Asian Institute of Technology

Working Paper on

AIT's Response to the Earthquake and Tsunami in South and Southeast Asia

25 January 2005

There is now international acknowledgement that efforts to reduce disaster risks must be systematically integrated into policies, plans and programmes for sustainable development and poverty reduction, and supported through bilateral, regional and international cooperation, including partnerships. Sustainable development, poverty reduction, good governance and disaster risk reduction are mutually supportive objectives, and in order to meet the challenges ahead, accelerated efforts must be made to build the necessary capacities at the community and national levels to manage and reduce risk.

United Nations, Hyogo Framework for Action 2005–2015

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Overview of AIT's Response to the Tsunami

On Sunday, 26 December 2004, the biggest earthquake in 40 years occurred some 150 kilometers off the west coast of Aceh Province on the northern tip of the island of Sumatra in Indonesia. The earthquake measured 9 on the Richter scale, making it the fourth largest earthquake in the world since 1900, and the largest since the 1964 Alaska earthquake. The earthquake generated a disastrous tsunami that caused destruction in 11 countries bordering the Indian Ocean. The quake was widely felt in the Indonesian island of Sumatra, Malaysia, Myanmar, Singapore, Thailand, Bangladesh and India, including the Nicobar and Andaman Islands.

The AIT community was deeply saddened and shocked by the unprecedented scale of destruction of lives and properties caused by the earthquake and tsunami. The magnitude of the disaster is hard to comprehend, and the close ties AIT enjoys with affected partner countries render these losses still more distressing In the immediate aftermath of the catastrophe, various AIT experts were called upon by relevant international and national agencies, and they have contributed to the emergency and initial assessment phase of the response.

AIT's mission is "to develop highly qualified and committed professionals who will play a leading role in the sustainable development of the region and its integration into the global economy." To this end, AIT serves the human resource development needs of developing countries in Asia, taking into account their specific development priorities, gender issues and social values. In response to the recent tragedy, the Institute has looked into how it can assist and contribute, as an institution of technology in service of the region. Teams of experts from AIT joined with local and international agencies on several missions to visit the affected areas in southern Thailand and in Sri Lanka, to assess the situation first hand, and to define ways in which AIT together with its partners could further provide assistance including the rehabilitation of the affected areas.

The team's findings were presented at a special seminar held at AIT on Wednesday, 19 January 2005. Representatives of the governments of the affected countries and AIT's key partners, local and international agencies, partner institutions, alumni, media together with members of the AIT Community attended the seminar. The program and presentations are available on the AIT website at *www.tsunami.ait.ac.th*.

Following the presentations, there was an open discussion about specific areas in which AIT could provide assistance, what should be the Institute's strategy, and with whom AIT could partner. Much positive feedback and many expressions of interest in partnering AIT in specific activities were received.

There was agreement that AIT's role should focus more on longer-term reconstruction and rehabilitation efforts than immediate relief efforts. The need to incorporate sustainable development as a core principle in all AIT's efforts was also stressed. While the planning of reconstruction and rehabilitation programs together with efforts to develop early warning systems are currently underway at the national and regional levels, it was agreed that AIT should offer its expertise in areas in which it could play an important role, and contribute to the necessary rethinking in the design of prevention and mitigation systems for all geo-hazards in the region.

The main areas in which AIT intends to pursue further initiatives with its partners are:

1. Assessing the damage and mapping the risks
2. Disaster management
3. Sustainable rehabilitation and reconstruction of affected areas.

Assessing the Damage and Mapping the Risks

There is an urgent need to collect and integrate information gathered on the effect of damage caused by the tsunami, and to incorporate this information into maps and images captured using RS and GIS on a web map server, open to the community at large. Other institutions are also participating in the data sharing and making their data available through the web map server network. This information can be compiled into a comprehensive digital archive for future study and research. Tsunami data on damage, wave height, wave directions and so on should be gathered urgently before clearing work removes valuable information.

The development of an interim tsunami alert system (TAS) is being considered. The design and administration of a regional tsunami warning system will take longer to agree upon. The TAS could use mobile phone technology to disseminate information about earthquakes that are likely to cause tsunamis. Information from a web page, updated every 10 minutes, would be checked and data entered into the TAS. A magnitude of 7 on the Richter scale would be the criterion for sending an alert message. The TAS will provide life-saving information for people in the event of any future tsunami.

After more complete information is available, a comprehensive longer-term study on tsunami risk assessment of the whole affected coastal areas should be carried out. Tsunami risk assessment requires a lot of data on aspects such as seismic activity in the region, a lot of which has been gathered by AIT. Further data needs to be collected on the accumulation of sedimentation in the Andaman Sea, which can cause submarine landslides, together with information on the geometry of the coastal line and seabed, the topology, and land use coverage. These data would eventually be used for reliable modeling of tsunami inundation and the effects of such inundation. Technology of mapping damages using remote sensing, 3D information, and mobile devices linked with geo-spatial information should be developed and implemented. This includes real-time disaster information collection.

To study the effect of a tsunami for different scenarios, including variation in the magnitude of an earthquake, location of the epicenter and degree of deformation, the recording of present tsunami inundation height and area is not adequate. Numerical modeling of tsunami propagation on a smaller scale, including fishing villages and coastal towns, will help provide invaluable information for long-term planning, including evacuation plans. Computed results for the velocity of the current bore generated by a tsunami, run-up height and inundation extent will be useful for disaster preparedness. Real-time computation of tsunami propagation will even provide online information on the location of a tsunami and the degree of damage. This type of tool should be investigated for future preparation.

Proposed actions

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Disaster Management: Lessons Learned

Management of disasters in Thailand and in most developing countries is the responsibility of various agencies and organizations. In general, there is a lack of effective integration or comprehensive planning and coordination. Disaster management tends to be reactive, meaning in effect rescue, relief and recovery during and after a disaster. Many organizations and communities are involved in disaster management. Each coordinates its own activities, which frequently conflict with those of other organizations. No single agency has full responsibility for disaster management. There is no master plan, legislative support or standard policy and procedures to effectively manage disasters. Nationwide or basin wide databases, online monitoring information systems and infrastructure for disaster prevention and control need to be established.

The magnitude and extent of the 26 December 2004 tsunami took the world by surprise. The tsunami hit the coastline of Phuket and Phang Nga 1-1.5 hours after the earthquake off the northern coast of Sumatra. There was no prior warning, and people were unaware of its approach. As a result 5,322 people in Thailand, more than half of whom were foreign tourists, lost their lives, with many thousands more injured and missing. If a warning had been given, people could have moved to higher ground, and the number of casualties would have been much smaller.

After the tsunami, high-ranking officials from different organizations rushed to visit the affected areas. Acting in good faith, they established chains of commands for emergency, rescue and relief operations. Some actions taken were redundant, unclear or in conflict with commands by the authorized personnel, namely provincial governors or designated representatives, with the result that these persons lost their authority. During emergency, rescue and relief operations, many officers, afraid of violating their given authority, dared not to take decisions. Some did not know clearly the extent of their duties and responsibilities. Many subordinates waited for commands from their supervisors, as there was no clear emergency chapter for them to operate on site. Many donations of food and other supplies were not delivered to refugees in remote areas because of a lack of available vehicles.

There have been many problems of logistic supply, database, telecommunication and transportation. There is a lack of coordination and understanding of the work being done by rescue and relief units between provinces, district and sub-district administrative offices, NGO and private agencies including individual volunteers.

These findings indicate that the four principal components of disaster management – preparedness, readiness, emergency response, rehabilitation and recovery – are not functioning effectively. A clear-cut policy and legislation on disaster management are therefore required. An institutional framework should be established to avoid repetition of responsibilities and conflicts between agencies and organizations.

An effective lead agency should be established to take full responsibility for overall proactive disaster management at national, province and local or community levels. Enabling legislation should be passed to allow the lead agency to carry out integrated disaster management in cooperation with other organizations. Policy measures, including an implementation plan, should be developed for disaster management. A River Basin and Coastal Zone Civil Defense Committee should be established as the lead agency to manage large-scale disasters at the national level.

Proposed action

- An Integrated Proactive Approach to National Disaster Management (*page 26*)

Sustainable Rehabilitation and Reconstruction of Affected Areas

The main objectives of this group were to assess the medium and long-term impacts of the tsunami on communities in affected areas, and to identify a role for AIT in providing technical assistance in partnership with government agencies, international organizations, private sector, NGOs and local communities.

The impacts on natural resources, environment and people's livelihoods in tsunami-affected areas were identified. Many coastal and marine resources, including coral reefs, national parks, sea grass and mangrove forests, were damaged to varying degrees. Significant destruction was found to have occurred in fisheries, beach forests and resorts in tourist areas in Phang Nga province.

In local communities, environmental facilities, public infrastructures and settlements were destroyed, causing losses of life and property to local people.

Support to local communities from internal and external resources has been overwhelming. However, there remains a lack of proper coordination, both technical and financial, on rehabilitation efforts. There are still no clear guidelines or framework to direct the formulation of a long-term rehabilitation plan in those areas.

AIT is proposing a holistic, integrated and participatory approach to the design and implementation of local rehabilitation plans Such a plan should cover social, economic and institutional aspects of people's livelihoods, most importantly among vulnerable groups, which can ensure the sustainable development of local communities.

A key strategy to implementing the plan is to prioritize affected areas according to the degree of impact. This will ensure that appropriate interventions are designed and implemented according to priorities, and integrated into existing local-level planning frameworks.

