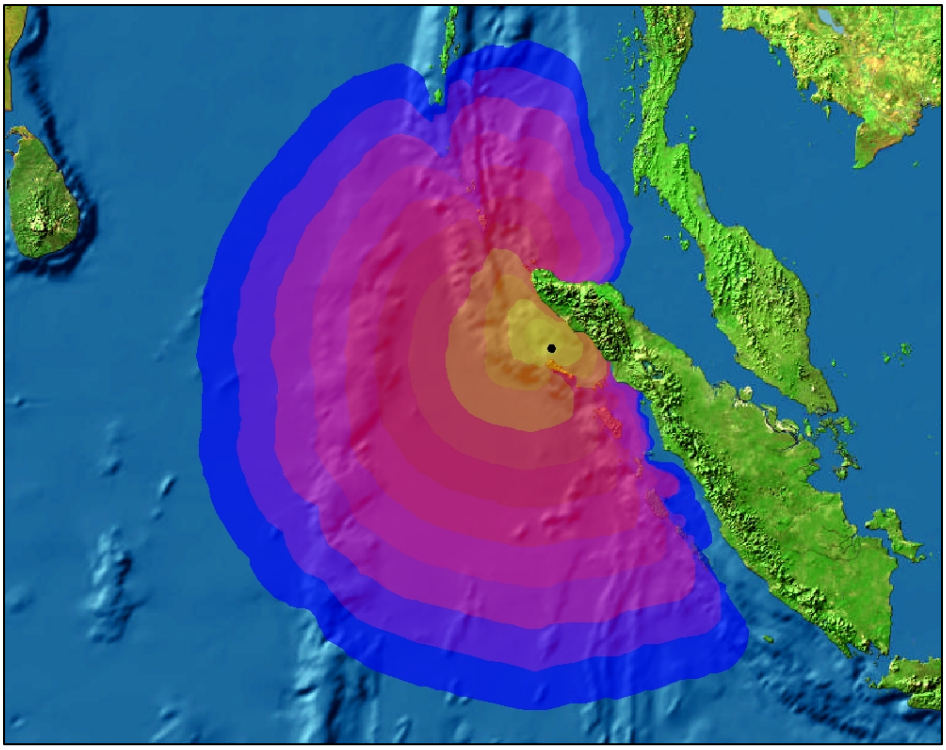
National Disaster Warning Center, Thailand

Concept of Operations



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The Pacific Disaster Center:

Fostering Disaster-Resilient Communities through Information, Science, and Technology

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Acknowledgements

Please note that this section is pending, and the following text is for placement – NDWC is asked to please add relevant information:

The Pacific Disaster Center would like to express its sincere gratitude to the National Disaster Warning Center, Thailand, for the assistance they have provided to support the development of this report…(more to follow)

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Cover Page Image: Map Depicting Travel Time for the December 26, 2004 Indian Ocean Tsunami. Each colored contour represents 10 minutes of travel time from the epicenter (origin) of the Great Sumatra Earthquake. (Source: Pacific Disaster Center)

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Executive Summary

Thailand has long been vulnerable to a wide spectrum of natural hazard threats, including storms, flooding, and drought. According to *EM-DAT: The OFDA/CRED International Disaster Database*, severe droughts and floods combined to impact over 19 million Thai residents between 1996-2002.

The catastrophic Indian Ocean tsunami of December 26, 2004, which impacted a dozen nations in the Indian Ocean Basin, shattered Thailand's previous record of natural hazard deaths by nearly a factor of ten and caused widespread destruction.

In response, Thailand's Office of the Prime Minister formally established the "National Disaster Warning Center, Thailand" (NDWC), which was operational within five months of the event.

Subsequently, the U.S. Trade and Development Agency (USTDA) provided a grant to NDWC as part of the U.S. Government's broader support for the Indian Ocean Tsunami Warning System. The purpose of this funding is to provide Technical Assistance to the Thai Center towards enhancing its disaster management and warning capabilities. The Pacific Disaster Center (PDC) and its partners[1] were then awarded a contract to provide the Technical Assistance to the Thai Center.

The Thailand Early Warning System "Concept of Operations"

This report deliverable describes the existing Thailand Early Warning System "Concept of Operations" (CONOPS) in relation to relevant information providers and intergovernmental organizations, and summarizes the existing analysis and decision-making processes that are related to the early warning system of the NDWC. In addition, it provides "focal points" for all key domestic and international organizations that work with the NDWC to help provide early warning data and information. The PDC will utilize this information in its development and implementation of a prototype Decision Support System for the NDWC.

The principal components for the overarching project (outlined below in Figure 1) are all steps towards achieving the final project goal, development of an NDWC "Decision Support Platform," based on best practices. This Report, detailing the "Concept of Operations" (CONOPS) in relation to the proposed Decision Support Platform, comprises the first project deliverable. In tandem with this effort are concurrent activities to conduct an Infrastructure and Communication Technology Assessment and a Data Inventory (as summarized in the Introduction, below).

Methodology

In terms of methodology, information for this report was collected by PDC between December 2005 and January 2006 through a series of interviews, and through the translation of key Thai Government documents to gather information related to:

- existing national disaster management practices and processes;
- organizational structure;
- data availability; and
- supporting organizations and data providers.

The information has been synthesized to document existing practices and identify gaps based on international best practices. In addition, the findings and recommendations presented in this report are based on the information collected, interviews conducted, and comments obtained

[1] PDC's partners are: Sun Microsystems, the Environmental Systems Research Institute (ESRI), and Lockheed Martin Information Technology (LMIT).

during a two-day Stakeholder Workshop and follow-on session conducted February 16-17, 2004 in Bangkok, Thailand.

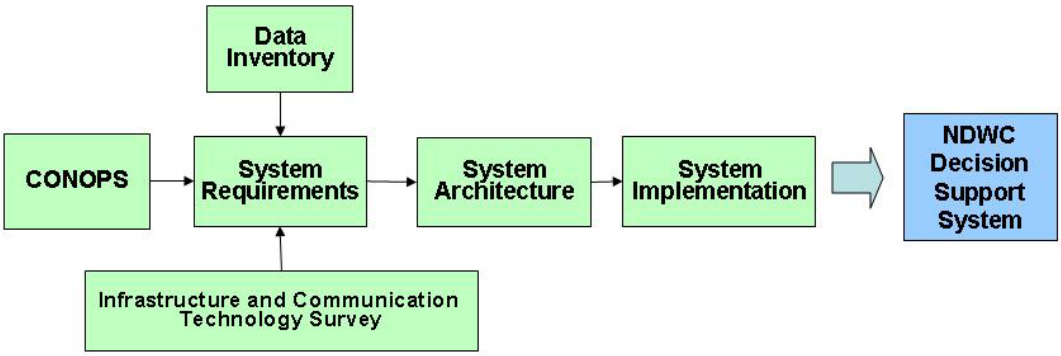

Figure 1: Principal Project Components for PDC's Technical Assistance to Thailand's National Disaster Warning Center. This "CONOPS" Report (first green box on left) comprises the first deliverable for the overarching project. This Report, together with the companion Data Inventory and Infrastructure and Communication Survey, provide the required information to develop the system requirements for the NDWC Decision Support System.

Key Findings, Recommendations and Gaps

Nine key findings, six recommendations, and five important gaps to be addressed are presented in the Conclusion of this report. The gaps are derived from the analysis that developed these findings and recommendations. Below is a summary of key findings, recommendations, and gaps:

Findings

1. **The existing NDWC Concept of Operations is functional**, well-developed, and has been built on international best practices. However, the current operations are dependent on **manual** observations, processing, and analysis of incoming earthquake and tsunami data. Accordingly, the automation of these processes can greatly improve efficiency, reduce uncertainties, and increase the time available for decision making.

2. **NDWC has established organizational relationships, protocols, and lines of communication with all critical agencies identified so far and analyzed by PDC**. Many of the key domestic agencies have established an "expert presence" and/or liaison staff at the NDWC on a "24-hour-per-day, seven-day-per-week" basis. This best practice facilitates rapid information exchange and data verification between agencies in times of emergency. NDWC has identified and established communications protocols and processes to receive and verify procedures for earthquake and tsunami data from all critical international data providers. A summary of relevant information providers is depicted below in Table 1.

3. **NDWC has ensured redundancy** through multiple communications methods (e.g. inputting information received from different international providers) and multiple information sources (e.g. verifying and comparing earthquake information from both domestic and international data providers). However, it should be reiterated that this method is currently manual and can be automated.

Agency	Data or Information Provided	Type of Data or Information	Data Transmission Modes	Process Type	Data Availability	Agency Website
Thailand Meteorological Department	Earthquake Parameters and Advisory Bulletins	Text	Fax, Email, and Hotline	Not Automated	Non-Real Time	http://www.thaimet.tmd.go.th/eng/
Hydrographic Department of Royal Thai Navy	Tidal height readings that changes in water levels	Text	Phone or Fax	Not Automated	Non-Real Time	www.navy.mi.th/
Royal Irrigation Department	Water level information	Text	Phone or Fax	Not Automated	Non-Real Time	http://www.rid.go.th/
Pacific Tsunami Warning Center	Earthquake Parameters and Advisory Bulletins for earthquakes and tsunamis	Text, map graphic	Website, Fax, Email, and Hotline	Not Automated	Near-Real Time	www.prh.noaa.gov/ptwc/
Japan Meteorological Agency	Earthquake Parameters and Advisory Bulletins for earthquakes and tsunamis	Text, map graphic	Website, Fax, Email, and Hotline	Not Automated	Near-Real Time	www.jma.go.jp/jma/indexe.html
U.S. Geological Survey	Earthquake Parameters and Advisory Bulletins for earthquakes	Text, map graphic	Website, and Fax, Email	Not Automated	Near-Real Time	http://earthquake.usgs.gov/regional/neic/

Table 1: Summary of domestic and international agencies providing relevant information to the NDWC, Thailand.

Recommendations

1. **The current decision support processes are completely manual and <u>must be automated</u>** in order to decrease the time required to issue warnings and improve efficiency in providing warnings. Automation will also decrease elements of human error. PDC's proposed Decision Support System, depicted in Figure 2, will address this pressing need.

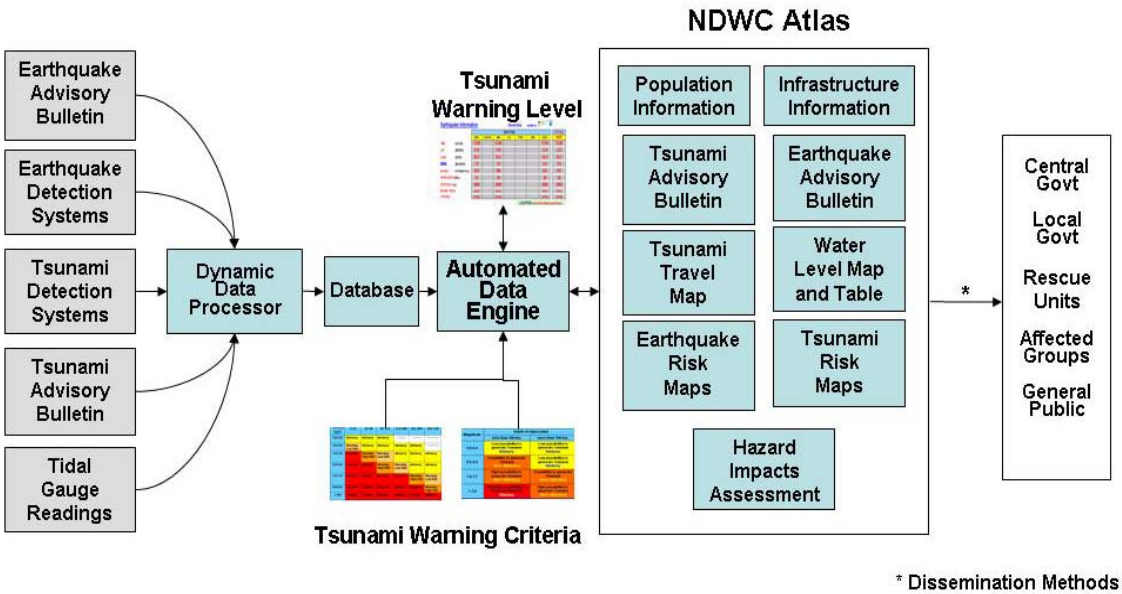

Figure 2: Integration of the Decision Support System (in blue) into the NDWC's Concept of Operations for Tsunami Warnings. Once complete, the Decision Support System (blue boxes) is envisioned to integrate into the NDWC's current "Concept of Operations" for tsunami warnings. This concept can be "scaled up" to include multiple natural hazards, but please note that this is outside the scope of the current project.

