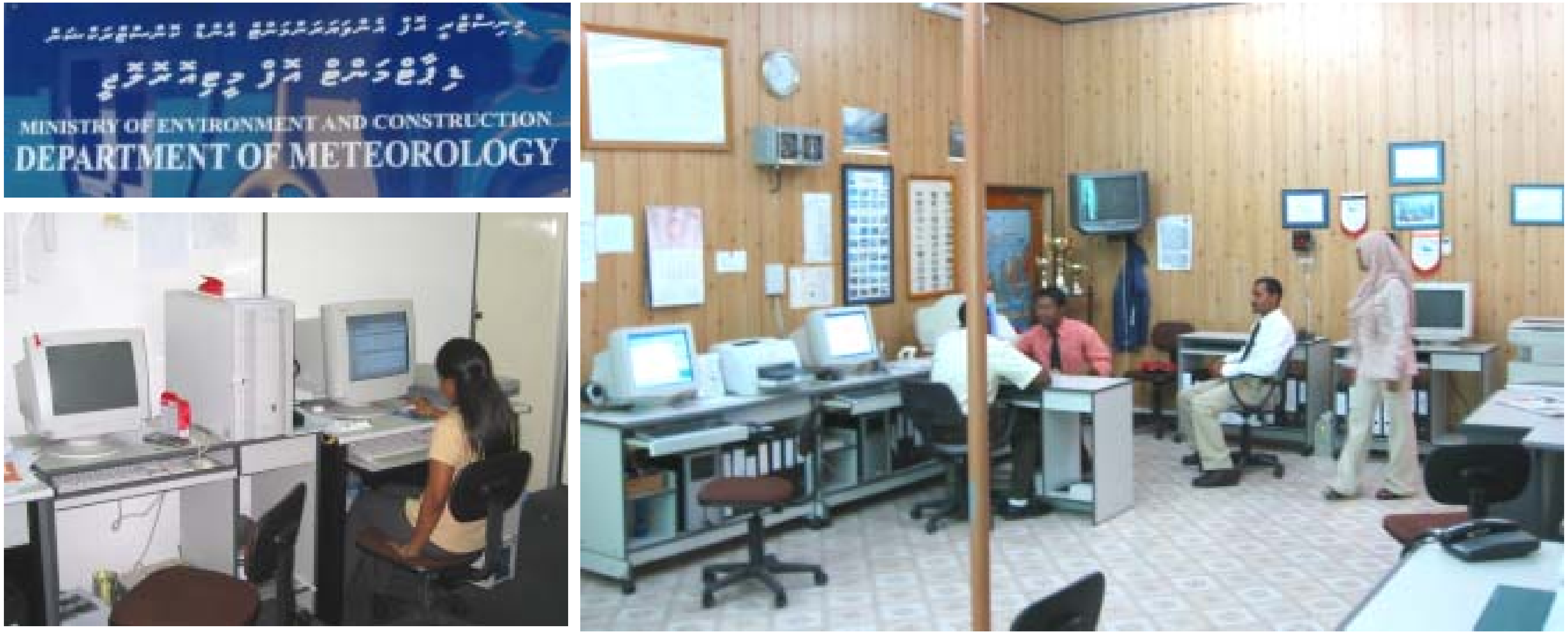


Photo 2-4 Views of the Climate Data Section in Male' (bottom left) and the Observatory Room in Hulhule (right)

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Fujima, K., Tomita, T., Honda, K., Shigihara, Y., Nobuoka, H., Hanzawa, M., Fujii, H., Ohtani, H., Orishimo, S., Tatsumi, M. and Koshimura, S. (2005): Preliminary Report on the Survey Results of 26/12/2004 Indian Ocean Tsunami in the Maldives, pp 95.

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3. Assessment of Public Information Delivery

3.1 Field Survey

(1) Activities

A field survey was conducted in the Maldives from June 17 to July 1, 2005. The field survey activities are listed in Table 3-1.

Table 3-1 Field Survey Activities

Date	Time	Activity / Location Visited	Contact Person	Position
June 17	22:00	Arriving in Male’	-	-
June 18	10:00 -	UNDP Recovery Team Office	Ms. Rita Missale	Recovery Officer
	15:00 -	Meeting with local consultant (Sehga Soft Private Limited)	Mr. Ibrahim Saleem	Director
June 19	09:00 -	Department of Meteorology, Ministry of Environment & Construction	Mr. Abdulla Algeen	Director
June 20	08:30 -	Statistic Section, Ministry of Planning & National Development	Mr. Ahmed Nihad	Chief Statistic Officer
	11:00 -	Ministry of Atolls Development	Mr. Adam Moosa	Director
	12:30 -	National Security Services	Mr. Mohamed Nazim	Major
	13:30 -	Ministry of Communication, Science and Technology	Mr. Farooq Mohamed Hassan	Assistant Director General
	15:00 -	Meeting with local consultant	Mr. Ibrahim Saleem	Director
June 21	08:40 -	UNDP Recovery Team Office	Mr. Man B. Thapa	Disaster Management Specialist
	10:00 -	Statistic Section, Ministry of Planning & National Development	Mr. Ahmed Nihad	Chief Statistic Officer
	13:00 -	Construction & Physical Planning Section, Ministry Environment & Construction	Mr. Abdul Bari Yoosuf	Deputy Director
June 22	09:00 -	Male Municipality	Mr. Ali Hussain Didi	Director General
	10:00 -	Environment Section, Ministry of Environment & Construction	Mr. Ahmed Jameel	Deputy Director
	13:00 -	Ministry of Planning & National Development	Mr. Asim Ahmed	Director
	15:00 -	Ministry of Atolls Development	Mr. Adam Moosa	Director
	17:30 -	National Meteorological Center, Department of Meteorology	Mr. Ali Shareef	Head Meteorologist
	21:00 -	Maldives Airport Corporation Limited, Ministry of Transportation & Civil Aviation	Mr. Ali Hashim	Assistant Managing Director
June 23	09:00 -	Collecting the filled questionnaire at Male Municipality	Mr. Ali Hussain Didi	Director General
	09:30 -	Department of Meteorology, Ministry of Environment & Construction	-	-
June 24	-	Report writing	-	-
June 25	-	Report writing	-	-
June 26	10:00 -	Ministry of Gender, Family Development and Social Security	Mr. Ahmed Shareef	Deputy Minister
	11:00 -	UNDP Recovery Team Office	Mr. Man B. Thapa	Disaster Management Specialist
	14:20 -	Moving to Laamu Atoll	-	-
	16:30 -	Island Office of Thun’dee Ward, Gan Island	-	Island Chief
June 27	-	Field Survey in Gan Island (Questionnaire Survey for Residents)	-	-
	17:00 -	Moving to Male’	-	-

Table 3-1 Field Survey Activities -continued-

Date	Time	Activity / Location Visited	Contact Person	Position
June 28	09:00 -	Ministry of Education	Mr. Ibrahim Ismail Ali	Executive Director
	10:00 -	Collecting the filled questionnaire at Environment Section, Ministry of Environment & Construction	Ms. Mizna Mohamed	Assistant Environment Analyst
	10:30 -	Collecting the filled questionnaire at Ministry of Planning & National Development	Ms. Atuifa Ali	Officer
	11:00 -	Collecting the filled questionnaire at Ministry of Gender, Family Development and Social Security	-	-
	14:00 -	Meeting with Arrowcrest Technologies Pte Ltd	Mr. Tham Keang Chung	Director
June 29	09:00 -	Ministry of Tourism	Mr. Ahmed Salih	Deputy Director
	11:00 -	Meeting with JICA	Ms. Ayako Omura	Project Formulation Advisor
June 30	09:00 -	Television Maldives	Mr. Mohamed Asif	Senior Programme Organiser
	12:00 -	Maldives Police Service	Mr. Ibrahim Khaleel	Chief Inspector
	13:00 -	Ministry of Health	Ms. Sheena Moosa	Deputy Director of Health Services
	16:20 -	UNDP Recovery Team Office	Mr. Man B. Thapa	Disaster Management Specialist
July 01	23:15	Leaving Male’	-	-

(2) Questionnaire Survey

A questionnaire survey was conducted among residents and government officials in the Maldives, one of the tsunami-affected countries, in order to ascertain their knowledge about tsunamis. Details about the survey method are as follows.

- Questionnaire survey on tsunamis for residents: The face-to-face interview method was employed. Enumerators visited individual households and camps in order to interview residents to get accurate responses to the questionnaire. Residents were selected through random sampling. The expected sample size was 1,000.
- Questionnaire survey on disaster management for government officials: Respondents filled out questionnaires on their own. The survey team returned later to collect their surveys. The expected sample size was 100.
- Survey of the current situation in the target area: To understand the current situation in the target area, we conducted an interview survey within government organizations. We also visited the affected site to grasp the extent of the damage.

The questionnaire covered the following topics.

- Residents: Their reaction during the tsunami, information received during evacuation, knowledge of tsunamis, countermeasures against natural disasters and other topics.
- Government officials: Training/seminars on natural disasters, countermeasures against natural disasters, measures for protecting tourists and other topics.

Photo 3-1 Interview with a displaced person (left) in Laamu Atoll

Photo 3-2 Interview with an affected person (right) in Laamu Atoll

(3) Interview Survey
To supplement the questionnaire, interviews were conducted without questionnaire sheets. The survey team interviewed officers in charge of disaster related activities (Table 3-1).

3.2 Sample Structure

(1) Residents
Table 3-2 shows the details of the residents surveyed by island. Residents of Gan Island include displaced people from Mundoo and Kalhaidhoo. The total sample size is 1,061. The damage sustained in the target areas is shown in Table 3-3.

Table 3-2 Survey Results

Atoll	Island	Date of Field Survey	Number of Questionnaires Collected	Number of Enumerators	Remarks
Laamu	Gan	June 27	125	2	Also surveyed displaced people from Mundoo and Kalhaidhoo
Laamu	Fonadhoo	June 28	125	7	
Kaafu	Dhiffushi	July 02	130	6	
Kaafu	Huraa	July 02	127	6	
Kaafu	Male (including Villingili & Hulhumale)	July 05-06	298	6	
Meemu	Kolhufushi	July 03	125	6	
Meemu	Muli	July 04	131	6	
Total			1,061		

Table 3-3 Damage Sustained in the Target Areas

Atoll	Population†	Number of Deaths	Number of Missing	Flooding Status‡ (Number of Islands)			Number of Damaged Buildings
				Completely	Half	Slight	
Laamu	11,318	22	3	7	2	3	285
Kaaf	8,458	3	2	6	1	1	482
Meemu	4,845	21	13	8	0	0	346

† as of mid 2004
‡ as of January 5 2005
(Source: National Disaster Management Center, Government of Maldives)

(2) Government Officials

The government institutions surveyed in this study are listed in Table 3-4. The survey team interviewed officials involved in disaster-related activities and asked for their cooperation in the questionnaire survey. The number of questionnaires returned is also included in the table.

Table 3-4 Samples of government officials

Organization	Contact Person	Position	Number of Questionnaires Collected
Ministry of Atolls Development	Mr. Adam Moosa	Director	98
National Security Service	Mr. Mohamed Nazim	Major	7
Ministry of Environment & Construction (Construction Section)	Mr. Abdul Bari Yoosuf	Deputy Director	5
Department of Meteorology	Mr. Abdulla Algeen	Director	9
Male Municipality	Mr. Ali Hussain Didi	Director General	20
Ministry of Environment & Construction (Environment Section)	Ms. Mizna Mohamed	Assistant Environment Analyst	5
Ministry of Planning & National Development	Ms. Atuifa Ali	-	5
Ministry of Gender, Family Development and Social Security	Mr. Ahmed Shareef	Deputy Minister	7
Ministry of Education	Mr. Ibrahim Ismail Ali	Executive Director	5
Maldives Police Services	Mr. Ahmed Shiyam	-	13
Ministry of Health	Ms. Shehenaz Fahmy	Deputy Director	8
Total			182

3.3 Results

(1) Residents

Q1. Where were you at the occurrence of tsunami on 26 December, 2004?

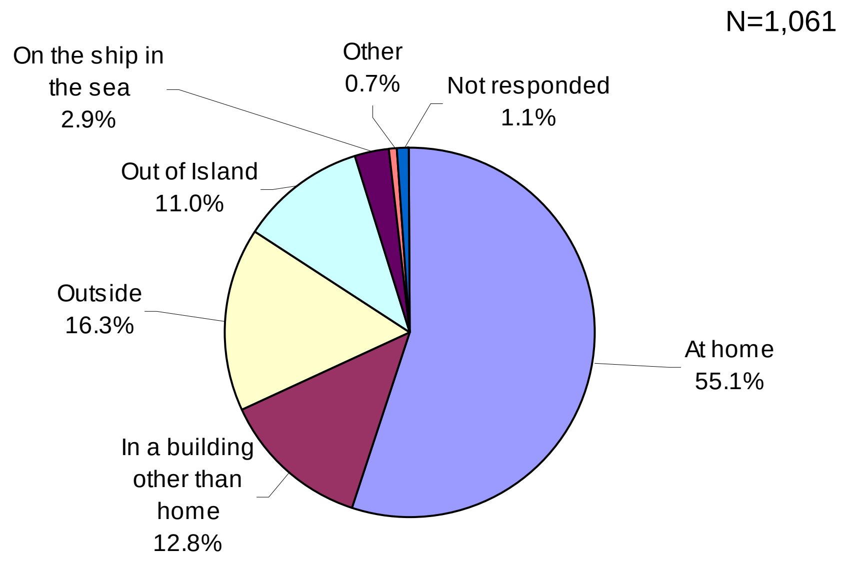


Figure 3-1 Location at the time of the tsunami

Q2. Was your house damaged by tsunami disaster?

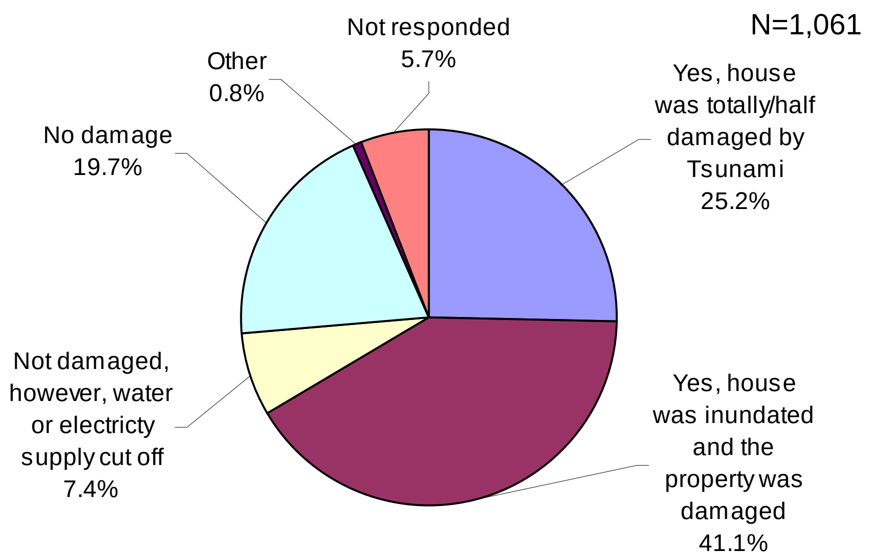


Figure 3-2 Damage to houses by the tsunami

Comment:
More than half of the respondents suffered property damage.

Q3. What was your reaction at the occurrence of tsunami? (Multiple answers)

(When I saw the sea level dropped)

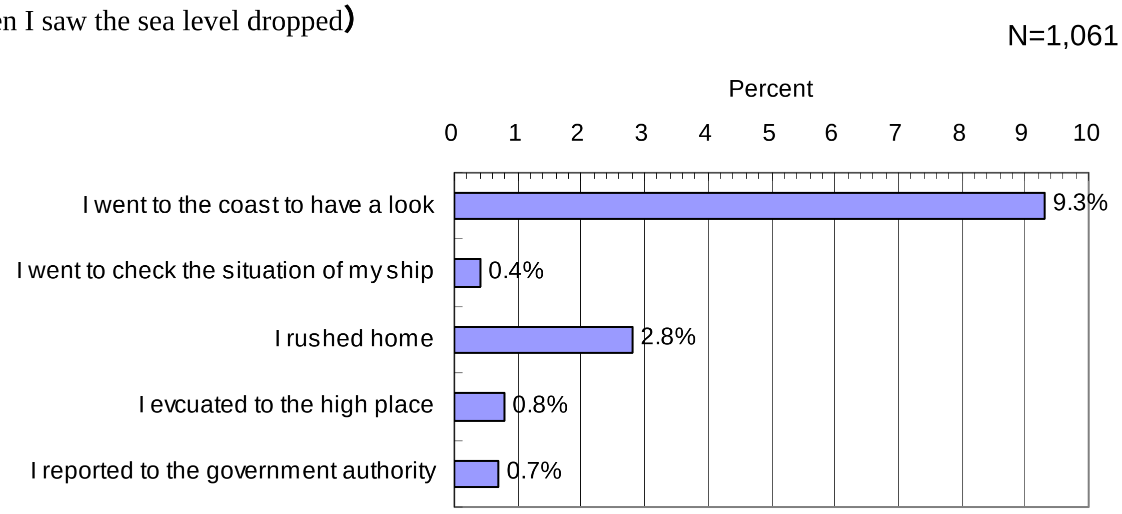


Figure 3-3 Action taken during the tsunami backrush

Comment:
A considerable number of people went to the coast to have a look when the sea level was dropping.

(When I saw the waves approached to the coast line)

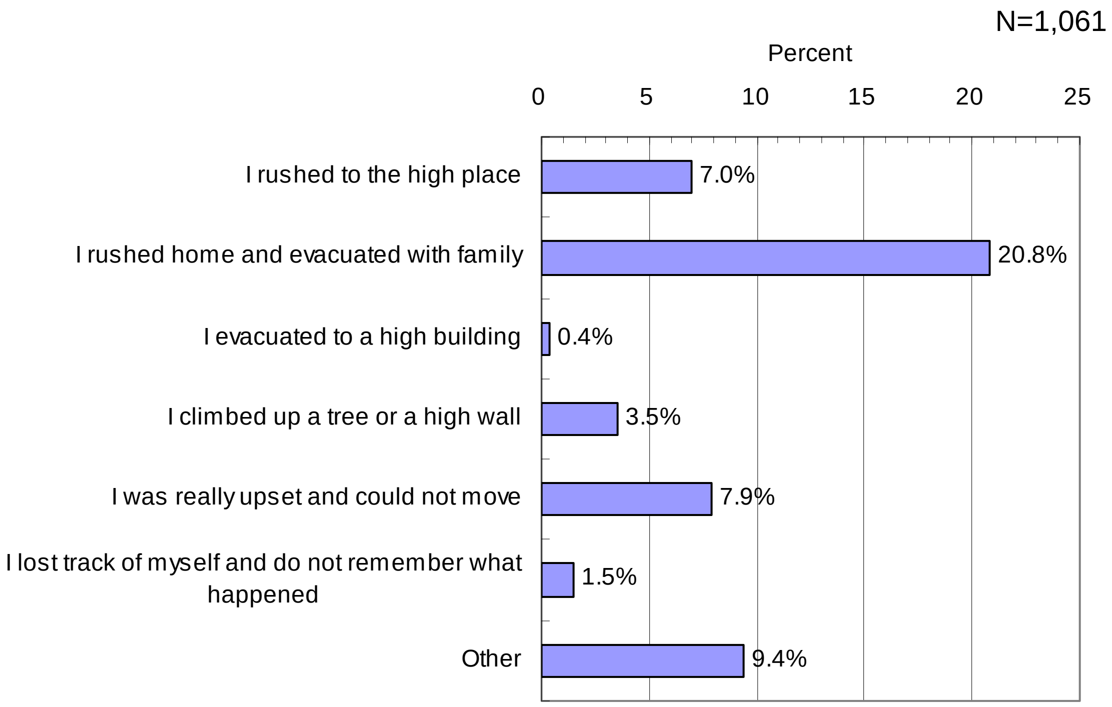


Figure 3-4 Action taken as the tsunami approached the coastline

(When I saw the waves approached to my house or toward me)

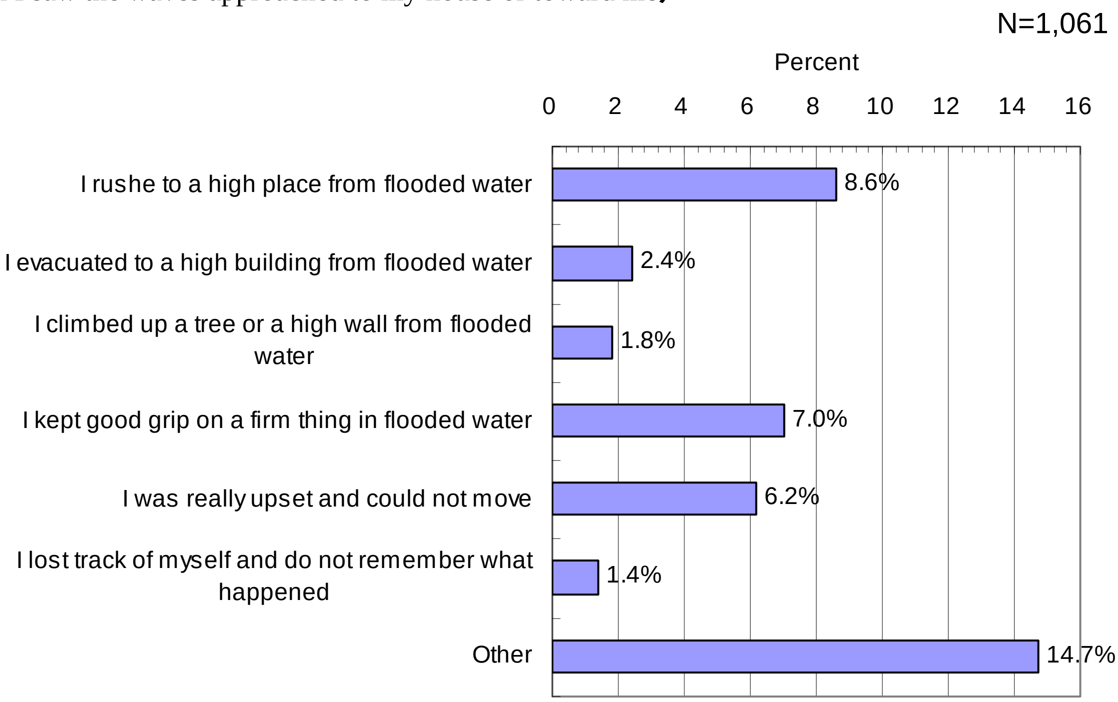


Figure 3-5 Action taken when the tsunami waves approached me

Q4. (Only for person who evacuated) What triggered your decision to evacuate? (Multiple answers)

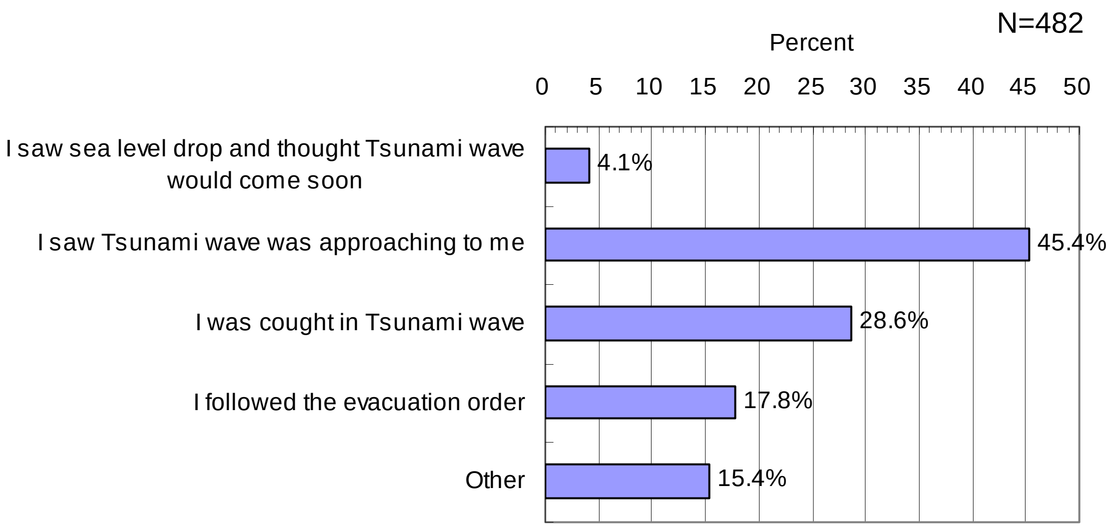


Figure 3-6 Trigger to evacuate

Comment:
Many people evacuated when the tsunami wave struck, while only a few escaped as the sea level dropped.

Q5. (Only for person who evacuated) Did you evacuate with your family or alone?

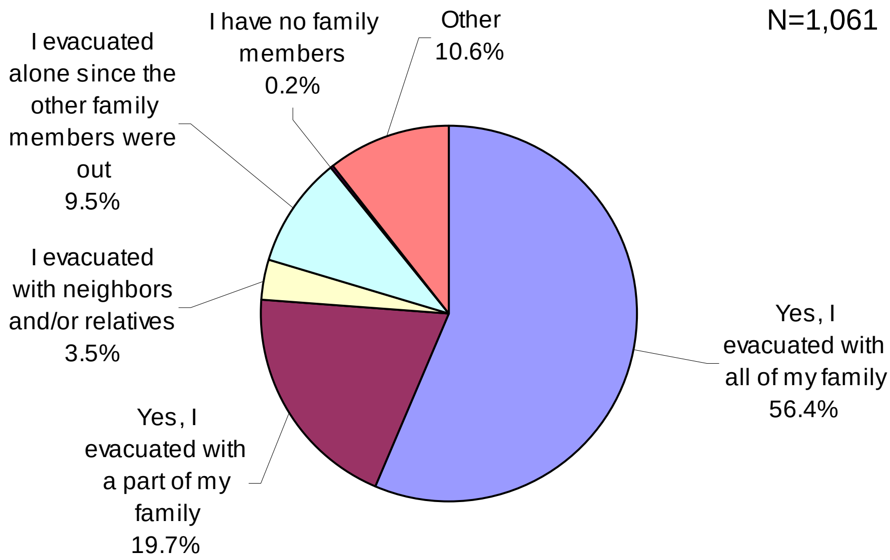


Figure 3-7 Others with whom the respondent evacuated

Q6. Were you at risk of tsunami wave?

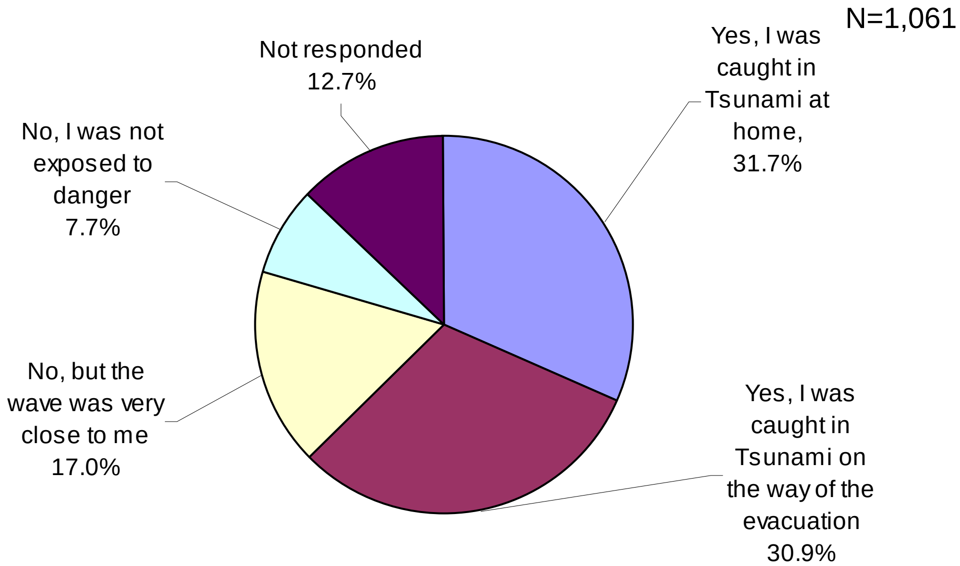


Figure 3-8 Degree of tsunami damage

Q7. How did you escape from the wave?

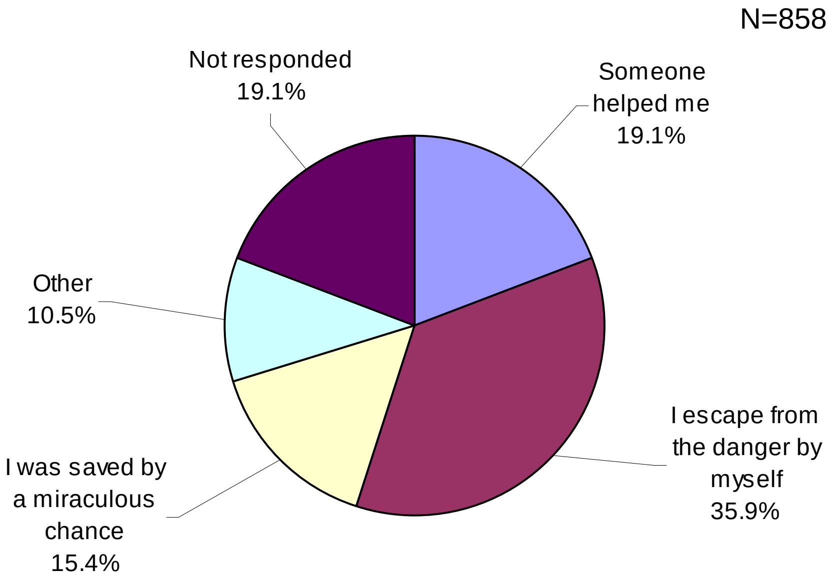


Figure 3-9 Method of escape from tsunami waves

Q8. Please answer on the dissemination of the tsunami Information. Did you hear any news on tsunami?

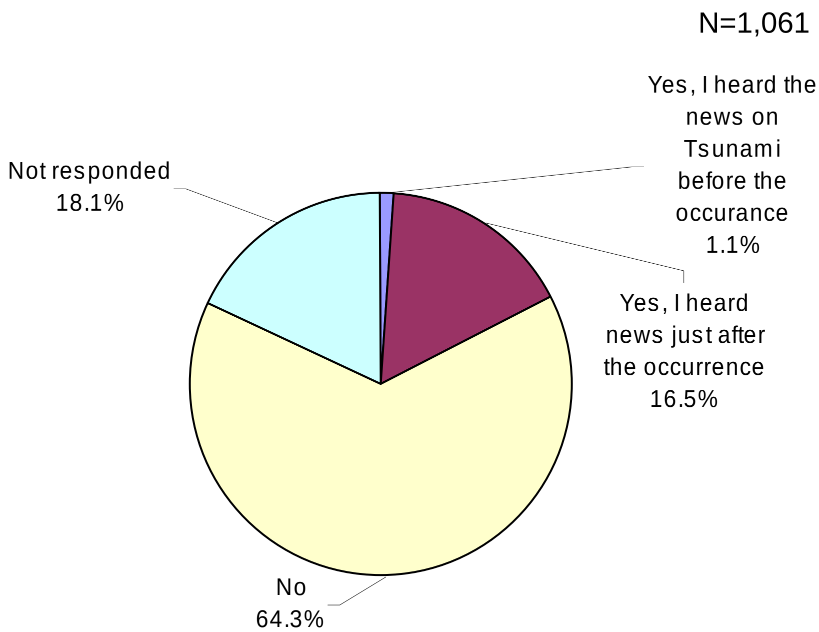


Figure 3-10 Dissemination of information about incoming tsunami

Q9. (Only for the person who heard the news on tsunami) How did you hear the news? (Multiple answers)

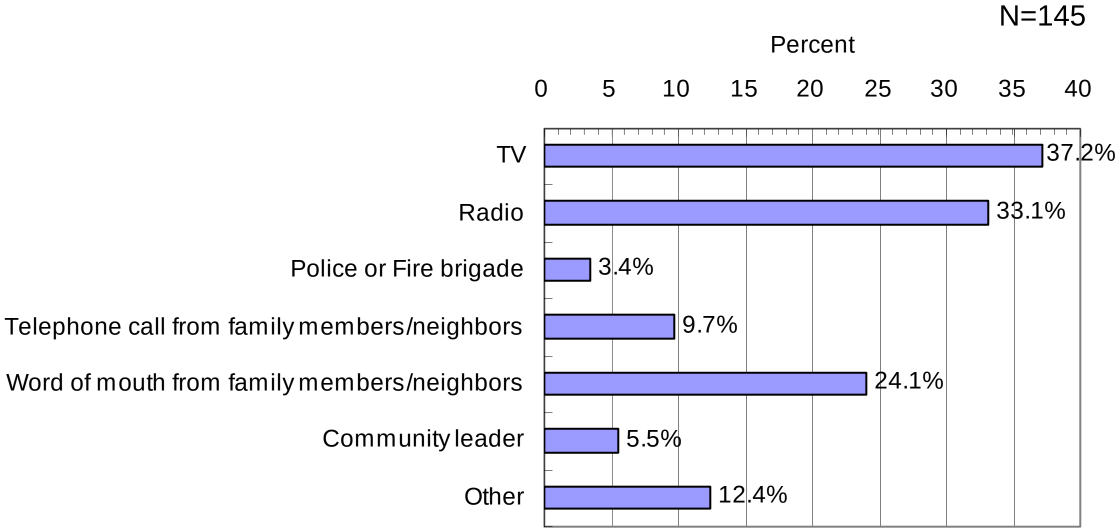


Figure 3-11 Tsunami information dissemination channels

Q10. How did you get the information on the rescue and relief during the first week after the tsunami occurrence? (Multiple answers)

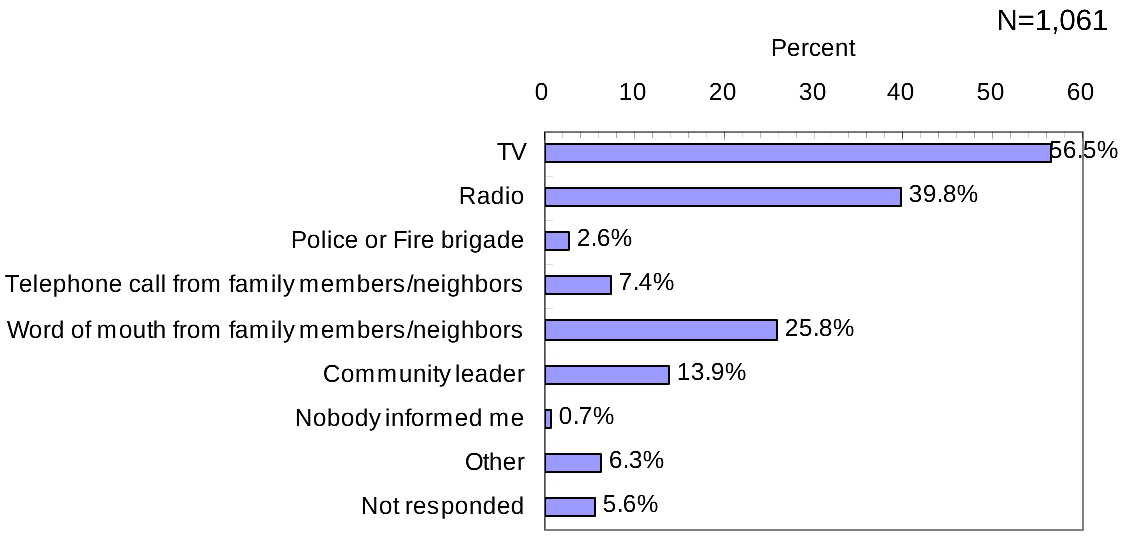


Figure 3-12 Rescue and relief information dissemination channels during the first week after the tsunami

Comment:
Many people received information from TV and radio.