AIT can provide technical assistance in several key areas covering ecology and coastal resources, environmental protection and management, tourism, fisheries/aquaculture, capacity building and community development.

Proposed actions

- An Innovative Multi-Disciplinary Approach to Community Reconstruction of Tsunami-Affected Region: A Model Village *(page 28)*
- Impact of Tsunami on Coastal Ecosystems: Evaluation and Rehabilitation *(page 31)*
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- Utilization of Mangrove Forests *(page 35)*
- Planning for Coastal Changes: Regulations and Guidelines for Development Setbacks (*page 37)*
- Waste and Wastewater Management in Tsunami-Affected Areas (*page 39*)

Other AIT Initiatives

A consortium of six Asian and European universities, including universities in three of the worst affected countries – Thailand, Sri Lanka and India – has been formed, and an AIT team is currently preparing a project proposal on disaster and natural hazard awareness education to be submitted to EC-EuropeAid.

AIT plans to initiate a region-wide consultation regarding the role of debt conversion for promoting sustainable reconstruction projects in the aftermath of the tsunami. Actors involved would include finance ministries and central banks of affected countries interested in such a scheme, international finance organizations and NGOs. It has also launched a reflection on legal and regulatory issues caused by the tsunami and the response to it.

AIT students will be encouraged to select research topics relevant to the topics addressed in this concept note.

Working in Partnership with the Region

AIT intends to pursue the actions outlined above in partnership with key government agencies, international organizations, NGOs, and other actors. It will leverage its international networks, both in the region and worldwide, to match local knowledge and know-how to state-of-the-art technology and expertise and contribute to the development and implementation of an appropriate and sustainable response to the disaster. It will fully mobilize its network of more than 13,000 AIT alumni, many of whom occupy key positions across the region.

In particular, AIT will act as a bridge enabling its findings to be brought to the attention of the concerned regional and international community so that the affected communities are better prepared for future calamities. Many academic and research institutions in the region are conducting similar studies and, to this end, AIT's leadership could play an important coordinating role.

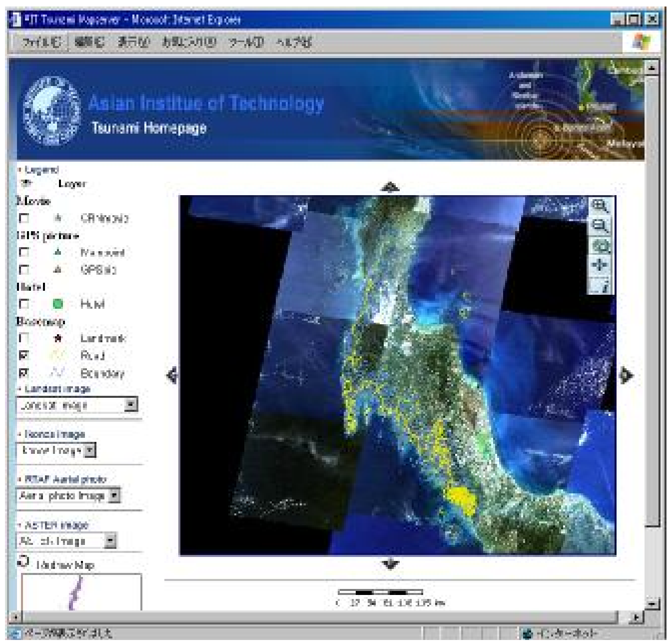
Concept Notes

Tsunami Geo-Spatial Information Sharing – A Web Map Server Network

Background

Geo-spatial information, such as remote sensing, aerial photographs, existing maps, field survey photos and movies, survey records and socioeconomic data are the base information to be analyzed for tsunami disaster mitigation. The analysis includes steps such as damage mapping, infrastructure rehabilitation, natural resources rehabilitation, risk map development, tsunami early warning system including information dissemination, and tsunami simulation. How quickly and easily geo-spatial information is provided at each step is one of the most important factor determining the effectiveness of tsunami relief work.

Web Map Service (WMS) is a recent technology that makes it possible to share geo-spatial information on the internet. Users can access data through the WMS, without copying huge quantities of data to their local system. It is also quite feasible for an organization to publish other institutes' data by running their own WMS. WMSs can be linked to each other so that users can obtain data from multiple WMS without knowing from where data are actually being served. Engineers, researchers, decision makers and anyone else who needs such data can share and access it , thus contributing to the effectiveness and consistency of tsunami relief work, enhancing awareness, and stimulating various analysis works.



Working with 13 collaborators, AIT has launched a WMS for sharing tsunami geo-spatial information. the WMS serves remote sensing images of before and after the tsunami from various satellites including very high resolution images (1m resolution), aerial photographs, base infrastructure maps, photos and movies from field surveys.

The current systems demonstrates the huge demand to the system. Just one day after launching the WMS, 80 different users accessed the site, with a total of 7,000 image requests recorded. The address of the current system is

mapserver.hondalab.star.ait.ac.th/tsunami/

Objectives

The main objective of the project is to expand the WMS network to serve geo-spatial information sharing for tsunami disaster mitigation. Here, 'the network' refers to both institutional network and the physical WMS network.

Specific objectives are to:

- Expand collaboration among participating agencies to gather more geo-spatial information. Participating agencies may form a Tsunami Geo-Spatial Information Consortium
- Database development, including data processing such as mosaicing and precision geometric correction on remote sensing images, given the huge number of photos

- Maintain and expand a server system to serve the huge amount of data
- Provide technical support to organizations who would like to run a WMS themselves.

Actions

The project period is two years. Other institutes are also invited to collaborate, and possibly to form a consortium. All data contributors will be acknowledged in the system to encourage others to contribute and collaborate. Other institutes may run their own WMS and publish data, or existing WMS may host their data. WMS will be linked to each other, and a WMS data sharing network will be established. If collaborators requires technical support for running their WMS, technical advice, training and education will also be provided. The system can easily be implemented or expanded to other disasters.

Current Collaborators

- Asian Institute of Technology, Thailand
- Alchemedia K.K., Japan
- National University Corporation Chiba University, Japan
- Chulalongkorn University, Thailand
- Department of Public Works and Town & Country Planning, Thailand
- Earthquake Disaster Mitigation Research Center, Japan
- Earth Remote Sensing Data Analysis Center, Japan
- Geo-Informatics and Space Technology Development Agency, Thailand
- ImageCat, Inc., USA
- King Mongkut's University of Technology Thonburi, Thailand
- Ministry of Natural Resources and Environment, Thailand
- Nippon Koei Co., Ltd. / Digital Service International, Japan
- Royal Thai Air Force, Thailand
- Seismological Bureau, Thai Meteorological Department, Thailand

Technical contact

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Tsunami Hazard Assessment Using Remote Sensing and GIS

Background

The 26 December 2004 tsunami devastated the coastal environment in coastal zones on the western seaboard of Thailand. Land use and land cover, including mangroves, plantations, seagrass and corals, were severely damaged, and in many affected areas destroyed. The damage will certainly impact the ecological balance in the region, and adversely affect the life of local people, many of whom are dependent on fisheries and tourism. Left unattended, recovery will be slow.

There is an urgent need to map the changes and assess the economic damage. This information is essential for decision makers to plan a strategy for restoration of ecology, reconstruction and rehabilitation.

Objectives

The objectives of this study are to map changes in land use and land cover, and to assess the economic damage in tsunami-affected areas

Scope

High resolution satellite data will be used to prepare maps of pre- and post-tsunami land use and land cover. Existing maps of land use, land cover, administrative boundaries, mangroves, aquaculture, plantations and forest will be input into a GIS. Socio-economic data will also be integrated into the GIS. Data received from different sources will be transformed to one standard, and scaled for compatibility and analysis.

Maps will be generated at a large scale, as the damage is generally located in a narrow coastal strip approximately one kilometer wide. All the generated maps will be supplemented by extensive ground truth to incorporate attributes related to the damage.

Satellite data and data from other sources will be utilized to develop a map of changes in coastal ecology, marine ecology, and coastal land use. In addition, an assessment will be made in terms of the economic evaluation of loss in the area.

Proposed Actions

1. Collection of high resolution satellite data
2. A field survey using GPS (Global Positioning System) and other equipment to link satellite driven outputs to real world attributes
3. A marine survey in selected locations where underwater ecology might have changed
4. Collection of ancillary maps and data from related departments
5. Creation of a detailed GIS database
6. Digital image enhancement and classification, and generation of large scale maps pre- and post-tsunami showing changes in land use and land cover
7. Field work for rechecking and validation
8. Assessment of economic loss
9. Report.

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3D Tourism Mapping for Assisting the Recovery of Tourism in Tsunami-Affected Areas

Background

The Indian Ocean tsunami caused the deaths of more than 225,000 people and billions of dollars worth of damage to property along the coastlines of Indonesia, India, Sri Lanka, Thailand and the Maldives. In Thailand, one of the most affected areas was the island of Phuket, world famous as a tourist destination. Thailand is now faced with the urgent task of enabling the tourism industry in Phuket and neighboring provinces to recover as quickly as possible. Even though many hotels and national parks were unaffected by the tsunami, people are still concerned about the after-effects of the tsunami, including its impact on hotels, local transportation, health and safety, and pollution, among other concerns. ICTs (information and communication technologies), remote sensing and geographic information systems can play an important role in the recovery of the region by tracing changes, modeling and simulation, and sharing updated tourism information through web servers.