2. **There is a need to improve protocols between domestic organizations for acquiring information in a timely manner.** Improved protocols must be established immediately for seamlessly transferring information and data between agencies in order to complete this project. The current process of collecting data involves checking relevant information through domestic agency websites. It is recommended to:
    - Improve access to real-time data from domestic data providers;
    - Improve data reliability from each of these organizations; and
    - Support real-time access to international data providers.
3. **Interagency coordination, operations, and policy issues must be addressed.** This includes, but is not limited to: a) developing a "Matrix of Roles and Responsibilities for Key Agencies" supporting the NDWC for each hazard; b) solidifying political commitment regarding interagency coordination to improve data sharing and agency support to the NDWC; c) allocating additional personnel from all key domestic agencies to develop the national early warning system; and d) developing a policy on personnel protection against liability from false alarms. To avoid duplication and to delineate clear lines of agency support, *it is encouraged that NDWC establish Memorandums of Understanding with all pertinent organizations*.

Gaps

Through the CONOPS report development process, five significant technical and institutional gaps have been identified from the findings and recommendations that would bring the NDWC to "international best practice standards:"

1. NDWC's data input is manual and must be automated as much as possible to enhance decision making capabilities.
2. The NDWC still requires additional onsite hazard expertise, as well as an established domestic and regional science and technology advisory committee.
3. NDWC must augment its tsunami warning capabilities with an all-hazards warning capability, in particular, a flood hazard warning capability.
4. Roles and responsibilities for all domestic agencies supporting NDWC require further clarification.
5. Data protocols and open sharing of data between domestic agencies must be improved through interagency cooperation and coordination.

Introduction

This section details: 1) relevant background information; 2) the purpose of this report; 3) background information on the overall technical assistance project's Scope of Work; 4) the definition of "Concept of Operations" (CONOPS); and 5) the methodology used to collect information.

Background

On December 26, 2004, the magnitude 9.0 Great Sumatra Earthquake struck off the coast of Indonesia's Sumatra Island. The earthquake triggered a massive tsunami that caused catastrophic and unprecedented death and destruction along the coast of a dozen nations throughout the Indian Ocean basin. Over 230,000 people perished across Indonesia, Thailand, India, Sri Lanka, Myanmar, Bangladesh, Mauritius, the Maldives, Seychelles, Kenya, and Somalia.

The tsunami ranks as one of the most destructive natural hazard events in Thailand's history. It inundated the Andaman coast in Phuket, Pang-nga, Krabi, Trang, Satoon and Ranong, causing 5,396 deaths nationwide. Nearly half of the casualties were foreigners. The tsunami also left 8,457 people injured, 2,951 people missing, and 880 children orphaned. The disaster caused more then 30 billion Thai dollars ($750 million U.S.) in economic losses to the Andaman coast's tourism industry. Damage to property and coastal environments was severe.

As a consequence of this catastrophe, the National Disaster Warning Center (NDWC), Thailand was established under the order of the Office of the Prime Minister. It is Prime Minister Thaksin Shinawatra's commitment to enhance existing systems to further protect the lives and property of Thai citizens and foreign visitors. Accordingly, the NDWC was established, funded, and open for operation within five months of the event.

Subsequently, the U.S. Trade and Development Agency (USTDA) provided a grant to NDWC as part of the U.S. Government's broader support for the Indian Ocean Tsunami Warning System (IOTWS). The purpose of the grant was to provide Technical Assistance to the Thai Center towards enhancing its disaster management and warning capabilities. The Pacific Disaster Center (PDC) and its partners[2] were then awarded the contract to provide the Technical Assistance (TA) to the NDWC.

Purpose of this Report

The purpose of this report is to provide the reader with an understanding of the existing Thailand Early Warning System "Concept of Operations" in relation to relevant information providers and intergovernmental organizations. It also provides a summary of the existing analysis and decision-making processes that are related to the National Disaster Warning Center's early warning system. The PDC will use this information to *develop and implement a prototype Decision Support System* for the NDWC based on best practices.

To accomplish this, PDC embarked on identifying main stakeholders in the context of Thailand's disaster warning needs—along with their roles, existing processes, information flow, and data requirements. This document captures the initial findings of the PDC, and will help guide the development process that is to follow under the TA contract.

Project Scope of Work

PDC's "Project Scope of Work" is to provide Technical Assistance to the NDWC's disaster warning capabilities through development of an integrated architecture for an early disaster warning and decision support platform. Equipped with Geographic Information Systems (GIS), hazard event tracking, collaboration tools, and basic hazard modeling, the system initially aims to provide support for earthquake and tsunami hazards. However, the system is envisioned to be scalable to include other hazards over time. The overall goal is to provide an *integrated environment that will support national disaster warning and decision making processes*.

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[2] PDC's partners are: Sun Microsystems, the Environmental Systems Research Institute (ESRI), and Lockheed Martin Information Technology (LMIT).

This Concept of Operations report will help PDC develop the requirements for the Decision Support System, thereby improving and enhancing the NDWC's decision-making capabilities to provide early warning.

Accordingly, this document identifies the existing "information flow," data collection and transfer, inter-agency communication protocols, organizational structure, agency roles and responsibilities, and operational processes pertaining to the NDWC within the scope of this project. It also details the organization's mission, duties, and responsibilities, as well as focal points for all relevant domestic and international agencies pertaining to the stated scope.

As depicted below in Figure 3, PDC has also conducted an Infrastructure and Communication Technology Assessment (ICT) and a Data Inventory, which are critical components in developing and implementing of a prototype Decision Support System for the NDWC[3].

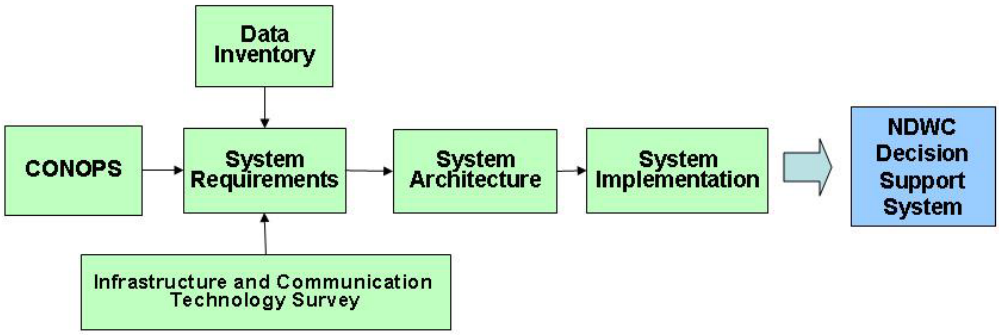

Figure 3 Principal Project Components for PDC's Technical Assistance to Thailand's National Disaster Warning Center. This "CONOPS" Report (first green box on left) comprises the first deliverable for the overarching project. This Report, together with the companion Data Inventory and Infrastructure and Communication Survey, provide the required information to develop the system requirements for the NDWC Decision Support System.

The Data Inventory Report provides a comprehensive data inventory consisting of the location and condition of GIS datasets that could be made available to improve and enhance NDWC's early warning capability.

The Infrastructure and Communication Technology Assessment identifies disaster warning data feeds and linkages available at the NDWC, analyzes the capability of existing hardware/software infrastructure and personnel (to fulfill the functionality proposed by the PDC for NDWC) and, in conjunction with NDWC technical staff, formulates a consensus regarding ICT gaps with respect to NDWC operational benchmarks established in this CONOPS report.

Definition of "Concept of Operations"

The Concept of Operations is specifically defined as: "the operational flow of hazard and non-hazard information between organizations; the intradepartmental reporting relationships within the NDWC; and the decision-making processes required to generate warnings to enable governmental officials to take appropriate action when needed, such as evacuating potentially threatened populations."

The Concept of Operations does not include Standard Operating Procedures or "Operational Checklists" that are common in all Emergency Operations and Warning Centers.

[3] Both of these efforts are currently in progress (as of March 2006).

Please note that this document examines the processes pertaining to the scope of the project (as stated above). As such, *it is a subset of the greater CONOPS that governs the full operational capabilities of a national center*. In other words, this CONOPS outlines the operational flow and information exchange relating to the decision support and disaster warning platform, and does not take into account actual response and recovery processes, mitigation analysis, or other disaster management functions.

Methodology

The information documented in this report was collected by PDC through a series of interviews, and through the translation of key Thai Government documents. The interviewees and the agencies were mainly identified during the December 2005 Project Initiation and Stakeholder Workshop held in Bangkok. The data collection period spanned from December 2005 through January 2006.

PDC's Chief Scientist, Stanley Goosby, and Emergency Management Consultant, Tavida Kamolvej, conducted interviews and follow-up sessions to gather information related to: 1) existing national disaster management practices and processes; 2) organizational structure; 3) data availability; and 4) supporting organizations and data providers.

Interviews included:

1. Mr. Pisnupong Anuratpanich* - Meteorologist - Meteorological Department
2. Mr. Burin Wechbunthung - Meteorologist - Seismological Bureau, Thai Meteorological Department
3. Col. Krith Bunthid - Chief of Map Information Center - Royal Thai Survey Department
4. Mr. Wattana Thongsiri - Executive Vice President - Hydro Power Plant – Electricity Generation Authority of Thailand Public Company Limited
5. Rear Admiral Thaworn Charoendee - Royal Thai Navy
6. Captain Song Ekmahachai, Royal Thai Navy - Chief of Operations - Hydrographic Department of Royal Thai Navy
7. Mr. Chanchai Suvanpimel - Expert on Hydrology - Royal Irrigation Department
8. Dr. Surachai Ratanasermpong - Director of the Institute of Space Knowledge-Based Development - Geo-Informatics and Space Technology Development Agency
9. Mr. Raywat Pongsuwan* - Senior Computer Official - Department of Disaster Prevention and Mitigation
10. Mr. Thiti Tinnakorn Na Ayudaya* - Senior Officer - Department of Disaster Prevention and Mitigation
11. Mr. Waiyapot Worakanok* - Geoscientist - Department of Mineral Resources
12. Mr. Tinnakorn Tatong* - Senior Geologist - Department of Mineral Resources
13. Mr. Passkorn Kunthasap* - Geoscientist - Department of Mineral Resources
14. Mr. Suwith Kosuwan* - Senior Geologist - Department of Mineral Resources
15. Col. Wanchai Singthong* - Office of Supreme Commander Headquarters
16. Dr. Solarwish Saikasem - Chief Advisor - NDWC
17. Dr. Cherdsak Virapat - Assistant Executive Director (International Affairs) - NDWC

* representatives of organizations in the NDWC

Accordingly, PDC has compiled and assessed "information content flow," processes, and procedures. This is necessary to document and develop recommendations that augment the current sound practices already being implemented by NDWC. The information gathered from the NDWC and other stakeholders has been synthesized to document existing practices, and to identify gaps based on international best practices.

National Disaster Warning Center, Thailand

Legislative Authority

This section describes the legislative authority of the NDWC—and its relationships to the Committee on Policy of the National Disaster Warning System (COPNDWS) and the Committee on National Disaster Warning Administration (CONDWA).

In the fall of 2005, the NDWC's steering organization's role and tasks were officially formulated in the *Regulation of the Office of the Prime Minister on the Management of the National Disaster Warning System BE 2548*. It was set forth that the NDWC would work under the COPNDWS and the CONDWA.

The Committee on Policy of the National Disaster Warning System (COPNDWS) is chaired by a Deputy Prime Minister, and consists of 31 committee members (two Vice Chairs—the Minister of Interior and Mr. Smith Dharmasaroja), 26 members, one Secretary (the Executive Director of NDWC), and one Assistant Secretary (the Vice Executive Director of the NDWC). The committee deals with policy issues, and has responsibilities to:

- Formulate—for the Cabinet—guidelines, policies, measures, and planning pertaining to the management of the national disaster warning system;
- Provide recommendations and advice to the Cabinet to approve planning and projects, as well as comment on the government agencies' budget (in order to follow the national disaster warning system policy and management plan);
- Devise measures, guidelines, plans, and projects for the management of the national disaster warning system as a framework for other related government agencies;
- Act as the coordinating center with other commissioners, appointed by law or a cabinet resolution, that have duties and responsibilities related to the management of a national disaster warning system;
- Invite personnel from governmental organizations and state enterprises to provide clarification, information, or any statistical data in accordance with the regulation;
- Appoint subcommittees or operating committees to carry out the tasks assigned by the CONDWA;
- Draft regulations, announcements, and orders in line with this regulation; and
- Perform any other necessary tasks assigned by the Cabinet.

The Committee on National Disaster Warning Administration (CONDWA) is chaired by Mr. Smith Dharmasaroja, Vice Minister to the Office of Prime Minister, and has a Vice Chair (Dr. Plodprasop), consisting of seven members from key departments, a Secretary (the Director General of the Department of Mineral Resources), an Assistant Secretary (the Deputy Director General of the Department of Mineral Resources, Mr. Samai Chiamchindarat) and five experts in the earthquake, water, air pollution, forest fire, and meteorology fields. The committee deals with technical advice, and has responsibilities to:

- Follow up, assess, and improve on the speed of the operation of the National Disaster Warning Center;
- Set forth measures and formulate the operational approach of the NDWC;
- Receive advice on any matter relating to the operation of the NDWC;
- Provide advice on any matter related to international cooperation and the operation of the NDWC; and
- Appoint subcommittees to carry out the tasks assigned by the COPNDWS.