Q11. What kinds of the information did you want to know the most during the first week after the tsunami occurrence? (Multiple answers)

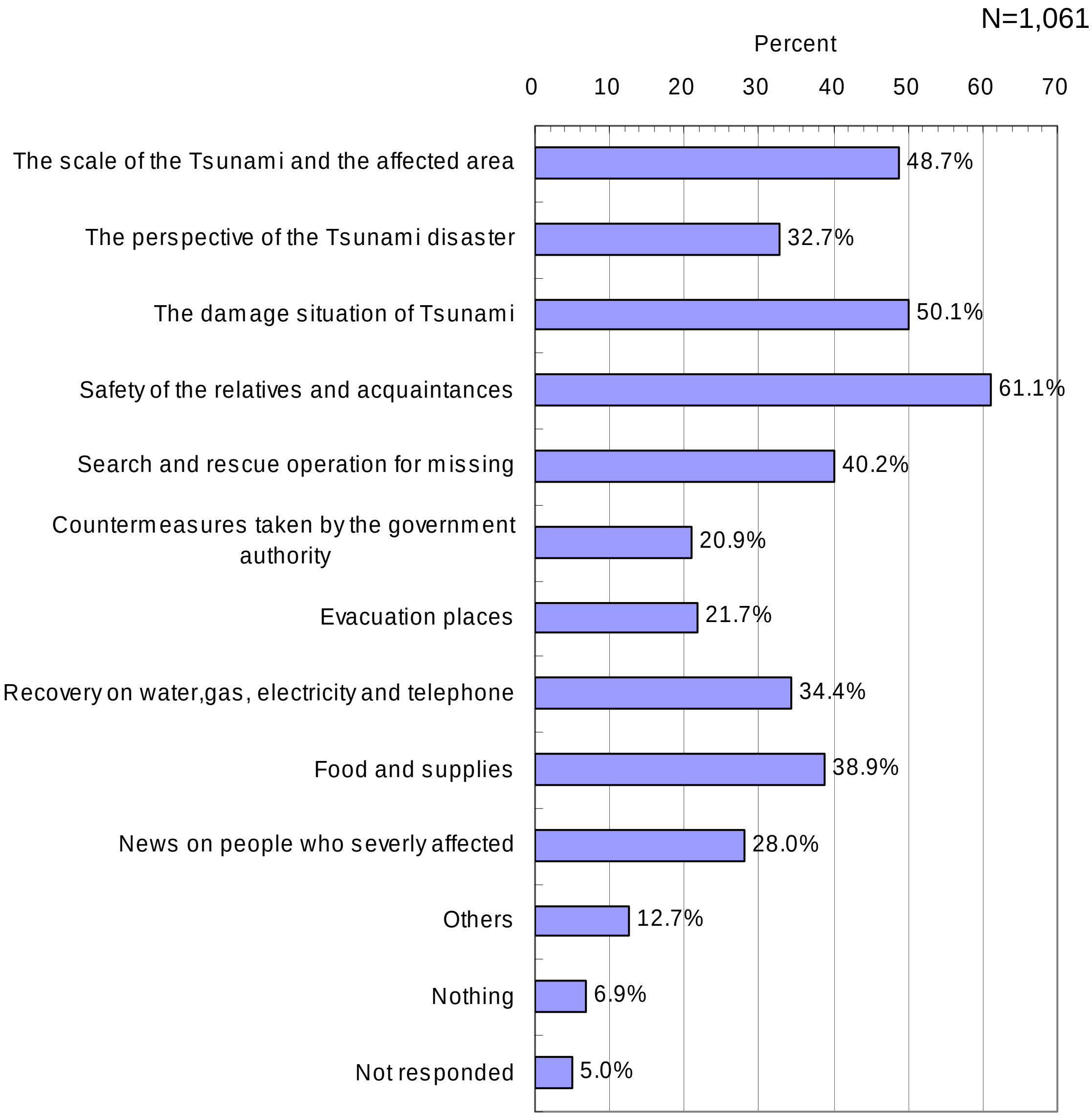


Figure 3-13 Essential information during the first week after the tsunami

Comment:
As expected, the respondents' primary concern was about the safety of their family and friends, while the next most serious concerns were the scale of the tsunami, the damage situation and search and rescue operations. Surprisingly, people were less concerned about the restoration of utilities such as electricity, gas and water.

Q12. Which mode most cater the above needs (Q11)?

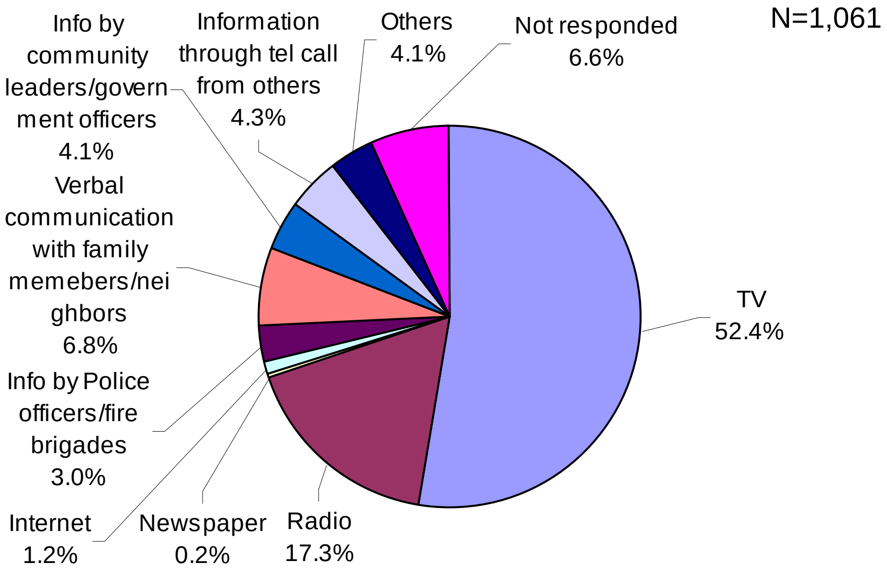


Figure 3-14 The best mode of essential information delivery

Comment:
People obtained information from TV or radio. This result indicates that media reports are important during times of disaster.

Q13. Would you like to live in the same location?

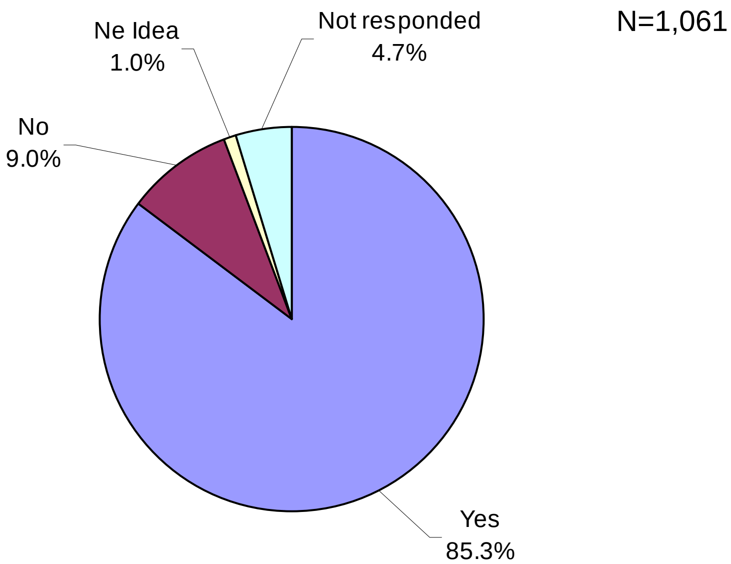


Figure 3-15 Intent to continue living in the same place

Q14. Have you heard about tsunami before the disaster?

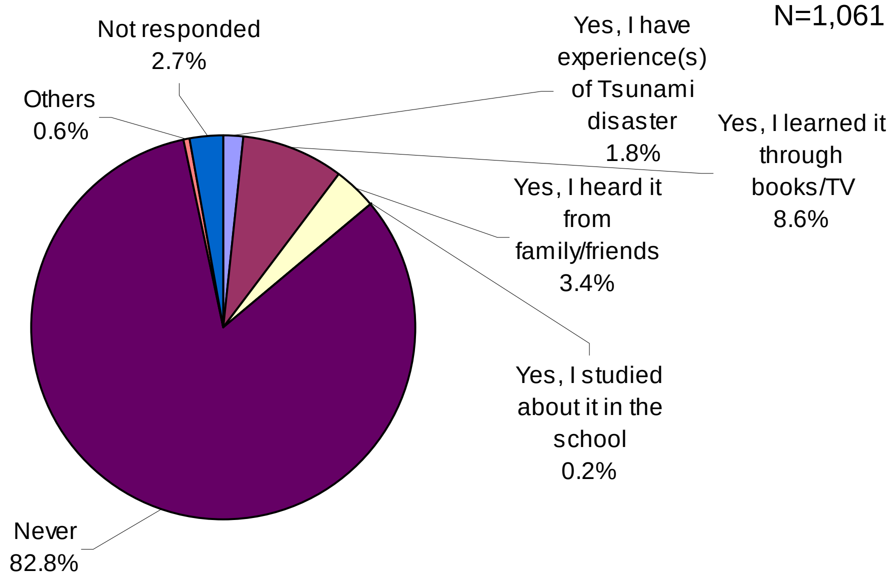


Figure 3-16 Level of tsunami knowledge

Q15. If you had known more about tsunami, do you think you could have reduced the damage in the affected area?

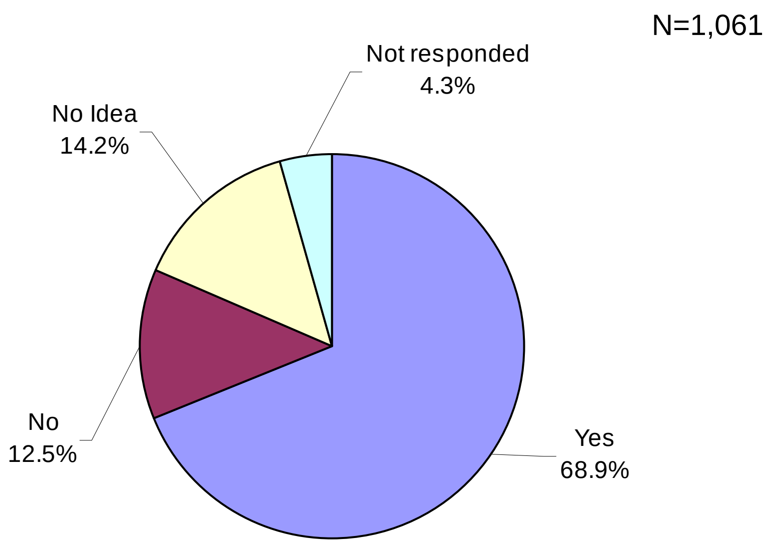


Figure 3-17 Possibility that additional tsunami knowledge could have reduced damage

Comment: The result indicates the importance of natural disaster awareness in minimizing losses.

Q16. Where is the most appropriate evacuation place for tsunami disaster?

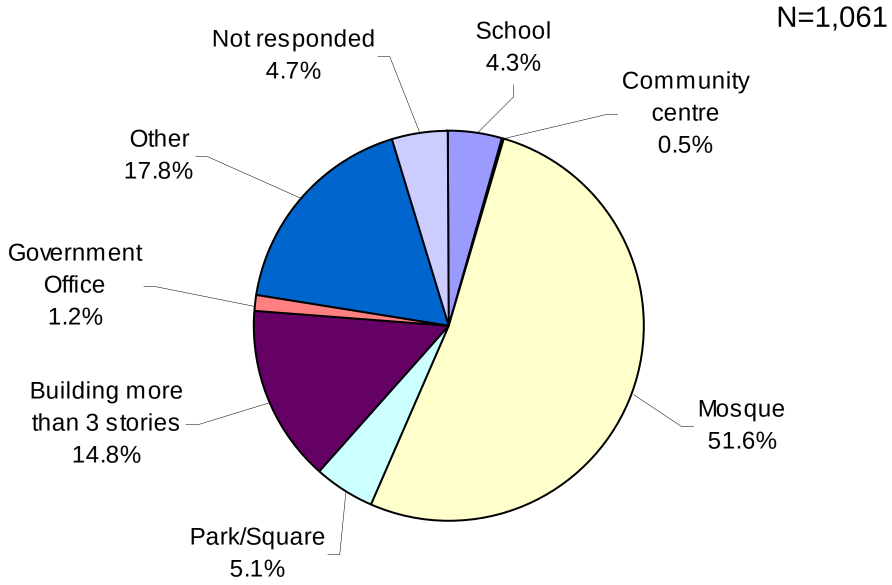


Figure 3-18 Suitable locations for tsunami evacuation shelters

Comment:
This result reflects the people's high level of confidence in religious facilities.

Q17. What is the most effective way to utilize the lessons for preventing/mitigating a tragedy from recurring? (Multiple answers)

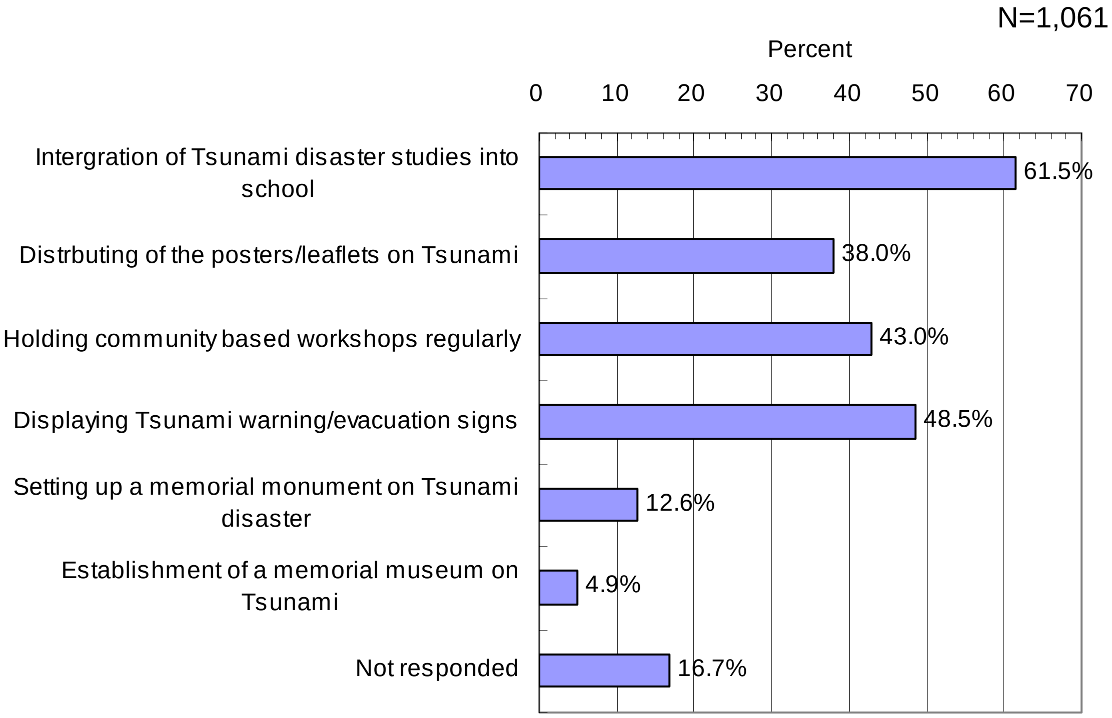


Figure 3-19 The most effective way to enhance public awareness of natural disasters

Comment:
Many people consider disaster education in schools to be the most effective. Based on their evacuation experiences, many favored the installation of tsunami warning/evacuation signs.

Q18. What kinds of countermeasures should be taken for reducing the future damage by tsunami? (Multiple answers)

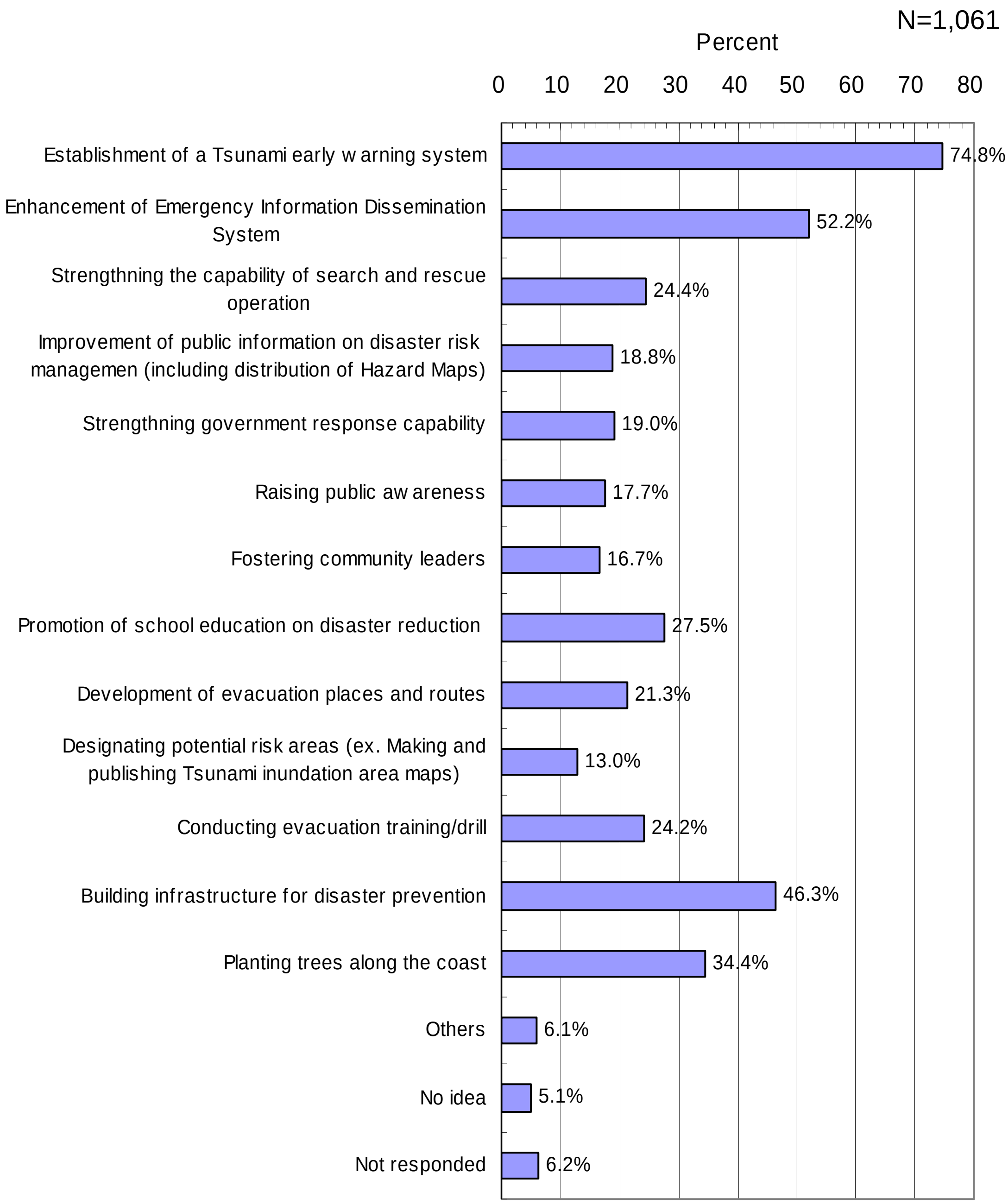


Figure 3-20 Necessary measures for reducing tsunami damage

Comment:
Most residents felt that efforts need to be made to establish a tsunami warning system. This was followed by the need to enhance emergency information systems, to construct sea walls and other infrastructure and to provide disaster education in schools.

Q19. Do you think tsunami will come again to Maldives in the future?

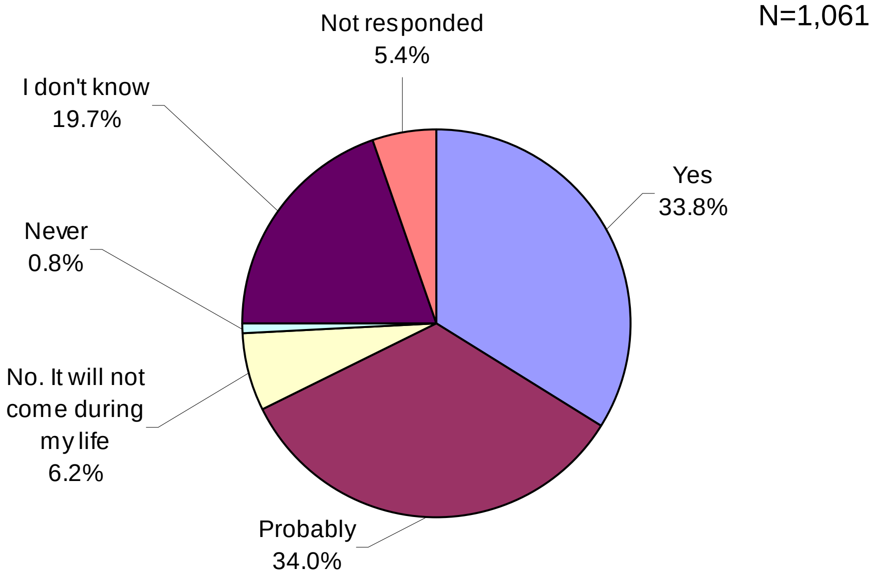


Figure 3-21 The possibility of a future tsunami

Basic Information about Respondents

- Age -

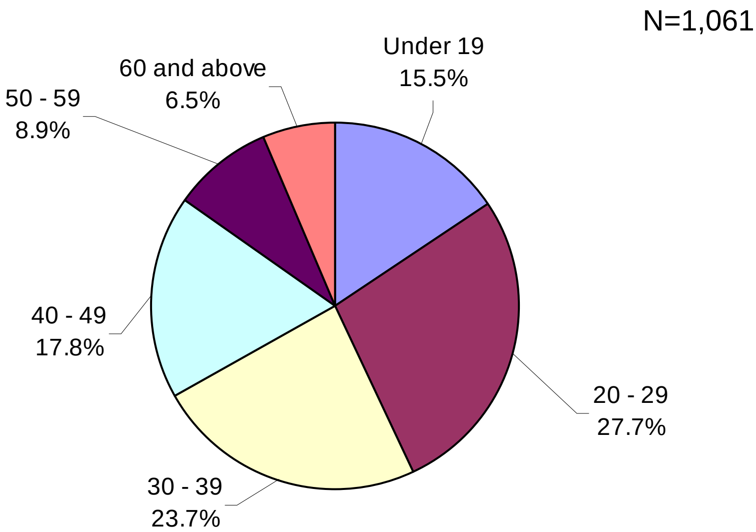


Figure 3-22 Age of respondents

- Gender -

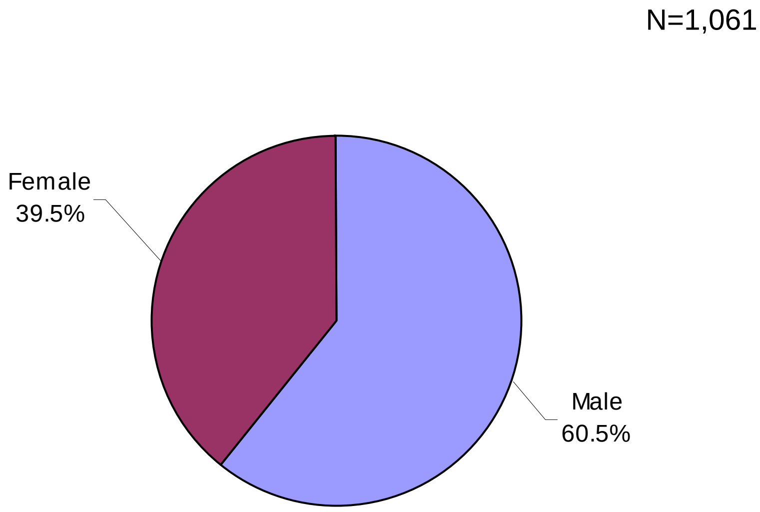


Figure 3-23 Gender distribution of respondents

- Occupation -

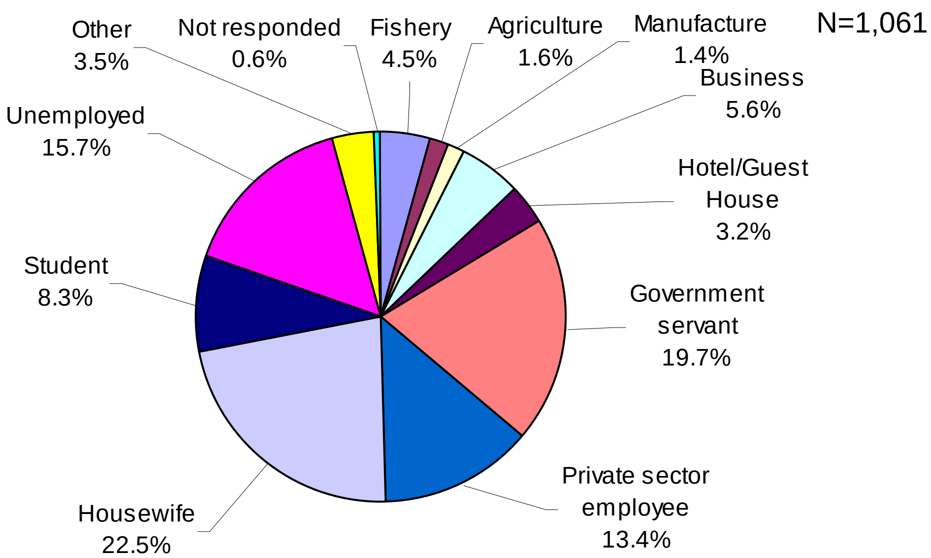


Figure 3-24 Occupations of respondents

- Type of house (as of December 26, 2004) -

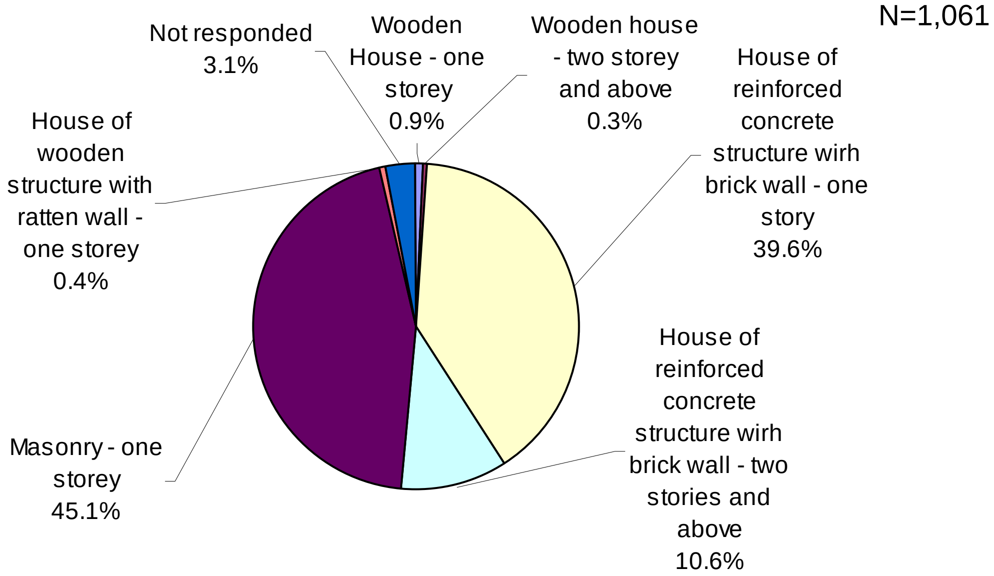


Figure 3-25 Respondents' type of house

- Distance from the sea to house (as of December 26, 2004) -

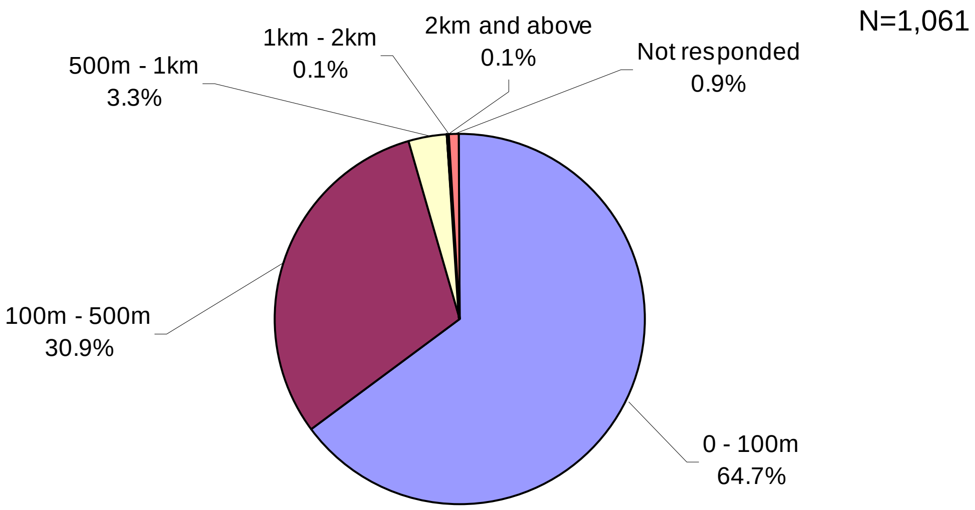


Figure 3-26 Distance from house to the coastline

- Educational background -

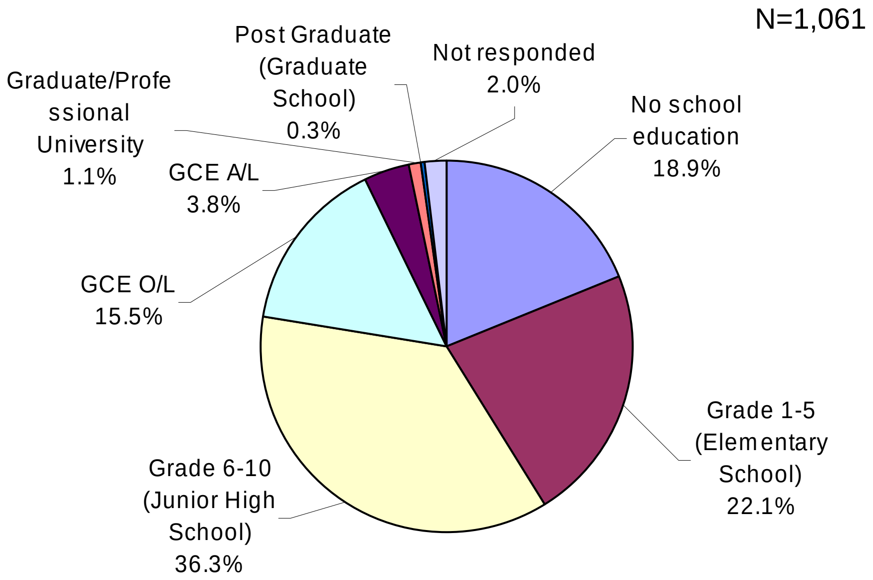


Figure 3-27 Respondents' educational background

- Island -

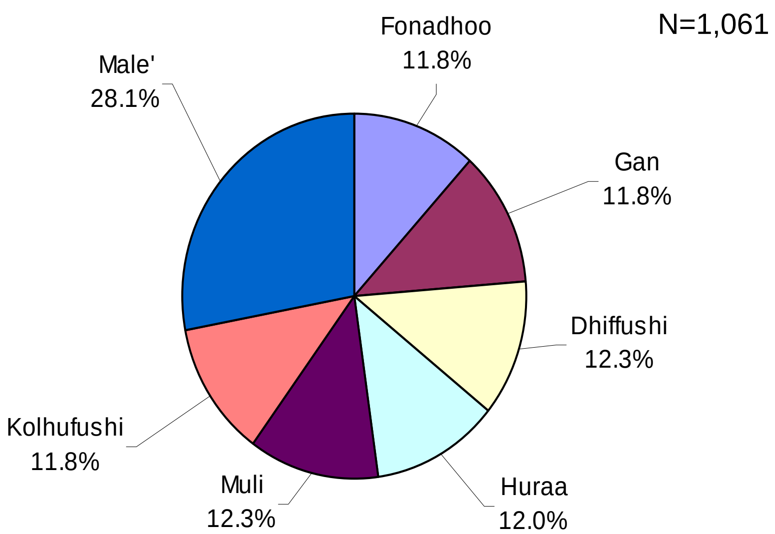


Figure 3-28 Islands inhabited by respondents

Cross Tabulation Results
In all of the following results, the significant differences between groups have been confirmed by a chi-square test (at a 5% level of significance).