From the results of our project on airborne Light Detection and Ranging (LIDAR) mapping, we will generate accurate 3D models for change detection and simulation of tsunami-affected areas. Since the impact of a tsunami on any particular hotel is a factor of its location, direction and elevation, we can use these accurate 3D models to generate a new type of tourism maps for re-evaluation of hazard levels for hotels, restaurants, national parks and other tourism facilities. Such maps can provide some guarantee of safety to tourists and tourism operators, essential for attracting people back to Thailand's coasts.

Objectives

The objectives of this research project are to:

- Generate 3D tourism maps on three levels – an index map for the region, a middle-scale map for individual parks or beaches, and large-scale maps for individual hotels and other facilities;
- Detect changes to man-made facilities such as hotels, roads, bridges, water supply lines, and power lines, and to share the updated information on web sites;
- Detect changes to natural phenomena, such as parks, coastlines, forest areas and coral reef areas, and to share the updated information on web sites; and
- Produce large-scale simulations of tsunami-affected coastal zones, and generate tourism hazard maps.

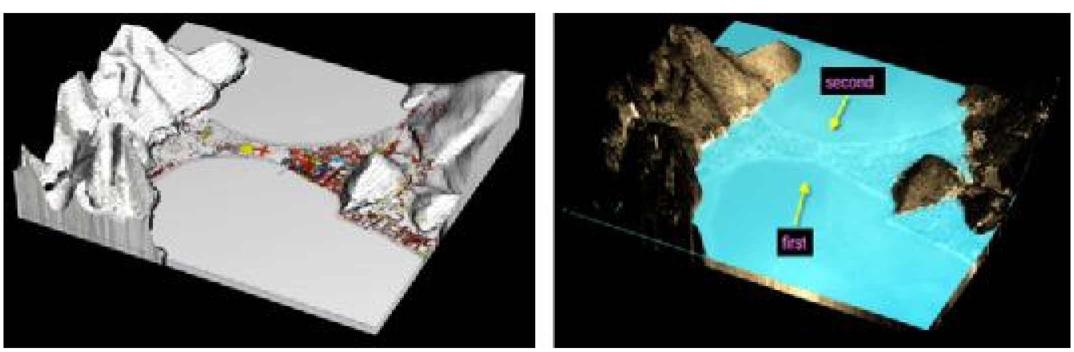

Figure 1. A 3D tourism map and tsunami simulation for Phi Phi Island

Scope

This research covers tsunami-affected areas in Phuket, such as Kamala and Patong, and Phi Phi Island.

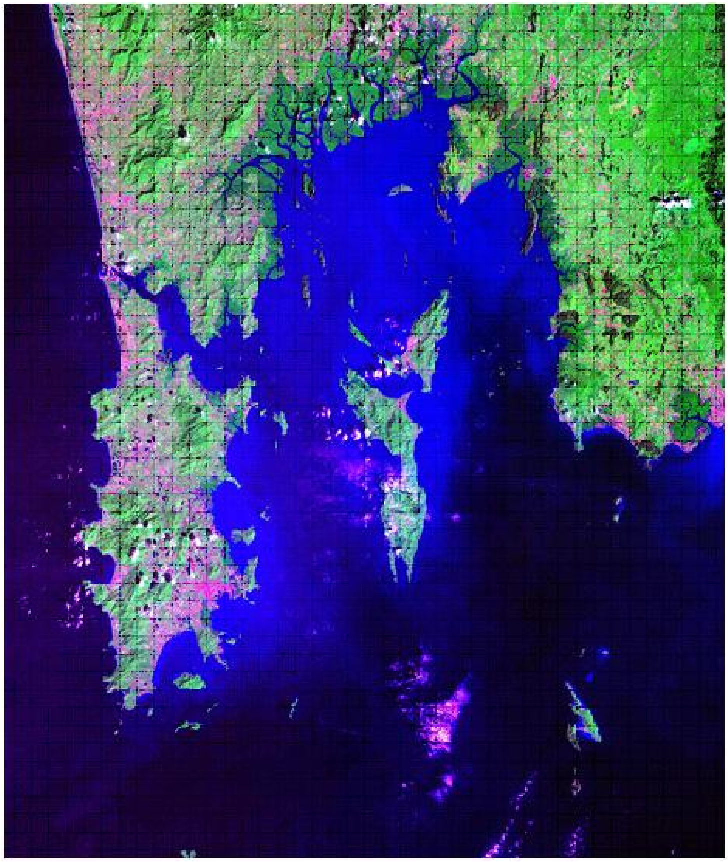

Figure 3. Tsunami-affected areas in southern part of Thailand

Proposed Actions

This research project will involve:

- Collection of information about tourism, including topographic maps, air photos, high-resolution remote sensing images, field surveying data, and text data about hotel and transportation.
- Generation of 3D tourism maps on three levels – an index map for the region, a middle-scale map for individual parks or beaches, and large-scale maps for individual hotels and other facilities;
- Software development for laser data processing, 3D modeling, and tsunami simulation;
- Selection of areas for testing works. Possible targets are Phi Phi Island and Patong Beach; and
- Promotion of regional and international cooperation, through bodies such as the International Society for Photogrammetry and Remote Sensing (ISPRS).

Technical contact

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Wireless GIS-based Tsunami Warning and Evacuation System on PDA

Background

People were caught unaware by the 26 December 2004 tsunami because there was no prior information or warning of the imminent disaster. One challenge to scientists and engineers after the tsunami therefore is to develop devices that provide people with immediate information about impending natural disasters. Automated systems that enable real-time warning of tsunamis would enable timely evacuation from possibly hazardous coastal areas, save precious human lives and avoid miseries for millions.

This project proposal deals with the development of a simple portable tsunami warning, preparedness and evacuation system. The device needs to be small so that people can carry it anywhere. It could be connected to mobile phones for real-time information about the tsunami and guiding people to safer locations. The integrated system would provide information about sea wave height and direction, using the same data as that used for modeling tsunamis.

Objectives

The objectives of this research project are to:

- Establish sea wave measuring and transmission towers at selected locations in Indian Ocean
- Develop a PDA (Personal Digital Assistant) based tsunami warning and evacuation system.

Scope

A PDA with a mobile phone and GPRS will be used to develop a wireless GIS. This system will also comprise advanced gadgets such as Bluetooth GPS (Global Positioning System) and a digital camera. An internet map server will be developed which will contain GIS data on coastal zone land use and land cover maps with all attributes. These maps will be updated using high-resolution satellite data. The server will be interfaced with a coastal hydraulic modeling system. Coastal hydraulic modeling system will receive wave data from the measuring towers at regular interval. This data will be used to forecast wave height and direction at different locations along the coastline. This information will be served online in real-time, and will be displayed on PDA systems in the form of a simulated map.

In the event of a tsunami, the system will forecast a warning for coastal areas about to be inundated, including the time at which the tsunami is expected. The most important feature of the system is the evacuation part. This module will display a map with safer locations and roads to reach those locations.

Proposed Actions

This research project would involve:

1. Establishing floating towers at several locations in the ocean, which can transmit the wave height, speed and direction at regular intervals
2. Developing an internet GIS server
3. Real-time modeling of sea wave height, direction and time at which it would strike the coastline
4. Developing a large-scale GIS database
5. Overlaying wave height on GIS layers of the coastal areas to forecast inundated areas

6. Developing a PDA-based wireless GIS integrated with Bluetooth GPS, CF digital camera and voice recording
7. Editing real-time data and uploading it to the internet map server using GPRS from any remote location
8. Downloading real-time data to the internet map server using GPRS from any remote location
9. Developing a warning system (compatible with any computer or PDA) for serving the tsunami warning on the internet, and
10. Developing an evacuation system (compatible with any computer or PDA) for serving the evacuation map and information on internet.

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Light Detection and Ranging (LIDAR) Mapping of Tsunami-Affected Areas

Background

The tsunami on December 26 2004 caused hundreds of thousands of deaths and billions of dollars worth of damage to property along Indian Ocean coastlines. Mapping the damage to tsunami-affected areas is now a critically important task Due to the elevation and orientation of coastal zones, the most important parameters for recording, evaluating and simulating tsunami-affected areas, three-dimensional and multi-surface mapping is of most importance.

The investigation by the AIT team in the six tsunami-affected provinces in southern Thailand revealed that existing geo-spatial data (such as remote sensing images, aerial photographs, existing maps, and field survey results) are very limited. High-resolution remote sensing images (such as IKONOS data at a resolution of one meter) are not available for many areas during the disaster period because of heavy cloud cover. Air photos are limited for interpretation of changes along many coast zones because of tree cover. Base maps at a scale of 1:50,000 are available for the whole area, but from these it is impossible to identify individual buildings and generate high-quality digital elevation models (DEM), due to the very large contour intervals. Accurate airborne LIDAR (Light Detection and Ranging) mapping for tsunami-affected areas based on international cooperation is therefore strongly recommended.

