ITSU XX

NATIONAL REPORT SUBMITTED BY SINGAPORE

A. BASIC INFORMATION

1. National Contact

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2. Primary Warning Recipient

Name	:	Duty Forecaster
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3. Tsunami Advisor

(same as National Contact)

4. Emergency Management

The Singapore Civil Defence Force under the Ministry of Home Affairs is the emergency management and response agency responsible for the safety of the population and the return of the economy to near-normal condition during any eventuality.

5. Local/Distant Tsunami Procedures

There are no records that Singapore has ever been hit by tsunamis, local or distant. Chances of this happening are also extremely low. Nonetheless, the catastrophic Indian Ocean tsunami on 26 Dec 04 showed the need for littoral states to be prepared for such calamities. Given the potential impact of such disasters, the Meteorological Services Division (MSD) of the National Environment Agency (NEA) of Singapore, which operates 24 hours a day, seven days a week, has been designated as the national organisation to assess tsunami risks and issue warnings and advisories to relevant government agencies accordingly. Currently, as an interim measure, advisories are issued based on seismic reading (for earthquakes of magnitude > 6.5 in the Sunda Trench and Sumatra Fault) and tsunami warnings issued by the Japan Meteorological Agency (JMA) and Pacific Tsunami Warning Centre (PTWC). As time is of the essence, such advisories are communicated to the relevant agency officials via an automated SMS system.

B. SUMMARY

There are no records that Singapore has ever been hit by tsunamis, local or distant. The chances of this happening are also assessed to be extremely low as Singapore is sheltered by surrounding landmasses such as Peninsular Malaysia, Sumatra, Java and Borneo, as well as the shallow waters of the Straits of Malacca and South China Sea.

Nonetheless, the catastrophic Indian Ocean tsunami on 26 Dec 04 showed the need for littoral states to be prepared for such calamities. Given the potential impact of such disasters on both lives and the economy, the Meteorological Services Division (MSD) of the National Environment Agency (NEA) of Singapore has been tasked to develop the necessary tsunami monitoring and early warning capability and to operate a tsunami early warning system for Singapore. This would help Singapore to: -

(a) better assess potential tsunami impacts on the country;
(b) enhance its national preparedness, and
(c) contribute to regional and international efforts to monitor and mitigate such potential disasters.

MSD, which operates 24 hours per day, seven days a week, has been designated as the national organisation that will assess tsunami risks and issue warnings and advisories to relevant government agencies accordingly. Currently, as an interim measure, advisories are issued based on seismic reading (for earthquakes of magnitude > 6.5 in the Sunda Trench and Sumatra Fault) and tsunami warnings issued by other centres (namely JMA and PTWC.) As time is of the essence for the nature of such advisories, they are communicated to the relevant agency officials via an automated SMS system.

Moving forward, Singapore has embarked on a Tsunami Early Warning System project to

(a) Enhance its tsunami surveillance networks through the enhancement of the existing local *seismic* and *tidal* monitoring systems;
(b) Develop modelling and prediction capability to assess tsunamigenic seismic events and predict long range propagation of tsunami waves and assess potential impacts on Singapore; and
(c) Build up existing capabilities to operate tsunami surveillance networks and models to issue timely tsunami early warnings and advisories to relevant agencies.

This involves upgrading its existing seismic monitoring system by installing an additional GSN sensor to provide redundancy to its sole existing GSN sensor, and installing an additional tidal gauge to provide real-time sea-level data to detect change in water level and tide patterns in the event of a tsunami. It will also include the upgrading the system to tap into the regional seismic and sea-level networks to access real-time data from other stations in regional countries.

Beside surveillance, in the longer term Singapore will develop our tsunami modelling capability in order to predict the generation and propagation of tsunami and to assess their possible impacts on Singapore. These model outputs will also be used for risk assessment and the formulation of response plans.

MSD's operational capabilities will also be built up for it to effectively take on the role of the national multi-hazard warning centre to provide early warnings/advisories for tsunamis as well as other natural hazards such as earthquake and tremors. MSD will also be responsible to work with other relevant agencies such as the Police to develop and put in place tsunami response plans.

C. NARRATIVE

There are no records that Singapore has ever been hit by tsunamis, local or distant. The chances of this happening are also assessed to be extremely low as Singapore is sheltered by surrounding landmasses such as Peninsular Malaysia, Sumatra, Java and Borneo, as well as the shallow waters of the Straits of Malacca and South China Sea.

Nonetheless, the catastrophic Indian Ocean tsunami on 26 Dec 04 showed the need for littoral states to be prepared for such calamities. Given the potential impact of such disasters on both lives and the economy, the Meteorological Services Division (MSD) of the National Environment Agency (NEA) of Singapore has been tasked to develop the necessary tsunami monitoring and early warning capability and to operate a tsunami early warning system for Singapore. This would help Singapore to: -

(a) better assess potential tsunami impacts on the country;
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(d) Enhance its tsunami surveillance networks through the enhancement of the existing local *seismic* and *tidal* monitoring systems;
(e) Develop modelling and prediction capability to assess tsunamigenic seismic events and predict long range propagation of tsunami waves and assess potential impacts on Singapore; and
(f) Build up existing capabilities to operate tsunami surveillance networks and models to issue timely tsunami early warnings and advisories to relevant agencies.

Tsunami Surveillance Network Enhancement

As most tsunamis are caused by earthquakes, seismic monitoring is a key component of a tsunami monitoring system. MSD's seismic monitoring system, set up in 1996, currently comprises four functional sensors, including one Global Seismographic Network (GSN) sensor. The project will include the installation of another GSN sensor to provide redundancy. It will also include the upgrading of the existing seismic monitoring system to also tap into the regional seismic networks in order to access real-time data from other GSN stations to improve the speed and accuracy of detecting and assessing earthquakes in the region. Following its implementation, Singapore will also contribute real-time data from one of the GSN stations to the regional network.

Besides seismic monitoring, it is important to have real-time sea-level data to confirm if a tsunami has indeed been generated after an earthquake, and to monitor its propagation. However, Singapore is located relatively far away from earthquake sources and is surrounded by relatively shallow waters. As such, we would have to depend on data from deep ocean pressure sensors and tidal gauges from member countries nearer to the earthquake source, and will upgrade our system to tap such data. In addition, we will also supplement this with a tidal gauge in Singapore, to provide real-time sea-level data to detect change in water level and tide patterns in the event of a tsunami. We aim to share data from this station with other member countries as part of the regional data exchange arrangement. This will be completed in two phases, with the data exchange component expected to be ready by early 2006, and the component for the installation of new sensors expected to be ready by end 2006.

Tsunami Modelling

Beside surveillance, in the longer term Singapore will develop our tsunami modelling capability in order to predict the generation and propagation of tsunami and to assess their possible impacts on Singapore. These model outputs will also be used for the purpose of risk assessment, and is anticipated to be useful in the formulation of response plans and also to enable the issuing of timely warnings and advisories. The capability will be developed over two phases: The first phase, to be completed by 2006, will involve the development of a database of scenarios of seismic events, the associated tsunami generation and propagation and preliminary assessment of their possible impacts on Singapore. The second phase, to be completed by 2008, would involve fine-tuning and calibration of the models and assimilation of data from the local and regional seismic and tidal observation networks.

MSD Capabilities

MSD's operational capabilities will also be built up for it to effectively take on the role of the national multi-hazard warning centre to provide early warnings/advisories for tsunamis as well as other natural hazards such as earthquake and tremors. MSD will also be responsible to work with other relevant agencies such as the Police to develop and put in place tsunami response plans. This part of the project will be put in place by 2006.