a) The relationship between damage to house and distance from coastline

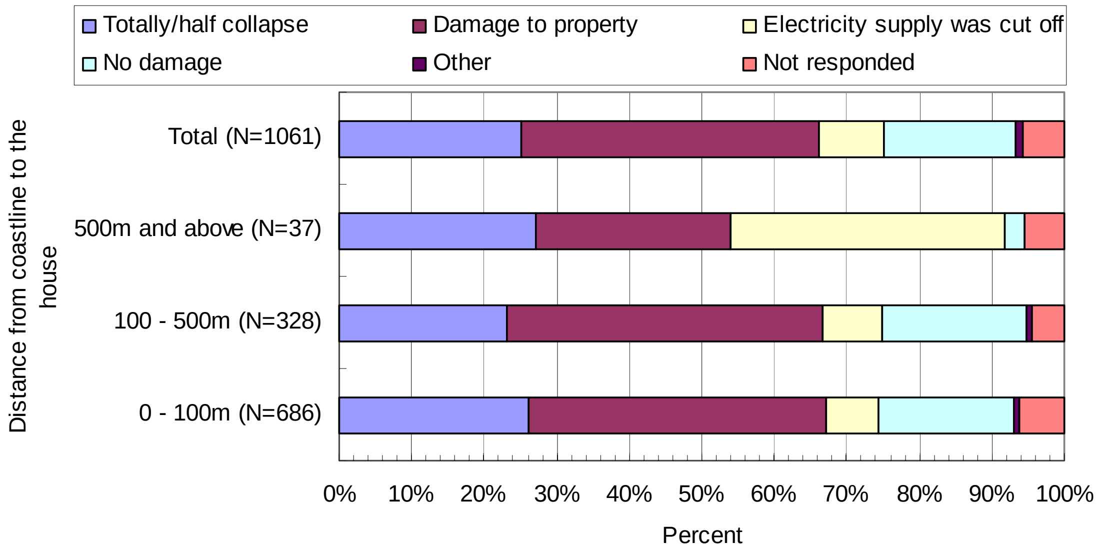


Figure 3-29 Damage to houses by distance from coastline

Comment:
Although there was no correlation between the number of collapsed houses and the distance from the coastline, houses within 500m of the coastline did experience a much higher ratio of damage to property, which indicates that the risk in this area is high. On the other hand, the ratio of damage to property decreased in locations more than 500m from the coast.

b) The relationship between damage to house and island

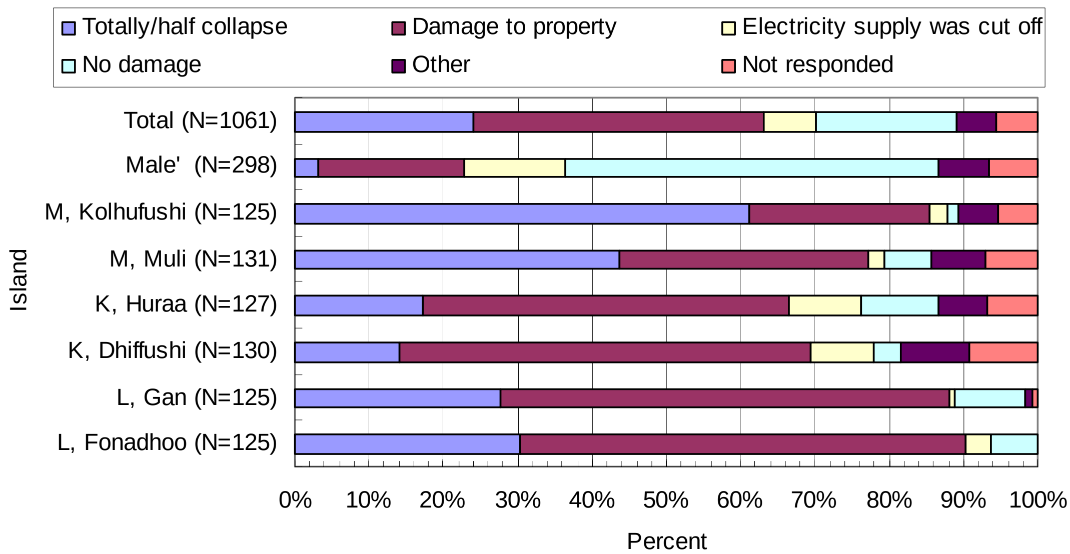


Figure 3-30 Damage to houses by island

Comment:
The number of collapsed houses and degree of property damage depends on the atoll. Damage in Male' was slight, while many houses collapsed in Meemu Atoll. In Kaaf Atoll, excluding Male' and Laamu Atoll, the majority of respondents indicated that they had sustained property damage.

c) The relationship between impact on respondent and distance from coastline

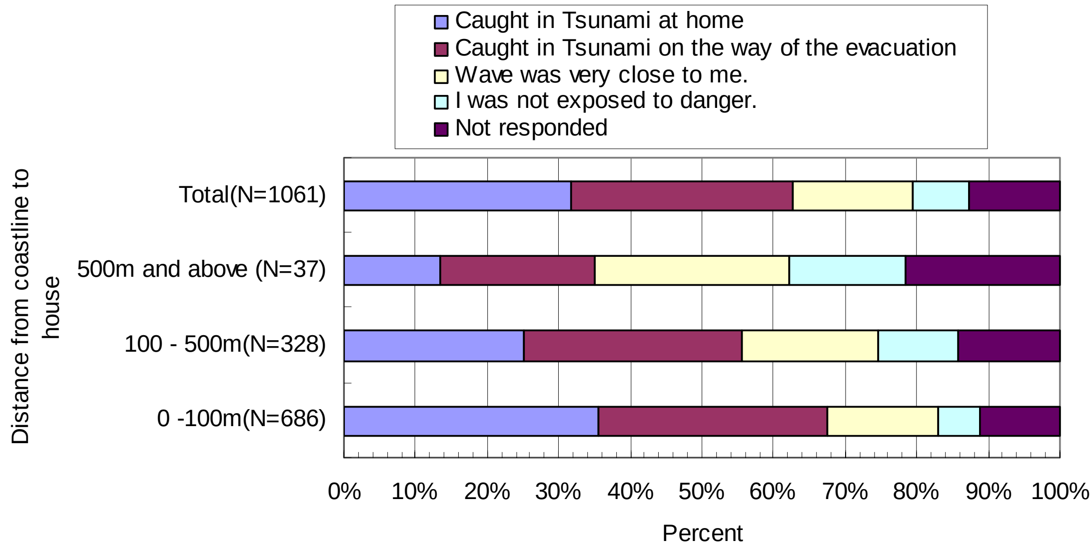


Figure 3-31 Level of impact on residents by distance from coastline

Comment:
The number of people impacted by flooding tends to decline as the distance from the coastline to the house increases.

d) The relationship between impact on respondent and age

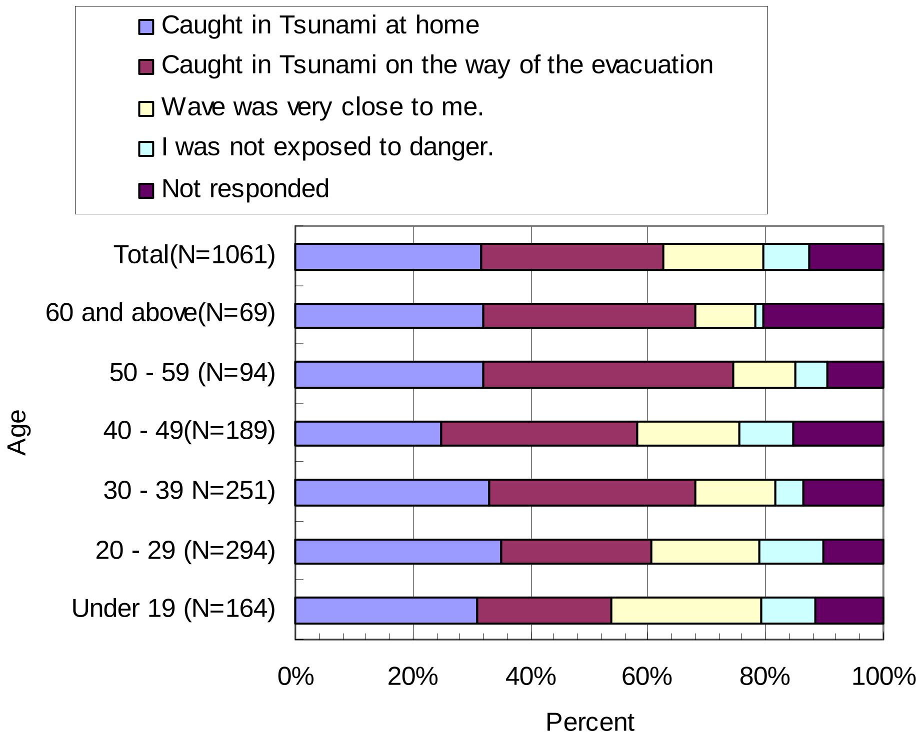


Figure 3-32 Level of impact on respondents by age

Comment:
A higher ratio of people was impacted in the higher age groups.

e) The relationship between impact on respondents and island

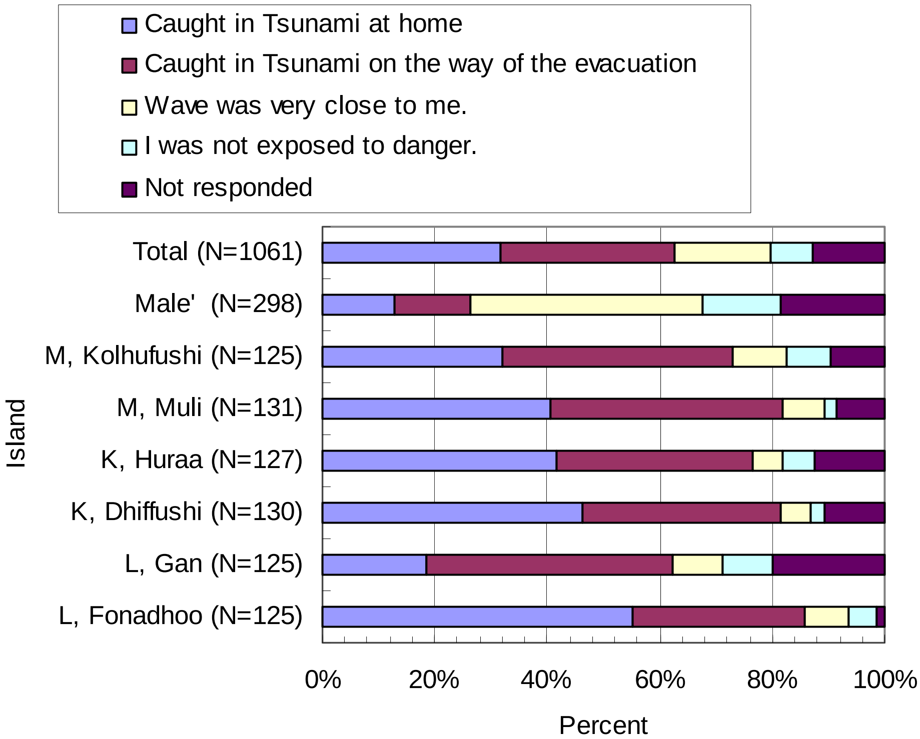


Figure 3-33 Level of impact of respondents by island

Comment:
The ratio of people impacted in Gan, the largest island, was small. Male' was protected by sea walls.

(2) Government officials

Q1. Is there any training/seminar available in your office to study about natural disasters?

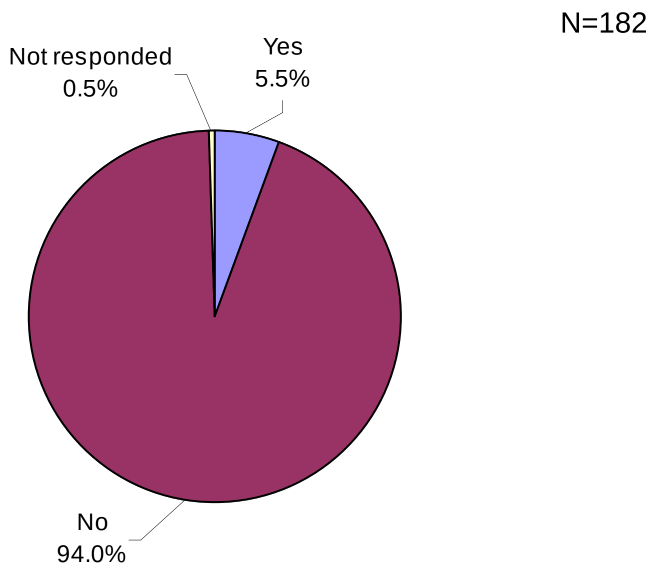


Figure 3-34 Training on natural disasters

Comment: Some who answered "Yes" were police officers and national security service officers. No trainings/seminars have been conducted by other institutions.

Q2. Is there any emergency drill for natural disasters in your office?

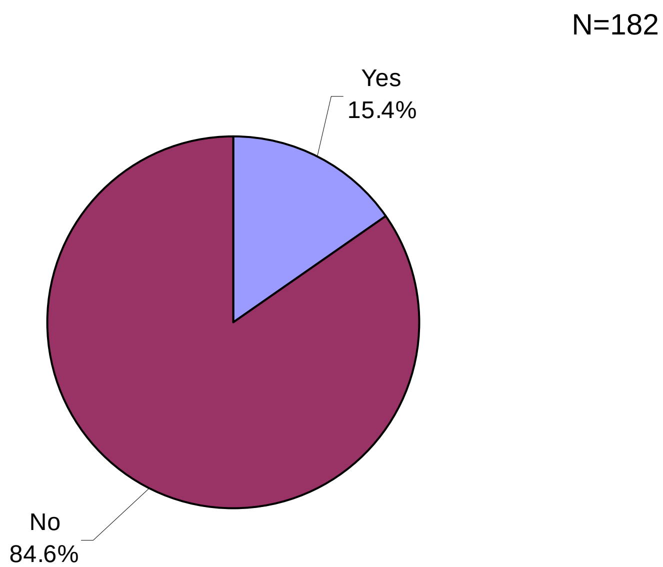


Figure 3-35 Natural disaster emergency drills

Comment: Some who answered "Yes" were national security service officers and island officers. No trainings/seminars have been conducted by other institutions.

Q3. When tsunami occurred on 26th December 2004, do you think you responded adequately/properly enough on your role/mandate?

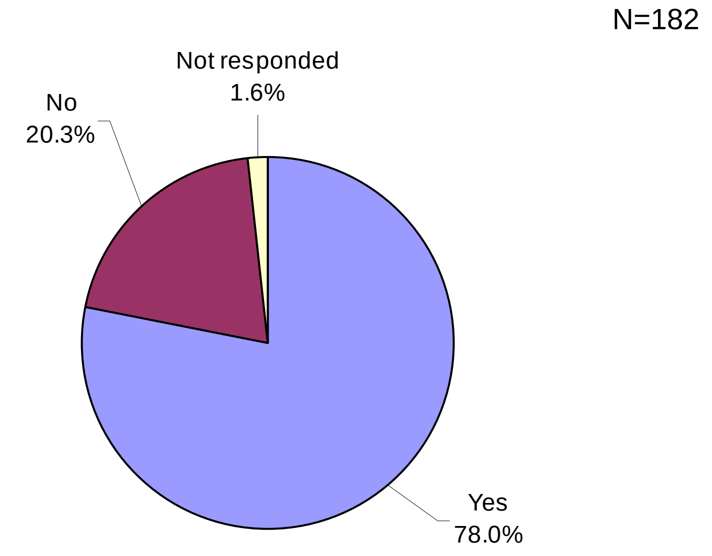


Figure 3-36 Confidence in tsunami response

Q4. (Related to Q3.) Is there any reflection/regret/future task for you?

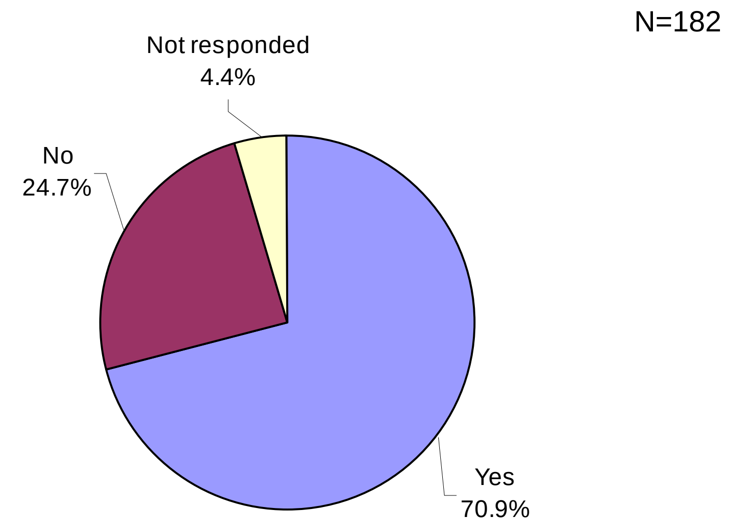


Figure 3-37 Need for future efforts based on a review of the tsunami response

Comment:
Most officials answered that they responded adequately in their duties while conceding some remorse and the need to take further steps to address issues in the future.

Q5. When tsunami occurred on 26th December 2004, do you think you responded adequately/properly enough to the requests from the residents?

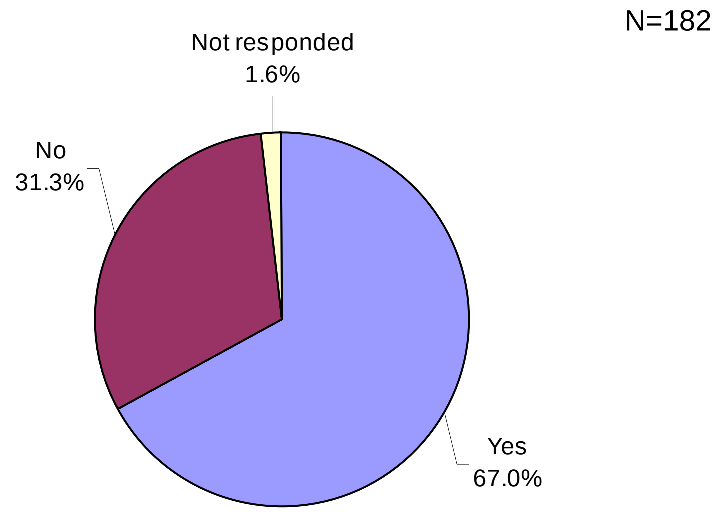


Figure 3-38 Response to the needs of residents during tsunami

Q6. When tsunami occurred on 26 December 2004, was the system of information collection and dissemination successfully functioned?

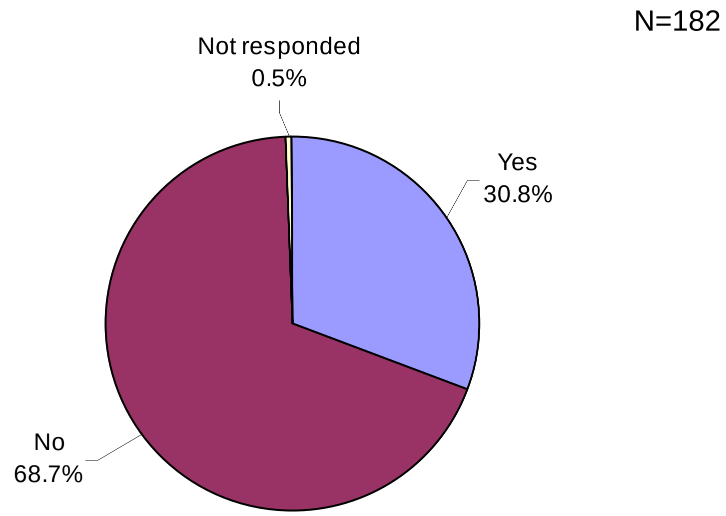


Figure 3-39 Functionality of information collection and dissemination systems

Q7. After the occurrence of tsunami, did you collect the information about damage situation of residents?

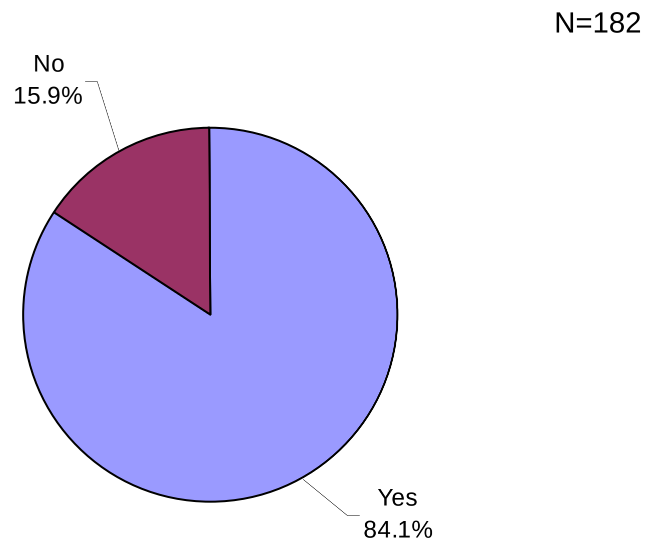


Figure 3-40 Collection of information regarding damage sustained by residents

Is there any particular point to be improved in the future?

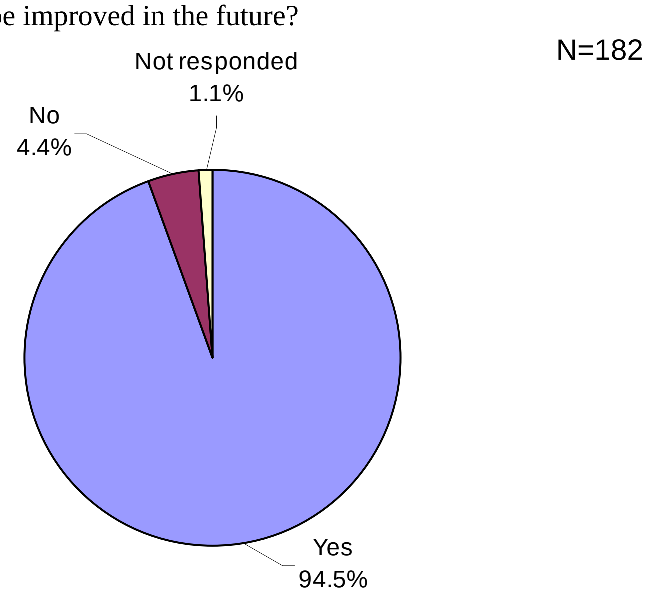


Figure 3-41 Potential for improving information collection in the future

Q8. Is there any opportunity to exchange opinions with community?

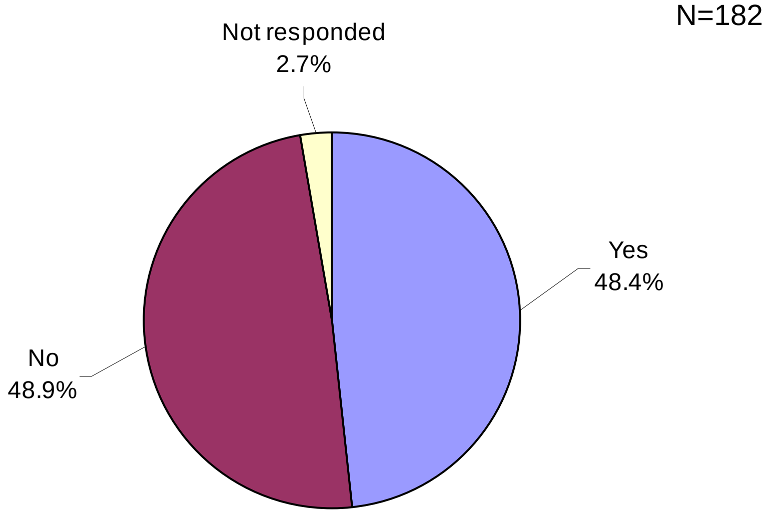


Figure 3-42 Opportunities for government officials and communities to exchange information -Total-

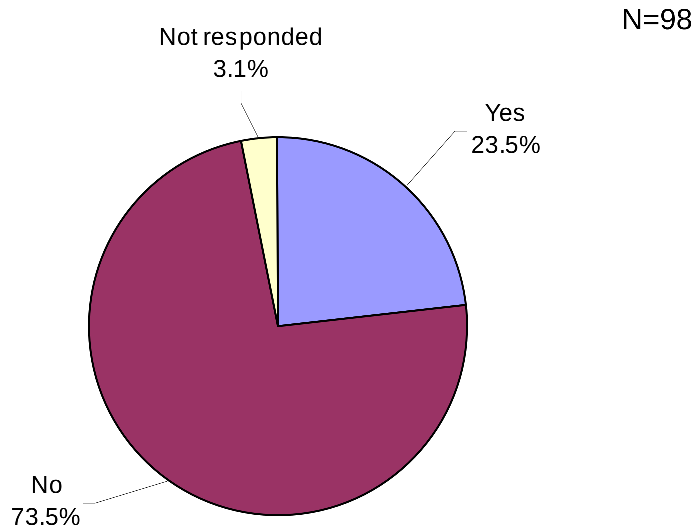


Figure 3-43 Opportunities for government officials and communities to exchange information -Island Office-

Comment:
There are fewer opportunities for local island government officials and communities to exchange information.

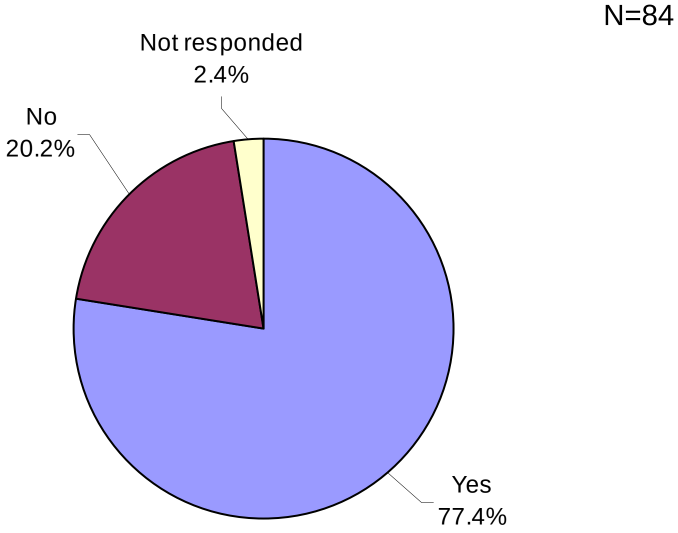


Figure 3-44 Opportunities for government officials and communities to exchange information -Other Ministries-

Comment: Surprisingly, officials other than island officials have opportunities to exchange information with communities.

Note: The significant differences between Figures 3-43 and 3-44 are assured by a chi-square test at a 5% level of significance.

Q9. Do you think the evacuation drill with community will be needed?

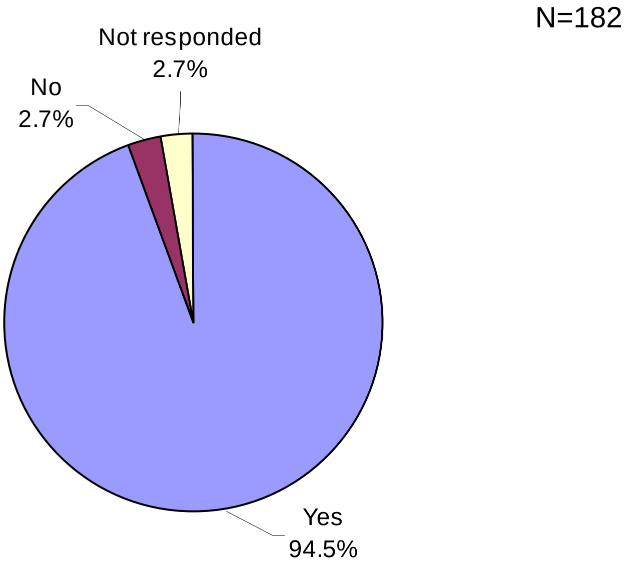


Figure 3-45 Need for integrated evacuation drills with communities

Q10. What kinds of countermeasures for natural disasters would be needed in the future? (Multiple answers)

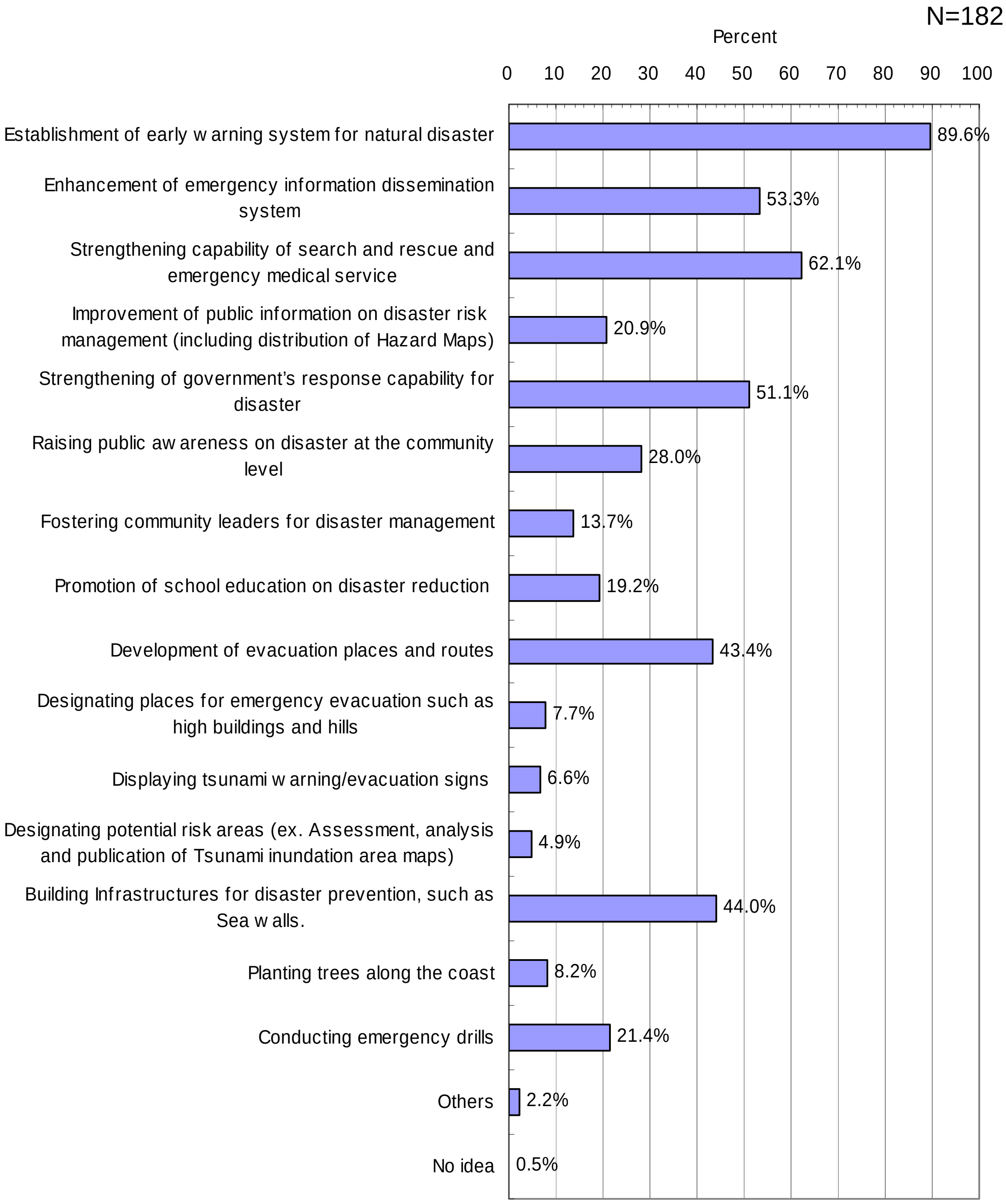


Figure 3-46 Necessary countermeasures for natural disasters -Total-

Comment:
Most officials considered the establishment of an early warning system to be the most important countermeasure for natural disasters.