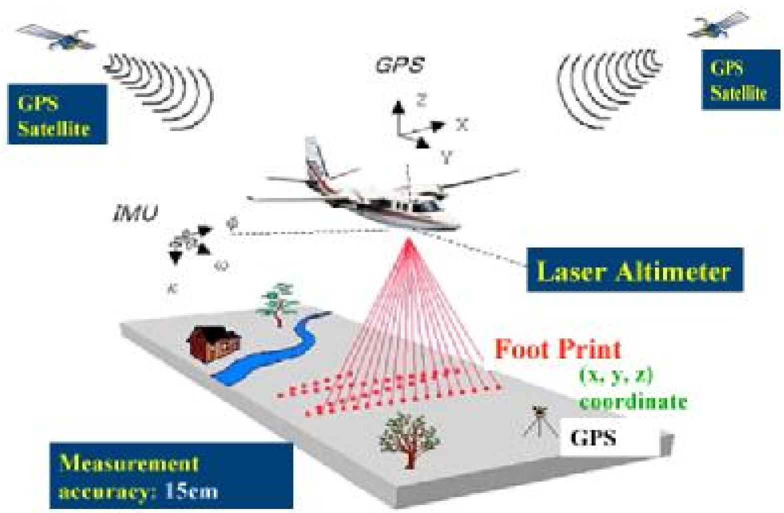

Figure 1. Principle of Airborne LIDAR Mapping

Figure 1 illustrates the basic principles of airborne LIDAR mapping. The laser scanner on the light aircraft uses oscillating deflection of the laser beam perpendicular to the flight direction. The area covered is referred to as the 'footprint.' The instant angle of deflection has to be known precisely, as the basic geometric principle is to maintain the position, direction and length of the vector from the ground point, for each shot. An essential feature of laser scanning is the potential for almost complete automation, the GPS, INS and laser data all being digitally recorded. After GPS processing and necessary system calibration the computation of the terrain points, the interpolation of a DEM and the block formation of the DEM is quite straightforward, as far as open terrain is concerned.

Objectives

The objectives of this research project are to:

- Acquire, through international cooperation, airborne laser range data of tsunami-affected areas in Thailand

- Generate accurate (15-20 cm) multi-layer Digital Surface Models (DSMs), including surfaces of tree canopies, surfaces of roofs, ground surface, water surface of coastal zones, seabed and so on.
- Detect changes to man-made objects, such as buildings, roads, bridges, water supply lines, power lines and fishing ponds.
- Detect changes to natural phenomena, such as coastal features, forest areas, farm lands, saltwater erosion areas and coral reefs
- Carry out detailed 3D modeling and mapping of man-made objects and natural phenomena in tsunami-affected areas
- Make a large-scale simulation of tsunami-affected coastal zones and generation of hazard maps.

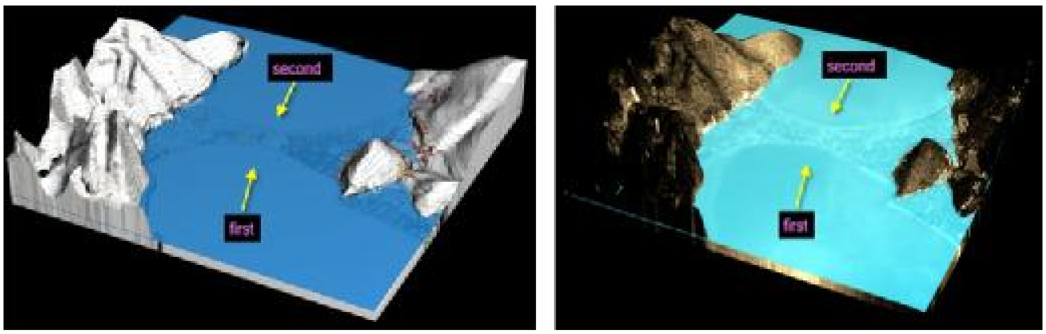

Figure 2. Tsunami simulation of Phi Phi Island

Scope

This research covers all tsunami-affected areas in southern Thailand, including typical test areas such as Khao Lak, Kamala, Baan Nam Kem, Patong and Phi Phi Island.

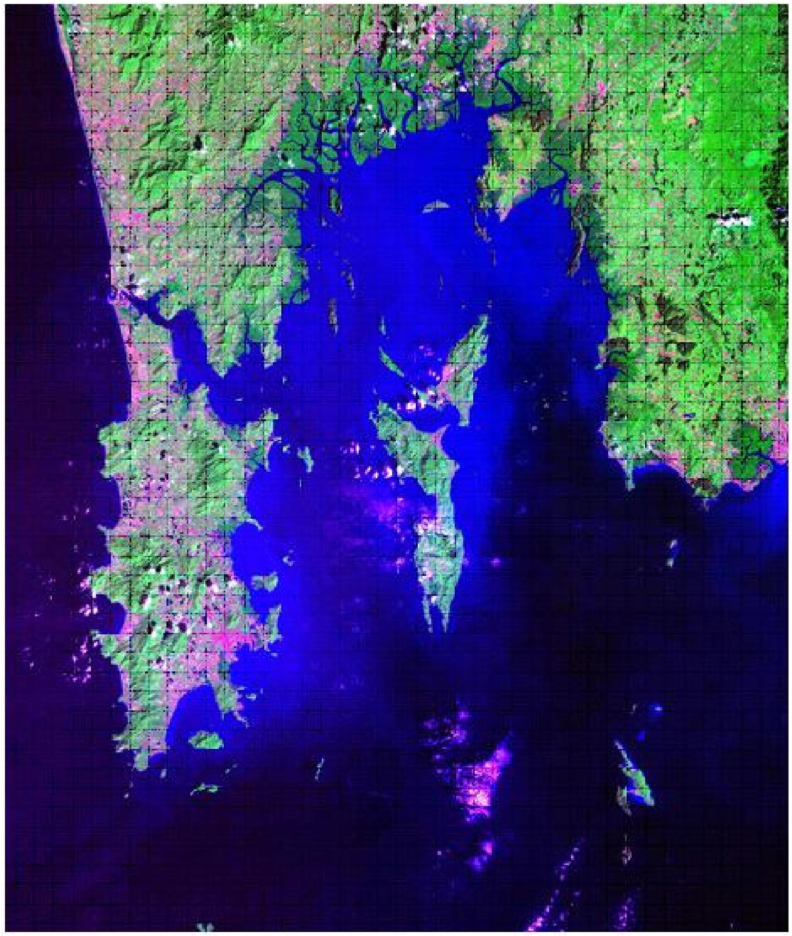

Figure 3. Tsunami-affected areas in southern Thailand

Proposed Actions

This research project will involve:

- Cooperation with the Royal Thai Government and RTG agencies, such as the Ministry of Natural Resource Development and the Thai Meteorological Department (Dr Sumalee).
- Acquisition of LIDAR survey data through international cooperation with some Japanese agencies such as the Institute of Geographic Surveying, Asia Air Survey Co. Ltd., Kokusai Kogyo Co. Ltd.
- Collection of topographic maps, air photos, high-resolution remote sensing images, field surveying data.
- Software development for laser data processing, 3D modeling, and tsunami simulation.
- Selecting small areas, such as Phi Phi Island, for pilot testing.
- Promotion of regional and international cooperation with agencies such as International Society for Photogrammetry and Remote Sensing (ISPRS).

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Interim Tsunami Alert System

Background

It will take some time to settle on the design and further implementation of the planned global tsunami warning. An early tsunami alert system (TAS) is therefore needed for countries affected by the Indian Ocean tsunami.

An interim TAS is therefore being proposed by the Asian Institute of Technology (AIT). The concept of the system is to use SMS messaging on mobile phones to disseminate information to ordinary people about earthquakes that might generate tsunamis.

The TAS will automatically scan updated earthquake information on the internet, and check and examine criteria for activation of the TAS.

All tsunami alert systems involve getting reliable earthquake information, including magnitude, location and depth of epicenter. There are presently six websites publishing real-time earthquake information, updated every 20 minutes.

4. It will be necessary to determine the criterion for sending out alert messages. It is proposed in this study that the criterion would be an earthquake of magnitude 7 on the Richter scale. This is based on the tsunami magnitude (m) proposed by Iida (1958) as summarized in Horikawa (1978):

$$\mathbf{m = 2.61\ M - 18.44}$$

where m is the magnitude of the tsunami, and M the magnitude of the earthquake.

Table 1: Estimation of tsunami damage at different magnitude m.

Tsunami magnitude *m*	**Tsunami height** *H (meters)*	**Damage**
-1	0.5	None
0	1	Very little damage
1	2	Coastal damage and damage to ships
2	4 ~ 6	Damage and loss of life in some coastal areas
3	10 ~ 20	Considerable damage along more than 400 km of coastline
4	30	Considerable damage along more than 500 km of coastline

Source: Horikawa (1978)

Table 1 shows predicted damage for different tsunami magnitudes. When the magnitude of a tsunami is zero, there is very little damage. This corresponds to an earthquake magnitude M less than 6.4. on this calculation, the earthquake magnitude M for an alert message would be set at 6.4 on the Richter scale.

However, in a recent presentation at the Thai Meteorological Department, V. K. Gusiakov concluded a different relationship between tsunami and earthquake magnitude in the Pacific. This is shown in Figure 1.