Role

On May 30, 2005, Prime Minister Thaksin Shinawatra officially opened the NDWC. The NDWC was designated as the lead organization for receiving, monitoring, processing, and disseminating critical information and official government warnings. Information was envisioned to be disseminated to officials, emergency response agencies, and the general public on a "24-hour, seven-day-per-week" basis. Figure 4 is a flow diagram depicting the organizational lines of communication between the NDWC, organizations providing data, and groups receiving NDWC warnings.

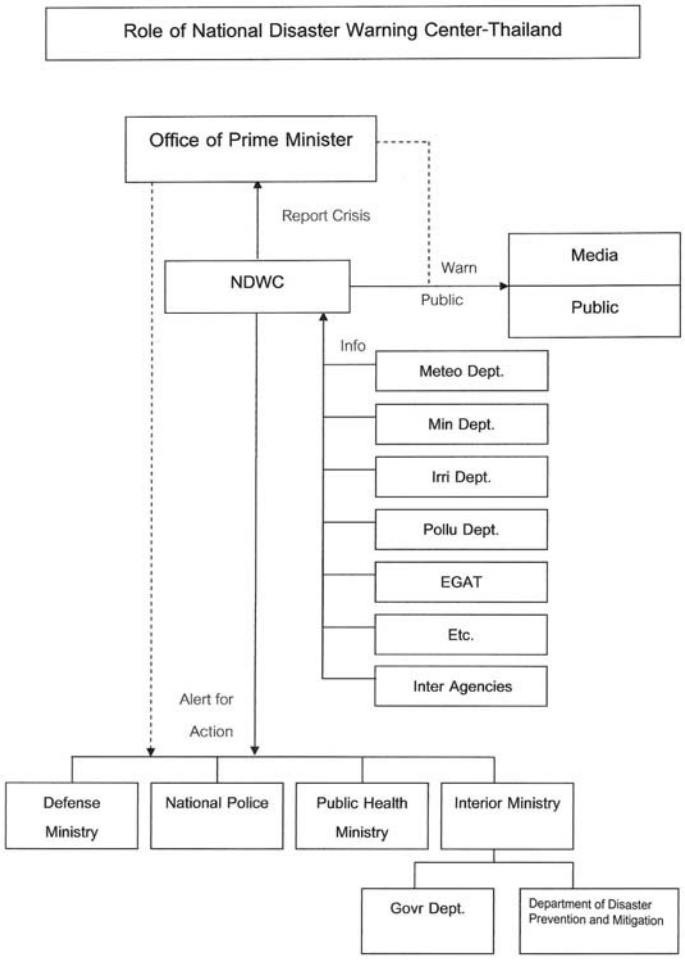

Figure 4: Organizational flow diagram showing organizational lines of communication between the NDWC, data-providing organizations, and groups receiving NDWC warnings. (Source: NDWC)

Vision: NDWC's Early Warning System for Earthquakes and Tsunamis

The major responsibility of the NDWC is to receive information related to earthquakes and other natural and man-made events. NDWC also analyzes data and issues warnings when necessary. In the event of an earthquake, seismic data are analyzed to determine the possibility of tsunami generation. Subsequently, notifications are then issued to the public and relevant agencies. This facilitates the evacuation of populations to safe areas.

The NDWC's vision is to issue warnings to the public for earthquakes *within five minutes of the detection of a potential tsunamigenic earthquake*, and *within twenty minutes for news of a possible tsunami*. This is depicted in Figure 5.

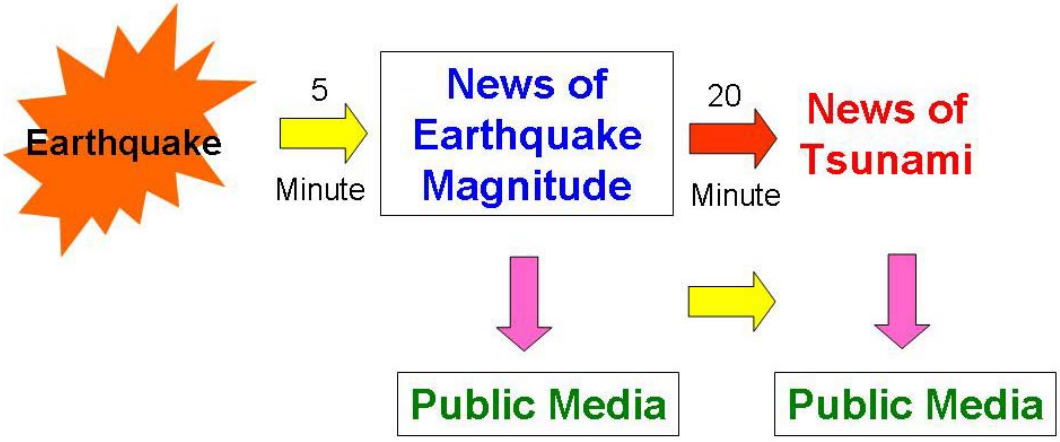

Figure 5: The National Disaster Warning Center's Vision to issue warnings and disaster-related information to the public in the least amount of time possible. (Source: PDC diagram derived from NDWC reference materials)

In a phased approach, the NDWC is also developing and upgrading its early warning system and extending its telecommunication networks to include detection and warnings for the following hazards:

- Flash Floods
- Landslides
- Storms
- Wild Fires
- Air Pollution, Water Pollution, and Oil Spills

Mission Statement

The NDWC is responsible for planning, coordinating, controlling, operating, and preparing the disaster warning facilities and system, along with researching and updating technology. This is to educate the public and involved agencies to diminish the severity of damage from natural disasters, and to support disaster mitigation effectively and efficiently.

Duties and Responsibilities

The NDWC is responsible for:

- Retrieving all data and information from international and domestic sources. This is to be used in analyzing the severity of a disaster and in formulating damage assessments.
- Activating warnings and broadcasting the severity of a disaster—and information about how to diminish its effects—and facilitating evacuation and/or mitigative actions. The warnings and broadcasts are also extended to emergency personnel and participating agencies to facilitate more efficient evacuation operations.
- Closely monitoring situations to deliver information about fatalities and property damage. This includes supporting the facilities and tools that assist rescue and evacuation processes. The Center also has a responsibility to coordinate between emergency personnel to assure the efficient implementation of rescue and evacuation activities.

- Studying data and information regarding multiple hazards (and all disasters). It is also responsible for practicing simulations by developing a database to be used in decision making. Such a database should be prepared and developed in advance to be able to deliver more timely, accurate, and informative decisions.
- Providing training and education to the public to augment their understanding of disaster prevention and mitigation.
- Other tasks that are assigned.

Organizational Structure

On September 6, 2005, the Cabinet approved a framework that would provide for a total of 277 NDWC staff. As of February 2006, NDWC had a total of 61 staff (39 employees and 22 officials.) By April 2006, it is anticipated that the total number of staff will rise to 90—four experts, 22 officials, and 64 employees. (An initial "release of positions" has in fact authorized a total of 110 staff—6 experts, and 104 employees and officials).

NDWC's staff provides operational, technical, and administrative support on a continuous basis. The Center is commanded by the Executive Director—who is in turn assisted by the Vice Executive Director, the Administrative Committee, as well as the Disaster Warning Operation and Disaster Warning Management Divisions, and the Research and Education Division. This relationship is depicted in Figure 6.

Executive Director – Serves as Commander-in-Chief, and has absolute authority in emergency situations to issue a warning—and the associated level of severity—to involved organizations.

Vice Executive Director – Assumes the duties of the Commander-in-Chief whenever the Executive Director is not available.

Research and Education Division – Conducts studies and research on various hazards to depict the potential areas of devastation and overall severity of an event. It also helps to develop potential solutions. This division is also responsible for training and educating both NDWC staff and the general public.

Disaster Warning Operation Division – Prepares the warning system for activation (when needed) and monitors data and information sources both domestically and internationally during normal and emergency operations.

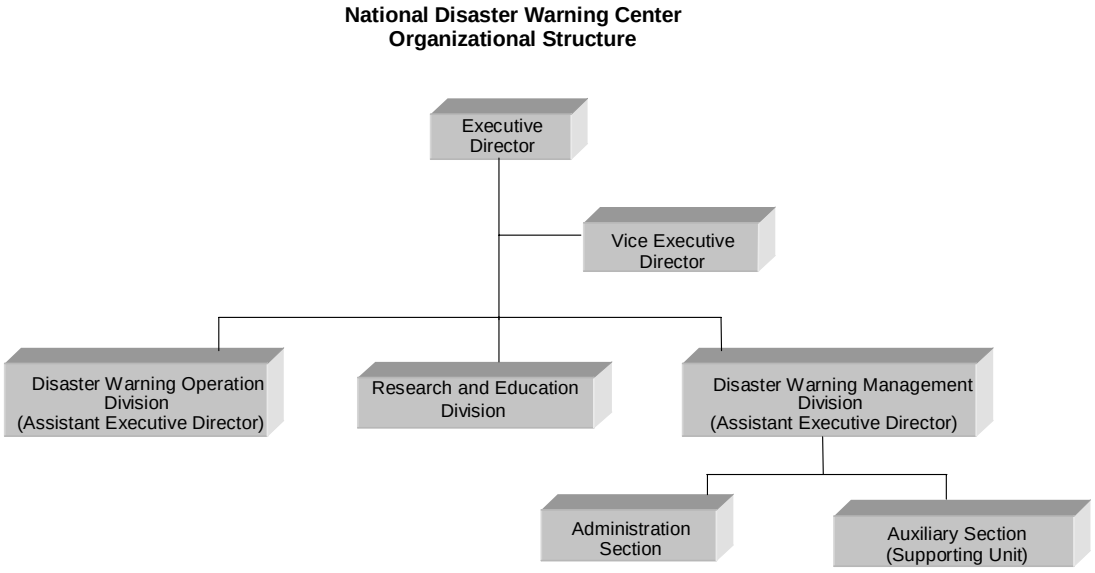

Figure 6: NDWC Organizational Structure. (Source: NDWC)

The Disaster Warning Operations Division assesses the severity and resulting devastation of a disaster, and issues a warning. It also broadcasts to involved agencies and the public. The Division plans, administers, coordinates, and assists in emergency mitigation and operations, and also assists in monitoring the event close to the time of impact.

The Disaster Warning Management Division consists of two sections:

- Administrative - Plans, administers, coordinates, and provides direction on matters related to policy, human resources, budget, legal, and other support.
- Auxiliary - Operates and coordinates financial procedures, the budget, manpower, stock, transportation, benefits, services, and the overall security of the facility.

NDWC's Concept of Operations for the Early Warning System

This section describes: 1) the existing NDWC Concept of Operations "information flow" and communication methods for the early warning system; 2) the information flow for earthquake and tsunami hazards; and 3) existing NDWC decision support procedures and processes.

NDWC's Concept of Operations for Information Flow and Communication Methods

The "information flow" for the early warning system developed by NDWC consists of three components: 1) Information Sources (Input); 2) Evaluation and Decision Making (Analysis); and 3) Information Users (Output). This is depicted in Figure 7.

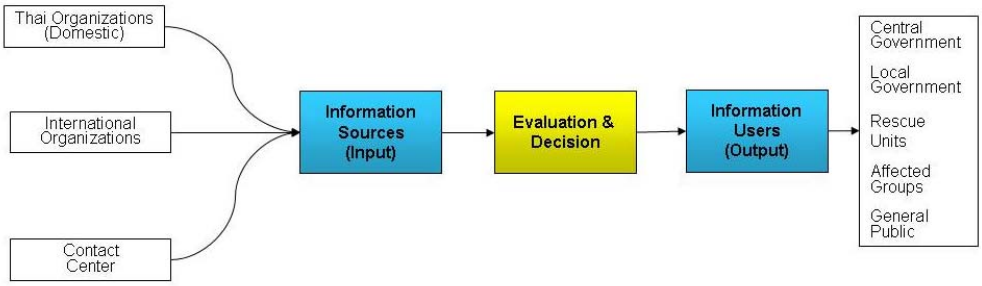

Figure 7: NDWC Concept of Operations Information Flow, depicting the Concept of Operations information flow for decision making within the NDWC's Early Warning System. (Source: NDWC)

The three "high-level components" from Figure 7 are further described below:

- Information Sources (Input) – Domestic and international organizations that provide disaster or disaster-related information, analysis, and/or warning information. Examples include the Thailand Meteorological Department, and the Pacific Tsunami Warning Center;
- Evaluation and Decision Making (Analysis) – Analytical processes that NDWC has developed to validate hazard, warning, or disaster-related information, and to assess at-risk areas; and
- Information Users (Output) – Warnings or related information distributed to government authorities, rescue units, affected groups, and the general public by various modes of communication.