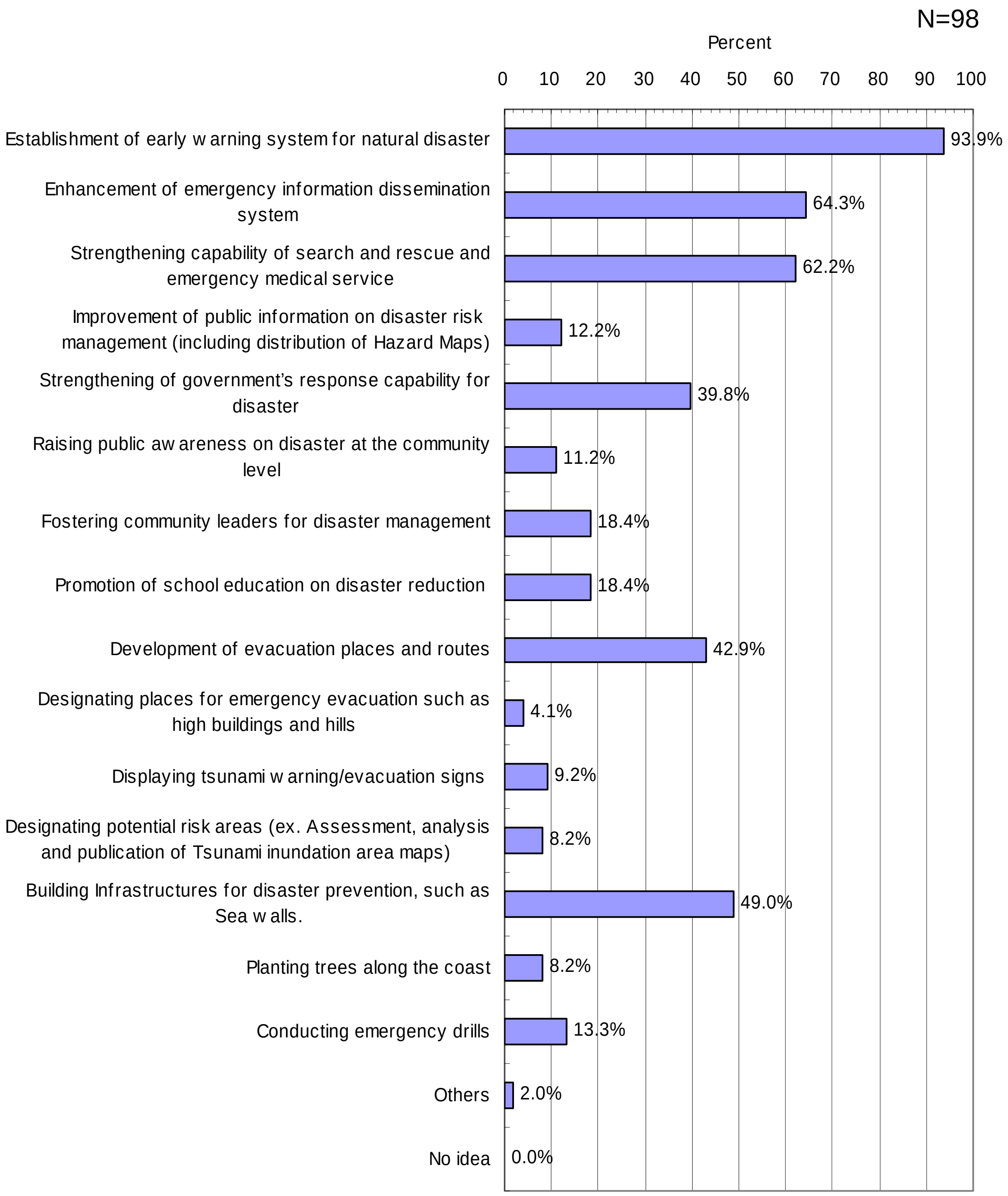


Figure 3-47 Necessary countermeasures for natural disasters -Island Office-

Comment:
Many island office officials pointed to the importance of establishing an early warning system and enhancing information dissemination systems.

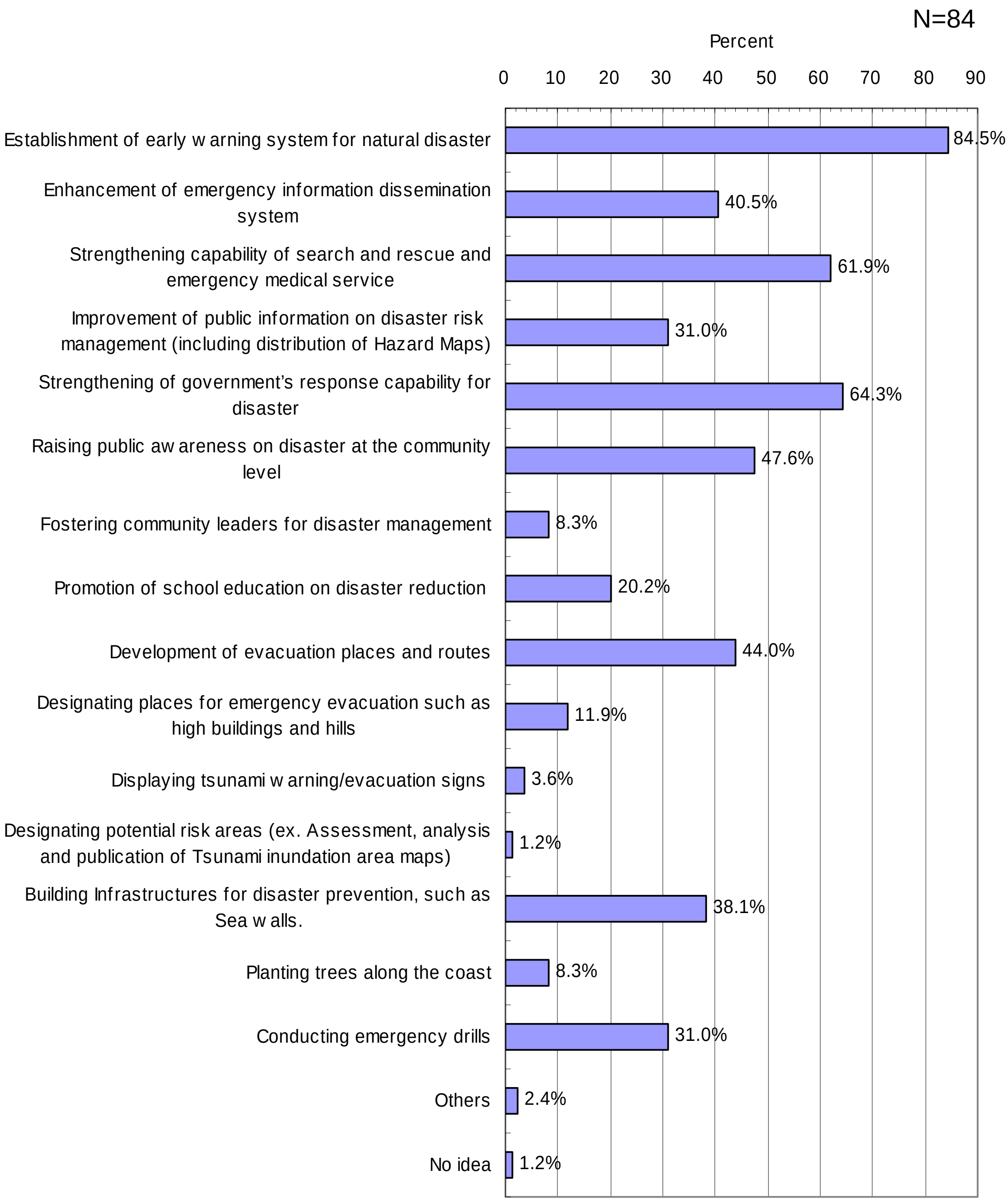


Figure 3-48 Necessary countermeasures for natural disasters -Other Ministries-

Comment:
Many officials in other ministries favored the establishment of an early warning system and the strengthening of the government's disaster response capabilities. The first response indicated was the same one indicated by the island officers, but the second and subsequent preferred countermeasures differed due to differences in official roles and responsibilities.

Note: The significant differences between Figures 3-47 and 3-48 are assured by a chi-square test at a 5% level of significance.

Q11. Do you think the disaster countermeasures for tourists will be needed?

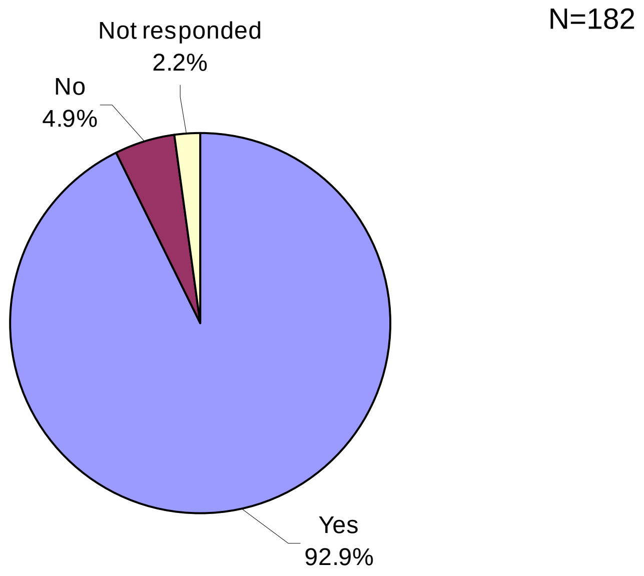


Figure 3-49 Disaster countermeasures for tourists

Comment
Since tourism is the most important industry in the Maldives, most officials felt a need to prepare adequate disaster countermeasures to protect tourists.

Q12. (For the person who answered "Yes" in Q11.) What kind of measure of prevention is most effective for tourists?

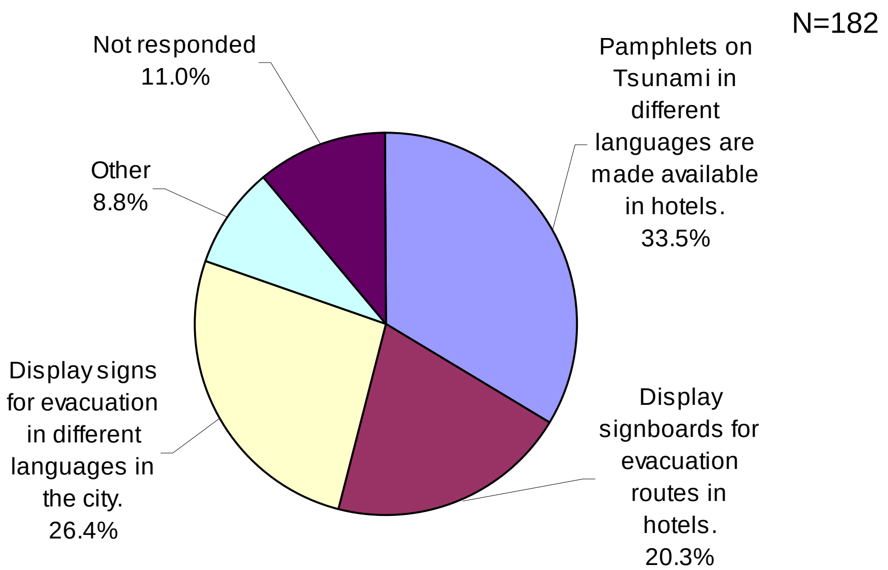


Figure 3-50 Types of disaster countermeasures for tourists

Comment:
Many officials favored pamphlets on tsunamis in different languages.

Q13. What is the most effective way of information dissemination to the residents at an event of disaster? (Multiple answers)

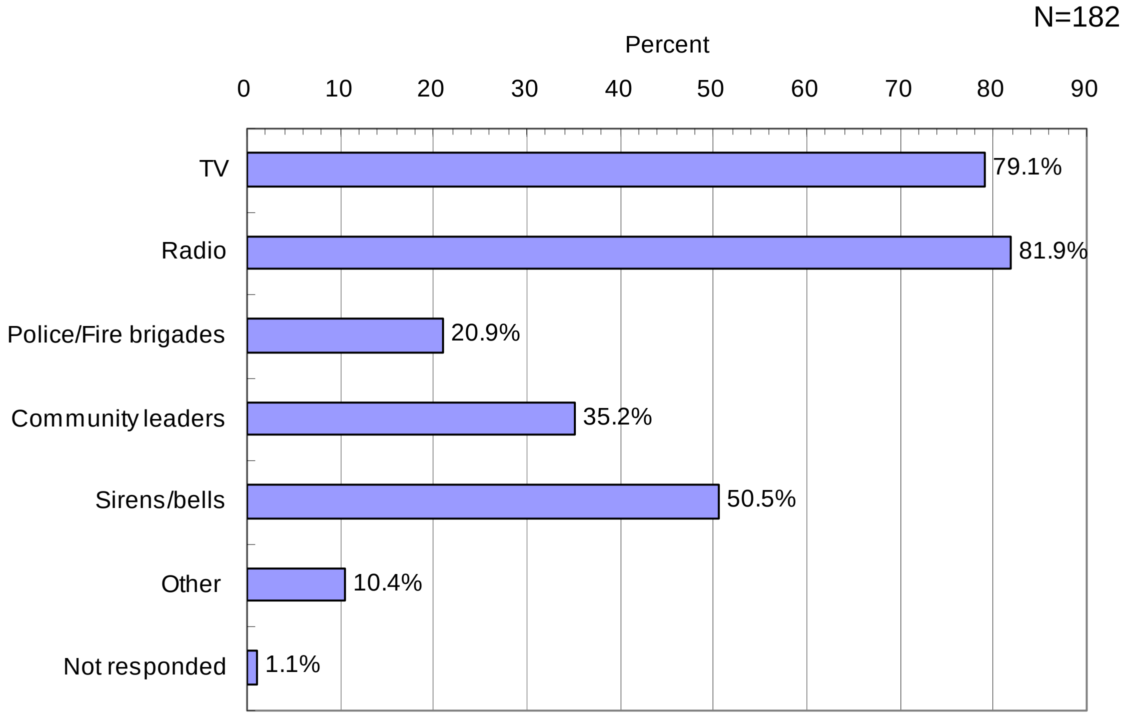


Figure 3-51 Effective methods of disseminating information to residents

Q14. Where is the most suitable place for evacuation center?

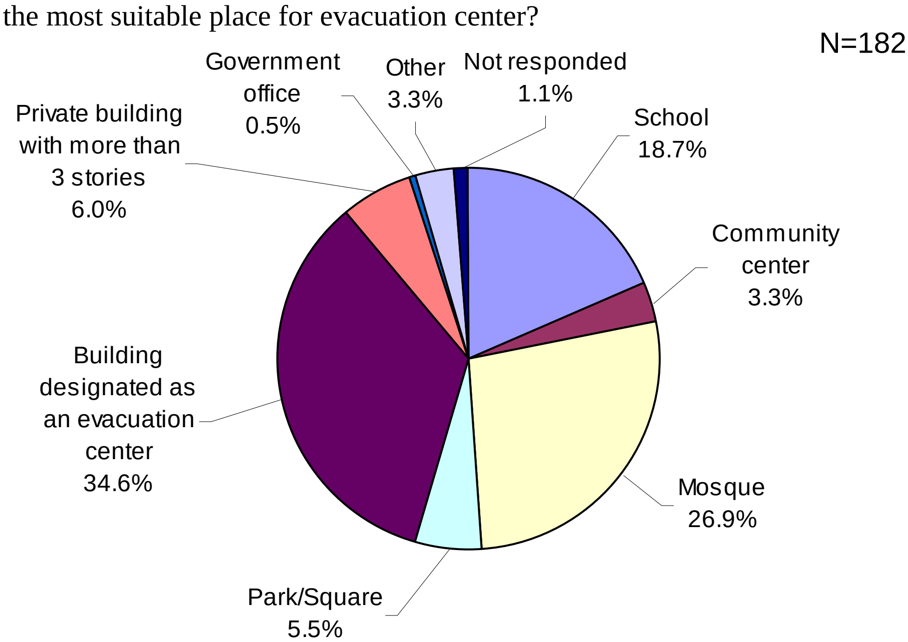


Figure 3-52 Suitable tsunami evacuation sites -Total-

Comment:
Many officials consider designated evacuation buildings and mosques to be adequate tsunami evacuation shelters.

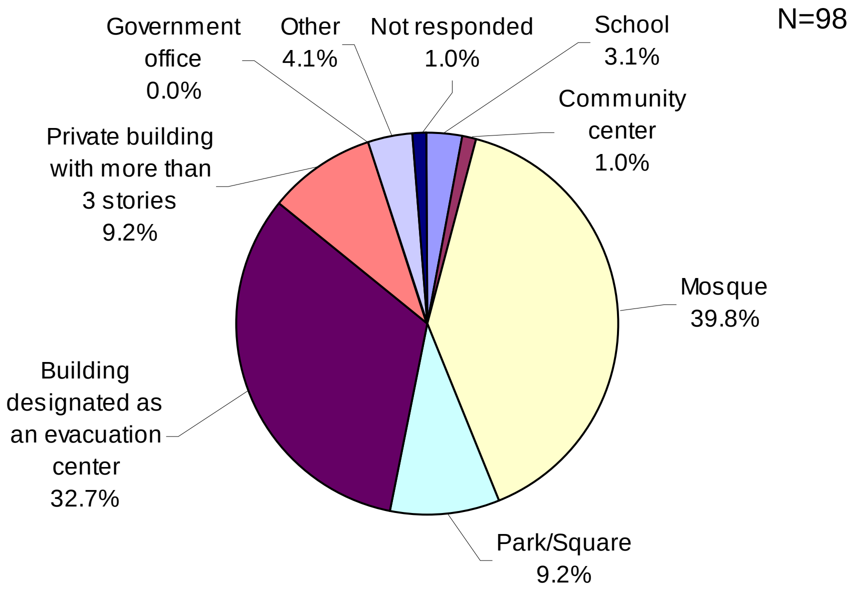


Figure 3-53 Suitable tsunami evacuation sites -Island Office-

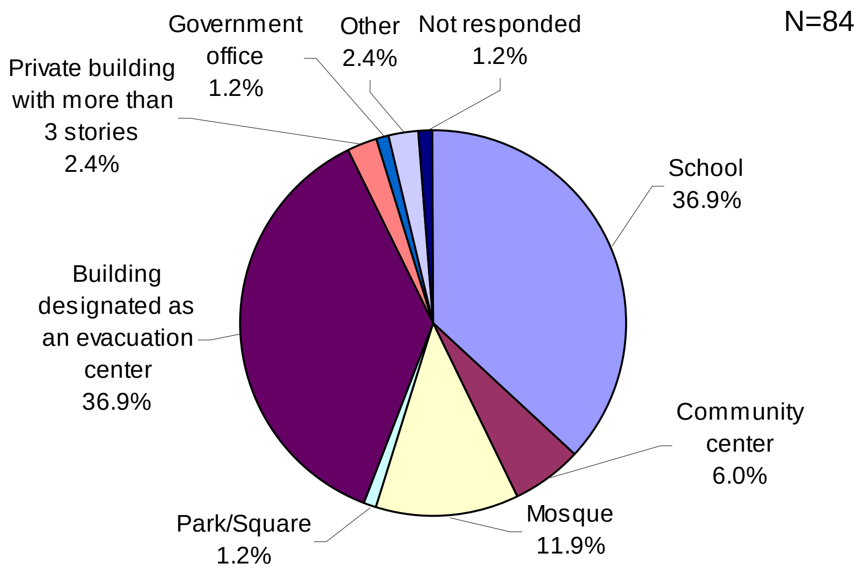


Figure 3-54 Suitable tsunami evacuation sites -Other Ministries-

Comment:
Many island office officials cited mosques as the most suitable sites for tsunami evacuation, while many officials in other ministries cited schools. The opinions of island office officials are similar to those of local residents.

Note: The significant differences between Figures 3-53 and 3-54 are assured by a chi-square test at a 5% level of significance.

Basic Information about Respondents

- Age -

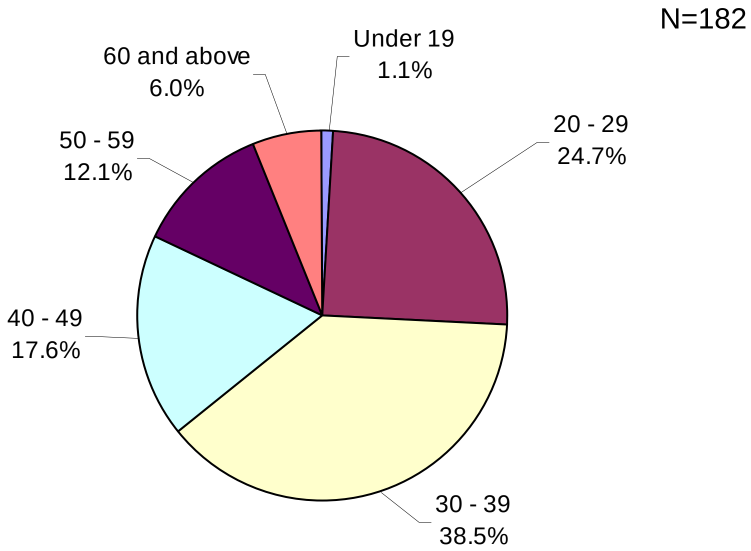


Figure 3-55 Ages of officials

- Gender -

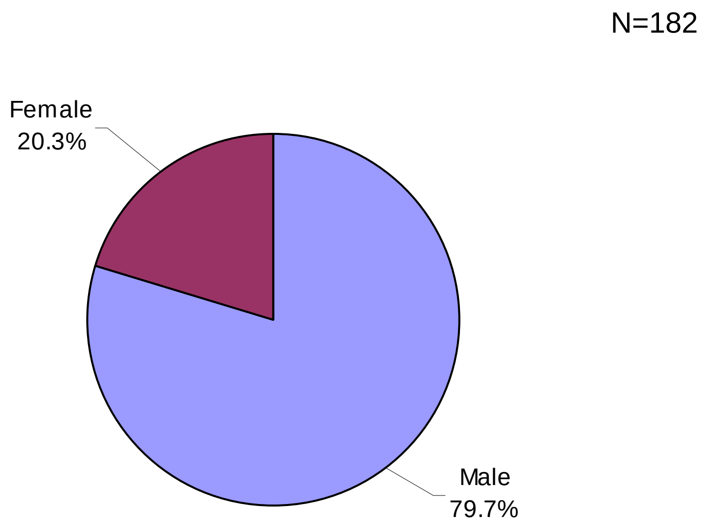


Figure 3-56 Gender distribution of officials

- Office/Department -

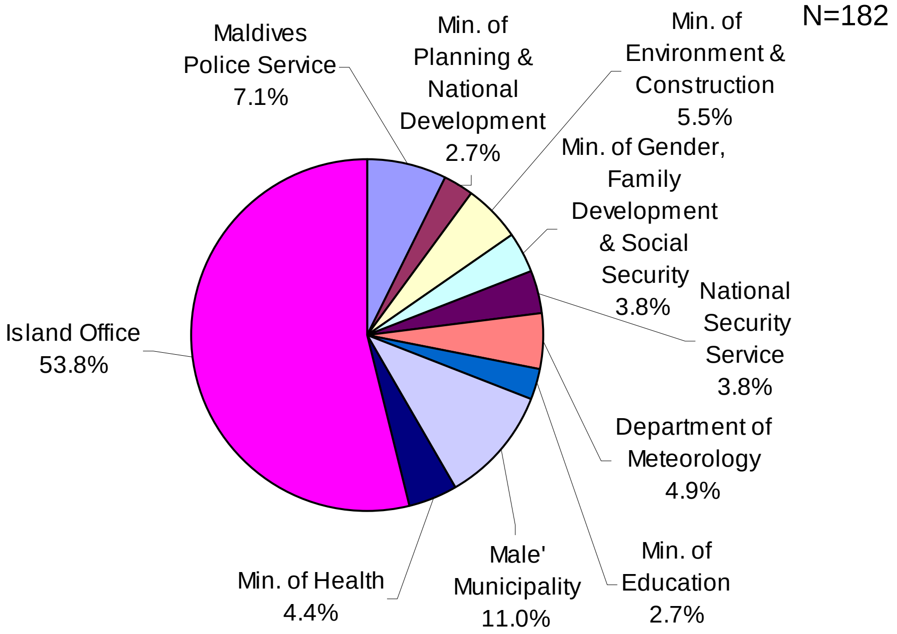


Figure 3-57 Affiliations of officials

4. Conclusions and Recommendations

4.1 Early Warning System

(1) The National Early Warning System of the Maldives

General View

The Maldives experiences natural disasters caused by inclement weather, rough sea conditions and tsunami waves. Given the frequency with which tsunami disasters occur there, the NEWSM (National Early Warning System of the Maldives) should be built for multi-disaster response, designed not only for handling tsunamis, but for handling tropical cyclones, high waves, storm surges and long-term changes in the sea level. The NEWSM should play the central role in promptly disseminating warnings to the public through government agencies, the mass media, and regional, atoll and island offices. It should provide information on natural phenomena before, during and after severe natural events, based on a 24-hour surveillance system.

The NEWSM has to perform multiple functions to facilitate ordinary and emergency responses to natural events. Through the daily and continuous monitoring of natural phenomena, the system should be able to evaluate the current situation, forecast inclement weather and rough sea conditions and detect seismic activity in the Indian Ocean region 24 hours a day. In emergency situations, the NEWSM will issue warnings regarding severe weather and sea conditions, urgent alerts regarding the occurrence of major earthquakes in the Indian Ocean region and tsunami warning messages concerning the Maldives to the public. The effective operation of the NEWSM requires tight linkages and exchanges of data and information on meteorological and oceanographic conditions, as well as forecasts, with the RTH (Regional Telecommunication Hub designated by WMO) New Delhi, and on earthquake activity and tsunami warnings with the Indian Ocean Tsunami Warning System now under development.

For the NEWSM to operate properly, natural phenomena surveillance and evaluation will have to be conducted on a 24-hour basis. The equipment and system will have to be carefully maintained so that those operating the system will be able to easily issue warnings and forecasts regarding severe natural conditions. International exchanges of information on meteorology, oceanography and seismology are essential. The DMM has been conducting meteorological functions nationwide 24 hours a day and communicating with other countries regarding natural events. To inform the public of natural conditions, methods of communication between the DMM and the mass media have already been established.

We found the DMM to be the most suitable government organization for ensuring early warnings regarding natural phenomena under the NEWSM. However, the current DMM has to be further strengthened through the addition of monitoring equipment with nationwide networking capabilities, the introduction of data acquisition and processing systems, enhancements to communication functions to enhance domestic information dissemination and international information sharing, the establishment of new internal organizations, and increases in human resources. Moreover, to ensure the dissemination, transmission and reception of warnings from the NEWSM, appropriate procedures for communicating urgent messages need to be established between the national, regional, and local governments, the mass media and the public. Efforts also need to be made to ensure that stable systems are in place for the supply of electricity and telecommunication.

Meteorological Observations and Forecast

Surface meteorological observations have been conducted at the five Meteorological Offices of the DMM, including the NMC in Hulhule, and upper-air observations have been conducted at one of those stations. The observation results are collected at the NMC using a modem system connected to commercial telephone lines, and daily weather forecasts as well as emergency weather warnings are disseminated from the NMC to the public.

An effective way to facilitate preparedness for approaching natural hazards would be to carefully monitor time variations in the weather, sea conditions and seismic activity, and to frequently disseminate information on current and expected conditions to concerned organizations and the public. The frequent issuance of information would enable the national, regional and local governments, as well as the public, to prepare for coming events, and would help improve future forecasting technologies. This would also facilitate the issuance of warnings with adequate lead time.

Some of the existing meteorological equipment, such as the wind systems at the meteorological offices, was upgraded several years ago, but other equipment has been in use for more than 12 years. Some equipment has even been operating for more than 30 years. Those instruments have functioned properly and been well maintained. Unfortunately, however, this older equipment is not capable of providing the continuous monitoring and online, real-time displays that less widely used newer pieces of equipment can offer. Most data reading and measurements are performed manually every one to three hours, and this creates inefficiencies in the system.

The first step that needs to be taken is to ensure that electronic equipment capable of continuously displaying and recording surface meteorological events is installed at the five existing Meteorological Offices and to ensure that data is simultaneously transmitted to the NMC for the precise surveillance of time variations in meteorological conditions nationwide. To enable authorities to monitor and evaluate natural conditions, effective systems for online and real-time data collection, display, data-processing and information sharing need to be installed simultaneously.

There are gaps in meteorological observation points in the northern and middle regions of the nation, making it difficult to get an accurate picture of rough weather conditions at the local level. Two automated stations are needed to obtain basic surface meteorological data, and the data from these stations should be sent to the NMC for careful monitoring.

The monitoring and detection of rain cloud systems would be very useful for watching and forecasting rough weather. A weather radar system is essential for monitoring the weather and making forecasts. A rain cloud evaluation system would not only enable the monitoring of weather, but also of rough sea conditions. To ascertain and monitor the overall rain cloud system in the atmosphere in and around the nation, two radar systems need to be installed in the middle and southern regions of the Maldives. Cloud images from geostationary meteorological satellites are obtained via the Internet, but acquisitions are made only infrequently and the numerical analyses of the cloud data are limited. A system for directly receiving satellite images at the NMC is needed to view and evaluate wide-scale cloud systems.

The use of a DCP (Data Collection Platform) of a geostationary meteorological satellite such as the MT-SAT or METEO-SAT 5 would be a convenient way for the NMC to collect meteorological data from the Meteorological Offices and automatic monitoring stations, especially given the stability issues and costs involved in establishing and maintaining a telemeter-system. In addition to collecting data, the DCP is capable of distributing text-formatted messages to sites on the ground. This function can be used as a back-up system for the transmission of urgent messages, though the size of such messages would be limited. Observation data stored in the data logger is often accessed via dial-up services over the telephone lines. The DCP and dial-up access systems can serve as dual back-up systems for data transmission.

Weather radar data, however, can not be transmitted via DCP due to the limited transmission capacity and velocity. Weather radar echoes could be sent via the Internet by reducing the ground resolution and frequency of transmissions, but clear images of the data shown on the radar echo would frequently be needed for weather analyses and forecasts. Radar echo data should be sent at the appropriate frequency and ground resolution to the NMC using the methods currently available, that is, leased line systems, microwave linkages, V-SAT systems or UN V-SAT systems.

The NMC is connected to the RTH New Delhi by the GTS (Global Telecommunication System) via the Internet. to exchange detailed and high-volume meteorological information, and to urgently exchange tsunami warning messages via the upcoming Indian Ocean Tsunami Warning System, an online GTS circuit needs to be opened up between the NMC and the RTH New Delhi using the leased line system.

Wave and Water-Level Monitoring

High waves, storm surges and abnormal swells occur on a regular basis and cause considerable damage to houses and structures, as well as coastal erosion. Continuous tide monitoring systems have been installed at three sites in the Maldives, but the continuous monitoring of tide variations have not been conducted due to the lack of online and real-time recording systems at the Meteorological Offices. To achieve the monitoring of tidal variations nationwide, the existing three tide gauges should be continuously monitored and the tide data should be sent from the observation sites to the NMC. Moreover, in order to ascertain the tide variations in the southern region, two tide gauges with recording and telemetering functions should be installed at the Kaddhoo and Kaadedhdhoo Meteorological Offices. An illustration of the two kinds of float-type tide gauges is shown in Figure 4-1. This tide gauge network could be used for monitoring wide-scale and localized tide variations across the Maldives in real time.

Waves caused by cyclones and rough sea conditions have also caused severe damage mainly along the coastlines, but there is no system for monitoring wave conditions. A wave monitoring system with a detector installed in the seabed and cabled to an onshore station would make it possible to continuously monitor off-shore wave variations. The detector and cable would be set up at about five km off-shore (Figure 4-2).

Establishing wave-monitoring systems in the northern, middle and southern regions of the nation would provide a very effective network for ascertaining the actual behavior of sea waves and evaluating sea conditions during rough weather conditions. Wave monitoring systems should be installed several km off-shore at three sites (Hulhule NMC, Hanimaadhoo and Gan Meteorological Offices) to facilitate the surveillance of wave conditions nationwide. Using the information from such systems in conjunction with the meteorological information from other equipment, weather radars and satellite images will contribute to more accurate forecasts of wave and sea conditions.

Measuring variations in the water level and waves at off-shore sites is a more effective way to get an accurate picture of sea conditions. Buoy systems equipped with GPS (Global Positioning Satellite) Tsunami Meters can be installed about 20 km off the coast and can take precise measurements of variations in waves, water levels and tsunami waves off-shore (Figure 4-3). Minor variations in water level due to waves, tides and tsunamis can be detected and monitored with the data processing and precise GPS positioning of the buoy system. GPS buoy systems should be installed off Hulhule and Gan islands to enable the monitoring of wave time variations, water levels and tsunamis in the middle and southern regions of the Maldives. The data would be transmitted to the coastal stations via UHF radio.