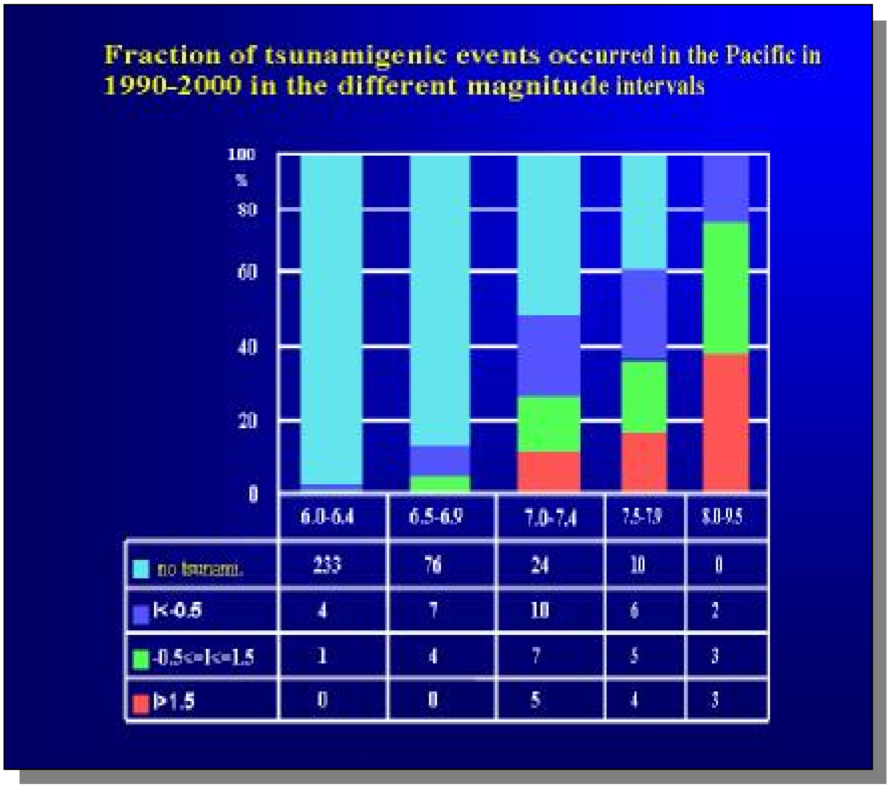

Fig. 1: Summary of tsunami events (Gusiakov, 2005)

Magnitude of earthquake M	Approximate probability of tsunami occurrence
6.5 – 6.9	18 %
7.0 – 7.4	50 %
7.5 – 7.9	60 %
8.0 – 9.5	100 %

This covers tsunamis of all magnitudes. The chance of a tsunami occurring is 50 % for earthquakes with a magnitude of 7 on the Richter scale. An earthquake magnitude of 7 on the Richter scale is therefore proposed for tsunami alert purposes, with the possibility of a tsunami of any magnitude occurring equal to 50 %.

- The location of the earthquake epicenter is less than 60 km below the seabed. (Reeve et al, 2004)
- The area of the earthquake is limited to Indian Ocean locations with a record of past earthquakes, namely northern Sumatra in Indonesia, off the west coast of northern Sumatra, and the Andaman and Nicobar Islands in India
- When earthquake information fulfills the above criteria, a SMS will be sent out for Tsunami alert purpose.

Fig.2 shows a flow chart summarizing how the proposed TAS will work., including a sample SMS message. When the line source of tsunami generation can be assumed, the wave celerity can then be computed and the arrival time of the tsunami at a particular point on the coast determined.

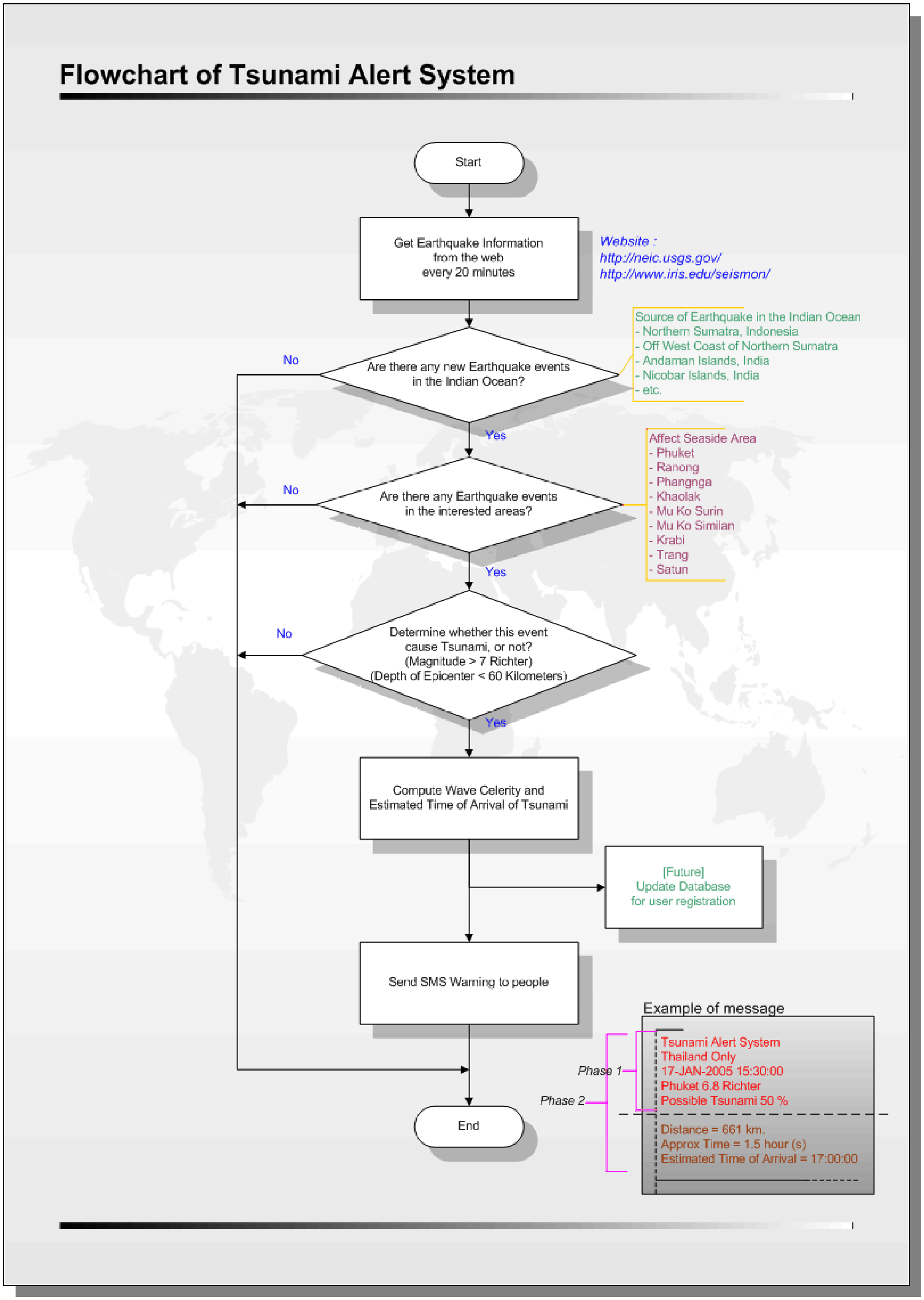

Fig. 2: Flowchart of proposed Tsunami Alert System

This information is most useful for purposes of disaster preparedness. However, there is a possibility that a progressive rupture, such as that which occurred on December 26 2004, will take longer to occur again. An earthquake may cause a local tsunami, which propagates radially. The present work cannot distinguish between these different types of tsunami generation. In addition, the bathymetry of Indian Ocean is not absolutely correct and this will be a source of uncertainty in wave celerity computation.

Objectives

The objectives of this research project are to:

- Develop a system that will provide a tsunami alert message to mobile phones as an SMS message.
- Disseminate and apply the TAS in countries in the Indian Ocean region.

Proposed Actions

This research project would involve the following actions:

- The framework of the system has already been developed, and preliminary work accomplished. The computer program is now at the testing stage.
- Further in-depth analysis of earthquake information, including details of Indian Ocean bathymetry.
- The present system is applied only in Thailand, and can be extended to cover other countries in the Indian Ocean.
- A MMS message system can also be developed to show the location of an earthquake.
- The present system can record and incorporate useful information from other sensors, in addition to earthquake information.

Project Duration

Eight months.

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Technical contact

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Numerical Model of Tsunami Generation, Propagation and Inundation

Background

A tsunami is a natural phenomenon that can cause enormous damage to people, to infrastructure and to property. Tsunamis of different magnitudes and directions occur, with the inundation area varying accordingly. Numerical modeling can provide information about inundation at particular locations, flood depth and time of tsunami, all of which information is necessary for establishing a tsunami risk assessment and evacuation plan.

Objectives

The objectives of this research project are to:

1. Develop a numerical model of tsunami propagation from the ocean to coastal cities on the Indian Ocean .
2. Provide a detailed inundation map for all six provinces in southern Thailand.
3. Model tsunamis that are generated and propagated on coastal areas of southern Thailand.
4. Establish real-time modeling of tsunami generation, propagation and inundation using a super computer.

Scope
The study area will cover in Thailand, Indonesia, Sri Lanka and India, and six provinces in the south of Thailand, namely Ranong, Phang Nga, Phuket, Trang, Krabi and Satun, which will be studied intensively for inundation map.

AIT's partner will be Prof. Fumihiko Imamura from Tohoku University. Prof. Imamura was seconded to AIT during the period 1995-1996.

Technical contact

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Mobile Data Collection System

Background

When disasters occur, field data collection must be immediate. The data should be collected ideally in real time, so that authorities are able to understand the situation quickly, take necessary actions immediately and ensure that timely accurate information is disseminated to people.

Mobile devices such as PDA, mobile phones and GPS that can be easily connected each other are now widely available. Internet connection through a mobile phone is now also offered, using technology such as GPRS. AIT has been developing mobile device systems and demonstrating their usefulness. Such systems have the capability to locate themselves at the field, request GIS data or remote sensing images from a server, and update databases on servers. Information from mobile devices can thus be shared over the internet and shared among mobile devices.

However, the system needs to be further developed to be applicable for actual disaster case. It is also essential that the developed system is both robust and user friendly.