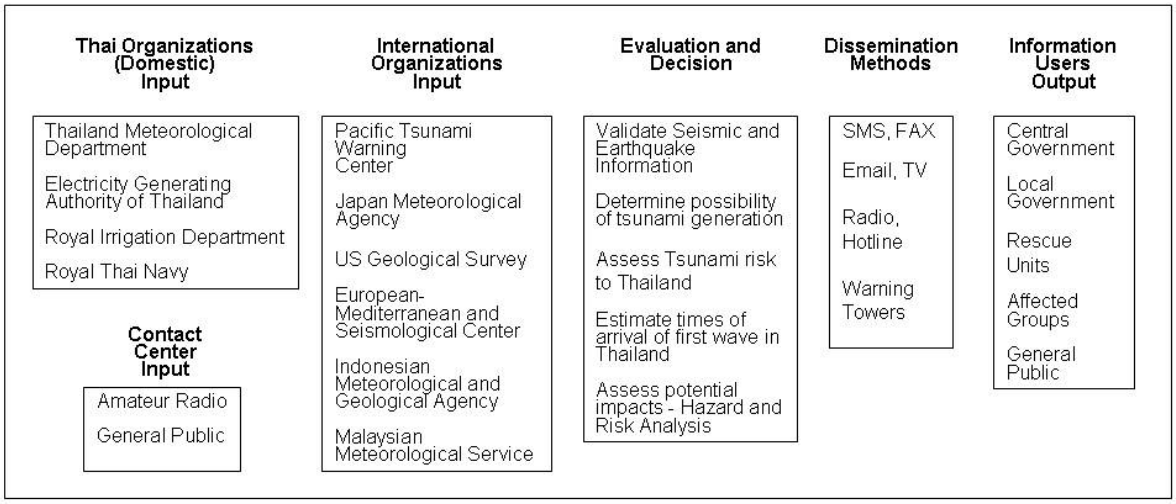

Figure 8: Details of the Concept of Operations organizational and process flow for the NDWC Early Warning System. Each column presents the individual elements of the Concept of Operations. The columns summarize the input sources, evaluation and decision procedures, and dissemination methods to information users. These may vary depending on the hazard type. (Source: NDWC)

Data Provided and Communications Methods for Earthquake and Tsunami Hazards

Input data for earthquake and tsunami early warning are comprised of: earthquake records; water-level records; field observations; and tsunami advisory, warning, and cancellation bulletins.

For earthquakes and tsunami warnings, NDWC receives information through seismic stations located within Thailand via four organizations:

1) the Thailand Meteorological Department (TMD);
2) the Electricity Generating Authority of Thailand (EGAT);
3) the Royal Irrigation Department (RID); and
4) the Hydrographic Department of the Royal Thai Navy (HDRTN).

The Seismic Bureau of the Meteorological Department operates a seismic network consisting of 25 stations. From eight digital stations, data is collected by a Very Small Aperture Terminal (VAST) satellite link. The Royal Thai Navy operates several tidal stations on the Gulf of Thailand and on the Andaman coast. Several of the stations are digital, and information is sent via radio or GSM.

For water-level records, NDWC receives information through the EGAT, the Royal Irrigation Department, and the Hydrographic Department of the Royal Thai Navy. The Royal Thai Navy also provides water level information from gauges located along the shore and river systems, as well as on the islands of Tarutao, Thaphao Noi, Miang, and Simila.

Additionally, NDWC receives seismic and water-level data and tsunami warning bulletins from international information networks in Europe, Asia, and the United States. These include: the Pacific Tsunami Warning Center (PTWC) in Hawaii; the United States Geological Survey (USGS); the Japan Meteorological Agency (JMA); the European-Mediterranean and Seismological Center (EMSC) in France; the Indonesian Meteorological and Geological Agency (IMGA); and the Malaysian Meteorological Service (MMS).

The existing communications methods these centers use to provide warning information to NDWC are telephone, facsimile, and email. The centers also post warning and related information on their websites, which are continuously monitored by NDWC personnel. Table 2, below, provides a summary of relevant information providers.

Agency	Data or Information Provided	Type of Data or Information	Data Transmission Modes	Process Type	Data Availability	Agency Website
Thailand Meteorological Department	Earthquake Parameters and Advisory Bulletins	Text	Fax, Email, and Hotline	Not Automated	Non-Real Time	http://www.thaimet.tmd.go.th/eng/
Hydrographic Department of Royal Thai Navy	Tidal height readings that changes in water levels	Text	Phone or Fax	Not Automated	Non-Real Time	www.navy.mi.th/
Royal Irrigation Department	Water level information	Text	Phone or Fax	Not Automated	Non-Real Time	http://www.rid.go.th/
Pacific Tsunami Warning Center	Earthquake Parameters and Advisory Bulletins for earthquakes and tsunamis	Text, map graphic	Website, Fax, Email, and Hotline	Not Automated	Near-Real Time	www.prh.noaa.gov/ptwc/
Japan Meteorological Agency	Earthquake Parameters and Advisory Bulletins for earthquakes and tsunamis	Text, map graphic	Website, Fax, Email, and Hotline	Not Automated	Near-Real Time	www.jma.go.jp/jma/indexe.html
U.S. Geological Survey	Earthquake Parameters and Advisory Bulletins for earthquakes	Text, map graphic	Website, and Fax, Email	Not Automated	Near-Real Time	http://earthquake.usgs.gov/regional/neic/

Table 2: Summary of domestic and international agencies providing relevant information to the NDWC, Thailand.

Figure 9, below, depicts the "informational communications flow" of NDWC's Early Warning System for earthquake and tsunami hazards.

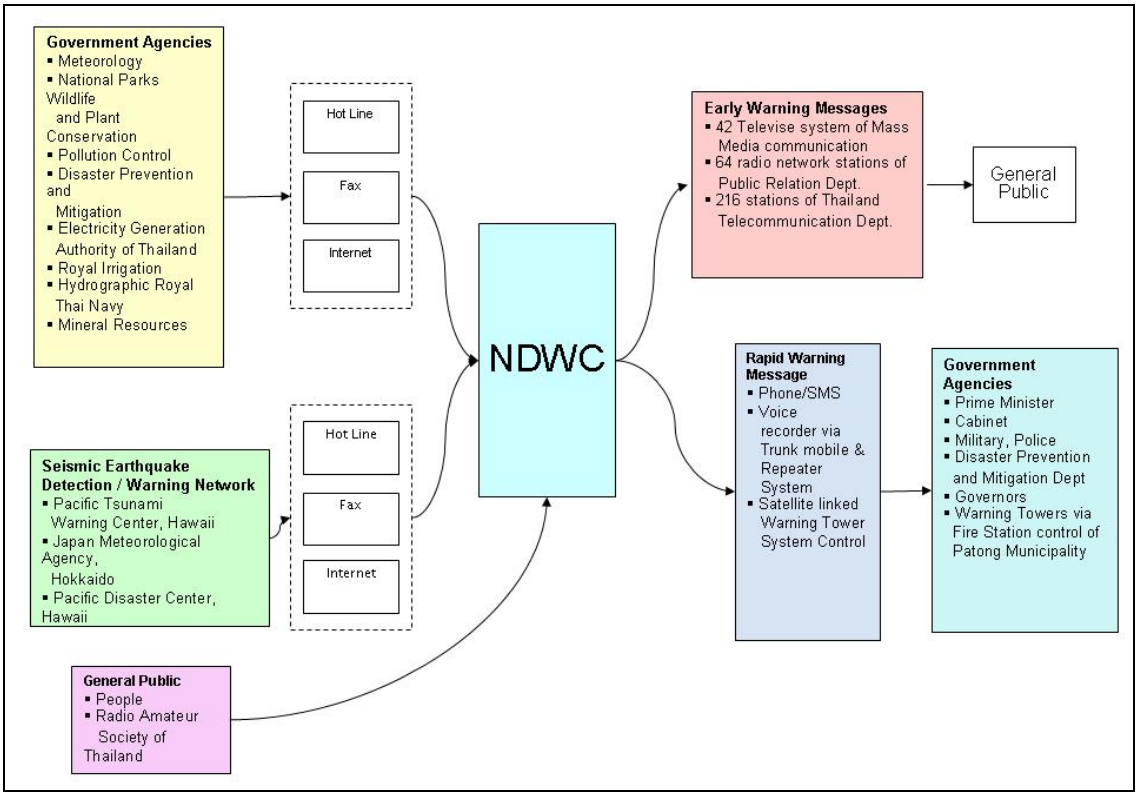

Figure 9: NDWC's Early Warning System "informational communications flow" for earthquake and tsunami hazards. (Source: NDWC)

NDWC Concept of Operations Decision Support Procedures and Processes

This section describes the *existing decision support procedures and processes* developed and implemented by the NDWC, based on input data and warning criteria.

NDWC has established procedures to:

- determine the possibility of a tsunami resulting from an undersea earthquake;
- assess the level of a tsunami's potential impact;
- estimate the arrival times of the first wave to coastal areas; and
- provide warning notification to disaster response agencies (and related organizations), the media, and the public.

Once NDWC receives notification of seismic activity or an earthquake of greater than Magnitude 7.0 Richter—from either domestic or international hazard information providers—the supervisor (duty officer) will consult with the experts of the command center. The experts will then verify the information, use computer-based simulations to estimate tsunami wave's arrival to coastal areas, and generate and analyze scenarios to assess the potential risk.

Information from various geophysical sources is then collected, compared, and analyzed to verify earthquake information, ensure redundancy, and understand the maximum level of risk. This is illustrated in Figure 10.

Earthquake Information Recent time 8/9/2005 16:32

		UNOFFICIAL							OFFICIAL
		EMSC	GEOFON	JMA	KJC	PTWC	TMD	USGS	NDWC
TIME	(LOCAL)	12.00		12.00				12.00	12.00
LAT	(NORTH)	3.52		3.53				3.52	3.52
LONG	(EAST)	92.3		92.4				92.3	92.3
MAG	(RICHTER)	7.8		7.9				8.0	8.0
DISTANCE	(TO PHUKET Km.)	650		640				652	652
HYPOCENTER	(Km.)	33		30				30	30
DEPTH SEA	(m.)	2000		2000				2000	2000
INLAND / INSEA		insea		insea				insea	insea
CRITERIA		warning		warning				warning	warning

LOCATION : NORTHERN SUMATERA INDONESIA

NATIONAL DISASTER WARNING CENTER,THAILAND

EMSC	European-Mediterranean Seismological Centre
GEOFON	National Research Center for Geosciences in Germany
JMA	Japan Meteorological Agency
KJC	Malaysia Meteorological Department
PTWC	Pacific Tsunami Warning Center
TMD	Meteorological Department,Thailand
USGS	United State Geological Survey

Figure 10: Earthquake Notification Analytical Procedure. The NDWC has devised an effective, "comparative method" to verify and compare earthquake information. This is also used to ensure redundancy, and to understand and analyze the maximum level of risk. (Source: NDWC)

Once an earthquake of Magnitude 7.0 or greater is confirmed, the supervisor immediately informs the Executive Director, Vice Executive Director, and all relevant agencies. Command Output Officers are also informed to "stand by" and prepare to activate the warning towers. The NDWC immediately communicates with officers at the Similan Island to closely monitor sea level changes, which will indicate the presence of an approaching tsunami.

Within 20 minutes of receiving the notification, NDWC compiles, analyses, and assesses the probable impact, based on the hazard warning criteria that are described in Figure 11.

Distance (Km) Magnitude (Richter)	0-24	25-48	49-112	113-200	201-400	401-720
3.0-3.9	Advisory	Advisory	Advisory	--------	--------	----------
4.0-4.9	Warning Low Risk	Advisory	Advisory	Advisory	Advisory	----------
5.0-5.9	Disaster	Warning High Risk	Warning Low Risk	Advisory	Advisory	Advisory
6.0-6.9	Disaster	Disaster	Warning High Risk	Warning Low Risk	Advisory	Advisory
7.0-7.9	Disaster	Disaster	Disaster	Disaster	Warning High Risk	Warning Low Risk
8.0-8.9	Disaster	Disaster	Disaster	Disaster	Disaster	Warning High Risk
> 8.9	Disaster	Disaster	Disaster	Disaster	Disaster	Disaster

Figure 11: NDWC Criteria for Warning Advisories. The summary table shows "levels of risk," and the distance of the earthquake's effective radius from coastal areas of Thailand. (Source: NDWC)

Additionally, as shown in Figure 12, NDWC has developed criteria to assess the possibility of a tsunami being generated based on the depth of the earthquake or its hypocenter (which is used to further refine the risk level.)

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

Figure 12: Possibilities (or likelihoods) of tsunami generation based on the additional information of the hypocenter's location. (Source: NDWC)

The NDWC assesses tsunami risk based on the magnitude of the earthquake, and its distance from coastal areas of Thailand. Based on sound practices, NDWC has developed a four-level, public advisory system—with associated risk levels—to alert responders and to communicate the situation to the public. Table 3, below, outlines the NDWC Public Advisory System.

Risk Level	Description
Advisory	No effect on life and assets
Watching	Potential effect on life and assets
Warning	High Potential effect on life and assets
Termination	No event after two hours of predicted tsunami wave arrival

Table 3: NDWC's Four-Level Public Advisory System.

In the event that there is a high probability of a tsunami occurring, a warning for high-risk areas around Thailand will be issued within 30 minutes from the time that the earthquake was reported.