Data from the tide gauge observation sites, the wave meters installed at shore stations, and the coastal stations used by the GPS buoy systems could be transmitted to the respective Meteorological Offices through the best available mode: private cable, the DCP or the dial-up system. Water level variations, waves, and tsunami waves could then be monitored at the offices.

The observation data from tide gauges, wave meters and tsunami meters can be transmitted via the DCP or dial-up system to the NMC in Hulhule for the online and real-time and monitoring of water levels, waves and tsunamis nationwide. These observations could provide effective data for understanding and evaluating actual sea conditions and could contribute to the issuance of warnings about sudden changes in sea conditions, thereby contributing to the advancement of sea condition forecasts and to the basic understanding of marine meteorology.

If the GPS buoy system were to detect tsunami waves off the coast, the authorities would know about it was on its way before it arrived, and this information could be used for more effective tsunami preparedness. Actual measurements of tsunami waves using tide gauges and the GPS buoy systems, including wave meter records, are very important for confirming the height of the tsunami waves that can be expected to make landfall. The results can be also be used to correct tsunami propagation models. These observation data are particularly essential for the advancement of highly accurate tsunami forecasting operations. Also, the ability to confirm that incoming tsunami waves have decreased in size allows authorities to cancel tsunami warnings, thereby avoiding unnecessary disaster management activities such as evacuations, harbor closures and sea transportation interruptions. A stable network of tide gauges, wave meters and GPS buoy systems installed throughout the Maldives will enable a more accurate understanding of the sea conditions, including the local features of waves, currents, tsunami waves and water swells.

Moreover, the long-term monitoring of the water level is also extremely important in evaluating sea level rise caused by global warming. A rising tendency of the mean sea surface over a long period suggests that the sea level is rising. However, this could also be due to land subsidence, which would also cause an apparent long-term rise in the sea level. To evaluate the situation and reach accurate conclusions, the results of the leveling surveys that have been conducted at the tide gauge sites need to be analyzed. It is virtually impossible to conduct a leveling survey across the many islands in the vast atolls of the Maldives. However, the use of differential GPS can make it possible to monitor and detect vertical variations, down to a centimeter, in points on the ground surface of the islands.

Seismological Observations

The earthquakes that could generate disasters in the Maldives would be large events at sites situated far from this country. Tsunami disasters in this country could be caused by seismic activity in the Sumatra region, as well as major seismic events in regions far west and south of the Maldives. In fact, tsunami waves caused by the M 8.7 earthquake on March 28, 2005 reached the shores of the Maldives. However, tsunami events do not occur at a greater frequency here than in other countries or regions situated on or near plate boundaries.

Given the seismological surveillance needs in the Maldives, the WMO (2000) has recommended the establishment of a seismological network equipped with short-period seismometers at four sites in the middle region of the nation, with one station near the capital. The system is mainly intended to monitor and detect seismic events in and around the central area of the nation. Since the network has not yet been established, seismic activity in and around the Maldives has not yet been analyzed.

The Maldives is composed of a long and narrow chain of coral atolls. Basically, the seismometers have to be installed in wide areas at adequate distances to allow them to accurately determine the hypocenter of an earthquake. If an attempt were made to determine the hypocenter and magnitude of an earthquake from a distance using only the seismological network installed in the Maldives, considerable errors in the location, depth and magnitude would be inevitable. However, the international seismological network, which uses broadband seismometers installed at intervals of several hundred kilometers, can do well at determining the hypocenters and magnitudes of events larger than M 5 all over the world. The broadband seismometer system is the international standard known as the IRIS (Incorporated Research Institutions for Seismology) system that has been established worldwide by the USGS to construct a global seismological monitoring network.

Of course, a seismological observation system needs to be established in the Maldives because of fears regarding possible earthquakes and tsunamis. Local authorities want to know about major earthquakes in foreign countries by directly monitoring seismograms so that they can evaluate whether the events are actually seismic in nature based on their local seismograms results. Given this, we recommend the establishment of a minimum seismological observation system in the Maldives.

The seismological observation system in the Maldives uses two types of seismometers: short-period seismometers installed at shallow depths and broadband seismometers installed at the bottom of bore holes. Figure 4-4 is a schematic figure of the two types. The former is installed at the NMC site in Hulhule, and the latter are installed at two different sites in the middle and the southern regions, at the NMC sites and the Gan Meteorological Office, to create a seismological network in the middle and southern regions of the Maldives.

The former type of seismometer may be able to roughly evaluate the distance and magnitude of any recorded seismic event from the interval of arrival times of P and S phases as well as from amplitude. The latter system has two broadband seismometers placed at a distance of about 520 km to emphasize the difference in arrival times of seismic waves and to detect the difference in amplitudes. This distance would be suitable for the IRIS network in the Indian Ocean region. The raw wave data obtained from the broadband seismometers installed at these two sites should be telemetered to the NMC for the monitoring of seismic activity inside and outside the nation. The data collected on seismic wave patterns from Gan to Hulhule has to be transmitted using the available modes, that is, leased lines, microwave linkages, the VSAT system or the UN VSAT system because of the extremely large volume of data that needs to be transmitted. Data can also be collected over the Internet though this will result in some lag time in the data collection. With the online and real-time monitoring of two seismic wave signals at the NMC, the approximate location and magnitude of a recorded earthquake can be fairly well estimated based on the differences in the arrival times and amplitudes of seismic signals recorded at the different sites.

The coming Indian Ocean Tsunami Warning System (IOTWS) will be equipped with a broadband seismological network to ensure the quick and accurate identification of hypocenters, as well as the magnitudes of earthquakes in the Indian Ocean region. The seismological network in the Maldives will be important not only for domestic seismological surveillance but also for its contribution to the regional network of seismological observation. The online and real-time communication of raw wave patterns to the IOTWS will further increase the accuracy and speed with which the location and magnitude of seismic events can be determined and with which tsunami forecasts can be made. Accurate and quick earthquake and tsunami warnings issued by the IOTWS will be very useful for disaster management efforts in the Maldives. The seismic wave data should be also transmitted to the IRIS Network to contribute to international seismological monitoring and research.

Strengthening the Capabilities of the Department of Meteorology of Maldives

The DMM is the key agency responsible for the dissemination of warnings based on careful, nationwide monitoring of natural conditions 24 hour a day. For the NEWSM to work effectively, the DMM has to conduct various activities including the ongoing monitoring of natural conditions, evaluations and forecasts of potential natural disasters, the dissemination of information and warnings, the exchange of information with the IOTWS and the RTH New Delhi, and the maintenance of equipment and data processing systems.

The equipment and systems for monitoring and evaluating natural conditions, as well as for communicating with international organizations, all of which will be needed for performing these various functions, are described in the previous sections. In addition to these, the DMM will need to do the following:

- Develop new organizational structures within the DMM to operate the NEWSM.
- Arrange an adequate number of personnel to perform the necessary tasks.

- Arrange an adequate number of technicians to maintain the equipment and systems.
- Improve the agency's ability to interpret, evaluate and forecast natural phenomena.
- Develop tight procedures for disseminating messages and communicating with concerned government offices and the mass media.
- Develop tight linkages with international organizations.
- Improve the abilities of professionals in the fields of marine meteorology, oceanography and seismology.
- Provide training and skill developments opportunities.
- Continue the project of the Human Resource Development in DMM (Department of Meteorology, 2005).

Dissemination and Transmission of Warnings

(a) Flow of Warnings from the NEWSM to the Public

When warnings intended for the general public are to be issued from the NEWSM, quick transmission is of the utmost importance. To ensure the transmission of information throughout the nation, the highest priority of the NEWSM would be to disseminate warnings to the national level and to the mass media in Male'. The second most important priority would be the transmission of that information to the regional and atoll governments from Male' and then the transmission of warnings from the atoll level to island residents. These two conveyances must be done in as short a time as possible. Figure 4-5 shows the first-stage flow of warnings from the NEWSM to the national level authorities. The NEWSM monitors and evaluates natural conditions and shares information with the RTH New Delhi and the IOTWS (the right side of the figure). This shows how the NEWSM issues warnings to the national level authorities in Male' (the middle and left side of the figure).

The warnings will be promptly broadcast via TV and radio within the Maldives to inform the people about the emergency situation. This is a very important and effective method of conveying information to the public, and is the first method that should be considered for communicating emergency information. In addition to this method of disseminating information, formal procedures for conveying information on natural disasters should be determined. The formal transmission of warnings should be conveyed from the national government offices to the regional offices first, then from the regional offices to the atoll offices and from the atoll offices to the island offices, and finally from the island offices to the general public. Residents, public facilities, local organizations, local companies and others at the island level should receive warnings via the formal, official procedures, as well as through TV and radio broadcasts.

A brief flow of the formal procedures is shown in Figure 4-6. Warnings will initially be disseminated to the national government offices and mass media from the NEWSM (a white arrow with a capital A on the right side of the figure). Then the regional offices will receive the warnings from the responsible government offices (a white arrow with a capital A on the left side of the figure). As soon as possible, the regional offices will then transmit the information to the atoll offices, which will then transmit it to the island offices. The island offices will urgently announce the warnings to island residents (black arrows with a capital A on the left side of the figure). There would also be sub-flows of information from the related national, regional, atoll and island offices to the island level (arrows with small letter a in the left side of the figure).

(b) From the NEWSM to the National Level, Then Regional, Atoll and Island Levels

One way this system could operate would be for one designated national level office to receive the warnings from the NEWSM and then for that office to redistribute the message to all of other government organizations in Male'. Another option would be for the NEWSM to disseminate warnings to all government organizations, including the mass media.

If the former system is adopted, an appropriate government office would have to be designated for this task, and the office would have to be equipped with a communication system capable of reliably receiving warnings from the NEWSM and transmitting them to all other national offices. This function would have to be operated on a 24 hour basis. The system would have to be capable of processing a large quantity of information in a short time, and reliable transmissions would have to be ensured even as the disaster progressed. The latter system would create a lot of work for the NEWSM given that it would have much to do in a short time. It would have to condense message content, continue monitoring the severe natural conditions, exchange information with international systems, and issue ongoing messages regarding the changing natural conditions. The NEWSM would have to operate a highly sophisticated communication system to ensure that messages were being transmitted and received.

However, both of these systems involve the inherent risks of having to transmit large quantities of information to many government offices in a short time. And the frequency of transmission and volume of information that needs to be conveyed may increase over time. This could cause a system-wide failure or severe disruptions in the communication and transmission procedures. This risk must be avoided.

Therefore, we recommend that the warnings from the NEWSM be disseminated to selected government offices designated as first-order transmission offices, including the mass media (a broken arrow with a capital B in the upper right portion of Figure 4-6). As mentioned before, TV, cable TV and radio have been very important and effective modes of transmitting disaster information to the public. Newspapers have provided precise instructions for and explanations about natural disasters and disaster management in the Maldives. Thus, the mass media should be designated as a first-order transmission office along with the designated national offices. The warnings then have to be promptly transmitted to relevant national level offices designated as the secondary transmission offices (two broken arrows with a capital B in the upper left portion of the figure). From there, the warnings need to be transmitted as soon as possible to the regional offices. Responsible government offices should be assigned to the task of transmitting emergency messages to the regional offices.

From the regional offices, information would be transmitted to the atoll offices then to the island offices and then to the public, following the same procedures as shown with black arrows A and small arrows a in Figure 4-6, as described in the previous section. The transmission of warnings to public facilities such as police stations, schools, and hospitals and to commercial organizations such as tourist facilities, fisheries, and transportation operators could be conducted by their respective government offices, in close cooperation with the regional, atoll and island offices. Under this system, the flow of information should be simple, and overlaps in incoming and outgoing information should be avoided as much as possible. The components of this flow can be reviewed, adjusted, and consolidated, as necessary.

(c) Procedures for Disseminating, Transmitting, Receiving and Announcing Information

Warnings from the NEWSM will be transmitted to the government offices that have been designated as the first- and second-order transmission offices in the formal procedures (Figure 4-6). The transmission and reception of messages should be processed on computer networks using leased telecommunication lines. The message should be sent using a formatted document printed on paper for prompt transmission. Due to the possible failure of computer networks in Male' if the electricity or telecommunication lines are destroyed, alternative modes of transmission should be prepared. In this case, the first-order method would be fax transmission, and the next would be voice transmission. The final alternative would be voice communications using public telephone lines and mobile phones.

The transmission and reception of warnings between the national, regional, atoll and island levels should be performed using reliable communication systems similar to those used throughout the national level (computer networks and hotlines using leased lines). Communications via public-line faxes and telephones should also be identified as alternate modes of transmission.

A reliable telecommunications system and electric power supply are essential to the proper functioning of the NEWM. Back-up systems for both functions need to be established not only the responsible companies but also by the national, regional, atoll and island offices.

For transmission procedures to operate effectively, national, regional, atoll, and island offices, along with the mass media, need to be prepared to transmit and receive emergency warnings 24 hours a day. Public facilities and organizations such as the police, fire stations, hospitals also need to be on call 24 hours a day.

In case of emergency, the relevant staff members have to come to their respective offices as soon as possible to initiate their own disaster management procedures. A framework for sending out an urgent call to the designated staff members has to be developed. The simultaneous transmission of a signal or short message to designated personnel is usually achieved using beepers. In the Maldives, however, cellular phones are very popular, and the coverage area easily extends to the atoll offices. The mailing function of cellular phones could be used as a backup system for simultaneously sending out urgent messages to designated personnel of the national, regional, atoll, and island offices.

Announcements from the island office to residents, communities, public facilities and private organizations on each island is the ultimate goal of the formal urgent transmission procedures. This could be achieved in various ways, but the most suitable might be through the use of the loudspeaker systems that have been set up around the islands. Loudspeaker announcements could be made using voice alerts or a siren. The people on the islands can also obtain warnings through their TVs and radios. Having duplicate procedures for issuing warnings would be very effective for the different islands.

(d) Alternative Telecommunications in Case of the Failure of Formal Procedures or TV/Radio Broadcasts

Failures of both the formal transmission system to the islands and TV/radio broadcasts would not be very likely to occur if back-up electricity and telecommunications are prepared according to the measures recommended in the previous section (c). However, unexpected failures of telecommunications might occur. Moreover, the absence of TV and radio communications is common during the night when people are sleeping.

The following alternative measures can be considered and introduced in addition to the formal transmission procedures described in section (c). Items (1) and (2) can be used mainly for directly communicating with the people, and items (3) to (5) would be used as formal procedures for transmitting information to the island offices,

1) Automatic switching on of TVs and radios on the islands when a special radio wave signal is emitted by the broadcast companies in Male’
   This measure has been practically implemented in Japan and the capability has been confirmed. Improvement in the receiver functions of TV and radios is essential.
2) Siren sounding over loudspeakers remotely triggered by radio waves emitted by the responsible government office in Male’
   Among the wireless methods that use existing broadcasting facilities, this method has already been technically developed and can use the transmission systems of ordinary radio broadcast waves. The satellite radio system is also effective for this purpose. Practical usage on remote islands should be carefully examined.
3) CS (Communication Satellite) System
   Telecommunications using computers, telephones and fax machines can be achieved without remarkable restrictions to the volume of information to be sent. Transmission and receiving systems work with a solar cell unit.
   High costs involved in device installation and maintenance.
4) V-SAT system
   Telecommunication capabilities similar to the CS system. The system works with a solar cell unit. This system is to be used for the transmission of seismic wave data from Gan to NMC and from NEWSM to IOTWS in Phase 3 because of the large volume of data that needs to be transmitted (see Table 4-1 in the next section (2)).
   High costs involved in device installation and maintenance.
5) DCP (Data Collection Platform) on board the geostationary meteorological satellite
   Every geostationary meteorological satellite such as MTSAT and METEO-SAT has a DCP (Data Collecting Platform) function for collecting observation data on meteorological and tidal conditions. The DCP has also the polling function which can distribute the warnings issued from the NEWSM, simultaneously to the receiving stations across a wide area using UHF antennas (Figure 4-7). The baud rate seems slow but it is fast enough to send warnings in text format. To use the DCP function, additional equipment and software will be required, as will periodic maintenance costs, but there are no communication fees. DCP functions on board the METEO-SAT 5 and MT-SAT can be used in the Maldives.

It is impossible to exactly forecast serious natural conditions. Thus, for the above systems to operate effectively, especially the systems listed in items (3) to (5), they would have to be always on and someone would have to be positioned to monitor them on a 24 hour basis. This would be the only way to ensure that island residents would receive warnings about unexpected events.

The actual alternative communication system in the Maldives has to be carefully considered and examined in order for the most appropriate procedures to be established. The DCP and satellite radio systems are considered to be the most effective alternative systems for the regional, atoll, and island offices and for the public facilities on the islands. These systems can quickly transmit warnings across a wide region with relatively low maintenance costs. However, there are several plans for future telecommunication systems in the Maldives that would involve the use of digital HF radio, multiplex radio, VHF radio or communication satellites. The most effective communication system for the NEWSM should be considered based on an overall assessment of the situation from various viewpoints.

(e) Open Window to the Public

Before a natural disaster strikes and as they progress, the general public expects to obtain information about the current situation, what they should do, and evacuation cancellations not only through the formal announcements and TV and radio broadcasts, but also from direct explanations from the government offices. People will visit or call the respective offices at the national, regional, atoll and island levels to ask about these subjects. Those inquiries will also be directed to the NEWSM.

Official announcements regarding current conditions, information that people need to know, and the future projections should be made frequently. At the same time, it is important for the NEWSM to provide adequate, exact and intelligible information on the natural conditions to the relevant offices at the national, regional, atoll and island levels so that they can address inquiries from the public.

Data Archives and Research

A system of archiving meteorological, seismological and oceanographic observations obtained through the NEWSM should be established under the DMM for the future analyses of natural events and for increasing the accuracy of simulation models used domestically and internationally. A system for regularly publishing the observation data is also important for the long-term study of fields in the natural sciences. Research should be promoted in the various fields of geophysics.

(2) Plan for the Establishment of the National Early Warning System in the Maldives

The comprehensive configuration of the NEWSM is planned to incorporate an online GTS system connected to the RTH New Delhi, data processing systems with information delivery functions, meteorological observation systems, weather radar, systems for acquiring meteorological satellite imagery, tide gauge stations, off-shore wave meters, off-shore GPS buoys, short-period and broadband seismometers, a V-SAT system for the transmission of seismic wave data, a DCP system for collecting domestic data (except weather radar and seismic wave data) and linkages with the RTH New Delhi and the Indian Ocean Tsunami Warning System (Figure 4-8). The establishment of the whole system involves very high costs, and it is therefore essential that adequate technical preparations be conducted for maintenance and operation of the system and that the personnel who will operated it are sufficiently trained.

The entire NEWSM system should be established one step at a time, one year at a time. The establishment process is divided into three stages as shown in Table 4-1. Figure 4-9 shows the proposed installation sites for each piece of observation equipment. The function and configuration of the NEWSM and the flow of information inside and outside of the system are shown in Figures 4-10 and 4-11, respectively. Brief descriptions of the system at each of three stages (Phase 1 - 3) are given below.

Phase 1

This stage consists of the establishment of the monitoring systems of the surface meteorological conditions, tide and wave variations and seismic event occurrences.

a) All meteorological observation systems at the NMC and four Meteorological Offices have been upgraded with new systems that can be continuously monitored and that have automated data processing functions.
b) Continuous monitoring systems of the outputs of existing tide gauges at the three stations are attached and continuously monitored.
c) One wave meter is newly installed off the coast of Hulhule. The detector is installed on the seabed and the signal is continuously monitored.
d) One short-period seismometer is newly installed at a shallow depth at the NMC site. The signal is continuously displayed for monitoring.
e) Observation data from meteorological systems, tide gauges and wave meters is transmitted to the NMC from the Meteorological Offices and is continuously monitored at the NMC.
f) Open a GTS circuit between the NMC and the RTH New Delhi that does not rely on the Internet, and upgrade the GTS circuit.
g) The data processing system is newly installed at the NWC and the four Meteorological Offices. The system at the NMC can be linked to the RTH New Delhi and the coming Indian Ocean Tsunami Warning System. Online dissemination of information to designated government agencies and mass media is achieved.

Items (b) and (f) are to be implemented by the IOC and the WMO, respectively. When those upgrades are implemented, adjustments will have to be made to the transmission settings and data format to ensure that they are compatible with the NEWSM's devices, and the installation of the equipment will also have to be coordinated with the NEWSM. At this stage, plans to establish a system for acquiring meteorological satellite imagery using second-generation software directly from METEO-SAT 7 and conveying it to the NMC (item f) in Phase-3 should be transferred to Phase-1 to improve the nation's ability to ascertain and make projections about meteorological conditions.

Phase 2

This stage consists of the further efforts to strengthen systems for monitoring surface meteorological conditions, wave variations, and cloud systems, as well as cyclone, storms and earthquake activity.

a) Automated meteorological monitoring systems are newly installed at two sites in the northern and middle regions. The data is collected and continuously monitored at the NMC.
b) A second wave meter system is newly installed off the coast of Gan. The signal is continuously monitored by the Gan Meteorological Office, as well as by the NMC once the necessary telecommunications lines and data transmission capabilities can be achieved. Weather radar system is newly installed at the NMC site and is operated/monitored at the NMC.
c) One broadband seismometer system is newly installed at the NMC. The detectors are set at the bottom of a bore hole 50 m in depth at the NWC site. The data is continuously displayed for monitoring.
d) The NEWSM's GTS system will be equipped with a new function allowing automated input of observation data.

Phase 3

This stage consists of the final establishment of functions for monitoring tide variations, off-shore waves, off-shore water level variations, atmospheric cloud systems and earthquake activity. Seismic wave data and weather radar data are collected by the NEWSM.

a) Tide gauge systems are newly installed off the coast of Kadhdhoo and Kaadedhdhoo. Data is continuously monitored at the Kadhdhoo and Kaadedhdhoo Meteorological Offices, as well as at the NMC once the necessary telecommunications lines and data transmission capabilities can be achieved.
b) A third wave meter is newly installed off the coast of the Hanimaadhoo site. The signal is continuously monitored at the Hanimaadhoo Meteorological Office, as well as at the NMC once the necessary telecommunications lines and data transmission capabilities can be achieved.
c) Two tsunami GPS buoy systems are newly installed off the coasts of Hulhule and Gan islands. The data is continuously monitored at the Gan Meteorological Office, and the two types of data are collected and continuously monitored at the NMC.
d) A second weather radar system is newly installed at the Gan site and the radar echo is continuously watched at the Gan Meteorological Office. The data is transmitted to and monitored continuously at the NMC.
e) A second broadband type seismometer is newly installed at the Gan Meteorological Office. The detectors are set at the bottom of a 50-m bore hole and the signal is continuously monitored at the Gan Meteorological Office. The seismic wave data is transmitted to the NMC and monitored continuously. Seismic wave patterns from the two sites are sent to the IOTWS and the IRIS System.
f) A system for acquiring meteorological satellite imagery directly from the METEO-SAT is newly installed at the NMC.
g) System can be linked to the Indian Ocean Tsunami Warning System.

Feasible Data Collection Systems for the NEWSM

The general view of the NEWSM shown in Figure 4-8 was proposed herewith as a comprehensive system for conducting online and real-time monitoring of natural conditions with continuous records provided by all of the observation sites in the Maldives. An important purpose of the NEWSM is to conduct the online and real-time monitoring of continuously recording data from all the observation stations in the country. Data collection is usually achieved via cables leased from the telephone company or via satellite data transmissions using V-SAT or communication satellites. This system will result in the adequate and accurate continuous monitoring of natural conditions, but will involve fairly high maintenance and operating costs. Given the size of the data involved, the DCP function is an effective means of collecting data on surface meteorological conditions, as well as data on tide, wave and sea level variations obtained through meteorological equipment at the Meteorological Offices, the automated observation sites and the tide gauges, wave meters and GPS buoy systems, respectively.

The observation data collected from each station is sent to the geostationary meteorological satellite, and from there the data is sent to the data processing center: Japan for MT-SAT and France via Germany for METEOSAT. The data is systematically transferred to the New Delhi, Indian Meteorological Department because this organization is the Regional Telecommunication Hub designated by WMO. Then, the data is returned to the NMC. The collection and receiving of data via satellites, whether Japan or France and New Delhi, are conducted automatically using computer systems. However, this system takes several minutes. However, nationwide monitoring will utilize this system even though there is short time lag. The maintenance and operating costs will be fairly low. However, radar echo and seismic wave data are extremely large and cannot be collected using the DCP due to the limitations of the transmission velocity of that system. The feasible modes of data collection for the weather radar data and broadband seismic wave data are V-SAT, microwave linkage, UN V-SAT and leased telecommunication cables, even though they have high operating costs.

For the NEWSM system to be feasible, it has to have low maintenance and operating costs. The meteorological equipment at the Meteorological Offices and the automated observation sites are connected by private cables and phone lines. From those sites, the DCP system can transfer data to the NEWSM site. The dial-up data calling system using a data logger can be also be used for data collection but short time lags (on the order of one minute) in data collection are unavoidable.

Observation data from tide gauges, wave meters and GPS buoys are usually collected at the shore stations. The distances between the shore stations and the Meteorological Offices may not be short enough to set up private cables for data transmission. The DCP and the dial-up data collection systems can be used to connect these stations to the respective Meteorological Offices and to the NEWSM for data monitoring. The usage of both methods for collecting data on meteorological observations and sea condition measurements would be an effective dual data-gathering system for the NEWSM.

The data obtained from the weather radar systems and broadband seismometers installed in the middle and southern regions of the Maldives is important for analyzing cloud systems and evaluating remote seismic activity. These are installed at the NMC and the Gan Meteorological Office, and the data is sent to the offices via private cables. Weather radar echo data and seismic wave data should be transmitted using such systems as satellites or leased lines due to the extremely large volumes of data that have to be transmitted. As an interim procedure, this data can be collected over the Internet. However, this could involve a lag time of about 10 minutes depending on the communications conditions, traffic, and other circumstances at the time the data is being monitored by the NEWSM.

The volume and resolution of the data transmitted via the Internet would be restricted. However, if continuous observation data that cannot be obtained at present could be obtained in the future, even intermittently or with a time delay, this data on meteorological and sea conditions could be used together with data provided by other countries to enable the monitoring of natural events nationwide more accurately than is currently possible. Figure 4-12 shows the simplified continuous monitoring system using the DCP and the Internet for data collection.

Preparation for the Establishment of the NEWSM

The action plan for establishing the NEWSM first needs to be discussed and accepted nationwide. Field surveys need to be conducted and meetings need to be held with responsible governments officials at the national, regional, atoll and island level to determine the appropriate procedures for transmitting emergency information, to discuss the practical operations of the NEWSM, to establish back-up systems for the formal information dissemination system, and to ensure the availability of reliable electricity and telecommunications systems.

The next set of tasks to be conducted includes precise field surveys of the actual installation sites for equipment and devices, surveys of underground structures and rock hardness, surveys of sub sea topography for equipment installation, examinations and confirmations of the functions to be performed at various offices, preparations of electric power supply and leased lines, efforts to design the display of analyzed results, the formatting of warnings, the proper layout of equipment and devices under the NEWSM, and the development of related software.

And the final tasks to be performed are the configuration of the NEWSM, confirmation of the information flow, the publication of operating manuals, the establishment of back-up and alternative systems of electric power and telecommunications, and the establishment of cooperative ties with international organizations.

(3) Capacity Building

Nationwide disaster management efforts under the NEWSM demand systematic training and capacity building activities. Within a short period, a well trained staff should be cultivated to operate the NEWSM, to evaluate natural conditions, to disseminate urgent warnings to the public and to exchange information with the coming Indian Ocean Tsunami Warning System and concerned international organizations. The officials at the government, regional, atoll and island offices also have to learn disaster managements procedures at their respective levels. Those involved in decision making should be well informed on the disaster management procedures in place at the national, regional and local levels.

Capacity building should be composed of the following three courses: a course on the NEWSM, a course on the various fields of the natural sciences and a course for the leaders and officials at the national, regional, atoll and island levels.

Course on the NEWSM:

This course focuses on the operation and maintenance of the NEWSM. This system will be set up in a short period and short-term capacity building courses need to be offered on this topic. The term of the course should be at least two months and should be held every year for different personnel, during the establishment of the NEWSM and over the course of its operation.

This course should include training and lectures on actual operations and maintenance procedures, such as data processing, urgent warning dissemination, and system operations closely related to the functions and operations of the NEWSM. Equipment and system maintenance should be also covered in this course. Attendees would primarily be the DMM who would directly operate the NEWSM, as well as officials in the relevant governmental offices. Similar trainings and lectures should be held for officials in the regional, atoll and island offices.

To ensure the smooth operation and maintenance of the NEWSM, at least one week of training should also be provided for technicians at the companies manufacturing the equipment. Two weeks of practical training for the DMM staff at foreign EWS organizations such as the PTWC, the JMA , the NOAA and the USGS would be also very beneficial.

Course on the Natural Science:

For the NEWSM to be operated effectively, DMM staff needs to have background knowledge in the areas of meteorology, oceanography, earth sciences and seismology. Knowledge of these various fields will help officials understand and evaluate disturbances in natural conditions. These courses should have a five-year term due to content that needs to be learned by attendees. The DMM should designate staff members to take this course.

Overseas study courses have been conducted and these have built up a considerable pool of experts throughout the world. Courses given at JICA in Japan will contribute to the basic studies of the natural sciences, and overseas courses offered by the WMO, USGS, NOAA, and other research institutes and universities would be very effective for providing basic studies on the various fields of natural science.

A five-year term capacity building project has been implemented by the DMM since 2004 for the purpose of improving the general educational capacity of its staff. The year 2005 marks the second stage of the project, and many courses in meteorology, oceanography, atmospheric chemistry, geology, forecasting, and seismology have been arranged (Department of Meteorology, 2005). This capacity building project is expected to continue and further progress is strongly anticipated. Both of these courses could be joined together.

Course for Leaders and Officials:

Understanding the disaster management system, including the operations of the NEWSM, is essential for government officers at the policy-making and decision-making levels, as well as for the government officials who will actually be involved in disaster management. This course should be held in the Maldives and an overseas course offered by the ADRC in Japan would also serve this purpose. For disaster management at the regional, atoll and island levels, similar instructional courses should be provided for the regional chiefs, atoll chiefs, island chiefs, community leaders and officials at the regional and local levels.

The term would be at least one week and the course would be repeatedly offered so that all relevant individuals could attend.

The trainings and educational courses mentioned above would be maintained by national and foreign experts who are well educated in these areas. It is especially important that foreign experts in these specific subjects be utilized to contribute to disaster management capacity building.

In addition to these courses, instructional programs should be offered at the island level to educate the public about natural disasters, the functioning of the NEWSM, the kinds of warnings that may be issued and their meanings, and the procedures that should be followed for evacuation and other activities.