Database templates for different types of disaster have to be developed, so that the system will collect essential information effectively. The non-availability of mobile phone links in many areas around the Indian Ocean needs also to be considered, and the durability of GPRS internet links on mobile phone during a large-scale disaster needs also to be evaluated.

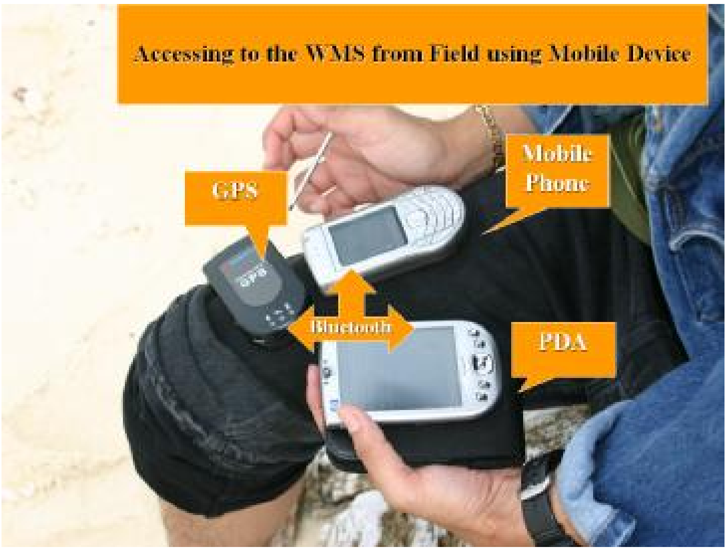

Figure: The system accesses the AIT Tsunami Web Map Server to obtain remote sensing images and GIS data. It then updates its location information on the server. Location information can be viewed by other devices using a GPRS connection. The system was tested at Phuket and Khao Lak after the tsunami.

Objectives

The main objective of the project is to develop a mobile data collection system to update disaster information on a server in real time.

Specific objectives are to:

- Analyze information required in case of disasters, and design an effective database.
- Analyze the availability and durability of communication modes and design a system that can work even when ordinary communication systems are not available.
- Design a security system to prevent false data being used.

- Design and develop the system.
- Produce a prototype ready for pilot testing, and distribution at large.

Duration of the project

1.5 years

Technical contact

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An Integrated Approach to Proactive Disaster Management

Background

Management of disasters in Thailand and in most developing countries is the responsibility of various agencies and organizations. In general, there is a lack of effective integration or comprehensive planning and coordination. Disaster management therefore tends to be reactive, meaning in effect rescue, relief and recovery during and after a disaster. Many organizations and communities are involved in disaster management. Each coordinates its own activities, which frequently conflict with those of other organizations. No single agency takes full responsibility for disaster management. There is no master plan, legislative support or standard policy and procedures to effectively manage disasters. Nationwide or basin wide databases, online monitoring information systems and infrastructure for disaster prevention and control need to be established.

The magnitude and extent of the 26 December 2004 tsunami took the world by surprise. The tsunami hit the coastline of Phuket and Phang Nga 1-1.5 hours after the earthquake off the northern coast of Sumatra. There was no prior warning, and people were unaware of its approach. As a result 5,322 people in Thailand, more than half of whom were foreign tourists, lost their lives, with many thousands more injured and missing. If a warning had been given, people could have moved to higher ground, and the number of casualties would have been much smaller.

After the tsunami, high-ranking officials from different organizations rushed to visit the affected areas. Acting in good faith, they established chains of commands for emergency, rescue and relief operations. Some actions taken were redundant, unclear or in conflict with commands by the authorized personnel, namely provincial governors or designated representatives, with the result that these persons lost their authority. During emergency, rescue and relief operations, many officers dared not take decisions, as they were afraid of violating their given authority. Some did not know clearly the extent of their duties and responsibilities. Many subordinates waited for commands from their supervisors, as there was no clear emergency chapter for them to operate on site. Many donations of food and other supplies were not delivered to refugees in remote areas because of a lack of available vehicles.

There are many problems of logistic supply, database, telecommunication and transportation. There is a lack of coordination and understanding of the work being done by rescue and relief units between provinces, district and sub-district administrative offices, NGO and private agencies including individual volunteers.

Objectives

The main purpose of this research project is to establish a comprehensive national master plan for disaster management, taking into account the four major interrelated components of disaster management – preparedness, readiness, emergency response, and recovery and rehabilitation.

Scope

1. To develop a policy and plan for proactive disaster management, with Thailand as a case study.
2. To establish general principles for disaster management and to recommend institutional framework and corresponding administrative structure in disaster management
3. To discuss governance issues in civil defense for proactive disaster management and improvement of existing disaster management through participation of organizations and individuals at national, province and local or community levels.

4. To propose an implementation plan and follow-up measures for effective disaster management.

Technical contact

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Developing a Model Environmentally and Economically Sustainable Community – An Innovative Multi-Disciplinary Approach to Post-Tsunami Reconstruction

Background

The December 26 2004 tsunami devastated coastlines around the Indian Ocean and the lives of many millions living in coastal areas. Affected areas are now being cleaned up, people are being provided with temporary shelters, food and other basic necessities, and medium to long-term rehabilitation plans are being formulated from national to local levels. We have known for a long time that coastal zone settlement in Thailand, Indonesia and Sri Lanka has been organic. Little or no effort has ever been given to proper planning of coastal communities in any of the areas affected.

Consequently, homes have been built very close to the shoreline with no housing codes to follow, and frequently without any natural or artificial barriers against the impact of storms, wave surges or tsunamis. Household or industrial effluents from these compact communities are directly discharged into the sea, often close to fish growing cages. Many fishermen continue to engage in unsustainable fishing practices, such as trawling, the use of gill nets, poisons or dynamite fishing.

Tragic as the current situation is, it does provides a unique opportunity to do things better. Reconstructed community will need to be more environmentally and economically sustainable. But as yet no single coastal community in any tsunami-affected countries can serve as a model for such development. Such a model would be a community built with sufficient planning and foresight to minimize damage from natural disasters, would be environmentally sound, and would provide diverse sustainable livelihood opportunities so that fishers would no longer have to engage in illegal and unsustainable fishing practices to make their living. Such a model community could serve as a case study for each country, to be emulated by other community developers.

The broad aim of this project is to assist in the planning, design and development of a model environmentally and economically sustainable community.

Scope

Planning should be initiated at the village level. All village plans should be consolidated into a sub-district (*tambon*) plan, which should then be merged into a district (*amphoe*) plan. The planning mechanism and structure of the affected communities should follow the existing local level planning framework of Thai administration to ensure long-term sustainability. The community plan should be phased in over different implementing periods, both in the medium and long term, ranging between 3-5 years and coinciding with the current planning cycle of the local-level planning.

Proposed Actions

This research project will involve the following interventions.

Short-term and medium-term interventions:

- **Select site** carefully, and **prioritize target affected areas**.
- Achieve not only agreement but also buy-in from the provincial governor and district administrative organization (*tambon*) to receive and work with such a technical support.
- **Compile basic information** on disaster assessment at village and tambon levels from all available sources.

- Use a **participatory planning approach** to find out what people in the community need and want.
- Assemble a **multidisciplinary** team to plan the model community, comprising civil engineers, architects, transportation engineers, environmental engineers, urban environmental specialists.
- **Allocate tasks to team members** to work out the details of the plan, using community participatory planning techniques and integrating the plan with higher level plans.
- Regroup and agree on the **master plan**, with community leaders endorsing the plan.
- **Construct** the planned community, and monitor and evaluate construction and development.
- **Develop social infrastructure**, including community management and support groups.
- Restore **a local development committee of local leaders**. This group should serve as a focal civic group to undertake local planning exercises and coordinate with other development agencies.
- Mobilize local leaders, the local development committee, local government, civic groups, NGOs and government line agencies to **conduct a joint participatory needs assessment** with local people on environmental management and livelihood prospects in the community. Occupational development options additional to fisheries and tourism should be clearly identified, specifically for specific vulnerable groups such as orphans and widows, and elderly, displaced and handicapped persons as well as ethnic minorities. **Gender needs and differences** in each community should be taken into consideration including the **skills requirements** of those vulnerable groups.
- Local needs of the community and local people should be listed and prioritized by each vulnerable group. Necessary resources required for future implementation should be identified and mobilized by responsible agencies. Specific interventions should be phased in to match the degree of impact demanded by each affected community. **Local needs should be consolidated and integrated** from the village to the sub-district level and up to the district level. Local needs should be classified according to an area-based approach.
- **Design local programs and projects** in response to the various needs of the vulnerable groups.
- **Identify and match funding resources** to support those programs and projects from internal and external resources, and phase in implementation activities according to the time frame identified in the community plan.
- **Phase in implementation activities** ranging from 3 to 10 years in duration, and design medium and long-term interventions for the community. An annual action plan should be prepared in more detail, identifying resources and budgets required from internal and external resources, and responsible agencies.
- **Promote** this village for tourism as a ‘green village,’ where people are environmentally aware and practice sustainable income-generating livelihoods.

Long-term interventions:

- Establish a systematic **participatory monitoring and evaluation system** for the community plan to ensure its effective implementation.
- Formulate **community-based groups** to assist in the implementation of planning activities in the community rehabilitation plan. The groups should be established (or reestablished), and strengthened in the areas of natural resources and environment (i.e., raising awareness, conservation and maintenance of infrastructure) and occupational development (i.e., income generating activities)**.** These should become self-help groups, crucial for future social, economic and institutional recovery.
- Train villagers for **alternative livelihoods**, particularly fishermen afraid to venture to the sea. Provide **micro-credit** to initiate small enterprises.
- Strengthen **community networks** with local civic groups, local government, NGOs, government line agencies, educational institutions, including universities, and the private sector.
- **Build the capacity** of the village and tambon level government and community based groups for the long-term sustainable development of the community. Training programs should be identified and provided as indicated in the community rehabilitation plan.