NDWC's System for Early Warning Dissemination

NDWC presently uses several methods to disseminate advisories, watches, warnings, and terminations. These include:

- Short Message Service (SMS) (2 million mobile phones/ 5,000 batch)
- Warning Towers
- Fax (150 unit/5,000)
- E-mail
- Television (nationwide)
- Contact Centers
- Radios (280 stations nationwide)

In July 2005, the Thai Cabinet approved a budget for NDWC to construct 62 alarm system towers in the six Andaman provinces and Bangkok. The alarm towers will all be linked by satellite and activated automatically from the NDWC. This is illustrated in Figure 13 (left).

Figure 13: NDWC Diagram of Warning Tower Siren System for High Risk Coastal Regions.
(Source: NDWC)

In addition to delivering warnings through the alarm system towers, the system will be able to interrupt regular radio and TV programs to alert the public of an approaching tsunami or any other hazard. The Supervisor will use information as specified in NDWC facsimile to broadcast via TV Channel 5. The notice will be broadcast every 5-10 minutes until the estimated time of arrival has reached the last location. Figure 14 and Figure 15 are conceptual representations of NDWC's methods for disseminating warnings.

Figure 14: Conceptual Diagram of NDWC's Methods for Disseminating Warnings.
(Source: NDWC)

Figure 15: "Close-up" View of NDWC's Dissemination Methods. (Source: NDWC)

The NDWC Early Warning System also provides warnings through a radio communication system to governors in six coastal provinces, via the Department of Provincial Administration. In addition, it warns authorities who are concerned with the time available before a tsunami actually arrives. (Please note that governors and authorities will proceed with provincial evacuation plans that have been exercised in each specific risk area.)

Proposed NDWC Decision Support System

This section describes how PDC's proposed Decision Support System integrates into the NDWC's Concept of Operations for tsunami warnings (as depicted below in Figure 16), as well as descriptions of domestic and international data providers.

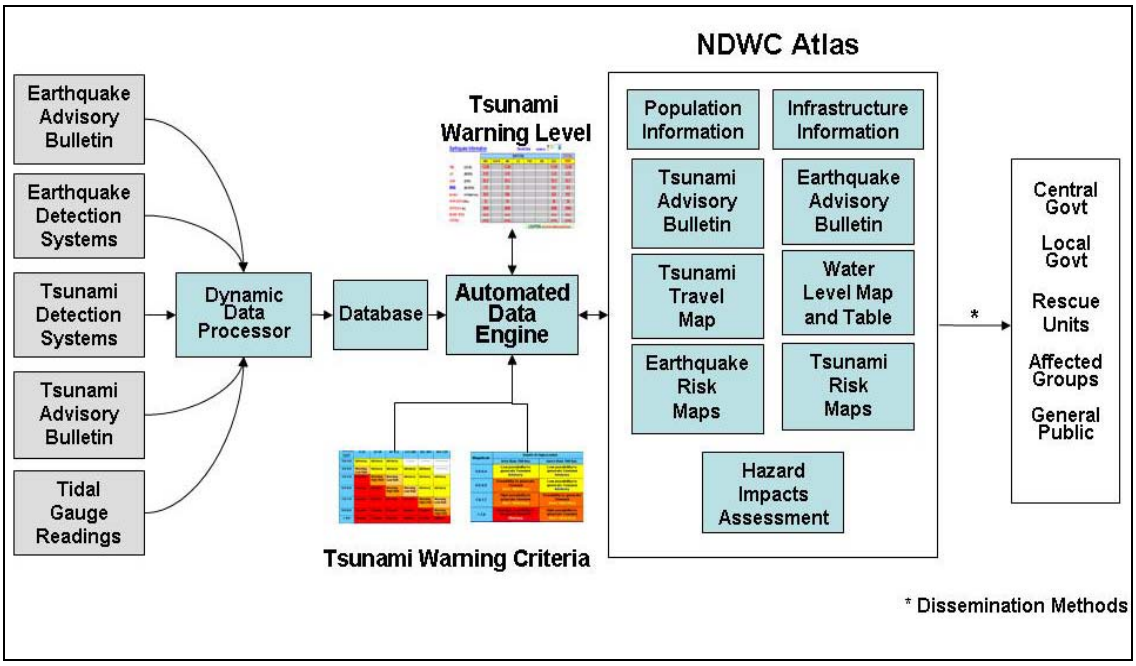

Figure 16: Integration of the Decision Support System (blue boxes) into the NDWC's Concept of Operations for Tsunami Warnings. This diagram further illustrates the overall data collection Concept of Operations for the NDWC.

In the conceptual diagram above, boxes in the left-hand column represent input data sets to the database. The blue boxes represent the Decision Support System elements to be developed by the PDC. This will include a Dynamic Data Processor (DDP), which will retrieve and process hazard alerts, a database system, which will organize and store relevant information, an automated data engine, and finally a system that will display incoming information as it becomes available.

The Decision Support System boxes represent the system that will automatically generate warning levels via the incoming information, *based upon the NDWC's warning criteria*. This information will include details about an earthquake's magnitude, location, and hypocenter, as well as the distance from the earthquake's epicenter to the Thai coast. The incoming earthquake and water-level (tidal gauge) readings will then be automatically posted to the Tsunami Warning Level display. Once official values for the earthquake and water level readings are determined (either automatically or by NDWC analysts) this same information will be used to generate warning levels based on the criteria used by NDWC staff and authorized personnel. Automatically-generated warning levels may then be augmented by other decision support products (such as model runs, as appropriate), and will be ready to be displayed in the "NDWC Decision Support Atlas"—which is an interactive, GIS-based tool.

Please note that for the purposes of this document, warnings are only generated for, and are accessible to, NDWC staff. Authorities within the Center can review these warnings and decide if public notification is necessary. If so, they can ***MANUALLY*** "trigger" the process of issuing public warnings.

The blue boxes in the right-hand "NDWC Atlas" column are a representation of key products, available through the Atlas, and include tsunami travel time maps, water level maps and tables, and earthquake and tsunami risk maps. Other information can be included—such as population and infrastructure information—in order to perform and display hazard impact assessment

products. Information products and tables generated by the Decision Support System—and displayed in the Atlas—will be used in the NDWC decision-making process as additional support for warning decision criteria.

It critical to convey that the goal is to have the majority of these products and processes automated. Once information is available, data are automatically retrieved and are "captured" in the system. Once in the system, the Decision Support System displays the data, analyzes the information based on pre-determined criteria (provided by NDWC), and automatically generates warning levels based on these criteria. The system also automatically generates and updates several products as soon as the input is received (in near-real time). The "static" products are generated from the database (for example risk maps or impact assessments.)

Figure 17 illustrates how the Decision Support System in Figure 16 can be "scaled up" to address multiple hazards. (However, please note that this is outside the scope of work for this project.) By basically extending the Decision Support System paradigm to address multiple hazards, Figure 17 shows that the same system can be applied to multiple hazards as the data and information becomes available—automatically arriving from several different sources and collecting in the database. Warning criteria would be developed for floods, using a combination of stream gauge and rainfall information, as well as risk maps showing areas prone to flooding and landslides. The system could examine rainfall rates as well, as look at historical occurrences of flooding and landslides to assess the current flood situation.

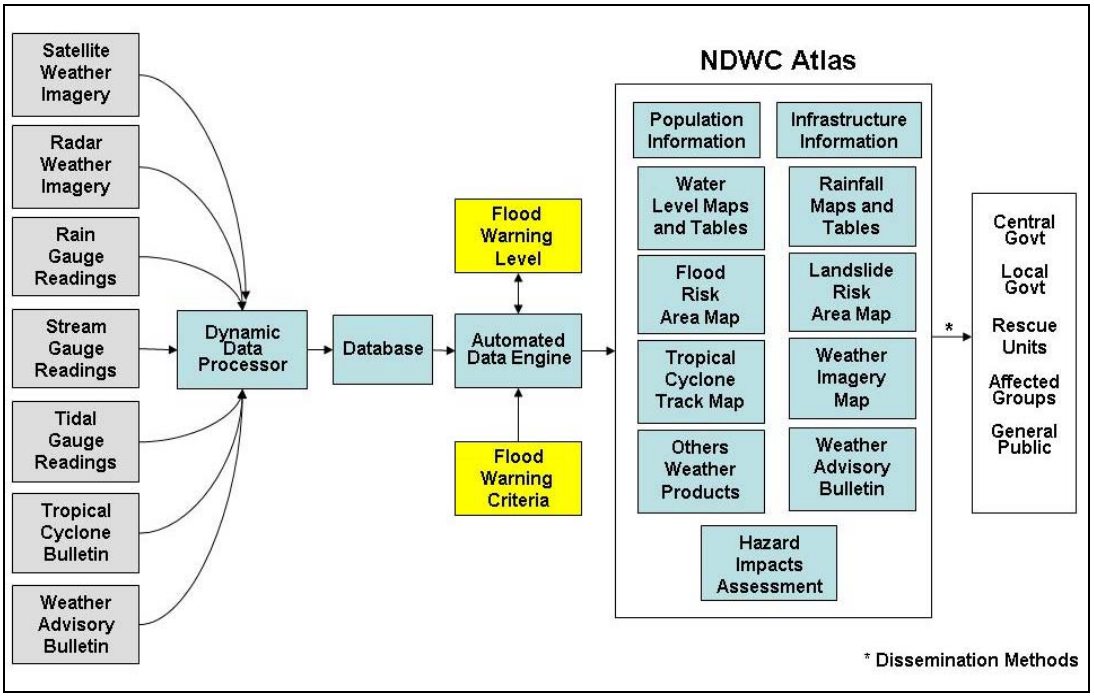

Figure 17: Conceptual Decision Support System (blue boxes) Design for Multiple Hazards. The Decision Support System from Figure 16 can be "scaled up" to include automation of warning criteria for multiple hazards, including flooding. Note that developing this concept is outside the scope of this project.

Domestic Data Providers

Thailand Meteorological Department (TMD) - A key information provider to the NDWC for both weather and earthquake data. The four service bureaus of TMD provide weather and monitoring services to each of the regions of TMD, and to aviation and transportation authorities.

Support to NWDC during Emergency States

TMD is a key information provider to the NDWC for both weather and earthquake data. During normal operations, NDWC obtains weather and earthquake information from the TMD website. During Emergency Operations, TMD faxes advisory information to NDWC and will utilize the hotline if there is a dramatic change in an emergency situation.

Department of Disaster Prevention and Mitigation (DDPM) - Develops an information technology system for disaster prevention, warnings, and mitigation. DDPM provided information support to NDWC by installing baseline data, such as demographic, boundary, and base mapping.

Support to NWDC during Emergency States

NDWC has hotline for DDPM to contact in an emergency situation. DDPM headquarters and local offices also “call in” to update relevant information.

Hydrographic Department of Royal Thai Navy (HDRTN) - Conducts oceanographic surveys, tidal observations, and forecasts for Thai waters, as well as collects seismic and meteorological information. HDRTN operates the Differential Global Positional System Reference Station. HDRTN operates a seismic center at Chiangmai, which can detect seismic activities and report locations, as well asother details within 20 minutes of occurrence.

Support to NWDC during Emergency States

Presently, HDRTN contacts NDWC by phone or fax if any dramatic change occurs in sea level heights. A formal “trigger mechanism” has not been established, but there is a plan to create a direct link between HDRTN and NDWC. During an emergency, HDRTN will open the link to NDWC so that the Center can directly access the information.

Department of Mineral Resources (DMR) - Develops GIS, digital maps, and data for Thai hazards including, but not limited to, Landslide Hazard Maps, Risk Maps, Tsunami Inundation Maps (GIS format), and Geological Map Active Fault Maps.

Support to NWDC during Emergency States

DMR experts and staff will make and support decisions of NDWC staff, as needed.

Royal Irrigation Department (RID) - Operates 173 telemetered stations to obtain real-time data of water levels at dams, water sheds and along river systems. RID uses this information to compare the annual average water levels to real time values.

Support to NWDC during Emergency States

RID notifies the NWDC of water level information.

Royal Thai Survey Department (RTSD) – National Mapping Agency
Conducts ground and aerial surveys to develop maps in a GIS format.

Support to NWDC during Emergency States

Provides the Center with maps and other related information upon request.

Electrical Generation Authority of Thailand (EGAT) - Controls hydroelectric dams. The agency has installed seismometers to detect seismic activities in areas where these dams are located.

Support to NWDC during Emergency States

If seismic activity is detected, the information is forwarded to EGAT and to TMD. Presently, EGAT does not release seismic data to other organizations.

Pollution Control Department (PCD) - Submits opinions for the formulation of national policy and plans for the promotion and conservation of environmental quality with respect to pollution control.

Forest Fire Control Division (FFCD) - Provides fire fuel types, loading (biomass), topography, and weather conditions to determine fire potential and fire risk areas.