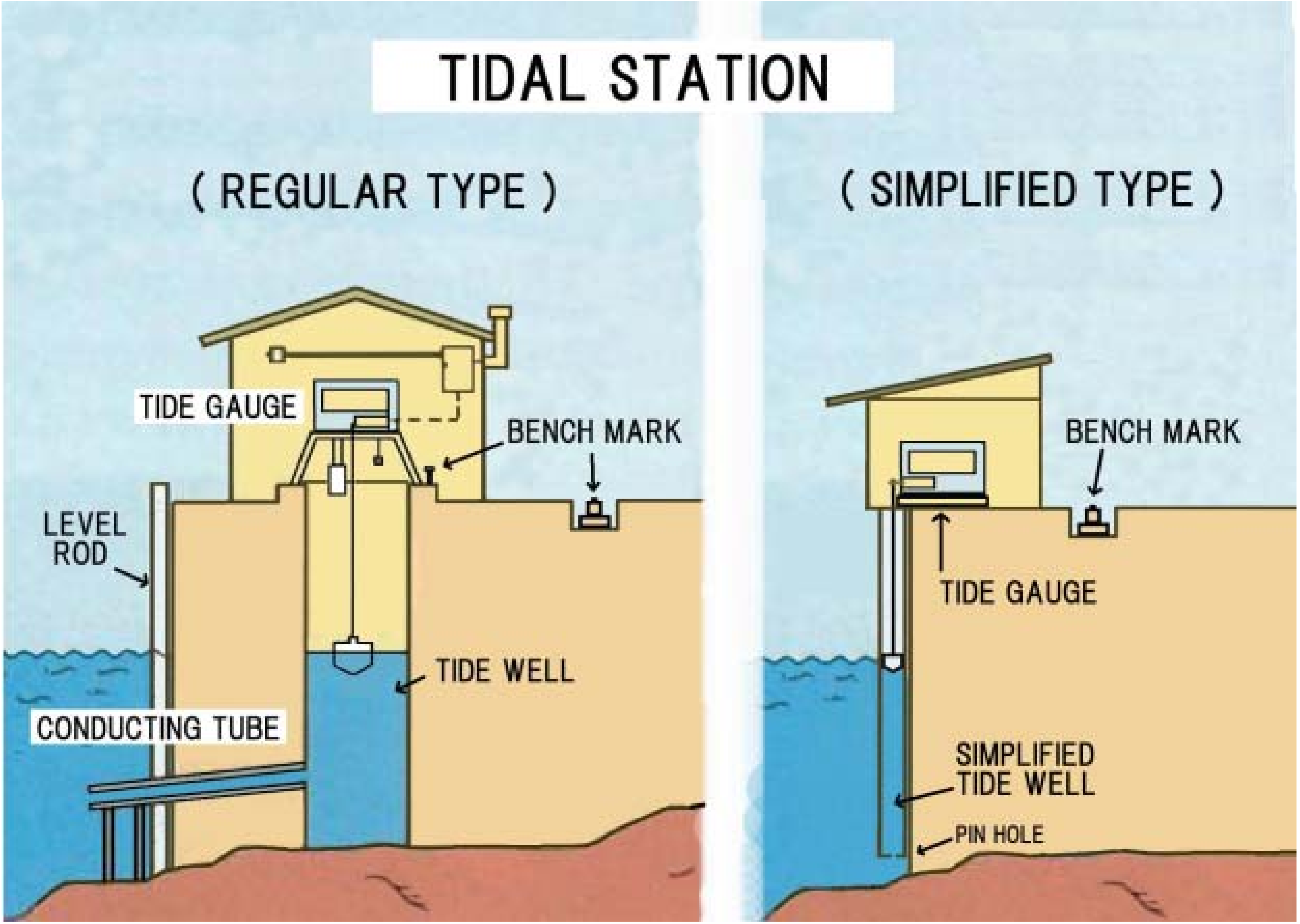


Figure 4-1 Float Type Tide Gauge System (Regular and Simplified)

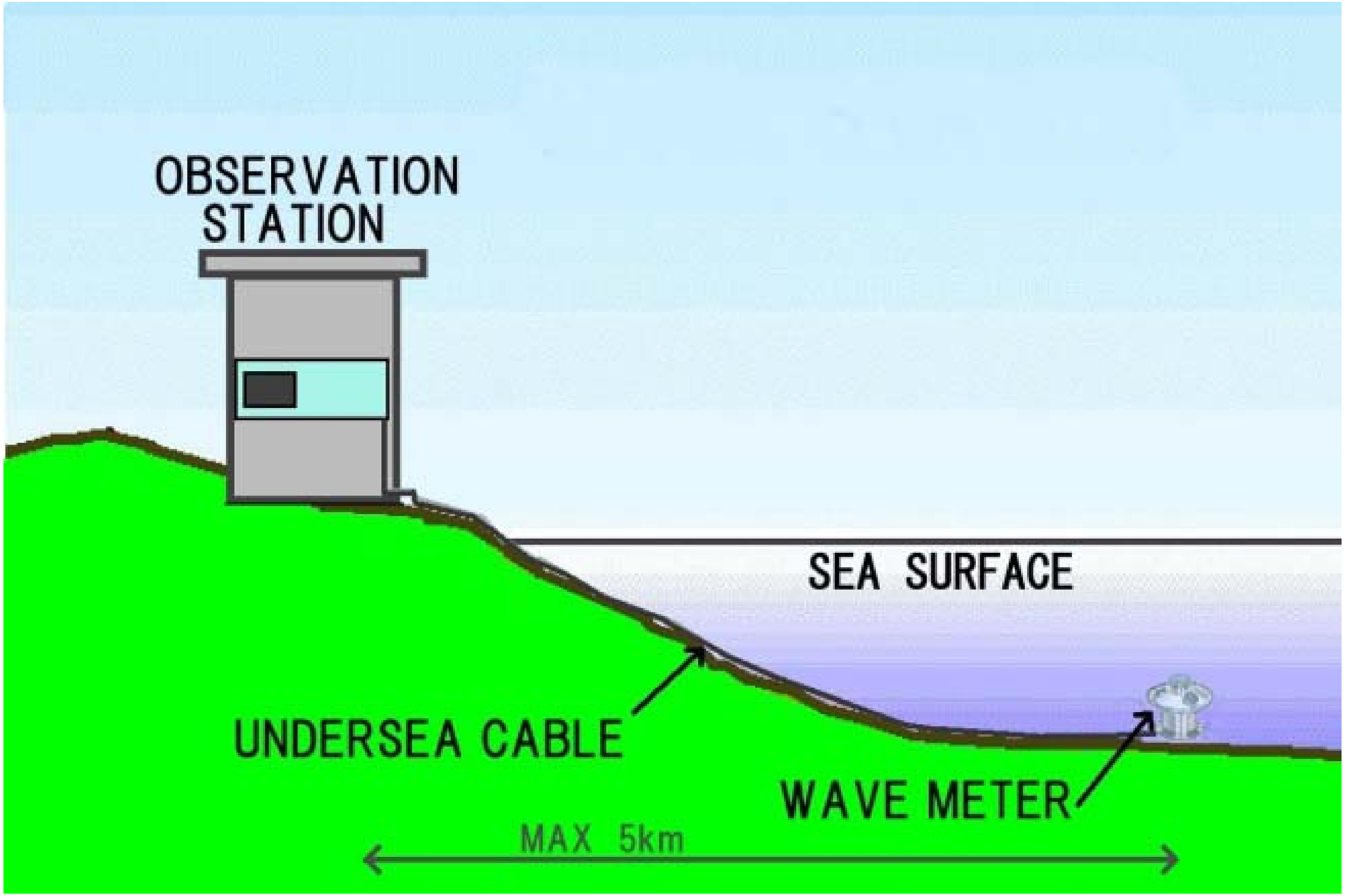


Figure 4-2 Wave Monitoring System with Wave Meter Installed on Sea-Floor

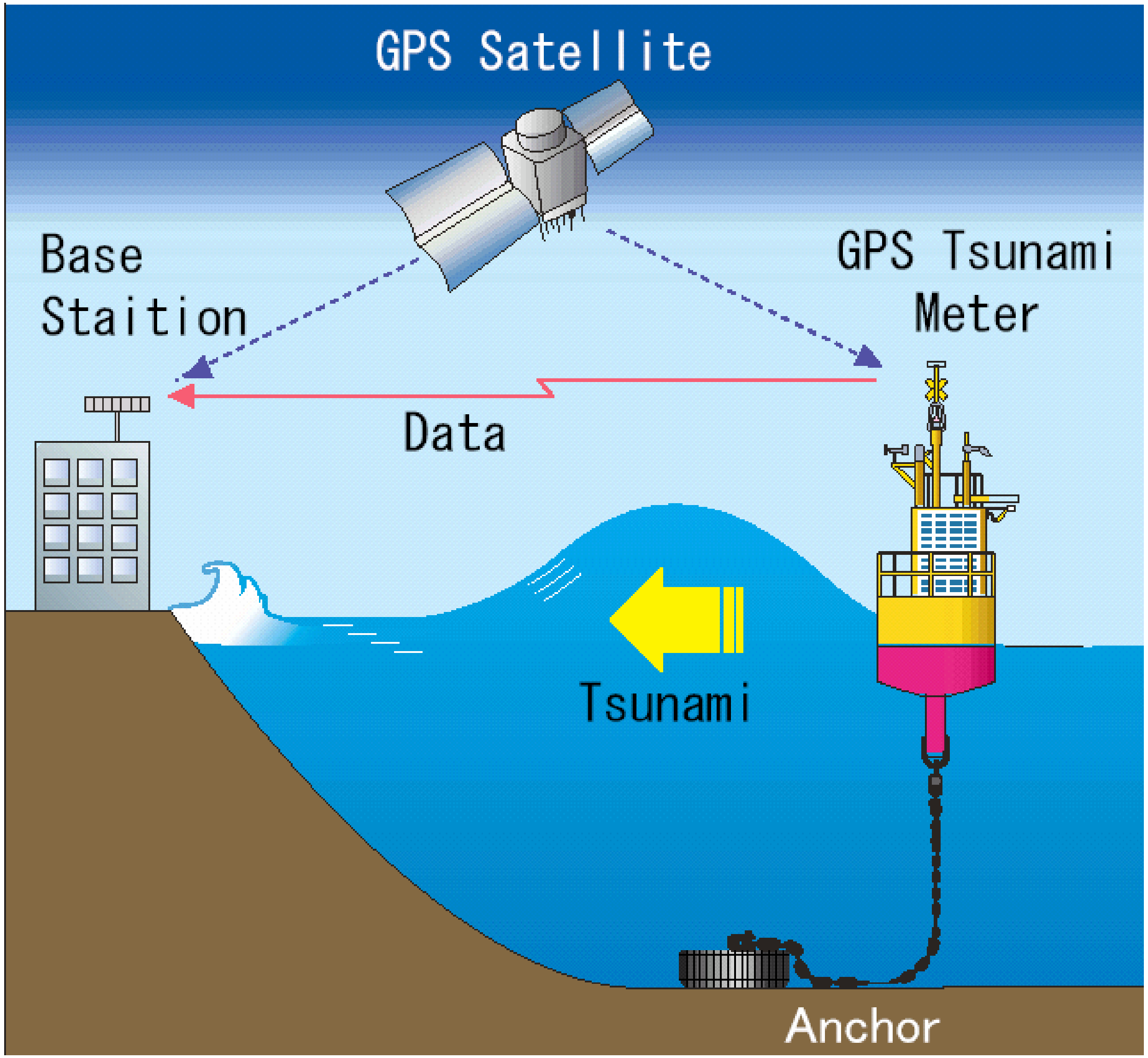


Figure 4-3 Water-Level, Wave and Tsunami Monitoring Using an Off-Shore GPS Buoy System

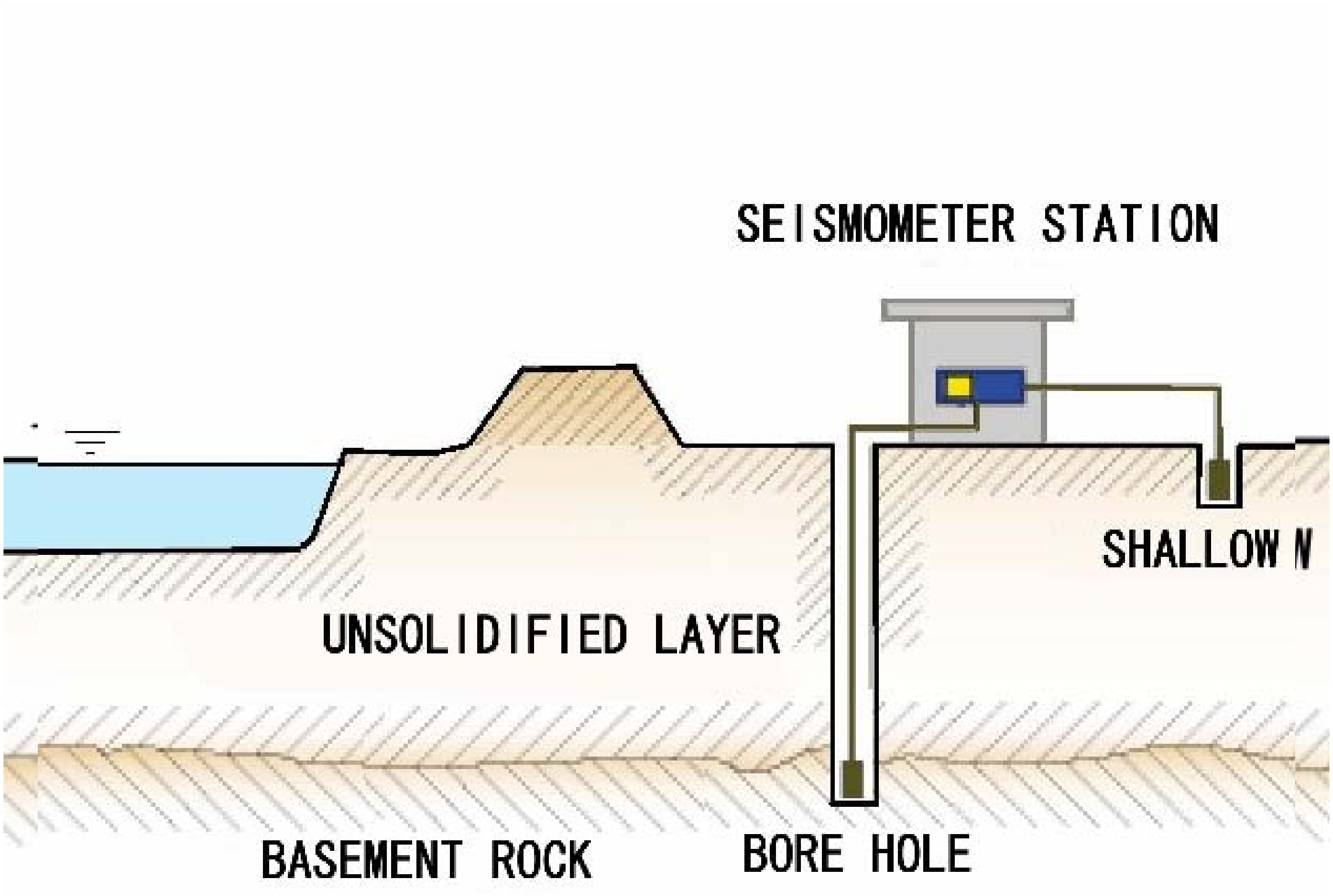


Figure 4-4 Two Types of Seismometers Installations (Shallow and Bore Hole)

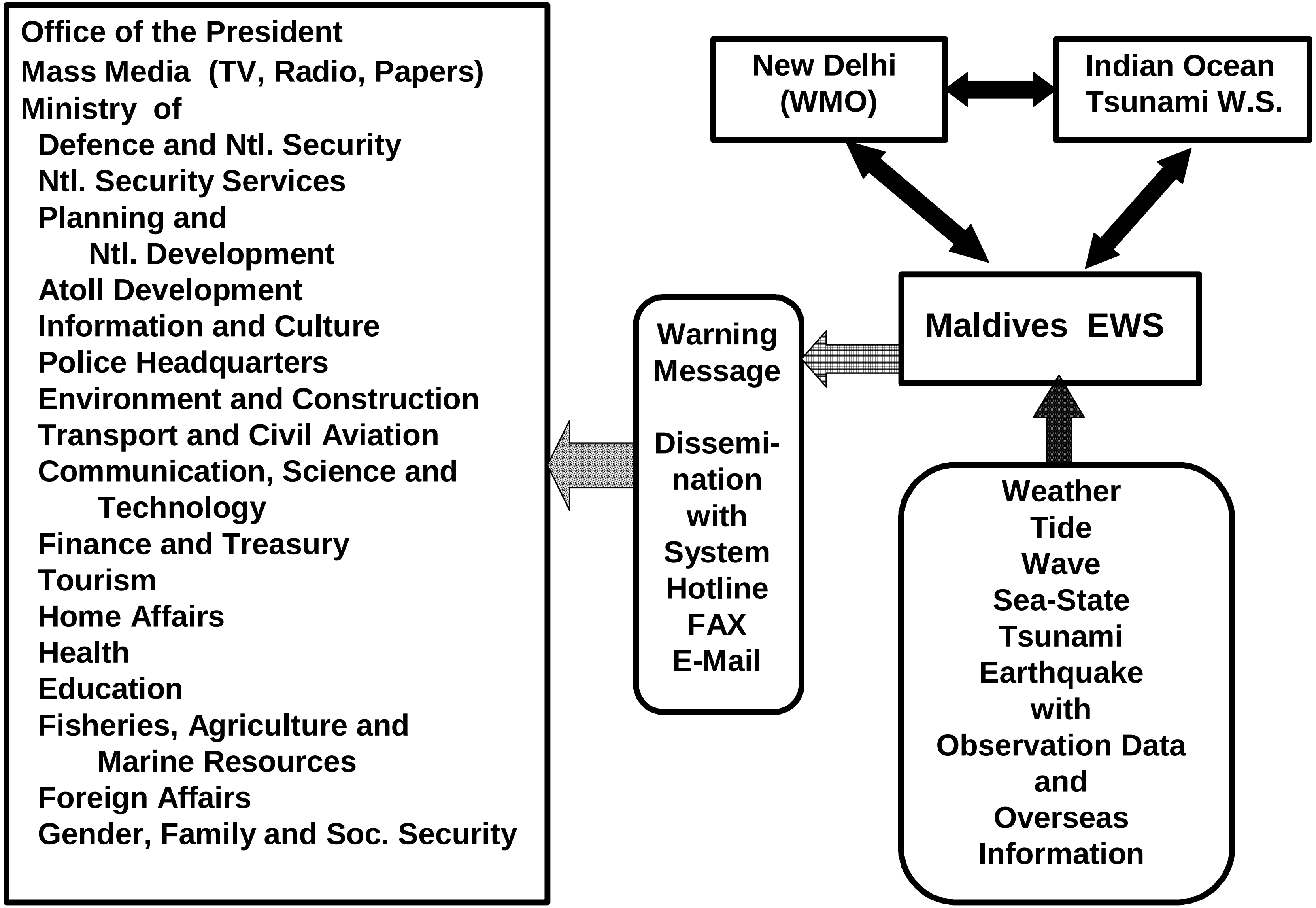


Figure 4-5 Monitoring and Evaluation of Natural Phenomena and Dissemination of Warnings at the National Level

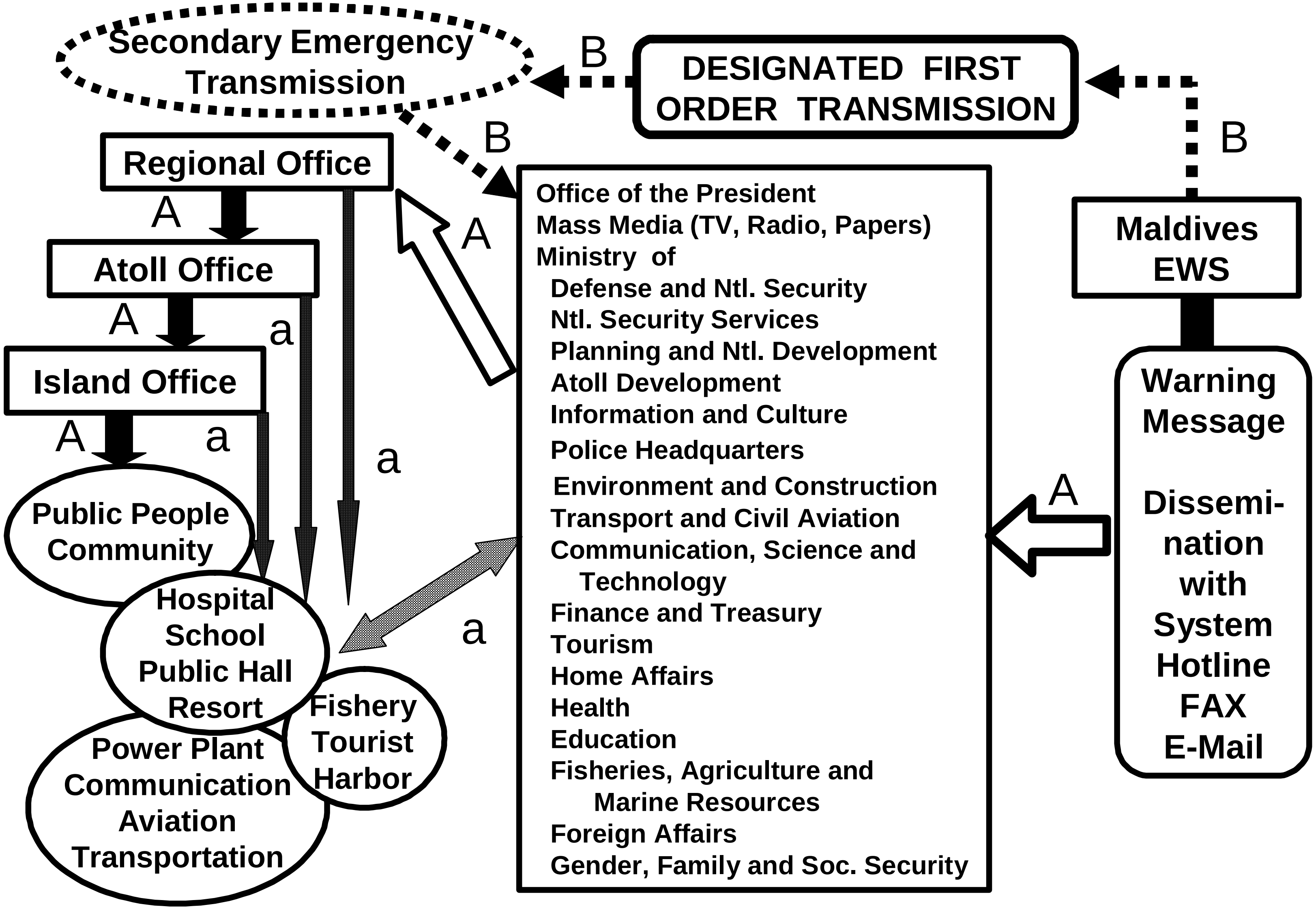


Figure 4-6 Transmission of Emergency Message from the EWS to the Public

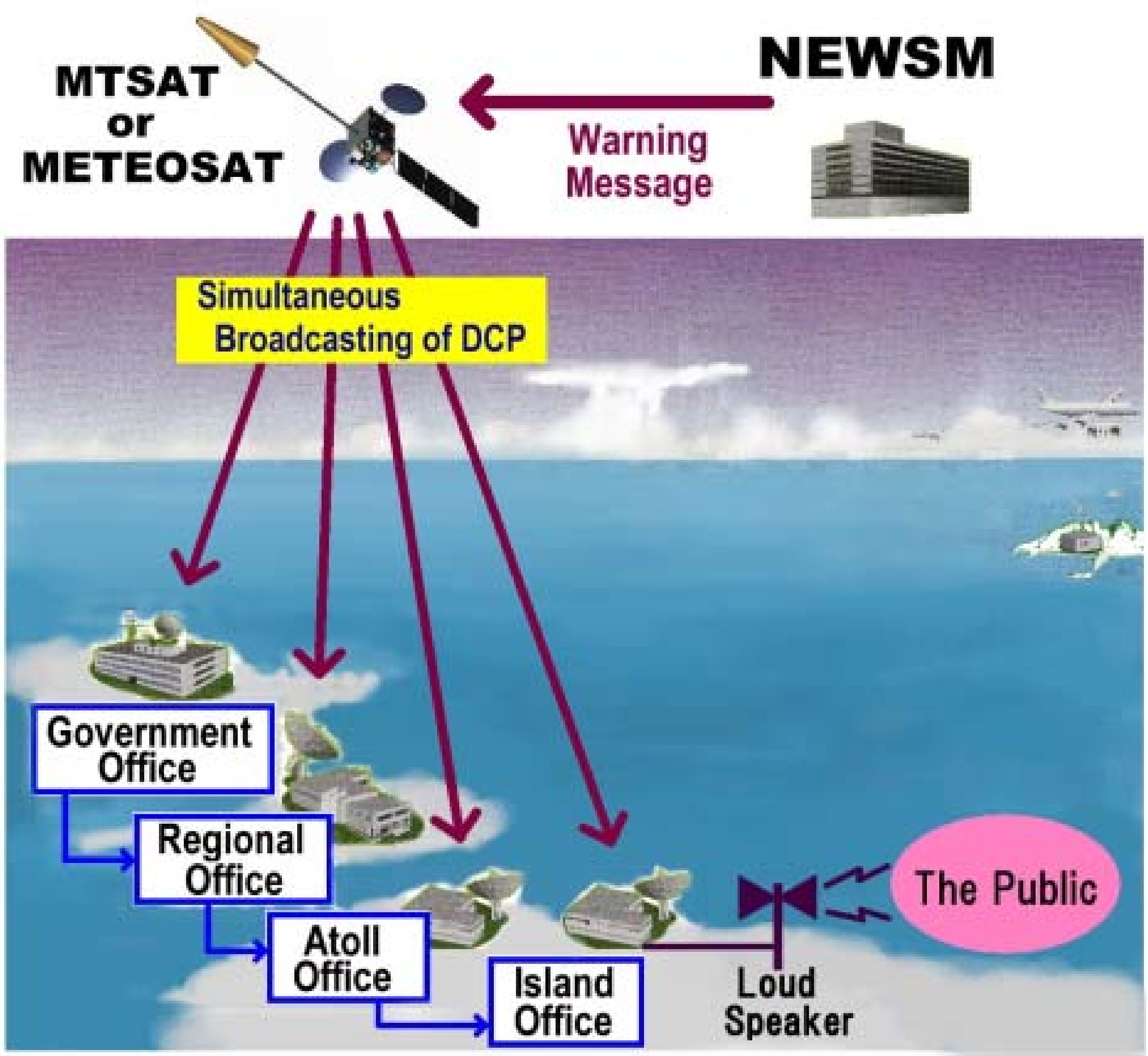


Figure 4- 7 Simultaneous broadcasting of warnings across a wide region using a DCP in case of the failure of the communication system.
Island residents could be informed using loudspeakers installed at the Island Offices.

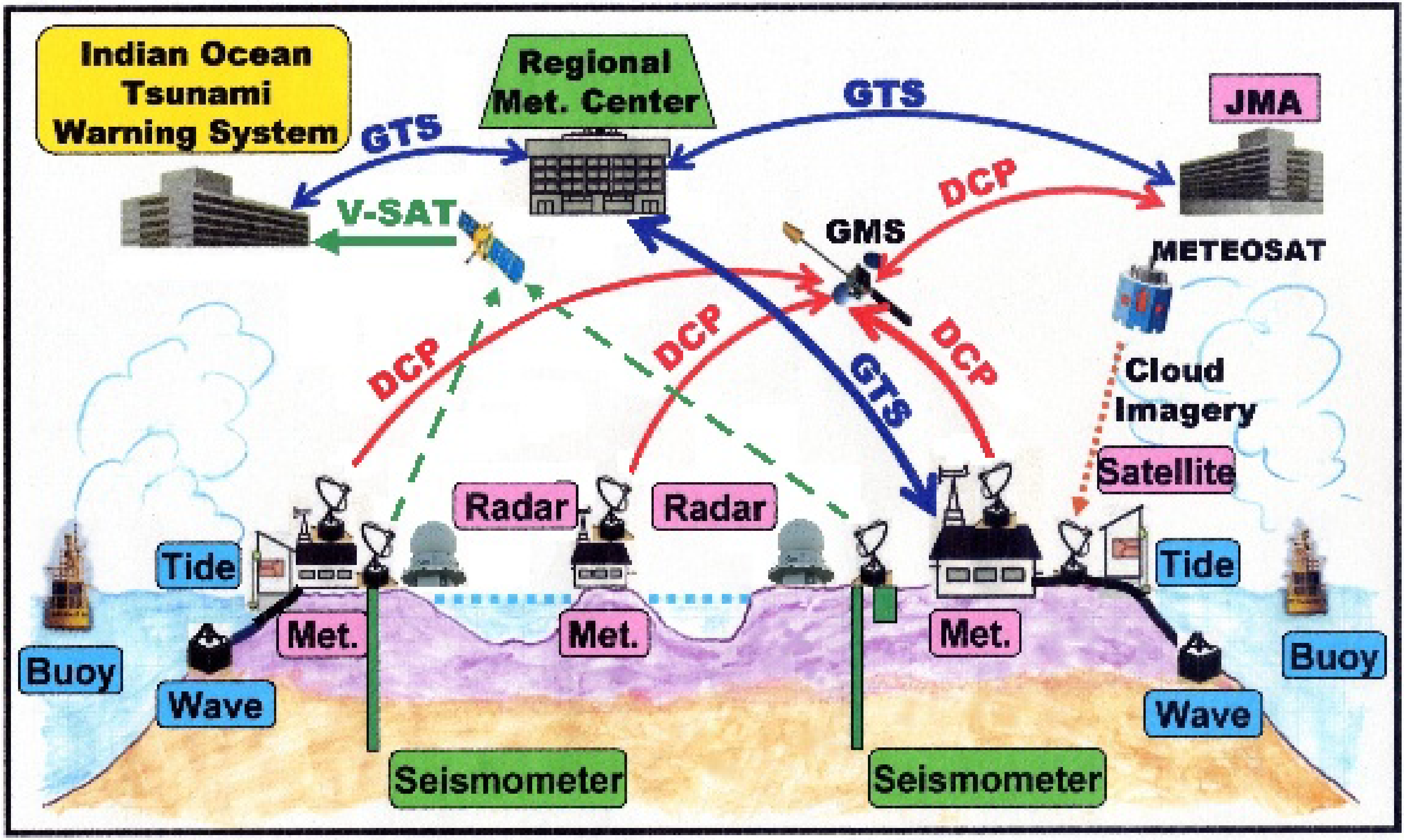


Figure 4-8 General View of the Comprehensive Monitoring System Employed Under the National Early Warning System of the Maldives

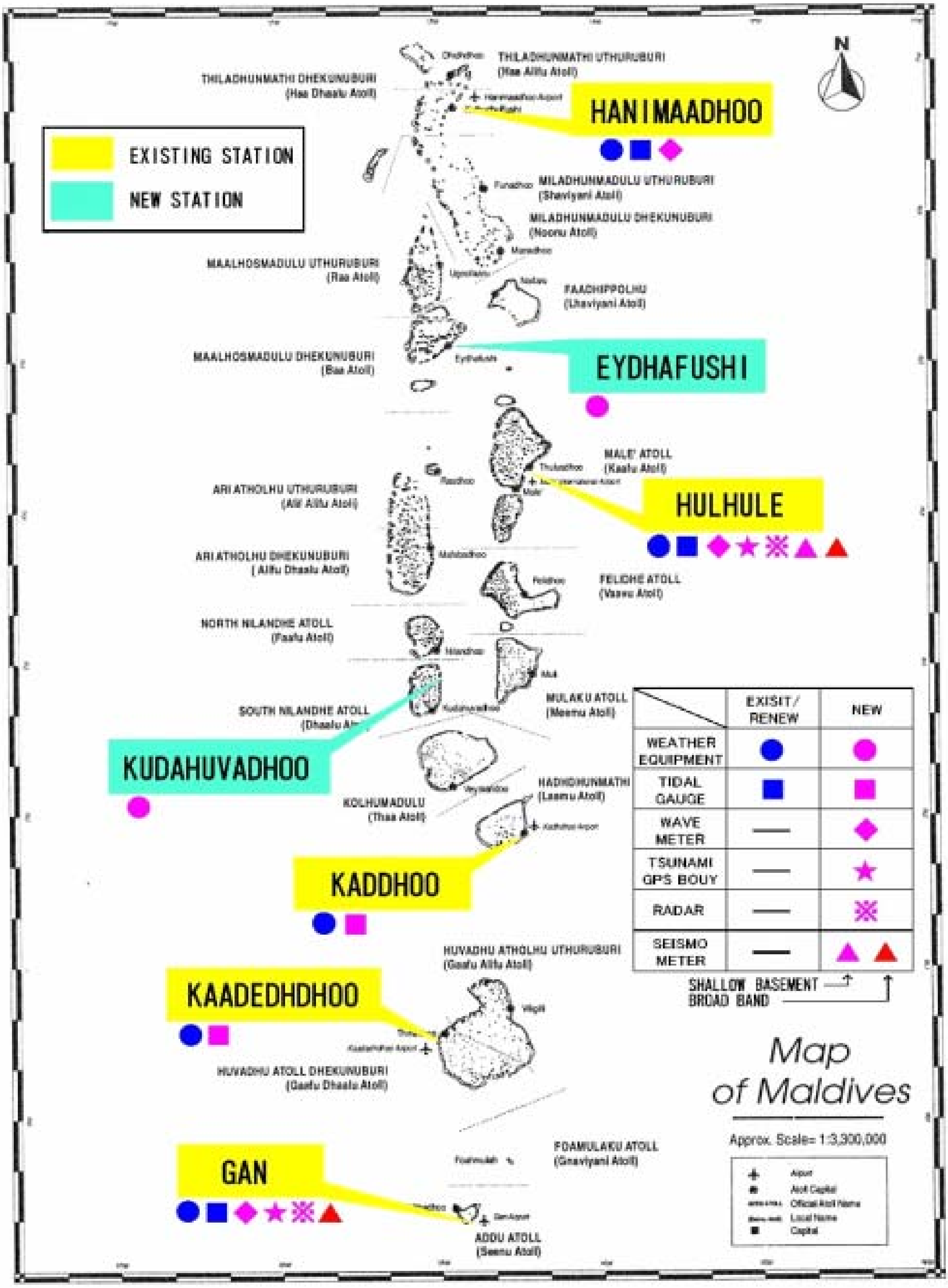
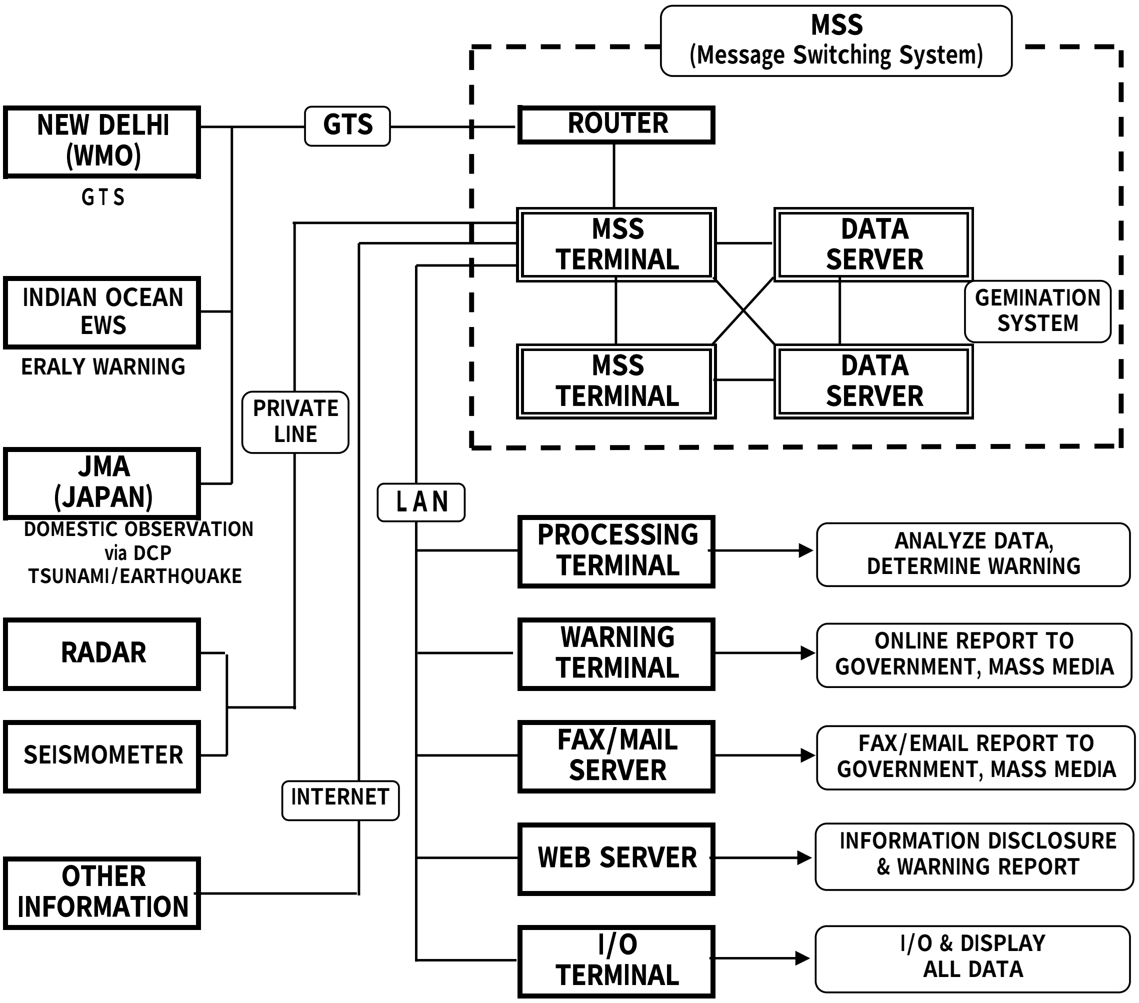