Technical contacts

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Impact of Tsunami on Coastal Ecosystems: Evaluation and Rehabilitation Background

The Indian Ocean tsunami has led many people to reevaluate current activities and practices in coastal areas. There is a widespread view that coastal development that has not been properly planned and managed, and that this has contributed to the great loss of natural habitats, massive loss of life, and properties and infrastructure. Since the disaster, it has been argued that the destruction of the mangroves aggravated the negative impacts of the tsunami. Mangrove forests act as a buffer that can lessen the effect of both tsunamis and tropical storms, by absorbing wave action and reducing the velocity of water. Dense trees may also serve as handholds when people are carried away by the waves, and this also could save lives. These functions of coastal ecosystems should be considered during the rehabilitation process.

The role of mangroves in coastal development and coastal protection therefore merits serious consideration by planners and decision-makers. Before proposing projects for coastal area rehabilitation, attuned to the needs of both local people and other stakeholders, there is a need to conduct a thorough study to determine the current status and assess the situation in the tsunami-affected areas. There is a growing call for immediate rehabilitation and restoration of affected areas, but there should be a thorough study before any project can be implemented for it to be sustainable and effective.

Comprehensive data and information on previous and present conditions needs to be gathered. This information will help policy-makers, planners and decision-makers in evaluating both the impact of the tsunami and its impact on other activities and coastal phenomena, their various conditions, and past and future functions. This is necessary for rehabilitate and for the sustainable development and protection of coastlines. All these things need careful evaluation and assessment to ensure a scientific basis to support decisions and actions.

Objectives and scope

To assist in the proper rehabilitation process of tsunami-affected areas by providing scientifically-based information about impacts, ecosystem functions and rehabilitation of coastal ecosystems, AIT should conduct scientific research to:

1. Determine the various contributory elements, types of activities and practices in coastal zones before the tsunami struck the region, and their possible contribution to the gravity of the impact of the tsunami.
2. Determine the relationship among coastal zone activities, the causes and effects of the tsunami and other disasters and other important factors (such as wave height, water velocity, and role of mangrove in minimizing adverse effects of tsunami and other disasters).
3. Generate scientific information that will help policy-makers, planners and decision-makers to come up with concrete projects and activities to be implemented in the tsunami-affected areas as well as neighboring areas.

Proposed actions

This research project would involve:

1. forming a multi-disciplinary team of researchers able to cover the various areas of needs in an integrated manner.
2. collaborating with other institutions.
3. coordinating and working with communities and local authorities.
4. generating data and information useful in coming up with appropriate projects and development activities in the tsunami-affected areas.

5. hiring full-time researchers to help in this particular research.
6. preparing a database and a report, with scientific data and information that will be useful in the formulation of policies, and planning for and implementation of appropriate projects.

Technical contact

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Low-cost Housing

Background

There is an urgent need for low-cost affordable housing in tsunami-affected areas. Local governments housing programs alone will not be able to address the demand for affordable housing, which has suddenly become very large.

The answer to the problem of delivering housing to large numbers of low-income groups lies in a strategy employing systematized construction systems as an integral part of the construction industry's formal and informal sector. These systems should allow for the use of less skilled labor in construction activities, should utilize raw and processed materials that have been transformed locally, should adopt light industrialization in the production of building materials and in the house construction process itself, and should promote technology transfer for better sustainable development.

As its name indicates, the goal of AIT's Habitech Center is to research, develop and transfer housing technologies that can better respond to local housing demand, contribute to socioeconomic development in a sustainable way, create employment and generate income locally.

At Habitech, we have been addressing the problem of delivering affordable housing by developing building material and construction techniques that can be used by unskilled labor. These lower the cost of housing and enable the construction of solid and durable houses able to resist earthquakes, floods and typhoons. Houses built this way are as much as 30-50% cheaper than those built using traditional and conventional construction systems.

The components of the Habitech building system are prefabricated modular interlocking concrete-based elements that can be put in place easily without the need for heavy equipment. Because the components are self-aligning, unskilled workers or self-help builder families and friends can take part in the building process.

production facility can be set up locally, creating jobs that generate income for local populations. A typical production facility will employ 30 to 40 workers in production and in construction for the project it supplies. Production facilities can become permanent and address local construction markets.

Since its inception, Habitech Center has been transferring technology to various housing projects and cooperating with international and national institutions, NGOs, housing cooperatives, the private sector and low-income community groups. It has participated in the delivery of more than one hundred and fifty small and medium scale production facilities in Afghanistan, Cambodia, Cameroon, Bhutan, Fiji, Haiti, Indonesia, Laos, Malaysia, Mexico, Myanmar, Nepal, Papua New Guinea, Paraguay, Philippines, Sri Lanka, Thailand and Vietnam.

In 1994, Habitech Center was awarded the Matsushita Memorial Prize by the Japan Housing Association "in recognition of excellent achievements in improving human settlements in Asian countries by promoting research and development related to technologies for low cost housing as well as providing educational programs and facilities to disseminate the results of their research efforts." In 1995, one of Habitech's project: the Khao Kho Housing Resettlement Project in Petchabun, Thailand, was selected as a finalist for the World Habitat Awards.

The Habitech Building System has been recognized by the United Nations Human Settlements Program as contributing to housing and economic development through the transfer of technology and has been included in the Best Practices database for others to learn from and incorporate in their own work.

Objectives

The general objectives of the proposed study are to

- Better respond to the housing demand created by the tsunami
- Contribute to sustainable socioeconomic development in tsunami-affected areas

The specific objectives are to

- Create employment and generate income locally
- Meet the housing needs of low-income groups in tsunami -affected areas
- Disseminate simplified construction methods enabling unskilled labor and lower housing construction costs
- Promote the use of environmentally friendly construction materials and methods.

Scope

This project will make cost-effective building materials and technology available to low-income families in tsunami-affected areas. The techniques used rely on self-help and mutual assistance methods, and are highly appropriate for low-income families to participate in house construction, as the cost of the building materials normally represent as much as 85% of the cost of building a house.

We initially propose to establish incubators in tsunami-affected areas of Sri Lanka and Indonesia, where groups can be trained in the management and operations of micro, small and medium scale building material production facilities.

Once established, each incubator could train groups of 15 – 20 persons each month, and assist them in establishing and operating building material production units. People trained at the incubators could in turn hire local villagers for their production unit and deliver low-cost building materials for reconstructing the houses destroyed.

Local production units could also serve as raw and processed building material distributions centers and eventually be grouped into a building material - producer cooperative association.

Proposed actions

At the onset of projects and through local surveys, potential groups can be identified and those interested trained in becoming producers at typical facilities of incubators.

Habitech can provide technical assistance throughout the project. It can also provide a variety of plans and instructions for families to adapt and follow in rebuilding basic core houses as we have done in many countries in the past.

Funds to establish and equip production units can be made available through rotating funds, NGOs, donations and existing programs supported by international agencies.

Technical contact

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Utilization of Mangrove Forests

Background

Mangroves are woody trees and shrubs that grow in estuarine or brackish water environment. Since mangrove forests are located in estuarine environments, they are intersected by a number of small creeks and channels and in many cases large open water bodies are also found associated with them. Mangrove forests and associated tidal creeks, channels, canals and water bodies together constitute mangrove wetlands. Mangrove wetlands are dominant features of the coastal areas of tropical countries.

Mangroves can act as a sophisticated natural protective mechanism to help the tropical coastal and island ecosystems to survive from the surging waters of tsunamis and extreme weather. Mangroves serve as natural shock absorbers, and reduce coastal erosion caused by tsunamis in two ways. First, the velocity of the tsunami water is greatly reduced after it enters the mangroves. Second, the volume of water reaching points inland is greatly reduced, since tsunami water, after entering into the mangroves, is distributed to all the canals and creeks that are present all over the mangroves.

Tsunamis can have devastating impacts on all kinds of natural resources, as shown in the following table.

Table: Impact of tsunami on different natural resources

Land Resource	Water Resource	Forest Resource	Fishery Resource	Human Resource
• Land degradation • Soil salinity	• Water quality • Seawater intrusion • Coral reefs destruction • Seagrass destruction	• Forest loss • Forest productivity • Coastal protection* • Soil nutrients • Carbon fixation • Oxygen release	• Coastal fishery • Off-shore fishery • Food chain	• Income disparity • Health hazards • Employment • Quality of life

Mangroves provide livelihoods for coastal communities with fishery products, timber, fuel and thatching material. They also serve as an effective carbon sink, since they help to enhance carbon sequestration, and thereby contribute to reducing the growing imbalance between carbon emissions and absorption. By releasing nutrients in the water, they promote sustainable fisheries. Thus, coastal communities benefit greatly from the existence of mangrove forests.

But in many regions there has been extensive conversion of coastal habitats such as mangroves due to industrialization, urbanization, coastal migration, aquaculture, agriculture, and tourism development. For example, according to the National Economic and Social Development Board of Thailand, 253,000 hectares of the country's 380,000 hectares of mangrove forest have been destroyed to create shrimp farms since the 1980s. The December 26 2004 tsunami also caused significant damage to many more mangroves suffocating from silt deposited by the waves, which is clogging the pores of their aerial roots.