Geo-Informatics and Space Technology Development Agency (GISTDA) - GISTDA operates ground receiving stations to acquire data from leading remote sensing satellites. Images are archived in standard formats and media, available for users worldwide. GISTDA also coordinates with some related agencies to study and analyze satellite images for various applications. In addition, this public organization operates the maritime environmental monitoring system, “Sea Watch.” The program started in 1991. Currently, three bouys are operational.

Support to NWDC during Emergency States

As a service, GISTDA provides satellite images, orthophotos, image maps, and selected geo-information.

International Data Providers

Pacific Tsunami Warning Center (PTWC), Hawaii, USA. The PTWC continuously monitors seismological data from the National Earthquake Information Center and countries within the Pacific Basin. When the likelihood of a tsunami is high, PTWC will issue a warning bulletin.

Support to NWDC during Emergency States

Provides near real-time: a) Tsunami Watch, Warning, and Cancellation Bulletins; b) Tsunami Travel Time maps; c) Seismic data; and d) Water level data, where available.

U.S. Geological Survey's (USGS) National Earthquake Information Center (NEIC), Colorado, USA. The USGS can quickly determine (in near-real time) the location and magnitude of any destructive earthquake occurring worldwide, using the Global Seismic Network (GSN).

Support to NWDC during Emergency States

NEIC data and information products include: a) Warning Bulletins; b) Map products showing locations of current, past, and historical earthquakes; c) Seismic sources of current, past, and historical earthquakes; and d) Informational links to other network systems.

Japan Meteorology Agency (JMA), Tokyo, Japan - Provides weather and climate information.

Support to NWDC during Emergency States

Provides seismic information and tsunami warning bulletins if a tsunami is likely, along with data products such as: a) Warning Bulletins; b) Tsunami Travel Time maps; c) seismic data; and d) water-level data, if available.

Asian Disaster Preparedness Center (ADPC) *(Proposed)*

ADPC will serve as a regional early warning center for participating countries in Southeast Asia and the Indian Ocean region by establishing a real-time seismic and sea level monitoring network.

Support to NWDC during Emergency States *(Proposed)*

Will provide warning information to NDWC, including both seismic and sea level data.

Conclusions: Findings and Recommendations

This section *summarizes findings and sets forth recommendations to improve the NDWC's Concept of Operations.* It also incorporates the findings and recommendations documented at two Stakeholder Workshops which provided a feedback process to improve this report. The findings and recommendations are based on data collected and interviews conducted, as well as the agency input from these workshops.

Stakeholder Workshops

On February 16 and 17, 2006—during two, full-day Stakeholder Workshops in Bangkok, a draft CONOPS Report ("Version 2.5") was presented and distributed by PDC in hard copy for review by all stakeholders identified by NDWC. Accordingly, input on "Findings and Recommendations," as well as corrections to content (both text and figures) were recorded by PDC and reviewed by all stakeholders. Finally, stakeholders were provided with an *Organizational Feedback Form* on February 17 to provide written comments to correct and improve the CONOPS draft document. The final input was collected and recorded at a third stakeholder workshop on February 24, 2006. Accordingly, the following findings and resulting recommendations represent PDC's "Findings and Recommendations" from the draft CONOPS report ("Version 2.5"), augmented by input from the stakeholder review process. The Stakeholder Workshop agendas and participants lists are included in Appendix C.

Findings

1. **Functionality of the NDWC Concept of Operations.** The existing NDWC Concept of Operations is functional, well-developed, and has been built on international best practices. However, the current operations are dependent on manual observations, processing, and analysis of incoming earthquake and tsunami data. Accordingly, the automation of these processes can greatly improve efficiency, reduce uncertainties, and increase the time available for decision making. This finding is reflected in Recommendation 1, below.

2. **Communications Protocols with Critical Agencies and On-site Organization Liaisons.** NDWC has established organizational relationships, protocols, and lines of communication with all critical agencies (identified so far and analyzed by PDC). Many of the key domestic agencies have established an "expert presence" and/or liaison staff at the NDWC on a "24-hour-per-day, seven-day-per-week" basis. This best practice facilitates rapid information exchange and data verification between agencies in times of emergency.

3. **Expertise Resources Available at NDWC.** NDWC has identified experts who provide "expert advice" into the decision support process around issuing warnings.

4. **International Data Providers.** NDWC has identified and established communications protocols and processes to receive and verify procedures for earthquake and tsunami data from all critical international data providers.

5. **Multiple Communications Methods.** NDWC has developed an effective method for inputting information from different international providers to provide a degree of redundancy. This includes data from:

   - Japan Meteorological Agency and Pacific Tsunami Warning Center via fax, email, and hotline;
   - United States Geological Survey via fax and email; and
   - all relevant websites.

6. **Multiple Information Sources.** The NDWC has devised an effective, comparative method to verify and compare earthquake information from both domestic and international data providers to ensure redundancy. However, this method is currently manual and can be automated.

7. **Standard Operating Procedures (SOPs).** Established SOPs are in place for earthquake and tsunami early warning processes.

8. **Exercises that test the NDWC's Concept of Operations**. Through several table-top and full-scale exercises, the NDWC has demonstrated "end-to-end" testing of its Concept

of Operations for early warning—including receiving bulletins, notifying the public, and activating sirens.

9. **Emphasis on Development of a Multiple-hazard Warning System.** As a best practice, NDWC is strategically developing its warning capability to include all major hazards. **Flood hazard warning** is a high priority for the NDWC leadership.

Recommendations

1. **Automation of NDWC Decision Support Processes.** The current decision support processes are completely manual and must be automated in order to decrease the time required to issue warnings and improve efficiency in providing warnings. Automation will also decrease elements of human error.

2. **Improve Data Transfer Protocols, Data Reliability, and Data Redundancy.** There is a need to improve protocols between domestic organizations for acquiring information in a timely manner. These protocols must be established immediately for seamlessly transferring information and data between agencies in order to complete this project. The current process of collecting data involves checking relevant domestic agency websites. Improve access to real-time data from domestic data providers. Data reliability from each of these organizations must still be improved. Support real-time access to international data providers to supplement this current gap to other domestic data sources.

3. **Interagency Coordination, Operations, and Policy.**
    - Although the CONOPS details relationships between NDWC and domestic agencies (TMD, DDPM, RID, HDRTN), the level of support from each of these organizations must still be improved. To further refine the Concept of Operations, all domestic agencies should participate with NDWC to develop a "Matrix of Roles and Responsibilities for Key Agencies" supporting the NDWC for each hazard. For example, this Matrix would clearly identify and define agency roles and responsibilities to develop hazard impact scenarios, as discussed at the Stakeholder Workshop.
    - Political commitment regarding interagency coordination is required to improve data sharing and agency support to the NDWC to ensure success. Stakeholders observed that authority and permissions are granted, but practical interagency coordination still must improve. To avoid duplication and to delineate clear lines of agency support, *it is encouraged that NDWC establish Memorandums of Understanding with all pertinent organizations.*
    - More personnel should be dedicated from all key domestic agencies to develop the national early warning system.
    - Develop policy on personnel protection against false alarms. False alarms, where warnings are issued and no tsunami occurs are inevitable. The issuance of false alarms or warnings can result in both economic loss and personal injury. Thus, there is a need to protect decision makers from false warning liabilities and responsibilities.

4. **Improve Risk Criteria and Standardize Advisories**
    - Develop and convene a Local Expert Committee, with Regional Expert input, to advise NDWC on all unresolved scientific and technical issues. Several examples are listed below, as identified at the Stakeholder Workshops:
        - Review and refine the NDWC criteria for tsunami warning as described in Figure 10 and Figure 11, above). In addition, further reduce the time that Thailand agencies require for achieving optimum warning.
        - Solicit scientific input to critical issues, such as the accuracy of the hypocenter criteria (see Figure 11, above).
        - Analyze requirements for all-hazards expertise at NDWC and add identified research and development expertise for all hazards to reduce current gap.

- Conduct a comprehensive study to assess tsunami risk to Thailand's eastern coast to determine the tsunami threat to Thailand, including Bangkok, from the Philippine Sea earthquake sources.
- As the Indian Ocean Tsunami Warning System develops into the envisioned multilateral regional system, NDWC should research and standardize the advisory and warning criteria as well as standardize advisory language with counterpart countries and regional efforts.

5. **Develop Flooding hazard warning capabilities to supplement tsunami hazard warnings.** NDWC should develop a Flood Warning and Risk Reduction Program paralleling the development effort for earthquakes and tsunami. Some priority actions that were identified in the Stakeholder Workshops are to: a) develop a matrix of flood data providers similar to Table 1 in order to obtain critical data sets from flood information data providers and data sources; b) establish real-time flooding data feeds from domestic agencies; c) develop warning level criteria for floods; d) provide better flood monitoring through sensor coverage in flood prone areas; and e) undertake community-based flood warning strategies.
6. **Formalize a "CONOPS Update Process," with Associated Training.** NDWC is strongly encouraged to develop processes for compiling and integrating "lessons learned" into the CONOPS and derivative Standard Operating Procedures.

Appendix A – References

Please note that this section is pending.

Appendix B – Descriptions of Information Providers

Domestic Information Providers

Thailand Meteorological Department (TMD)

TMD falls under the Ministry of Information and Communication Technology. It was established in 1923 as Thailand's meteorological and statistical organization. TMD is a key information provider to the NDWC for both weather and earthquake data.

Organization, Duties, and Responsibilities

Currently, the total staff of TMD is approximately 900. The Department's main office is located in Bangkok and consists of an Administration Unit, National Forecast Center, Development and Research Unit, Telecommunication Center, as well as a unit for the maintenance of its observation network. TMD is organized into two divisions, four service bureaus, and four regional centers

The two divisions of TMD include:

- **Meteorological Telecommunication and Information Division –** maintains the telecommunications network for the national and international exchange Meteorological data utilizing the World Meteorological Organization/Global Telecommunications System.
- **Meteorological Telecommunication and Information Division –** maintains Meteorological equipment to international standards.

The four service bureaus of TMD provide weather and monitoring services to each of the regions of TMD, as well as to aviation and transportation. These include:

- **Weather Watch and Warning Bureau** – measures, reports, researches, and studies weather, climate and climate change, seismology, and geophysics;
- **Weather Forecast Bureau** – issues and disseminates severe weather warnings using modern weather forecasts tools and techniques;
- **Meteorological Development Bureau** – issues and disseminates severe weather warnings to agriculture and industry; and
- **Bureau of Meteorology for Transportation** - provides a weather warnings service to the transportation and communication sectors
    - aviation weather services
    - observes, monitors, communicates, and reports weather for aviation and transportation sectors.

TMD has four regional centers, which include:

- **Northern Meteorological Center** – provides regional warning on severe weather to the public, as well as the aviation, and agricultural sectors;
- **North-Eastern Meteorological Center** – provides regional warning on severe weather to the public, as well as the aviation and agricultural sectors;
- **Southern Eastern Meteorological Center** (East Coast) – provides regional warning on severe weather to the public, as well as the aviation, and agricultural sectors; and
- **Southern Eastern Meteorological** Center (West Coast) – provides regional warning on severe weather to the public, as well as the aviation, agriculture, maritime, fishery and tourism sectors.

Meteorological Information

TMD has weather stations in most provinces throughout Thailand. The provincial stations provide weather updated every three hours to TMD in Bangkok. Weather information related to aviation is updated hourly. The Department utilizes data from a number of sources, including Doppler radar, satellite imagery (visible and infrared), and weather stations located throughout the country, and from the World Meteorological Organization (WMO).

TMD posts weather radar and satellite imagery, and other weather-related information products such wind speed, temperature, and rainfall on its website, which are periodically updated.

Table 4 depicts the information data sets and update rates.

Name	Update Rate
Average Temperature	3 hours
Min and Max Temperature	Once per day
Wind Speed (Doppler)	1 hour
Weather Map	6 hours
Satellite Imagery	1 hour
Precipitation	3 hours
Acclimate Precipitation	6 hours

Table 4: TMD Weather Information Products and Update Rates.

Geophysical Information

TMD operates a seismic network consisting of 14 analog and 11 digital seismometers, three of which are broadband. It also obtains seismic data from U.S. Geological Survey by e-mail and from their website. Additionally, TMD automatically receives tsunami warning bulletins from the Pacific Tsunami Warning Center and the Japan Meteorological Agency by fax, email, GTS, and hotline (dedicated phone), if the magnitude of the earthquake is greater than 6.5.

Relationship to NDWC and Information Provided

TMD is a key information provider to the NDWC for both weather and earthquake data. During Normal Operations, NDWC obtains weather and earthquake information from the TMD website. During Emergency Operations, TMD faxes advisory information to NDWC, and will utilize the hotline if there is a dramatic change in the situation.

Focal Point

TMD has a representative at NDWC to assist in analysis, and who coordinates with TMD for specific information or help from different departments within TMD.

- The Focal Point from TMD at NDWC is Mr.Pisnupong Anuratpanich*, who is also an expert in Meteorology at NDWC.
- The Focal Point at TMD's Seismic Bureau is Mr. Burin Wechbunthung - Meteorologist.

Department of Disaster Prevention and Mitigation (DDPM)

DDPM was founded in 2002 (under the Civil Defense Act 1979, per the National Safety Council Regulation of 1995).