Figure 4-9 Proposed Installation Sites for EWS Equipment

Table 4-1 EWS Equipment Plan

ITEM			IMPROVEMENT PLAN			METHOD OF ONLINE
			PHASE-1	PHASE-2	PHASE-3	
ACQUISITION	OBSERVATION	WEATHER	RENEW & AUTOMATE EXISTING 5 STATIONS	MORE 2 STATIONS (AUTOMATED SYSTEM)	----	DCP
		TIDE	AUTOMATE EXISTING 3 STATIONS	----	MORE 2 STATIONS	DCP
		WAVE	NEW 1 STATION	MORE 1 STATION	MORE 1 STATION	DCP
		TSUNAMI (GPS BUOY)	----	----	NEW 2 STATIONS	DCP
		RADAR	----	NEW 1 STATION	MORE 1 STATION	PRIVATE LINE, LEASED LINE
		EARTHQUAKE	NEW 1 STATION SHORT PERIOD SENSOR (SHALLOW BASEMENT)	MORE 1 STATION BROAD BAND SENSOR (UNDERGROUND 50m)	MORE 1 STATION BROAD BAND SENSOR (UNDERGROUND 50m) (SEND VIA VSAT)	PRIVATE LINE, LEASED LINE, VSAT
		SATELLITE	(NOW GET VIA INTERNET)	←	GET VIA METEOSAT	INTERNET, METEOSAT
	OVERSEAS	GTS CIRCUIT	OPEN UP LEASED LINE	←	←	LEASED LINE
		TSUNAMI WARNING OF JMA & PTWC	RECEIVE & DISPLAY	←	←	GTS CIRCUIT
		INDIAN OCEAN EWS	ENABLE CONNECTION	←	CONNECT	GTS CIRCUIT
		EARTHQUAKE (USGS,IRIS etc)	(NOW GET VIA INTERNET)	←	GET FROM INDIAN OCEAN EWS	INTERNET GTS CIRCUIT
REPORT	INSIDE	DISPLAY	ALL DATA	←	←	LAN
		DATA SHARING	NETWORK	←	←	LAN
	EXTERNAL	WARNING,EMERGENCY, GENERAL INFORMATION	ONLINE COMMUNICATION TO GOVERNMENT & MASS MEDIA	←	←	LEASED LINE, FAX, Email, INTERNET
		GTS CIRCUIT	MANUAL INPUT	AUTOMATIC INPUT	←	GTS CIRCUIT
		PLANNING YEAR	2005	2006	2007	



1. CONFIGURATION OF EWS

This EWS is composed by two principle units. The first one, it is called MSS (Message Switching System), is in charge of collecting, storing and processing observation data. The second one is a group of PC terminals which are in charge of analyzing and I/O processing.

2. FUNCTION

(1) MSS TERMINAL

It is the data exchanging terminal to the outside. It is matching many protocols, ex. TCP/IP, digital line, private line, internet and LAN.

(2) DATA SERVER

It receives data from the MSS terminal and store the data as a data base.

(3) GTS

It is an international meteorological information exchange network (GTS : Global Telecommunication System) , which is promoted by WMO. Many meteorological agencies in the world are connected by GTS and they exchange meteorological information at all times.

3. BASIC CONCEPT OF RECEIVING/SENDING INFORMATION

- Domestic observation data are basically collected via DCP.
- Radar and earthquake data observed in the meteorological site are sent via a private line.
- Meteorological, oceanographic and seismological information, emergency information and warning messages are sent to concerned organizations via FAX, Email and internet. They also are disclosed on web server.

Figure 4-10 EWS Functions and Configuration

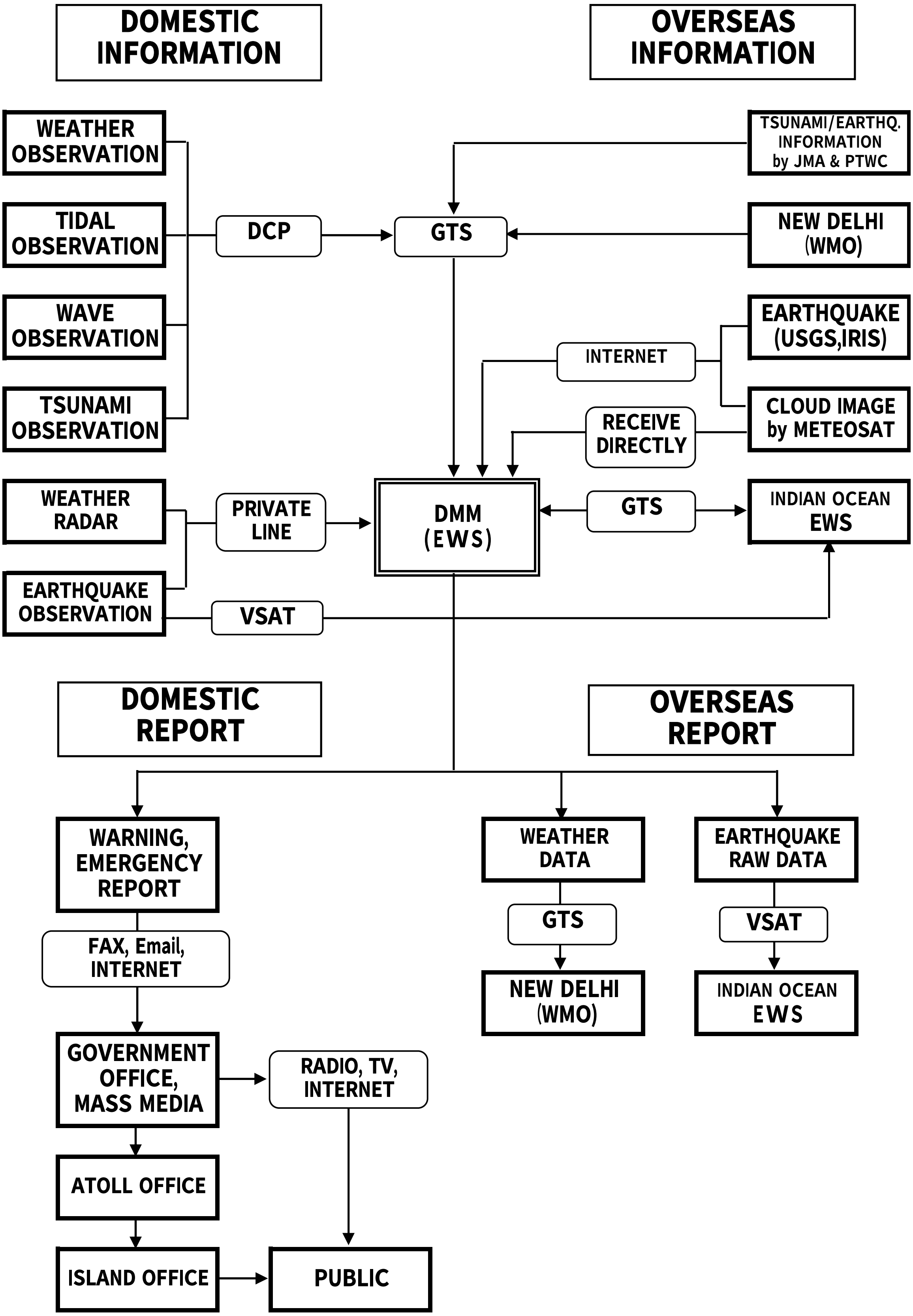


Figure 4-11 Flow of Information Inside and Outside the EWS

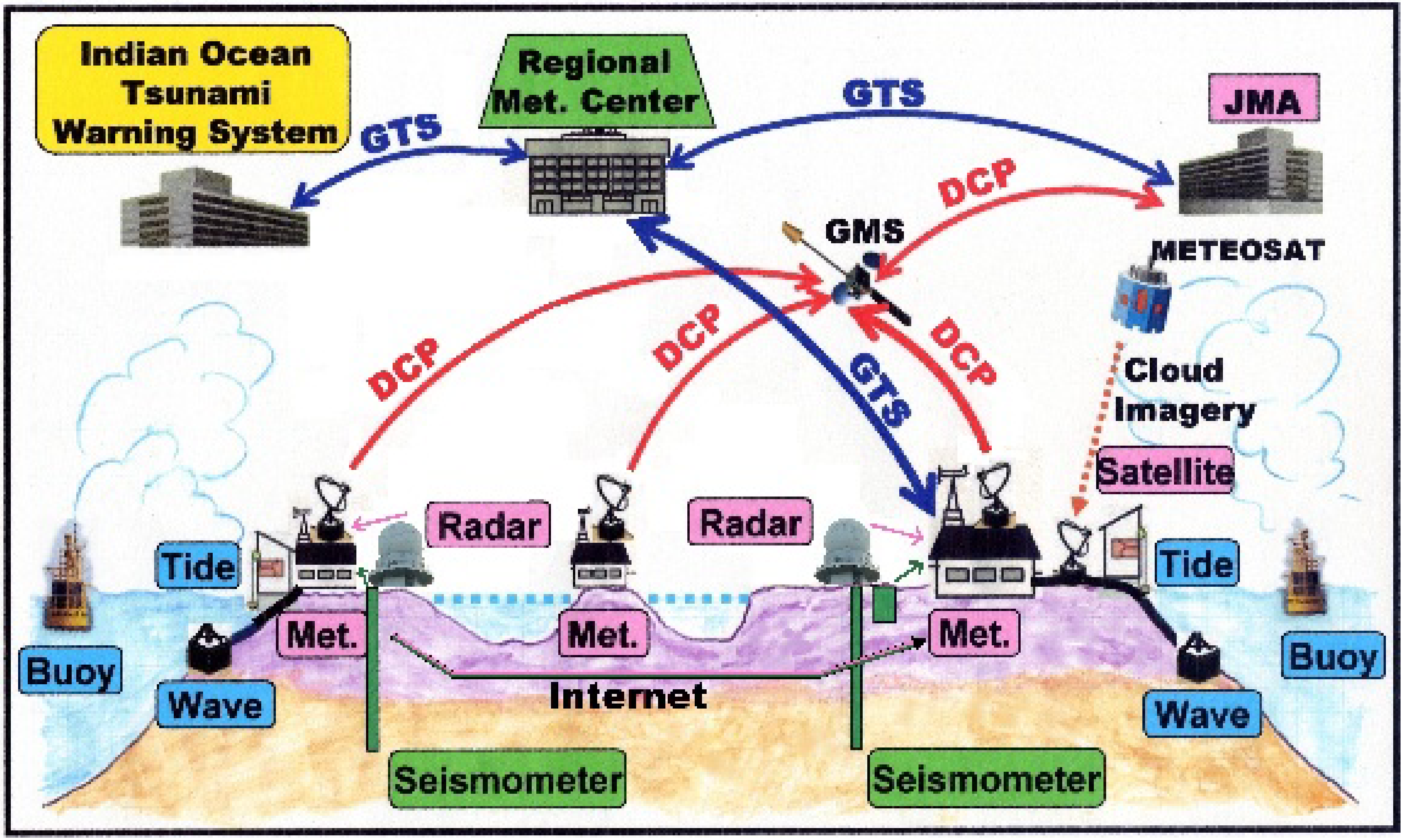


Figure 4-12 A feasible data collection system using the DCP for meteorological, tide and wave data, and using the Internet to convey weather radar and seismic wave data from the observation sites to the NEWSM. A dial-up system could be operated as a dual data collection system for the NEWSM.

References

Department of Meteorology (2005): Human Resources Development in Department of Meteorology - Phase 2. pp 15.

World Meteorological Organization (2000): Report on a Consultative Mission in Seismology (prepared by Hua, L.C.). pp 23.

4.2 Public Information Delivery

(1) Conclusions

Thanks to the cooperation of a local survey team, survey results were obtained from 1,061 residents and 182 officials involved in disaster-related activities. This survey enabled a quantitative evaluation of the awareness of tsunami and disaster management among residents and government officials. The questionnaire results are as follows.

Residents

- Among residents, 83% have very limited knowledge of tsunamis and 69% think that tsunami damage could have been reduced had they known more.
- The most useful information sources soon after the Tsunami were media such as TV (52%) and radio (17%). These outnumbered verbal communications with the family or neighbors (7%) and information from community leaders/government officials (4%). This indicates the vital role played by the mass media as a means of communication.
- More than 50% of respondents consider mosques suitable locations for tsunami shelters.
- Many residents indicated that the most effective way to raise public awareness of disaster reduction is through school education (62%).
- Residents feel the following countermeasures should be promoted for disaster reduction: establish an early warning system for natural disasters (75%), enhance the emergency information dissemination system (52%) and build infrastructure for disaster mitigation, such as sea walls (46%). This shows that a forward-looking approach is being taken toward disaster management in general.
- Most respondents want to continue living in the same place (85%).
- Among people living within 500m of the coastline, 67% sustained damage to their houses or property, while almost 40% of those living 500m or further from the coastline did not sustain any property damage.
- Among residents living within 100m of the coastline, 67% were affected by flooding. This trend shows that the number of affected people decreases the further one moves away from the coastline. More than 40% of those living 500m or further from the coastline did not experience flooding.
- Older people suffered more from submergence than younger people. Nearly 75% of those aged 50 to 59 years old were affected by the tsunami, while only 54% of those younger than 19 years of age were affected.
- The seriousness of damage to property and lives varied by island.

Government Officials

- Approximately 6% of officials, some of whom were from the national security services and police officers, indicated that they had undergone training/seminars for natural disasters in their workplaces. Natural disaster emergency drills were conducted in the workplaces of 15% of respondents, but more than 80% have not received any training or undergone any drills.
- Many officers (95%) feel that government offices and communities need to conduct an integrated evacuation drill.
- Among the officials surveyed, 93% feel that disaster reduction measures need to be taken for tourists. They feel that the most effective way to do this is to prepare pamphlets on tsunamis in different languages and to place them in hotels (34%).
- The measures that need to be taken to reduce the impact of natural disasters are the establishment of an early warning system for natural disasters (90%) and the strengthening of search and rescue capabilities and emergency medical services (62%). The former is consistent with the responses of local residents. Other essential measures are the enhancement of emergency information dissemination systems (53%) and the strengthening of the government's natural disaster response capabilities (51%).
- Radio (82%) and TV (79%) are considered to be the most effective tools for disseminating disaster warnings to residents, followed by sirens/bells (51%).
- Among officials in island offices, 40% indicated that mosques are the most suitable locations for tsunami evacuation shelters, while only 12% of officials in other ministries indicated the same. The responses of the officials in the island offices were similar to those of local residents.

(2) Recommendations

To ensure the distribution of warning messages and disaster-related information to the general public, we propose the following recommendations.

a) Formulate Disaster Management Plans

Consistent disaster management plans involving the central government, local governments and municipalities should be developed. These plans should include (1) the designation of potential high risk areas, (2) the establishment of evacuation sites and routes, (3) a framework for communication and the information dissemination system, (4) instructions for responding when evacuation orders and traffic advisories are issued, (5) education and public awareness efforts, and (6) evacuation drills.

b) Provide Disaster Education in School

As a long-term strategy to raise public awareness of disaster reduction, disaster education should be provided in schools. Currently, there is a shortage of educational materials. Thus, existing know-how and materials should be transferred to the Maldives with cooperation from tsunami-experienced countries like Japan.

c) Implement Regular Emergency Drills

Regular participatory exercises in the community including residents, government officials and experts are effective at raising public awareness and promoting safe evacuation activities.

d) Install Loudspeakers on All Islands

A loudspeaker is a useful way to distribute warning messages to residents of the local islands. Several island offices have loudspeakers, but they are not prevalent on all the islands. Loudspeakers should be installed on all islands.

e) Establish Evacuation Sites and Routes

Since the Maldives is a flat island country, there is no place to escape from a tsunami or tidal wave (i.e., storm surge). Evacuation sites and routes need to be urgently developed. For the Maldives, the construction of artificial hills and multi-story evacuation buildings should also be considered. Evacuation buildings must be constructed using reinforced concrete as stipulated in seismic design codes and should have external staircases. Evacuation sites should be equipped with communication equipment, emergency food and lighting. Measures for marking night time evacuation routes should be considered (e.g., emergency signs and lighting, escape guides, etc.).

f) Install Tsunami Warning/Evacuation Signs

The installations of tsunami evacuation signs are important for ensuring a smooth evacuation. These are especially effective for tourists who do not know their way around. Tsunami warning signs are also effective at promoting public awareness of tsunami disasters.

g) Conduct Community-Based Hazard Mapping

Community-based hazard mapping is useful not only for checking evacuation routes and sites, but also for identifying potential high risk areas and strengthening community cooperation. The Asian Disaster Reduction Center (ADRC) is promoting “Town Watching,” a tool for community-based hazard mapping that can be introduced in the Maldives.

h) Take Measures for Tourists

As indicated by many government officials, measures for protecting tourists are very important. Early warning messages must be delivered to resort islands. To ensure the evacuation of resort islands, pamphlets on natural disasters should be prepared in various languages and workshops should be held for resort staff.

Appendix

A. Questionnaire sheet for residents (English)
B. Questionnaire sheet for government officials (English)
C. Questionnaire sheet for residents (Dhivehi)
D. Questionnaire sheet for government officials (Dhivehi)

Questionnaire for Residents

[About Tsunami]

Q1. Where were you at the occurrence of Tsunami on 26 December, 2004? Please select one from the followings.

1. At home
2. In a building other than home
3. Outside
4. Out side of Island
5. On the ship in the sea
6. Other

Q2. Was your house damaged by Tsunami disaster? Please select one from the followings.

1. Yes. The house was totally/half damaged by Tsunami.
2. Yes. The house was inundated and the property was damaged.
3. The house was no damage, however, the water and/or electricity supply was cut off.
4. No damage
5. Other

Q3. What was your reaction at the occurrence of Tsunami? You may select more than one from the followings.

(When I saw the sea level dropped)

1. I went to the coast to have a look.
2. I went to check the situation of my ship.
3. I rushed home.
4. I evacuated to the high place.
5. I reported to the government authorities.

(When I saw the waves approached to the coast line)

6. I rushed to the high place.
7. I rushed home and evacuated with family.
8. I evacuated to a high building.
9. I climbed up a tree or a high wall.
10. I was really upset and could not move.
11. I lost track of myself and do not remember what happened at that time.
12. Other

(When I saw the waves approached to my house or toward me)

13. I rushed to a high place from flooded water.
14. I evacuated to a high building from flooded water.
15. I climbed up a tree or a high wall from flooded water.

16. I kept good grip on a firm thing in flooded water.
17. I was really upset and could not move.
18. I lost track of myself and do not remember what happened at that time.
19. Other

Q4. (Only for person who evacuated)
What triggered your decision to evacuate? You may select more than one from the followings.

1. I saw sea level dropped and thought Tsunami wave would come soon.
2. I saw Tsunami wave was approaching to me.
3. I was caught in Tsunami wave.
4. I followed the evacuation order.
5. Other

Q5. (Only for person who evacuated)
Did you evacuate with your family or alone? Please select one from the followings.

1. Yes. I evacuated with all of my family.
2. Yes. I evacuated with a part of my family.
3. I evacuated with neighbors and/or relatives.
4. I evacuated alone since the other family members were out.
5. I have no family members.
6. Other

Q6. Were you at risk of Tsunami wave? Please select one from the followings.

1. Yes. I was caught in Tsunami at home, and buffeted by or soaked in the wave.
2. Yes. I was caught in Tsunami on the way of the evacuation, and buffeted by or soaked in the wave.
3. No, but the wave was very close to me.
4. No. I was not exposed to danger.

Q7. How did you escape from the wave? Please select one from the followings.

1. Someone helped me.
2. I escaped from the danger by myself.
3. I was saved by a miraculous chance. (ex. I got caught in a net or stuck on a branch)
4. Other

Q8. Please answer on the dissemination of the Tsunami Information. Did you hear any news on Tsunami? Please select one from the followings.

1. Yes. I heard news on Tsunami before the occurrence.

2. Yes. I heard news just after the occurrence.
3. No.

Q9. (Only for the person who heard the news on Tsunami)
How did you hear the news? You may select more than one from the followings.

1. TV.
2. Radio
3. Police or Fire brigade
4. Telephone call from family members/neighbors
5. Word of mouth from family members/neighbors
6. Community leader
7. Other

Q10. How did you get the information on the rescue and relief during the first week after the Tsunami occurrence? You may select more than one from the followings.

1. TV
2. Radio
3. Police or Fire brigade
4. Telephone call from family members/neighbors
5. Word of mouth from family members/neighbors
6. Community leader
7. Nobody informed me.
8. Other

Q11. What kinds of the information did you want to know most during the first week after the Tsunami occurrence? Please select up to 5 choices from the followings.

1. The scale of the Tsunami and the affected areas
2. The perspective of the Tsunami disaster
3. The damage situation of Tsunami
4. Safety of the relatives and acquaintances
5. Search and rescue operation for missing
6. Countermeasures taken by the government authorities
7. Evacuation places
8. The recovery on water, gas, and electricity supply and telephone line.
9. Food and supplies
10. News on the people who severely affected or miraculously survived
11. Others
12. Nothing

Q12. Which mode most cater the above needs (Q11)? Please select one from the followings.

1. TV

2. Radio
3. Newspaper
4. Internet
5. Information by the Police officers and/or the Fire brigades
6. Verbal communication with family members and/or neighbors
7. Information by community leaders/government officers
8. Information through telephone call from others
9. Others

Q13. Would you like to live in the same location? Please select one from the followings.

1. Yes.
2. No.
3. No Idea.

Q14. Have you heard about Tsunami before the disaster? Please select one from the followings.

1. Yes. I have experience(s) of Tsunami disaster.
2. Yes. I learned it through books and/or TV programme.
3. Yes. I heard about it from family and/or friends.
4. Yes. I studied about it in the school.
5. Never.
6. Others

Q15. There is a record that Tsunami disaster occurred in Indian Ocean in the late 19th century and early 20th century. If you had known more about Tsunami, do you think you could have reduced the damage in the affected area? Please select one from the followings.

1. Yes.
2. No.
3. No idea.

Q16. Where is the most appropriate evacuation place for Tsunami disaster? Please select one from the following.

1. School
2. Community center
3. Mosque
4. Park/Square
5. Building (more than 3 stories)
6. Government office
7. Other

Q17. What is most effective way to utilize the lessons for preventing/mitigating a tragedy from recurring? You may select up to 3 choices from the followings.

1. Integrating of the Tsunami disaster studies into school curriculum
2. Distributing of the posters/leaflets on the Tsunami
3. Holding community-based workshops on regular basis
4. Displaying Tsunami warning/evacuation signs
5. Setting up of a memorial monument on Tsunami disaster
6. Establishment of a memorial museum on Tsunami

Q18. What kinds of countermeasures should be taken for reducing the future damage by Tsunami? You may select up to 5 choices from the followings.

1. Establishment of Tsunami Early Warning System
2. Enhancement of Emergency Information Dissemination System
3. Strengthening the capability of search and rescue operation and emergency medical service
4. Improvement of public information on disaster risk management (including distribution of Hazard Maps)
5. Strengthening of government response capability for disaster
6. Raising public awareness on disaster at the community level
7. Fostering community leaders for disaster management
8. Promotion of school education on disaster reduction
9. Development of evacuation places and routes
10. Designating potential risk areas (ex. Making and publishing Tsunami inundation area maps)
11. Conducting evacuation training/drill
12. Building Infrastructures for disaster prevention, such as Sea walls
13. Planting trees along the coast
14. Others
15. No idea.

Q19. Do you think Tsunami will come again to Maldives in the future?

1. Yes.
2. Probably.
3. No. It will not come during my life.
4. Never.
5. I don't know.

Thank you very much for your cooperation.

[Please answer about yourself.]

Q1. Age

1. under 19
2. 20 - 29
3. 30 - 39
4. 40 - 49
5. 50 - 59
6. 60 and above

Q2. Gender

1. Male
2. Female

Q3. Occupation

1. Fishery
2. Agriculture
3. Manufacture
4. Business
5. Hotel/Guest House
6. Government servant (including teacher)
7. Private sector employee
8. Housewife
9. Student
10. Unemployed
11. Other

Q4. Type of your house (as of December 26, 2004)

1. Wooden house – one story
2. Wooden house – two stories and above
3. House of reinforced concrete structure with brick wall – one story
4. House of reinforced concrete structure with brick wall – two stories and above
5. Masonry – one story
6. House of wooden structure with rattan wall – one story

Q5. Distance from the sea to your house (as of December 26, 2004)

1. 0 - 100m
2. 100m - 500m
3. 500m - 1km
4. 1km - 2km
5. 2km and above

Q6. Please select your educational background.

1. No school education
2. Grade 1-5 (Elementary School)
3. Grade 6-10 (Junior High School)
4. G. C. E. (O/L) (General Certificate of Education- Ordinary Level)
5. G. C. E. (A/L) (General Certificate of Education- Advanced Level /High school)
6. Graduate/Professional (University)
7. Post graduate (Graduate School)

Q7. Atoll code (e.g. HA, HDh, etc.)

Q8. Island code (e.g. A16, B6, etc.)

Thank you very much for your time.

[For Interviewer's Use]

Serial Number:

Name of the area (Atoll and Island):

Name of the interviewer:

Date & time of interview:

Comments:

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Questionnaire for Government Officials

[About Tsunami & Disaster Management]

Q1.
Is there any training/seminar available in your office to study about natural disasters?

1. Yes 2. No

Q2.
Is there any emergency drill for natural disasters in your office?

1. Yes 2. No

Q3.
When Tsunami occurred on 26th December 2004, do you think you responded adequately/properly enough on your role/mandate?

1. Yes 2. No

Q4.
(Related to Q3.) Is there any reflection/regret/future task for you?

1. Yes 2. No

Q5.
When Tsunami occurred on 26th December 2004, do you think you responded adequately/properly enough to the requests from the residents?

1. Yes 2. No

Q6.
When Tsunami occurred on 26 December 2004, was the system of information collection and dissemination successfully functioned?

1. Yes 2. No

Q7.
After the occurrence of Tsunami, did you collect the information about damage situation of residents?

1. Yes 2. No

Is there any particular point to be improved in the future?

1. Yes 2. No

Q8.

Is there any opportunity to exchange opinions with community?

1. Yes 2. No

Q9.

Do you think the evacuation drill with community will be needed?

1. Yes 2. No

Q10.

What kinds of countermeasures for natural disasters would be needed in the future? You may select up to 5 choices from the followings.

1. Establishment of early warning system for natural disaster
2. Enhancement of emergency information dissemination system
3. Strengthening capability of search and rescue and emergency medical service
4. Improvement of public information on disaster risk management (including distribution of Hazard Maps)
5. Strengthening of government's response capability for disaster
6. Raising public awareness on disaster at the community level
7. Fostering community leaders for disaster management
8. Promotion of school education on disaster reduction
9. Development of evacuation places and routes
10. Designating places for emergency evacuation such as high buildings and hills
11. Displaying tsunami warning/evacuation signs
12. Designating potential risk areas (ex. Assessment, analysis and publication of Tsunami inundation area maps)
13. Building Infrastructures for disaster prevention, such as Sea walls.
14. Planting trees along the coast
15. Conducting emergency drills

16. Others
17. No idea

Q11.
Do you think the disaster countermeasures for tourists will be needed?

1. Yes 2. No

Q12. (For the person who answered "Yes" in Q11.)
What kind of measure of prevention is most effective for tourists? Please select one from the followings.

1. Pamphlets on Tsunami in different languages are made available in hotels.
2. Display signboards for evacuation routes in hotels.
3. Display signs for evacuation in different languages in the city.
4. Other

Q13.
What is the most effective way of information dissemination to the residents at an event of disaster? You may select up to 3 choices from the followings.

1. TV
2. Radio
3. Police/Fire brigades
4. Community leaders
5. Sirens/bells
6. Other

Q14.
Where is the most suitable place for evacuation center? Please select one from the followings.

1. School
2. Community center
3. Mosque
4. Park/Square
5. Building designated as an evacuation center
6. Private building with more than 3 stories
7. Government office
8. Other

Thank you very much for your kind cooperation!

[Please answer about yourself.]

Q1. Age
1. under 19
2. 20 - 29
3. 30 - 39
4. 40 - 49
5. 50 - 59
6. 60 and above

Q2. Gender
1. Male
2. Female

Q3. Office/Department (Please write in English)

Q4. Designation (Please write in English)

Q5. Atoll code (e.g. HA, HDh, etc.)

Q6. Island code (e.g. A16, B6, etc.)

[For Interviewer's Use]

Serial Number:

Name of the area (Atoll & Island):

Name of the interviewer:

Date & time of interview:

Comments:

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ޑޮސިއަން ޕޮޕިއުލޭޝަން ރިސާރޗް ސެންޓަރ

ސާރވޭ އޮން ދަ 2004 ސުމާތްރާ އާތްކުއޭކް އެންޑް ސުނާމީ އިން އިންޑިއަން އޯޝަން

ދިވެހިރާއްޖެ

ތަންފީޒުކުރާ ފަރާތުން :

އަތޮޅާއި ރަށު (މާލެ ނަމަ އަވަށު) --- [ ][ ][ ][ ]

ގޭގެ ނަން : --

މީހާގެ ފުރިހަމަ ނަން: --

ފޯމު ސީރިއަލް ނަންބަރ [ ][ ][ ][ ]

ސުވާލުކުރާމީހާގެ ނަން : --

ސުވާލު ކުރެވުނު ފުރިހަމަކުރި ތާރީޚާއި ވަގުތު --

މީހާ އާއި ބެހޭ މައުލޫމާތު

1- އުމުރު

1- 19 އަހަރުން ދަށް
2- 20-29
3- 30-39
4- 40-49
5- 50-59
6- 60-69

2- ޖިންސު

1- އަންހެން
2- ފިރިހެން

3- މަސައްކަތުގެ ދާއިރާ

1- މަސްވެރިކަން
2- ދަނޑުވެރިކަން
3- އުފެއްދުންތެރިކަން
4- ވިޔަފާރި
5- ފަތުރުވެރިކަމުގެ ދާއިރާ
6- ސަރުކާރުގެ ވަޒީފާ
7- އަމިއްލަ މަސައްކަތް ތިޔާރު
8- ގެވެހިއަންހެނުން
9- ކިޔަވާކުއްޖެއް
10- މަސައްކަތެއް ނުކުރަން
11- އެހެނިހެން

4- ގެދޮރުވެރިޔާ ބާވަތް

1- ޒަވާޖުން - އެއްބަނޑުދަރިން
2- ޒަވާޖުން - ދަރިންނާއިއެކު އުސްބައްޔާ
3- އާއިލާގެ ހުރިހާ ބައިވެރިން އާންމުކޮށް - އެއްބަނޑުދަރިން
4- އާއިލާގެ ހުރިހާ ބައިވެރިން އާންމުކޮށް - ދަރިންނާއިއެކު އުސްބައްޔާ
5- އާންމުކޮށް ސިންގަލް ޕޭރަންޓް - އެއްބަނޑުދަރިން
6- ޒަވާޖުން - ބިމުބައެއް ދަރިވަރުން ހެދިފައި

5- މޫދާއި ގެއާއި ހުރި ދުރުމިން

1- 0-100 މީޓަރު
2- 100-500 މީޓަރު
3- 500މީޓަރު - 1 ކިލޯމީޓަރު
4- 2 - 1 ކިލޯމީޓަރު
5- 2 ކިލޯމީޓަރު ދުރު

6- ތަޢުލީމީ ފެންވަރު

1- އެއްވެސް ތަޢުލީމީ ފެންވަރެއް ނެތް
2- ގްރޭޑް 1-5
3- ގްރޭޑް 6-10
4- ޖީ.ސީ.އީ އޯލެވެލް
5- ޖީ.ސީ.އީ އޭލެވެލް
6- ގްރެޖުއޭޓް
7- ޕޯސްޓް ގްރެޖުއޭޓް

ސާރވޭ އޮން ދަ 2004 ސުމަތްރާ އާރތްކްއޭކް އެންޑް ސުނާމީ އިން އިންޑިއަން އޯޝަން
ދިވެހިރާއްޖެ

އޭޝިއަން ޑިޒާސްޓަރ ރިޑަކްޝަން ސެންޓަރ

ދިރިއުޅޭ މީހުންނަށް ކުރެވޭ ސުވާލުތައް

1- 26 ޑިސެމްބަރު 2004 ގެ ސުނާމީ ކާރިސާ ކުރިމަތިވިއިރު ހުންނެވީ ކޮންތަނެއްގައިތޯ؟

ތިރީގައިވާ ލިސްޓުން ކޮންމެވެސް އެއްޗެއް ފާހަގަކޮށްދެއްވާ.