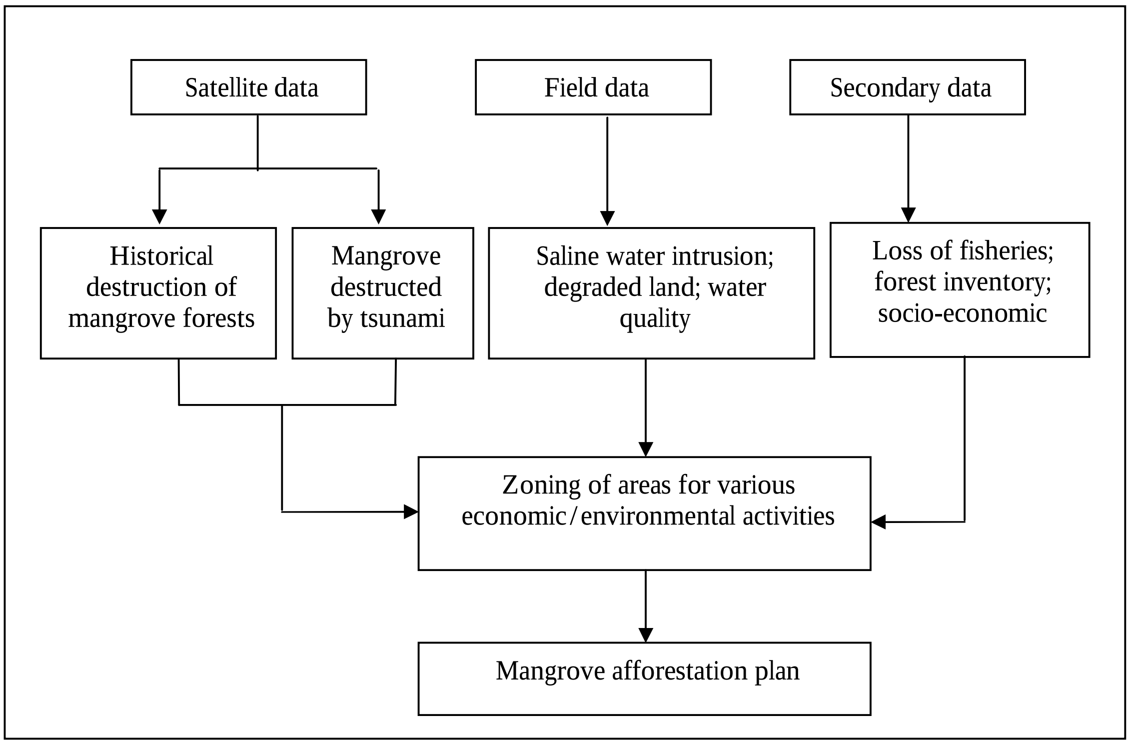
Objectives

The objectives of this research project are to:

1. Map mangrove forests destroyed by the recent tsunami
2. document historical destruction of mangrove forests caused by human intervention
3. Identify most vulnerable areas
4. Identify potential areas for mangrove plantation
5. Prepare plan for mangrove afforestation.

Proposed actions

Satellite data will be used for mapping the mangrove forests destroyed by human activities and by the tsunami. Satellite data will be analyzed to determine post-tsunami land conditions. Field data will be collected for estimating the extent of saline water intrusion, degraded land, and to determine the quality of contaminated water. Secondary data will be collected on loss of fishery and forests, and on socio-economic factors status. Geographical Information System (GIS) will



be used for overlaying different layers of data, and to make a comprehensive plan for mangrove plantation and other land use alternatives.

Technical contact

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Planning for Coastal Changes: Regulations and Guidelines for Development Setbacks

Introduction

Beaches constantly change their form and shape, and sometimes the very material of which they are composed. The best way to conserve beaches is to allow them the space to move – in a seaward direction during accretionary phases, and in a landwards direction during erosionary phases. The removal of beach sand and other materials interferes with these natural coastal sediment transport processes, and can lead to serious beach erosion, the impacts of which are often seen on beaches downstream in the form of sedimentation. Sedimentation may lead to the loss of habitats, including coral reefs and seagrasses, and to the consequent decline of commercially important fisheries. Coastal development setbacks, meaning the establishment of a safe distance between buildings and the active beach zone, can ensure that space is provided for a beach to move naturally, both during normal events and infrequent climatic events such as hurricanes, thereby ensuring that the beach is conserved for all to enjoy and that coastal infrastructure remains intact.

Coastal development setbacks have several functions. First, they provide buffer zones between the ocean and coastal infrastructure, within which the beach zone may expand or contract naturally, without the need for seawalls and other structures, which may imperil an entire beach system. In this sense, they may contribute to reducing beach erosion. Second, they reduce damage to beachfront property during high wave events. Third, they provide improved vistas and access along the beach. Fourth, they provide privacy for occupiers of coastal properties and for persons enjoying the beach as a recreational resource. However, zoning regulations such as these rarely exist in developing countries. Even where they do exist, they cannot be enforced effectively due to increasing pressure from population growth, agriculture, industrialization, and tourism in coastal areas.

There is now an urgent need for coastal managers to know precisely how coastal resources can be expected to be affected by coastal planning and management interventions. A historical database would provide a quantitative predictive tool for both normal beach changes and those caused by natural phenomena such as tsunamis and hurricanes. Such information is vital for coastal development setback regulation and guidelines, and for ensuring that future coastal developments are sustainable and in harmony with beach conservation principles.

The adoption of remote sensing and geographical information system (GIS) technologies can assist in providing decision makers and planners with necessary information for managing coastal resources. These technologies provide baseline change data, and can be used for tracking coastline change trends over time. The information extracted from trend analysis can be used to forecast future changes in the landscape.

This study focuses mainly on coastal shoreline change for the purposes of preparing regulation of development setback and establishing guidelines for development setbacks.

Objectives

The objectives of this research project are to:

1. Analyze changes to coastlines over time, characterize these changes and forecast future changes
2. Study coastal changes based on sediment transport models wherever detailed study is needed.
3. Provide necessary data for formulation of regulations and guidelines for development setbacks.

Proposed actions

Various available satellite data will be analyzed over a period of time to determine historical changes to coastlines. The trend of coastal changes will be studied using remote sensing and the historical database. Trend analysis will be used to study general changes over time and to predict future changes. This data will be utilized to assess areas where change is critical. Detailed study will be done on the most risk prone areas using available sediment transport models. These can accurately calculate long-term changes along shorelines, and on shore and off shore sediment transport rates, thereby predicting future shoreline position.

Knowledge about how the landscape is expected to change in the future. Beaches will be classified accordingly. Proper development setback regulation and guidelines will be developed for different classes of beaches. Regulations and guidelines will be based on scientific data and through discussion with coastal resource planners.

Expected results

The research is expected to show the trend of changes to coastlines over time and details of sediment transportation in high-risk area. Classification schema of coastal areas will be produced based on shoreline change. Development setback regulations and classification schema will be formulated based on beach characteristics.

Probable expansion areas of research

The study can be expanded to identify and protect select conservation area that contains critical habitat for a variety of endangered, threatened, and rare species. The basic concept is to use remotely sensed landscape map that ranks critical habitats based on conservation information.

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Waste and Wastewater Management in Tsunami-Affected Areas

Background

The massive damage wreaked by the December 26 2004 tsunami on the South and Southeast Asian region is hard to comprehend. The losses include not only countless lives and destruction of property, but also immense damage to the environment and infrastructure that supports diverse livelihoods. The extraordinary generosity of the international community's response to the disaster has been a reminder of people's essential humanity. The sums raised not only provide essential relief for victims, survivors and their families, but also afford opportunities in the affected areas to put in place improved systems and technologies for essential public services such as managing environmental waste.

Objectives

Preliminary assessment based on field observation and dialogue with locals in tsunami-affected areas in Thailand reveals that plans are already underway for the construction of new housing estates. But there is widespread ignorance of necessary environmental infrastructure, such as that for waste and wastewater management systems. Along with the planning and development of new housing zones, it is essential to take this opportunity to put in place improved waste and wastewater management systems utilizing appropriate sustainable technologies.

Scope

In the six provinces of southern Thailand, the tsunami caused levels of damage to waste and wastewater management systems that varied by location and topography. The proposed areas targeted for restoration of waste and wastewater management systems are:

1. Baan Nam Kem in Phang Nga province. This seriously affected inland community has no existing management systems. The major occupation is fisheries.
2. Phi Phi Island, Krabi province. This seriously affected offshore community has malfunctioning waste and wastewater management systems. The major occupation is tourism.
3. Pathong, Phuket province. This moderately affected coastal community has functioning but inadequate waste and wastewater management systems. The major occupation is tourism.

These three different locations are expected to offer valuable lessons learned on restoration of environmental management systems in tsunami-affected areas in the regions.

Proposed Actions

This research project will involve:

- Detailed field surveys
- Conceptual design and planning of waste and wastewater management systems
- Stakeholder analysis and public hearings
- Detailed design and planning of waste and wastewater management systems
- Training and other capacity development programs.

Potential Partners

- Wastewater Management Authority, Ministry of Environment and Natural Resources

- Pollution Control Department, Ministry of Environment and Natural Resources
- Department of Civil Engineering, Prince of Songkla University
- Bang Muang Sub-district Administration Office, Phang Nga province
- Ao Nang Sub-district Administration Office, Krabi province
- Pathong Sub-district Administration Office, Phuket province
- Danida-funded program on Capacity Development of Wastewater Management Authority

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