Mission Overview:

- Establish disaster prevention and civil defense systems, and creation of disaster awareness throughout Thailand.
- Direct and implement disaster mitigation and civil defense activities systematically, rapidly, equally, and thoroughly, wherever disasters occur.
- Procure materials, equipments, vehicles, and machineries dispensable for disaster prevention, mitigation, suppression, and for victims' assistance.
- Rehabilitate damaged public utilities, treat the victims of physical and psychological trauma, restore victims' livelihood, necessities, and occupations.
- Integrate disaster prevention and mitigation system, plans, and implement and follow-up with an evaluation of other internal and international organizations.

Duties and Responsibilities:

- Formulate policy, guidelines, and criteria for disaster management.
- Study, analyze, research, and develop the prevention and disaster mitigation systems.
- Develop information technology system for disaster prevention, warning, and mitigation.
- Mobilize peoples' participation to establish disaster prevention and mitigation projects and activities.
- Arrange training and exercises in disaster prevention and mitigation, rehabilitation of disaster areas, and in assisting victims as stated by law.
- Promote, support and carryout disaster prevention and mitigation activities, provide assistance to the victims and rehabilitate devastated areas.
- Direct and coordinate the operation of assisting victims and rehabilitate the areas devastated by large-scale or high magnitude disasters.
- Coordinate the assistance of international organizations in disaster prevention mitigation and rehabilitation.
- Perform any other function required by law or assigned by the Minister of Interior or the Cabinet.

DDPM consist of six bureaus, four divisions, two units, two centers, 12 regional centers and 75 provincial offices. The organizations include:

- Public Sector Development Group
- Internal Audit Unit
- Office of the Secretariat
- Personnel Division
- Road Safety Division
- Information Technology Center
- Public Relations Division
- Disaster Prevention and Mitigation Policy Bureau
- Disaster Prevention and Measures Bureau
- Disaster Prevention Promotion Bureau
- Office of Disaster Prevention and Mitigation Bureau
- Research and International Cooperation Bureau

- Office of Disaster Prevention (75 provinces) and Mitigation
- Disaster Mitigation Directing Center
- Disaster Victim Assistance Center
- Disaster Prevention and Mitigation Regional Center (12 DPMRs)

Information Used

- Information about area affected by flood, drought, storm, and toxic chemicals
- Landslide Project
- Some GIS data developed
- Boundary information
- Demographic information

Information Provided/Relationship to NDWC

- DDPM has installed baseline data in NDWC (demographic, boundary, and base map). NDWC also checks the DDPM website for information about any changes in a given situation.

Normal state

NDWC obtains information from the DDPM website and from the DDPM representative at NDWC.

Emergency state

NDWC has a hotline for DDPM to contact in case of any dramatic emergency situation. DDPM headquarters and local offices also call in to update information.

Focal Point

DDPM has representatives who assist in coordinating with NDWC around specific information or who provide assistance from organizations within DDPM. The representatives include:

- Mr. Raywat Pongsuwan* - Senior Computer Official - Department of Disaster Prevention and Mitigation; and
- Mr. Thiti Tinnakorn Na Ayudaya* - Senior Officer - Department of Disaster Prevention and Mitigation.

Hydrographic Department of Royal Thai Navy (HDRTN)

HDRTN officially formed in 1921. A Hydrological division had existed under the Navy since 1900.

Duties and Responsibilities:

- Conduct oceanographic surveys in all Thai waters and collect meteorological and seismic information. Tidal observations and forecasts are under the responsibility of the Oceanographic Division of the Hydrographic Department of the Royal Thai Navy.
- Conduct hydrographic surveys and production of all nautical charts in Thai waters.
- Operate a Differential Global Positional System Reference Station.
- Oversight of technical workings regarding the Law of the Sea in Thai waters, and the demarcation of boundaries of Thailand in inter-country rivers with neighboring countries.
- Aid navigation in the open seas of Thai waters.
- Maintain standard time of Thailand, and time services to the public.
- Distribute nautical charts, nautical publications, and astronomic information.

Information used

- HDRTN operates nine water gauge stations, five stations are located along the shore and four stations are located on the inlands of Tarutao, Thaphao Noi, Miang, and Similan. These stations provide real-time water level data directly to HDRTN, with three stations linked by satellite and the other six stations linked through the Global System for Mobile Communications. The HDRTN is currently upgrading the water gauge network to measure water levels every 15 to 30 minutes in support the national early warning system.
- Water level information is provided in both digital and textual formats. The water gauge network is being developed to use solar cell system to improve the linkage back to HDRTN.
- HDRTN operates a seismic center at Chiangmai, which can detect seismic activities, report locations, and provide other details within 20 minutes.

Information provided, Relationship with the NDWC

- Two of nine stations - Miang and Thaphao Noi Islands - have been installed and are operated by University of Hawaii through the GLOSS (spell out) Network. The information is updated every 10 minutes through the GLOSS website.

Normal State

- NDWC can assess the information from the HDRTN website. There is a plan is to have a direct link between HDRTN and NDWC by leased line. HDRTN will update the information by FTP. At the moment, HDRTN provides some information, such as sample files and maps to NDWC via FTP.

Emergency State

- Presently, HDRTN contacts NDWC by phone or fax if any dramatic change occurs in sea level heights. A formal trigger mechanism has not been established, but there is currently a plan to create a direct link between HDRTN and NDWC. At times of emergency, HDRTN will open the link to NDWC so the Center can directly access the information.

Focal Point

HDTRN provided Navy personnel to work closely with NDWC at the Center to set up and assist in information from the Navy base, as well as emergency response operation. Those personnel already rotated back to HDTRN, but are still working as the formal focal points.

Representatives include:

- Capt. Song Ekmahachai, RTN - Chief of Operation - Hydrographic Department of Royal Thai Navy; and
- Col. Itsara Suppanamou.

Department of Mineral Resources (DMR)

Mission Overview

DMR is responsible for the preservation, conservation, rehabilitation, and management of geological and natural resources, as well as geological and mineral resources exploration and evaluation. DMR is also responsible for defining and managing mineral resource preservation and conservation areas.

Duties and Responsibilities:

- Introduction of opinions or suggestions on specifications, policies, and plans for conservation, preservation, rehabilitation, and management of geological and mineral resources.
- Exploration, research, data dissemination, and cooperation with international governments and organizations on all aspects of geological and mineral resources.
- Specification of geological and mineral resources standards, including gathering and maintaining geological and mineral resources references.
- Enforcement of compliance with the relevant sections of the Minimal Act B.E. 2510.

- Introduction of improvements and amendments regarding the disciplines and measures on conservation, preservation, rehabilitation, and management of geological and mineral resources, including legal supervision, evaluation, and investigation.
- Implementation of any other operations specified by law and the Cabinet to be the responsibility of the DMR.

Information Used

DMR is continuing to develop GIS, digital maps, and data for the entire country. The area of coverage is dependent upon the specific scale required.

- Landslide: Hazard Maps (the Department of Land Development also develops the landslide map serving its own purposes)
- Risk Maps (partially)
    1. Tsunami Inundation Maps (GIS format)
    2. Geological Map (Digital map)
    3. Active Fault Map

Relationship to NDWC/ Information Provided

Normal State

- DMR has representatives at NDWC to assist in any disaster management procedures.

Emergency State

- DMR experts and staff will make decisions to contact NDWC, as needed.

Focal Point

DMR representatives at NDWC include:

- Mr. Waiyapot Worakanok - Geoscientist - Department of Mineral Resources
- Mr. Tinnakorn Tatong - Senior Geologist - Department of Mineral Resources
- Mr. Passkorn Kunthasap - Geoscientist - Department of Mineral Resources
- Mr. Suwith Kosuwan - Senior Geologist - Department of Mineral Resources
- Ms. Tamonwun Wunpun - Scientist - Department of Mineral Resources

Royal Irrigation Department (RID)

Mission Overview

RID falls under the Department Ministry of Agriculture and Cooperatives. RID is responsible for providing, storing and conserving, regulating, and distributing water and releasing or allocating water for agriculture, energy, domestic consumption, and industry. RID's responsibility also includes the prevention of damage caused by water and inland navigation within irrigation areas.

Duties and Responsibilities (Office of Hydrology and Water Management):

- Policy making and planning for the implementation plan in hydrology and water management.
- Formulation of hydrological criteria for the operation of irrigation projects. Investigation and compilation of data on hydrology, meteorology, sediment, and water quality in natural water resources and in irrigation projects.
- Study, analysis, and development of water management by modern technology for proper planning of water management of particular irrigation projects.
- Planning, research, studies, and experiments on crop irrigation water requirements for suitable planning of water resources development and water distribution of particular areas.
- Planning, implementation, and development for utmost efficiency of water forecast.

- Processing and compilation of basic data and statistics on hydrology, meteorology, water management, agriculture, etc. for irrigation purposes. Dissemination and technical advice on hydrological information.
- Cooperation with or support to the operation of other offices and divisions as assigned by the Department.

Information used

- RID operates 173 telemetered stations and obtains real-time data of water levels at dams and in watersheds along river systems. RID uses this information to compare the annual average water levels to real time values.
- During an event, the data can be updated from every hour to every 15 minutes. The data is collected manually and forwarded to one of eight TMD regional data facilities The data also goes to 16 Royal Irrigation Department offices around the country, including Bangkok.

Information provided/ Relationship to NDWC

Normal State

- RID sends email and fax of water level reports to NDWC at approximately 10 am daily.

Emergency State (Plan)

- At the moment, if a critical emergency occurs, RID would call or fax water level information to NDWC. There are plans to establish a direct link between NDWC and RID, and to install a server as a data transferring system.

Focal Point

- Mr. Chanchai Suvanpimel - Expert on Hydrology – (the Royal Irrigation Department has also conducted training for NDWC staff on RID databases and information.)

Royal Thai Survey Department (RTSD) – National Mapping Agency

The Royal Thai Survey Department (RTSD) is under the Office of Supreme Commander, and provides data, maps, and other information of Thailand at a 1:50,000 scale to the Ministry of Defense and other government agencies or private organizations upon request. The information can only be used for the purpose of country development.

Duties and Responsibilities:

- Conduct ground and air surveys to develop maps in a GIS format.
- Implement Geodesy and Geophysics System.
- Train and educate on the technical issues, and the use of military maps.

Information Used/Provided to NDWC

- The Royal Thai Survey Department has a Memorandum Of Understanding with the NDWC to provide the 1:50,000 maps and other related information upon request.

Focal Points

- Col. Wanchai Singthong* - Office of Supreme Commander H/Q; and
- Col. Krith Bunthid - Chief of Map Information Center - Royal Thai Survey Department.

Electrical Generation Authority of Thailand (EGAT)

Mission Overview

EGAT was established on May 1, 1969 by a promulgation of the Electricity Generating Authority of Thailand Act B.E. 2511. The promulgation merged assets and operations of three state enterprises, specifically, the Yanhee Electricity Authority, Lignite Authority, and the Northeast Electricity Authority. Presently, EGAT is a state enterprise under the Ministry of Energy. EGAT develops, owns, and operates the national transmission network, and controls hydro-electrical dams.

Information Used

- EGAT controls hydro-electrical dams, and consequently it has installed seismometers to detect seismic activities in areas where these dams are located.
- In some areas the data is automatically forwarded to EGAT headquarters in Bangkok, while in other areas the data is read manually, recorded, and is later sent to Bangkok.

If seismic activity is detected, the information is forwarded to the VIP [?] of EGAT and to TMD. In general, EGAT does not release seismic data to other organizations.

Focal Point

- Mr. Wattana Thongsiri - Executive Vice President - Hydro Power Plant – Electricity Generation Authority of Thailand Public Company Limited.

Pollution Control Department (PCD)

PCD was established on June 4, 1992 under the Royal Decree on the Organizational Division of Pollution Control Department, Ministry of Science, Technology and Environment B.E. 2535 (1992), as a result of the Enhancement and Conservation of the National Environment Quality Act B.E. 2535 (1992).

Mission Overview

PCD is responsible for controlling, preventing, reducing, and eliminating pollution, as well as conserving and rehabilitating an environment conducive for human life.

Duties and Responsibilities:

Submit opinions for the formulation of national policy and plans for the promotion and conservation of environmental quality with respect to pollution control.

- Make recommendations for the establishment of environmental quality standards and emission/effluent standards.
- Develop environmental quality management plans and measures to control, prevent, and mitigate environmental pollution.
- Monitor environmental quality and prepare an annual report on the state of pollution.
- Develop appropriate systems, methodologies, and technologies for the application in the management of solid waste, hazardous substances, water quality, air quality, noise level, and vibration.
- Coordinate and implement measures to rehabilitate and remedy damages caused by pollution in the contaminated area and environmental damage appraisals.
- Provide assistance and advice on environmental management.
- Cooperate with other countries and international organizations on environmental management.
- Investigate public complaints about pollution.
- Perform other functions on pollution control as specified by the Enhancement and Conservation of National Environmental Act, B.E. 2535 (1992) and other related laws.
- Perform other functions as may be designated by law to be the responsibilities of the Department or by the Ministry of Natural Resources and Environment or by the Cabinet.