1. ގޭގައި
2. ގޯތިން ބޭރުން އިމާރާތެއްގެ ތެރޭގައި
3. ބޭރުގައި
4. ރަށުންބޭރުގައި
5. ކަނޑުމަތީގައި
6. އެހެނިހެން

2- ސުނާމީ ކާރިސާގެ ސަބަބުން ތިޔަގެއަށް ގެއްލުން ލިބުނުތޯ؟

ތިރީގައިވާ ލިސްޓުން ކޮންމެވެސް އެއްޗެއް ފާހަގަކޮށްދެއްވާ.

1. މުޅިގެ ނުވަތަ ދެބައިކުޅަ އެއްބައި ހަލާކުވި
2. ގޭތެރެއަށް ކަނޑުގެ ފެން ވަދެ މުދަލަށް ގެއްލުންވި
3. ގެއަކަށް ގެއްލުމެއްނުވި، ނަމަވެސް ކަރަންޓާއި ފެން ހިންގުމަށް ދަތިވި
4. ގެއްލުމެއް ނުލިބޭ
5. އެހެނިހެން

3- ސުނާމީ އައުމުން ކަންތައް ކުރެވުނީ ކިހިނެއްތޯ؟ (އެއްގޮތަކަށްވުރެ ގިނަގޮތް ފާހަގަ ކުރެވިދާނެ)
(ޓީވީ ނުވަތަ ރޭޑިއޯއިން ދެނެގަތުން)

1. ފުލުހުންގެ އަރިހުން ދެނެގަތީ
2. އަހަރެންގެ އާއިލާ ފުލުހުންގެ ދެނެގަތީ
3. އަމިއްލަ ގޮތުން ދެނެގަތީ
4. އިސްތިހާރުތަކުން އެނގި
5. ރަށުގެ ނުވަތަ ސަރުކާރުން އެންގި

(ރޭޑިއޯ ނުވަތަ އިންތިޒާމުން ފެނުން)

6. އަމިއްލަ އިސްތިހާރު ދެނެގަތީ
7. އަމިއްލަ ގޭއިންގޮސް އާއިލާ ސަރުކާރުގެ ވަސީލަތްތަކުން
8. އިސްތިހާރުތަކުން ބަލައިލި
9. ގެއަކަށް ނުވަތަ އިސްތިހާރުކަން އެނގި
10. ހާސްވެގެން ގަޅުވެރި ހުށަހަޅައި
11. އެވަގުތު ވީގޮތެއް ހަމައެކަނި ނޭނގު
12. އެހެނިހެން

(ޓީވީ ނުވަތަ އަހަރެންގެ ގާތުގައި ނުވަތަ އަހަރެން ދެނެގަތުން އަރިހުން ފެނުން)

13. ޓީވީ ނުވަތަ ސަރުކާރުގެ ހިސާބު އިސްތިހާރުން އަމިއްލަ އެނގި
14. އިސްތިހާރުތަކުން އެނގި
15. ގެއަކަށް ނުވަތަ އިސްތިހާރުކަމަށް އެނގި
16. ބޮޑުވެގެން ޓީވީ ދަނޑުދަނޑުން ބަލައި ވަޅުގައި ހިފެހެއްޓި އެކަނި
17. ހާސްވެގެން ގަޅުވެރި ހުށަހަޅައި
18. އެވަގުތު ވީގޮތެއް ހަމައެކަނި ނޭނގު
19. އެހެނިހެން

4- ސަލާމަތް ވެވުނީ ދިޔުމުގެ ވިސްނުމުގައި ކޮންގޮތަކުންތޯ؟ (ހަމައެކަނި ސަލާމަތް ހިސާބުން ބަދަލުވުން މިހާރު. އެއްގޮތަކަށްވުރެ ގިނަގޮތް ފާހަގަ ކުރެވިދާނެ)

ހަމައެކަނި ސުނާމީގެ ސަބަބުން ބަދަލުވި މީހުންނަށް

1. ކަނޑުގެ ޓީވީ ނުވަތަ އަމިއްލަ ވަގުތުން ފަރާތްތަކުން ސުނާމީ އަހުލުވެރިކަމުގަ
2. ސުނާމީ ރާޅު އަރަނީ ފެނުނު
3. ސުނާމީ ރާޅުގައި ޖެހުނު
4. ސަލާމަތްވާން އިސްތިހާރު އެކަމަށް އިސްތިޢުދާދު
5. އެހެނިހެން

5- ސަލާމަތް ތަނަކަށް ދިޔައިރު އެކަނިވި ނުވަތަ އާއިލާގެ މީހުން އެކުގައިތޯ؟

ހަމައެކަނި ސުނާމީގެ ސަރަހައްދުން ބަދަލުވި މީހުންނަށް

1. އާން: އަހަރެން ސަލާމަތްތަނަކަށް ދިޔައީ އާއިލާގެ އެންމެންނާއެކު
2. އާން: އަހަރެން ސަލާމަތްތަނަކަށް ދިޔައީ އާއިލާގެ އެއްބައި މީހުންނާއެކު
3. އަހަރެން ސަލާމަތްތަނަކަށް ދިޔައީ އަވަށްޓެރިން/ ރައްޓެހިމީހުންނާއެކު
4. އާއިލާގެ އެހެންމެހެން ބޭބޭފުޅުން ފުރުން އަހަރެން ސަލާމަތްތަނަކަށް ދިޔައީ އެކަނި
5. އަހަރެންގެ އާއިލާމީހަކު ނުހުރޭ
6. އެހެނިހެން

6- ސުނާމީރާޅުގައި ޖެހުނުތޯ؟

ތިރީގައިވާ ލިސްޓުން ކޮންމެވެސް އެއްޖަވާބު ފާހަގަކޮށްދެއްވާ.

1. އާން: އަހަރެން ގޭގައިހުއްޓާ ރާޅުވަދެގެން ދަމައިގަތް ނުވަތަ ތަދުވެފި
2. އާން: އަހަރެން ސަލާމަތްތަނަކަށް ދަނިކޮށް ސުނާމީރާޅުގައި ޖެހިގެން ދަމައިގަތް ނުވަތަ ތަދުވެފި
3. ނޫޅޭ: އެހެންނަމަވެސް އަހަރެންނާއިރިސްތާ ވަރަށްކައިރިއަށް ރާޅުއައި
4. ނޫން: ރާޅުގެ އަސްލެއް ނުރައްކަލަކާ ކުރިމަތިއެއް ނުވޭ

7- ރާޅުން ސަލާމަތްވީ ކިހިނެއް؟ ތިރީގައިވާ ލިސްޓުން ކޮންމެވެސް އެއްޖަވާބު ފާހަގަކޮށްދެއްވާ.

1. މީހަކު އެހީތެރިވެދިނީ
2. އަހަރެން އަމިއްލައަށް ސަލާމަތްވީ
3. ނަސީބު ރަނގަޅުކަމުން ސަލާމަތްވީ (މިސާލަކަށް ގަހެއްގައި ނުވަތަ އެއްޗެއްގައި ހިފެހެއްޓުން)
4. އެހެނިހެން

ސުނާމީއާއިބެހޭ މައުލޫމާތު ފުރަތަމަ ލިބުނުހިނދުގައި ސަލާމަތުން ދެވިދާނެގޮތް އެނގުނުތޯ؟

8- ސުނާމީއާބެހޭ އެއްވެސް ހަބަރެއް އަޑުއެއްސެވުނުތޯ؟ ތިރީގައިވާ ލިސްޓުން ކޮންމެވެސް އެއްޖަވާބު ފާހަގަކޮށްދެއްވާ.

1. އާން: ސުނާމީ އައުމުގެ ކުރިން އެކަމުގެ ހަބަރު އަޑުއެހިން (ސުވާލު 9 ށް ދޭ)
2. އާން: ސުނާމީ އައިމާ ކުޑައިރުކޮޅެއްގެ ފަހުން އެކަމުގެ ހަބަރު އަޑުއެހިން (ސުވާލު 10 ށް ދޭ)
3. ނޫން (ސުވާލު 10 ށް ދޭ)

9- ސުނާމީގެ ހަބަރުލިބުނީ ކިހިނެއް؟ (ހަމައެކަނި ސުނާމީގެ ހަބަރު އަޑުއިވުނު ފަރާތްތަކަށް)

އެއްގޮތަކަށްވުރެ ގިނަގޮތް ފާހަގަ ކުރެވިދާނެ.

1. ޓީވީ
2. ރޭޑިއޯ
3. ފުލުހުން/ ސިފައިން
4. އާއިލާ ނުވަތަ އަވަށްޓެރިޔަކާ ފޯނުކުރުމުން
5. އަނެއްބަޔަކުން އާއިލާ / އަވަށްޓެރިންގެ ފަރާތުން
6. ވެރިންގެ ފަރާތުން
7. އެހެނިހެން

10- ސުނާމީ ކަރައިގަނޑާ ހަމަވުމުގެ ކުރިން ފަރާތްތަކުން އެޕްރޫވްކުރި ދިނުމާދޭ މައުލޫމާތު އެކަރަސްގެ ފަހުނބައި ފުރަތަމަ ހަރުގެ ވަގުތުގައި ލިބުމުން ދިޔައީ ކޮންގޮތަކުންތޯ؟

އެއްގޮތަކަށްވުރެ ގިނަގޮތް ފާހަގަ ކުރެވިދާނެ.

1. ޓީވީ
2. ރޭޑިއޯ
3. ފުލުހުން/ ސިފައިން
4. އާއިލާ ނުވަތަ އަވަށްޓެރިޔަކާ ފޯނުކުރުމުން
5. އަނެއްބަޔަކުން އާއިލާ / އަވަށްޓެރިންގެ ފަރާތުން
6. ވެރިންގެ ފަރާތުން
7. އެއްވެސް މީހަކު އަހަރެންނަކަށް ނުބުނޭ
8. އެހެނިހެން

11- ސުނާމީ ކަރައިގަނޑަށް ފުރަތަމަ ހަރުގެ ވަގުތުގައި ތިޔަފަރާތުން އެނގޭ ބޭނުން ބޭނުންތެރި ކަންކަން މައުލޫމާތުތަކެއްތޯ؟ ތިރީގައިވާ ބައިތަކުން ކޮންމެވެސް 5 ކަމެއް ފާހަގަކުރައްވާ.

1. ސުނާމީގެ ސަބަބުން ގެއްލުންވީމިންވަރާއި ގެއްލުން ލިބުނު ތަންތަން
2. ސުނާމީގެއްލުމާއި ބޭނުންތަކަށް މީހުންގެ ޝައުރުތަކާއި
3. ގެއްލުން ލިބުނު މިންވަރު
4. ތިމާގެ މީހުންނާއި ރައްޓެހިންގެ ހާލަތު
5. ނުވެސިޔަކަށް މީހުންނާއި ކުދިން ހެދުމުގެ ވަސީލަތެއް ކުރިއަށްދާކަމުގެ ހަބަރު
6. ގެއްލުން ކުޑަކުރުމަށް ސަރުކާރުން އަޅަމުންދާ ފިޔަވަޅުތައް
7. ހާލަތުގެ ތެރެއިން މީހުން ބަދަލުވާނެ ތަންތަން
8. ފެން، ކާބޯތަކެތި އަދި ފޭރާން ހިފުމަށްޓަކައި އާބާދީތަކަށް ދޭ ތަކެތި
9. ކާރިސާއާއި އެހެނިހެން ހާދިސާތައް
10. ބޭނުން ގެއްލުން ލިބިފައިވާ މީހުންނާއި މިކާރިސާގައި ޖެހިގެން ސަލާމަތްވެފައިވާ މީހުންނާބެހޭ ހަބަރު
11. އެހެނިހެން
12. ބޭނުމެއް ނުވޭ

12- އިސްވެ ބަޔާންކުރެވުނު ބޭނުންތަކަށް އެންމެ ރަނގަޅު ހެދުމަކީ ލިބާސް ކޮން ވަސީލަތަކުންތޯ؟
ތިރީގައިވާ ލިސްޓުން ކޮންމެވެސް އެއްޗެއް ފާހަގަކޮށްދެއްވާ.

1. ޓީވީ
2. ރޭޑިއޯ
3. ނޫސް
4. އިންޓަރނެޓް
5. ފުލުހުން/ ސިފައިން
6. އަހަރަބަހުން އާއިލާ / ރަށްޓެހިން
7. ޤައުމުގެ އިސްވެރިން/ ސަރުކާރު މުވައްޒަފުން
8. އެހެންގައުމުތަކުން ފެނުން
9. އެހެނިހެން

13- ސުކޫލު ދިރިއުޅުމުގެ ތެރޭގައި ރަނގަޅު މާޙައުލެއް ދިރިއުޅުން ބޭނުންވޭތޯ؟
ތިރީގައިވާ ލިސްޓުން ކޮންމެވެސް އެއްޗެއް ފާހަގަކޮށްދެއްވާ.

1. އާނ
2. ނޫން
3. އެއްގޮތަކަށްވެސް ނޫނޭ

14- ސުކޫލު ކުދިންނަށް ކުރިން އަޑުއަހާކަމެއްތަ؟ ލިސްޓުން ކޮންމެވެސް އެއްޗެއް ފާހަގަކޮށްދެއްވާ.

1. އާނ، އަހަރެން ސުކޫލު ކުދިންގެ ތެރެއިން ކިޔަވައިދޭ
2. ނޫން، ފޮނުވަނީ ކުދިންނަށް، ޓީވީ ޕްރޮގްރާމްތަކަށް ބަރާބަރަށް ބެލެހެއްޓުމުގެ މައުލޫމާތު ލިބިފައި
3. އާނ، އާއިލާއާއި ވަރަށް ގާތުން ކުރެވޭ އަމަލުތަކުގެ ފަހުން ލިބިފައި
އާނ، ސުކޫލުގެ މުދައްރިސުން މައުލޫމާތު ދެއްވުން
5. ދުވަހަކުވެސް ނުއަހަން
6. އެހެނިހެން

15- 19 ވަރަކަށް ގަޑިއިރުގެ ފަރުވާގެ ތެރޭގައި 20 ވަރަކަށް ގަޑިއިރުގެ ކުރިން އިންޑިޔާ ކައުންސިލް ސަރަހައްދުން ސުކޫލު ކުދިންނަށް ކުރިމަތިވާކަން މާލޭ ރަށްތަކުން ދެއްކި. ސުކޫލުތަކަށް މައުލޫމާތު އިތުރުން ލިބިފައި ހުރިނަމަ މިފަދަ ސުކޫލުތަކުން ލިބޭން ގެއްލުން ކުޑަކުރެވޭނެ މަސައްކަތް ގަބޫލު ކުރަނީތޯ؟
ތިރީގައިވާ ލިސްޓުން ކޮންމެވެސް އެއްޗެއް ފާހަގަކޮށްދެއްވާ.

1. އާނ
2. ނޫން
3. އެއްގޮތަކަށްވެސް ނޫނޭ

16- ސުކޫލު ކުދިންނަށް އަތުވެއްޖެނަމަ ސައިކޮލޮޖިކަލް ހެލްޕް އެންމެ އެކަށީގެންވާ ވަސީލަތަކީ؟
ތިރީގައިވާ ލިސްޓުން ކޮންމެވެސް އެއްޗެއް ފާހަގަކޮށްދެއްވާ.

1. ސުކޫލް
2. އިޖުތިމާއީ ޚިދުމަތް
3. މިސްކިތް
4. ބޭލަތަރަފުގެ ހޯސްޓެލް
5. އިޖުތިމާއީ (ފޯން ބޭނުންކުރުމުގެ ޚިދުމަތް)
6. ސަރުކާރު އޮފީސް އިޖުތިމާއީ
7. އެހެނިހެން

17- މިފަދަ ސުކޫލު ކުދިންނަށް ލިބޭނެ ފަރުވާގެ އަޑުގައި ކުރިއަށް އޮތްތަނުގައި ދިރާސާކުރާން މިފަދަ ކުދިންނަށް ސަލާމަތްވުމަށް ނުވަތަ ލިބޭ ގެއްލުން ކުޑަކުރުމަށް ކުރެވިދާނެ ކަންކަމަކީ ކޮބައިތޯ؟
ލިސްޓުން ގިނަވެގެން ކޮންމެވެސް 3 ތަކެއް ފާހަގަކޮށްދެއްވާ.

1. ސުކޫލް ކަރިކިއުލަމްގައި ސުކޫލު ކުދިންނާއިގުޅޭ އިލްމު ހިމެނުން
2. ސުކޫލްގެ މައުލޫމާތު ހިމެނޭ ޚިދުމަތާއި ޕްރޮގްރާމްތަކާއި ބެހުން
3. ޤައުމުގެ ފެންވަރުގައި މިފަދަ މައުލޫމާތު ދިނުމަށް މަސައްކަތް ބައިވެރިވުން ދުވަސްތަކުގައި ބޭއްވުން
4. ސުކޫލު އިންޓަރނެޓް ނިޒާމް ތަކައި ސައިކޮލޮޖިކަލް ހެލްޕް އިދާރާތައް ނިސްބަތް
ޙައްލުކުރެވޭ ފެންވަރެއް ބޭއްވުން
5. ސުކޫލު ކުދިންގެ ހަފްތާގާ މަޖިލިސްތައް ބޭއްވުން
6. ސުކޫލު ކުދިންގެ ހަފްތާގާ ދަރުސްތައް ގޮވާލުން

އިތުރުބަޔާން :	
	18- މުސްތަޤްބަލުގައި ދިރާސާކުރާން ސުކޫލީ ކަރިއަރާކުން ލިބޭ ގޮތުން އެދިދާން ފިޔަވަޅުތަކަކީ ކޮބައިތޯ؟ ތިރީގައިވާ ލިސްޓުން ކޮންމެވެސް 5 ކަމެއް ފާހަގަކޮށްދެއްވާ.
	1. ސުކޫލީގެ އިންޖިނަރު ވަގުތުތައްތަ ދަރިވަރަ ނިޒާމް ގާއިމުކުރުން
	2. ކުއްލި ނުރައްކާތަކުން ރައްކާތެރިވުމަށް އަމަލުކުރާނެ ނިޒާމު ހަރުދަނާކުރުން
	3. ކުއްލިނުރައްކާތަކުގެ ސިއްޙީ ހިދުމަތްތައް ހޯދުމުގައި ޤަވާއިދާ ލިބެން ހުރި ސަލާމަތީކުރުމުގެ ފާހަގަކޮށް އިތުރުކުރުން
	4. ކާރިސާތަކުގެ ނުރައްކާ ކުޑަކުރުމުގެ މަސައްކަތް ރާވާ ހިންގުމާބެހޭ އާއްމު މައުލޫމާތު ތަރައްޤީ ކުރުން (ދިގު ތަޖުރިބާގެ ނުރައްކާ ހިސާބުތައް ހާމަކުރެވޭ ޚާއްޞ ބައެއް ހިމެނޭގޮތަށް.)
	5. ކާރިސާ އައުމުގެ ފުރަތަމަ މުއްދަތުގައި ފެންވަރުގައި އަވަސްއެހީ ފޯރުކޮށްދިނުމާ އެކުލަވާ ފާހަގަކޮށް މުޖުތަމަޢުގައި ހަރުދަނާކުރުން
	6. ކާރިސާ ތަކުގެ ނުރައްކާ ކުޑަކުރުމަށް ޤައުމީ ފެންވަރުގައި ހޯދުންތެރިކަން އިތުރުކުރުން
	7. ކާރިސާ ތަކުގެ މުރައްކާ ކުޑަކުރުމުގެ މަސައްކަތް ރާވާ ހިންގުމުގެ ފާހަގަކޮށް ހުރި ލިޔުން ޤައުމީ ފެންވަރުގައި އުފެއްދުން
	8. ސަރުކާރުގައި ދެވޭ މައުލޫމާތު ތަރުތީބުގައި ކާރިސާ ތަކުގެ ނުރައްކާ ކުޑަކުރުމާ ބެހޭ މައުލޫމާތު ހިމެނުން
	9. ކުއްލި ހާލަތްތަކުގައި ބަދަލުވާން ރައްކާތެރި ތަނެއް ގާއިމުކުރުމާއި އެކު ކަންތައް ކުރަންޖެހޭ ގޮތް އެންގުމުގައި ޢަމަލު
	10. ނުރައްކާތެރި ތަންތަނުން ބަދަލު ސަރަހައްދުތައް ފާހަގަ ކުރުމުގައި ޢަމަލު
	11. ކުއްލި ހާލަތްތަކުގައި ރައްކާތެރި ތަނަކަށް ބަދަލުވުމަށް ތަމްރީން ދިނުން
	12. ސަލާމަތީ ބޯޓުތައް ފޯރި ފަހަރު ތަންތަން ބެލެހެއްޓުން
	13. އަތިރިމަތީގައި ގަސްއިންދުން (ޑްރެޖިން)
	14. އެހެނިހެން
	15. ނޭނގޭ
	19- މުސްތަޤްބަލުގައި ދިވެހިރާއްޖެއަށް ސުކޫލީ ދިރާސާކުރުން ހިތްވޭތޯ؟
	1. އާން
	2. ފަހަރެއްގައި
	3. ނޫން ، އަހަރެންގެ ހައްލުވާގެ ދެން ދިރާސާއް ނުވާނެ
	4. ދިވެހިރާއްޖެ ދިރާސާއްނުވާނެ
	5. ނޭނގޭ

ސާރވޭ އޮން ދަ 2004 ސުމަތުރާ އާރތްކުއޭކް އެންޑް ސުނާމީ އިން އިންޑިއަން އޯޝަން
ދިވެހިރާއްޖެ

ސަރުކާރު މުވައްޒަފުންނަށް ކުރާ ސުވާލުތައް

ތަޢާރަފު ކުރުން :

ރަށް (މާލެ ނަމަ އަވަށް) .... [ ][ ][ ][ ]

ފޯމު ސީރިއަލް ނަންބަރު .... [ ][ ][ ][ ]

ސުވާލުކުރާގެ ނަން : ....

ޖަވާބުދެއްވި ބޭފުޅާގެ ވަޒީފާ ....

މިޔާ އާއި ބެހޭ މަޢުލޫމާތު

1- އުމުރު

- 1- 19 އަހަރުން ދަށް
- 2- 20-29
- 3- 30-39
- 4- 40-49
- 5- 50-59
- 6- 60 އަހަރުން މަތި

2 - ޖިންސު

1- އަންހެން 2- ފިރިހެން

3- އެޑްރެސް : ....

4- މަގާމު : ....

1- ގުދުރަތީގޮތުން ދިމާވެދާނެ ކާރިސާއަކާބެހޭ އެއްވެސް ތަމްރީނެއް/ސެމިނާރެއް އޮފީހުގެ ފަރާތުން ހިންގާތޯ؟

1. އާން 2. ނޫން

2- ސުނާމީ ކާރިސާއެއް އަތުވެއްޖެނަމަ ސަލާމަތްވުމަށް ކުރުމަށް އަމަލީ ތަމްރީނު ދައްކާ ޕްލޭނެއް އޮފީހުގައި ކަށަވަރުކޮށްފައި އޮވޭތޯ؟

1. އާން 2. ނޫން

3- 26 ޑިސެމްބަރު 2004ގެ ސުނާމީ ކާރިސާ ކުރިމަތިވިއިރު ތިޔަފަރާތުން ހަރަކާތްތެރިވެވުނީ ހަމަޖެހޭ
އަމަލު ކުރެވުނީ ސަރުކާރު މުވައްޒަފުންގެ ގޮތުގައި އަދާކުރަން ޖެހޭ ޒިންމާތަކަށްތޯ؟

1. އާން 2. ނޫން

4- 26 ޑިސެމްބަރު 2004ގެ ސުނާމީ ކާރިސާ ކުރިމަތިވިއިރު ތިޔަފަރާތުން ހަރަކާތްތެރިވެވުނު ގޮތާއި މެދު
ކުރިމަތިވުމުގައި ކުރެވުނު ކަމެއް އެބައޮތްތޯ؟

1. އާން 2. ނޫން

5- 26 ޑިސެމްބަރު 2004ގެ ސުނާމީ ކާރިސާ ކުރިމަތިވިއިރު ތިޔަފަރާތުން ހަރަކާތްތެރިވެވުނީ ހަމަހަމަ
ތައްޔާރުވުން ހިންގަމުންދާ ފުރުޞަތަކަށްތޯ؟

1. އާން 2. ނޫން

6- 26 ޑިސެމްބަރު 2004ގެ ސުނާމީ ކާރިސާ ކުރިމަތިވިއިރު މަޢުލޫމާތު ހޯދުމަށް ދިރާސާގެ ނިޒާމް
ފުރިހަމައަށް ހިނގިތޯ؟

1. އާން 2. ނޫން

7- 26 ޑިސެމްބަރު 2004ގެ ސުނާމީ ކާރިސާ އާއި ގުޅިގެން ތައްޔާރުވުމަށް އަދި ގެއްލުންތަކަށް
ލިބުނު ގެއްލުމާބެހޭ މަޢުލޫމާތު އެއްކުރެވިއްޖެތޯ؟

1. އާން 2. ނޫން

8- ކުރިމަގުގައި ތަރައްޤީކުރުމަށް އެހީއާ ފިޔަވަޅު އެބައޮތް ތޯ؟

1. އާން 2. ނޫން

9- ރަށުގެ ރައްޔިތުންނާއި މަޝްވަރާކޮށް ހިއްލާ ބަދަލުތަކާ ގުޅޭ ފުރުޞަތު ލިބޭތޯ؟

1. އާން 2. ނޫން

10- ކުއްލި ހާލަތެއްގައި ރައްކާތެރި ތަނަކަށް ބަދަލުވުމަށް ވަގުތީ ދިރިއުޅުމަށް ބޭނުންވާނެ ތަނެއް ވޭ؟

1. އާން 2. ނޫން

11- މުސްތަޤްބަލުގައި ދިމާވެދާނެ ސުނާމީ ކާރިސާއަކުން ލިބޭ ގެއްލުން އަޑިޔާން ފިޔަވަޅުއެޅިދާނެ ކޮބައިތޯ؟
ތިރީގައިވާ ލިސްޓުން ކަނޑައަޅާފައިވާ 5 ކަމެއް ފާހަގަކޮށްދެއްވާ.

1. ސުނާމީގެ އިންޒާރު ދޭނެ ނިޒާމެއް ގާއިމުކުރުން
2. ކުއްލި ނުރައްކާތަކުގައި އަމަލުކުރާނެ ގޮތުގެ ތަމްރީނު ދިނުން
3. ކުއްލި ނުރައްކާތަކުގެ ސަބަބުން ހިނގާނެ ކަންކަމާއި ބެހޭ ގޮތުން ހޭލުންތެރިކަން އިތުރުކުރުން
4. ކާރިސާތަކުގެ ނުރައްކާ ކުޑަކުރުމަށް މަސައްކަތް ކުރާ ޖަމާޢަތްތަކާއި މުއައްސަސާތަކުގެ ގުދަރަތީ ކުރުން (މިގޮތުން ރަށުގެ ނުރައްކާ ހިސާބުތައް ކަނޑައެޅުން ހިމެނެއެވެ.)
5. ކާރިސާ އައުމުގެ ކުރިން ތައްޔާރުވުމަށް އެކަށީގެންވާ ފިޔަވަޅުތަކެއް އަޅުއްވާ ގޮތްތަކާއި މަޢުލޫމާތު ފޯރުކޮށްދިނުން
6. ކާރިސާ ދެމުން ނުރައްކާ ކުޑަކުރުމުގެ ޤާނޫނުތަކާއި ޖަމާޢަތުގެ ފެންވަރުގައި ހާލަތު އިތުރުކުރުން
7. ކާރިސާ ދެމުން މުޢައްސަސާ ކުޑަކުރުމަށް ގޮސް ހިންގާނެ ގޮތްތަކެއް ހުރި ތަނަކުން
ޖަމާޢަތުގެ ފެންވަރުގައި އިދާރާކުރުން
8. ސްކޫލްތަކުގައި ދަރިވަރުންގެ ތެރޭގައި ކާރިސާ ދެމުން ނުރައްކާ ކުޑަކުރުމާއި ބެހޭ މައުލޫމާތު ހިއްސާކުރުން
9. ކުއްލި ހާލަތެއްގައި ބަދަލުވާން ރައްކާތެރި ތަނެއް ގާއިމުކުރުމާއި އެކު ކަނޑައެޅި ކުރަންޖެހޭ ގޮތް
އެންގުމަށް ޓްރެއިން
12. ރައްކާތެރި ވަޅުތަކުން ބިނާކުރުން ސަރަޙައްދުތަކެއް ފާހަގަ ކުރުމާއި ޓްރެއިން
13. ސަރުކާރާއި ޖަމާޢަތްތަކާ ގުޅިގެން ފަޅު ކަނޑަކު ބިނާކުރުން
14. އަވަސް މަދަދުގެ ވަސީލަތްތައް (ދުޅަވަރު)
15. ކުއްލި ހާލަތެއްގައި ރައްކާތެރި ތަނަކަށް ބަދަލުވުމަށް ވަގުތީ ދިއުން
16. އެހެނިހެން
17. ނޭނގޭ

12- ކާރިސާ އައުމުން ރައްކާތެރިވުމަށް ބޭނުންވާ މައުލޫމާތު ފޯރުކޮށްދިނުމަށް ދިރިއުޅުމަށް؟

1. އާން 2. ނޫން (ސުވާލު 14 އަށް ދޭ)

13- މައުލޫމާތު ލިބުނު ކުރިން ކޮންކަހަލަ ކަންކަމެއް ކުރަންތޯ؟
ތިރީގައިވާ ލިސްޓުން ކަނޑައަޅާ އެއްވެސް ފާހަގަކޮށްދެއްވާ.

1. ސުނާމީއާއި ބެހޭ މައުލޫމާތު ބޭނުންކުރުމަށް ޓްރެއިނިންގ ދެވިފައި ބެލެހެއްޓުން
2. ސަރުކާރުގެ ލިބުނު މަޢުލޫމާތު ހިނގަމުން ދިޔަ ރެޑިއޯ ޓީވީއިން ބެލެހެއްޓުން
3. ސަރުކާރުގެ ލިބުނު މަޢުލޫމާތު ހިނގަމުން ދިޔަ ރަށުގެ އޮފީހުން ބެލެހެއްޓުން
4. އެހެނިހެން

14- ސުނާމީ ކާރިސާއަށް އަޅުއްވާފައިވާ އެހީގެ ތެރޭގައި ކޮންކަމެއް ކަމުދާކަމަށް ފެނިވަޑައިގަންނަވަނީ؟
ތިރީގައިވާ ލިސްޓުން ކަނޑައަޅާ 3 ކަމެއް ފާހަގަކޮށްދެއްވާ.

1. ކާނާ
2. ފެން
3. ދުއްވުން/ ސިވިލް
4. ޖަމާޢަތުގެ އިސްލާހު/ ސަރުކާރު މުވައްޒަފުން
5. ސަލާމަތް / ރައްކާތެރި
6. އެހެނިހެން

15- ސުނާމީ ކާރިސާއަށް އަޅުއްވާފައިވާ ސަރުކާރުން ހުރިހާ އެއްޗެއް ކަމުދާކަމަށް ތަކެތި ކޮބައިތޯ؟
ތިރީގައިވާ ލިސްޓުން ކަނޑައަޅާ އެއްވެސް ފާހަގަކޮށްދެއްވާ.

1. ސްކޫލް
2. އިޖްތިމާޢީ ޚިދުމަތް
3. މިސްކިތް
4. ބޭނުންވާ ކުރެހުން
5. މިހާރު ބިނާކުރި ރަށުގެ ހުރިހާ ތަނެއް
6. އިމާރާތްތައް (ދިރިއުޅޭ ގެތައް)
7. ސަރުކާރު އޮފީސް އިމާރާތް
8. އެހެނިހެން

ނިމުނީ

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