Focal Point

- Khun Annop Bungraksathum at PCD.

Forest Fire Control Division (FFCD)

FFCD falls under the National Park, Wildlife, and Plant Conservation Department, which is under the Royal Forest Department, Ministry of Agriculture and Cooperatives.

Duties and Responsibilities:

- Develop information needed for fire control planning.

- Develop fire statistics based on the historical occurrences fires.
- Develop fire equipment, fire campaign materials, techniques and tactics in fire prevention, as well as fire suppression.
- Provide training for Fire Boss, Crew Boss, Fire Crew, Fire Tiger Special Force, and Fire Volunteer in fuel management (fire break, control burning etc.), fire detection and reporting, pre-suppression, fire suppression, and evaluation.
- Supervise and coordinate fire control stations in their respective areas.
- Establish an ad-hoc Fire Command Post when needed.
- Execute Mobilization Plan to combat large fires and conduct rescue operations in forested areas.
- Conduct a year-round forest fire prevention campaign.
- Act as National Fire Monitoring Centre, as well as Competent Agency under the ASEAN Agreement on Haze Trans-boundary Pollution.

Information used

- Fire fuel types, loading (biomass), topography, and weather conditions to determine fire potential and fire risk areas.
- Fire fuel types, loading (biomass), topography, and fire statistics to determine pre-fire suppression areas.

Focal Point

- Khun Siri Akankara, FFCD.

Geo-Informatics and Space Technology Development Agency (GISTDA)

GISTDA operates ground receiving stations to acquire data from leading remote sensing satellites. Images are archived in standard formats and media, available for users worldwide. GISTDA also coordinates with some related agencies to study and analyze satellite images for various applications. In addition, this public organization operates the maritime environmental monitoring system, “Sea Watch.” The program started in 1991. Currently, three bouys are operational.

Focal Points

- Dr. Thongchai Charupat, Director;
- Dr. Pakcom Apaphamt, Senior Engineer; and
- Mrs. Sirilak Preukpitikul, Senior Scientist.

International Data Providers

Asian Disaster Preparedness Center (ADPC)
The Asian Disaster Preparedness Center (ADPC) is a non-profit organization supporting the advancement of safer communities and sustainable development, through implementing programs and projects that reduce the impact of disasters upon countries and communities in Asia and the Pacific, by:

- Developing and enhancing sustainable institutional disaster risk management capacities, frameworks and mechanisms, and supporting the development and implementation of government policies;
- Facilitating the dissemination and exchange of disaster risk management expertise, experience and information; and
- Raising awareness and enhancing disaster risk management knowledge and skills.

ADPC will serve as a regional early warning center for participating countries in Southeast Asia and the Indian Ocean region by establishing a real-time seismic and sea level monitoring stations network. ADPC will also provide warning information to NDWC and other participating national warning centers. ADPC will also provide training to enhance the capabilities on NDWC, as needed.

Information provided
- Seismic, sea level data, and warnings (proposed).

Focal Point
- Loy Rego at ADPC;
- Dr. A. Subbiah; and
- Dr. Penneung Wanitchai (co chair ADPC and AIT).

Pacific Tsunami Warning Center (PTWC), Hawaii, USA. The PTWC continuously monitors seismological data from the National Earthquake Information Center and countries within the Pacific Basin that are members of Tsunami Warning System. When a potential tsunami-generating earthquake occurs, PTWC monitors water level data to begin to assess if a tsunami has been generated. If the likelihood of a tsunami is high, PTWC will issue a warning bulletin.

PTWC provides near real-time (a) Tsunami Watch, Warning, and Cancellation Bulletins, (b) Tsunami Travel Time maps, (c) Seismic data, and (d) Water level data, where available.

Japan Meteorology Agency (JMA), Japan, provides weather and climatological information. Additionally, JMA also provides seismic information and tsunami warning bulletins if a tsunami is likely. JMA provides data products including (a) Warning Bulletins, (b) Tsunami Travel Time maps, (c) Seismic data, and (d) Water level data, if available.

U.S. Geological Survey's (USGS) National Earthquake Information Center (NEIC), Colorado, USA. The USGS can quickly determine (in near-real time) the location and magnitude of any destructive earthquake occurring worldwide, using the Global Seismic Network (GSN). GSN has 141 seismographs located worldwide, of which 84 are operated by USGS. Most of the 141 stations are telemetered to the NEIC data processing center.

NEIC data and information products include (a) Warning Bulletins, (b) Graphical map products showing locations of current, past and historical earthquakes, (c) Seismic sources of current, past, and historical earthquakes, and (d) Informational links to other network systems.

Appendix C
Stakeholder Workshop Agendas and Participants

Agenda & Participants Lists: NDWC CONOPS Stakeholder Workshop, Feb 16; NDWC Multi-Agency CONOPS Stakeholder Workshop, Feb 17; and Follow-up Interagency Coordination Meeting, February 24, 2006 (Participants List Only)

Agenda
Technical Assistance (TA)
To Thailand National Disaster Warning Center (NDWC)
The Concept of Operations (CONOPS) Workshop
February 16, 2006
At National Disaster Warning Center (NDWC), Thailand

9.00 – 9.15 AM	Welcome and Introductions (NDWC) • Purpose of Meeting • Project Overview and Status • Planned Proceedings for Feb 17 Stakeholder Workshop
9.15 – 9.45 AM	Draft CONOPS Review (PDC) • Purpose of CONOPS document • Approach and methodology to develop CONOPS • Findings and Recommendations Relative to Best Practices
9.45 AM	Q&A and NDWC Feedback on CONOPS (group discussion)
10.15 AM	Break
10.30 – 11.15 AM	Decision Support System (DSS) Brief • Proposed Decision Support improvement to NDWC info flow, tying DSS into NDWC Concept to Operations • Additional agency information improvements to DSS • Next Steps, towards multi-hazards
11.15 AM	Q&A and Feedback on DSS (group discussion) • Agreement on Critical Issue Discussion for Afternoon
12.00 PM	Lunch Hosted by PDC
1.00 PM	Feedback on key issues, working session • Small Working Groups, as necessary • Capture results and bring into second day
2.30 PM	Outcomes of Day & Key Issues and Findings
3.00 PM	Adjourn: Outcomes of Day & Key Issued and Findings

Participants List
Technical Assistance (TA)
To Thailand National Disaster Warning Center (NDWC)
The Concept of Operations (CONOPS) Workshop
February 16, 2006
At National Disaster Warning Center (NDWC)

Pacific Disaster Center

1. Mr. Stanley Goosby PDC
2. Mr. Jim Buika PDC
3. Ms. Pimkarn Sabprung PDC, Thailand

National Disaster Warning Center

4. Mr. Pisnupong Anuratpanich NDWC
5. Gp.capt. Chitipat Bejraburanin NDWC
6. Ms. Tamonwun Wunpun NDWC
7. Mr. Sanchai Sutjaritvongsanon NDWC
8. Mr. Suwith Kosuwan NDWC
9. Mr. Tinnakorn Tatong NDWC
10. Mr. Raywat Pongsuwan NDWC
11. Mr. Thiti Tinnakorn Na Ayudhaya NDWC
12. Mr. Passkorn Kunthasap NDWC
13. Mr. Cherdsak Virapat NDWC
14. AVM. Pakdeewat Vajirapunlop NDWC

Agenda
Technical Assistance (TA)
To Thailand National Disaster Warning Center (NDWC)
The Concept of Operations (CONOPS) Stakeholders Workshops
February 17, 2006
At Richmond Hotel, Bangkok, Thailand

9.00 – 9.30 AM	Welcome and Introductions (NDWC) • Purpose of Meeting • Project Overview and Status • Review of Previous Day Outcomes and Proceedings • Procedure for Stakeholder Workshop
9.30 – 10.15 AM	Draft CONOPS Review (PDC) • Purpose of CONOPS document • Approach and methodology to develop CONOPS • Significances of stakeholders contribution to CONOPS • Findings and Recommendations Relative to Best Practices
10.15 AM	Break
10.30 AM	Decision Support System (DSS) Brief • Proposed Decision Support improvement to NDWC info flow, tying DSS into NDWC Concept to Operations • Additional agency information improvements to DSS • Next Steps, towards multi-hazards
11.00 AM	Q&A and Feedback on DSS (group discussion) • Facilitated discussion with translation and moderation • Capture results • Agreement on Critical Issue Discussion for Afternoon • Discuss logistics for afternoon session (assign groups per issue)
12.00 PM	Lunch Hosted by PDC
1.00 PM	Feedback on key issues, working session • Small Working Groups, as necessary
2.00 PM	Group Plenary Report Out on Issues and Findings
2.45 PM	Closing Remarks (NDWC) • Project Next Steps, process, and mechanism for CONOPS finalization
3.00 PM	Adjournment

Participants List
Technical Assistance (TA)
To Thailand National Disaster Warning Center (NDWC)
The Concept of Operation (CONOPS) Stakeholders Workshop
February 17, 2006
At Richmond Hotel, Bangkok, Thailand

Pacific Disaster Center

1. Mr. Stanley Goosby PDC
2. Mr. Jim Buika PDC
3. Ms. Pimkarn Sabprung PDC, Thailand

National Disaster Warning Center

4.	Mr. Taweesak Deangchai	NDWC
5.	Mr. Pisnupong Anuratpanich	NDWC
6.	Ms. Tamonwun Wunpun	NDWC
7.	Mr. Suwith Kosuwan	NDWC
8.	Mr. Tinnakorn Tatong	NDWC
9.	Mr. Raywat Pongsuwan	NDWC
10.	Mr. Thiti Tinnakorn Na Ayudhaya	NDWC
11.	Mr. Passkorn Kunthasap	NDWC
12.	Mr. Cherdsak Virapat	NDWC
13.	Mr. Tawan Sukko	NDWC
14.	Mr. Waiyapot Vorakanok	NDWC
15.	Ms. Ratchanan Wannopad	NDWC
16.	Mr. Sanchai Sutjitwongsanon	NDWC

Stakeholders

17.	Mr. Pratuan Pettaku	Gistda
18.	Mr. Pakorn Apapan	Gistda
19.	Capt. Song Ekmahachai	Hydrographic Dept.
20.	Capt. Witoon Tuntikul	Hydrographic Dept.
21.	Dr. Anat Reungratsamee	Chulalongkorn Univ.
22.	Mr. S.H.M. Fakhruddin	ADPC
23.	Maj. Sompoch Puntavung	RTSD
24.	Maj. Attawud Kiatiwat	RTSD
25.	Mr. Samai Jiamjinda	DMR
26.	Mr. Vorawud Tantivanit	DMR
27.	Mr. Nattapon Sap-Anake	Sun Microsystems
28.	Mrs. Sumalee Prajuob	TMD
29.	Mr. Burin Vedbunturng	TMD
30.	Ms. Piyachat Pradubraj	USAID
31.	Mr. Orestes Anastasia	USAID
32.	Mr. Annnop Sujritatam	PCD
33.	Mr. Charoon Laolerdchai	DDPM
34.	Mr. Apirat Buncharaksri	DDPM
35.	Mr. Somsak Suwansujit	DDPM
36.	Mr. Chatchai Promlerd	DDPM
37.	Mr. Siri Akkaraatt	Wildfire Dept.
38.	Mr. Chanchai Suwampimon	RID
39.	Col. Issara Suppanamai	Civil & Military

Technical Assistance (TA)
To Thailand National Disaster Warning Center (NDWC)
The Concept of Operation (CONOPS) Stakeholders Workshops

"Follow-up Interagency Coordination Meeting on Issues, Findings, Recommendations, and Notes from NDWC CONOPS Stakeholders Workshop, February 16, 2006 and NDWC Multi-Agency CONOPS Stakeholders Workshop, February 17, 2006"

February 24, 2006
At National Disaster Warning Center (NDWC), Thailand

Participant List

Pacific Disaster Center

1. Mr. Stanley Goosby PDC,
2. Ms. Pimkarn Sabprung PDC,Thailand

National Disaster Warning Center

3. Mr. Raywat Pongsuwan NDWC
4. Mr. Waiyapot Vorakanok NDWC
5. Ms. Tamonwun Wunpun NDWC
6. Mr. Cherdsak Virapat NDWC
7. Mr. Taweesak Deangchai NDWC

Stakeholders

8. Mr. Pakorn Apapan Gistda
9. Maj. Attawood Kiatiwat RTSD
10. Dr. Anat Reungratsamee Chulalongkorn Univ.
11. Mr. Apirat Buncharaksri DDPM
12. Mr.Supakit Phopapapan DDPM
13. Ms. Sumalee Prachuab TMD
14. Mr. Phuwieng Prakhanintara TMD
15. Mrs. Kamolrat Saringkarnphasit TMD
16. Capt. Witoon Tuntikul Hydrographic Dept.
17. Mr. Annnop Sujritatam PCD
18. Capt. Wannapol Glormgeao Royal Thai Navy