Application of Remote Sensing and GIS for Tsunami Warning System

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Abstract: Tsunami occurred on December 26th, 2004 and caused heavy losses of lives and properties along the western coast of Thailand, especially in the six provinces along the Andaman Sea. In order to prepare for such unpredictable natural diasater, Tsunami Warning System Committee agreed to establish tsunami warning towers in the six provinces along the Andaman coastline as the first priority.

GISTDA utilized LANDSAT and IKONOS satellite images along with GIS to locate the most suitable sites for tower installation. Factors that were taken into consideration in locating the sites include the risk of the area for tsunami, effectiveness of tower working range and the towers must not block the good view of scenery. The Committee then selected the sites and has established three tsunami-warning towers in Phuket, which have been in operation since April 2005. Each is located 3 km. apart from each other and can broadcast within 1.5 km range.

In summary, satellite images are extremely useful and beneficial to tsunami warning management in term of accuracy, quality, up to datedness, timely availability and cost effectiveness.
Keywords: Tsunami Warning System, Remote Sensing and GIS

1. Introduction

The earthquake on December 26, 2004 with epicenter at the north Sumatra Island of Indonesia with 9.0 magnitude caused devastating tsunami. Lives and properties of the people along the coastline of South and Southeast Asia were affected. There were more than 250,000 deaths, 500,000 injured and 2 million homeless. In Thailand, the killer waves occurred along the Andaman coast, particularly in the six provinces, which include Ranong, Phuket, Phang-nga, Krabi, Trang and Satun. Because the region is in the earthquake active zone, earthquakes have occurred continuously. On March 25, 2005 the magnitude was recorded at 8.2 richer with the epicenter at west Sumatra Island. To prevent damages from future disasters, Office of the Prime Minister has set up a committee on Early Warning System to establish the disaster warning tower in the south of Thailand. Remote Sensing technology and GIS were applied with other data to locate the most suitable location.

2. Objectives

To find out the most suitable location for Tsunami Warning Tower.

3. Definition and properties

The criteria for selecting the site for the tower of Tsunami Warning System included the risk of the area, urban area or tourist area, obstruction of scenery, coverage area and stable base for establishment. The land should also be owned by government offices for ease of maintenance. Tsunami affected area Map, city map and field survey data were also used.

Tsunami Warning Tower is made of reinforced concrete and is 20 –30 m. high, established on a stable base with a size of 1 sq.m. It can endure strong wind up to 120 km./hr. Power is either supplied by battery or solar cell. Warning and siren sounds activate automatically. The amplifier has a capacity level not less than 121 decibel and the

broadcast radius is about 1.5 km. Broadcast is in 5 major languages (Thai, Chinese, German, English and Japanese) .The distant between each tower is about 3 km. The whole operation starts from the Thailand National Disaster Warning Center in Nonthaburi province, which receives warning advice from 10 concerned agencies, namely the Meteorological Department, the Department of Mineral Resources, the National Park, Wildlife and Plant Conservation Department, the Pollution Control Department, the Naval Hydrographic Department, the Department of Disaster Prevention and Relief, the Department of Fisheries, the Royal Irrigation Department, the Department of Maritime Transport and Commerce and the Electricity Generating Authority of Thailand (EGAT). Information on the intensity of seismic or wave activity will be received and transmitted via the Early Warning System established at the Thailand National Disaster Warning Center. The Center is staffed 24 hours by a team of experts tasked with monitoring and analysis of computer-generated reports. In the event that there is a high probability of a tsunami incident occurring, a warning to high risk areas around Thailand will be issued. Data will be relayed immediately via Inmarsat Satellite and can work in all weather condition.

4. The satellite data and database

The hazard detection in southern-Thailand was carried out by using data from LANDSAT and high resolution satellite data both IKONOS and QuickBird. LANDSAT imagery recorded on February 7, 2004 and January 31, 2005 display the overview damage of area along the Andaman coastline from Kapoe in Ranong province to Satun province. IKONOS data with 1 m. resolution was recorded on December 30, 2004, April 21, 2005 and QuickBird with 61 cm. was recorded on January 2, 2005 can show details of damage area such as transport network, water body, coastline, agricultural and built-up area. Data recorded after the tsunami disaster 100 days help to monitor the rehabilitation. Satellite imagery was analyzed to locate the damage area and urban area for selecting Tsunami Warning Tower sites. Database including topographic map, urban and business area, guide map, transport network etc. were also applied.

5. Methodology

5.1 Data Preparation

LANDSAT5-TM false color composite images, 5 scenes including path-row 12856 on February 1, 2005, 12954-55 on February 25, 2005 and 13053-54 on January 31, 2005.

IKONOS natural color images acquired on April 21, 2005 covering six provinces along the Andaman Sea, southern part of Thailand.

5.2 Affected Area

The wave could reach approximately 200-1,500 meters from shoreline at 2-5 meters elevation above mean sea level, shown in Table 1. and Fig. 1

Table 1. Ruin area from tsunami in 6 southern provinces of Thailand.

Province	Distance from coastal to land	Damage area (sq.km.) (Approximately)	Damage area (sq.km.) (Approximately)
Ranong	>1.5 km.	90	The Southern province from Amphoe Kapoe to King Amphoe Suk Samran and island in Amphoe Mueang
Phang-nga	200 m. - 1.5 km.	450	The West coast province from Amphoe Khura Buri to Amphoe Thai Mueang
Phuket	200 m. – 500 m.	60	The Western island from Hat Kata, Hat Karon, Hat Pathong, Hat Bang Thoa, Hat Yang Nai and Hat Kamala. Eastern island such as Ao Chalong, Ko Sileah
Krabi	200 m.	65	Along the beach of island or between beach and rock beach
Trang and Satun	200 m.	100	Coastal, beach, and alluvial or sand barrier

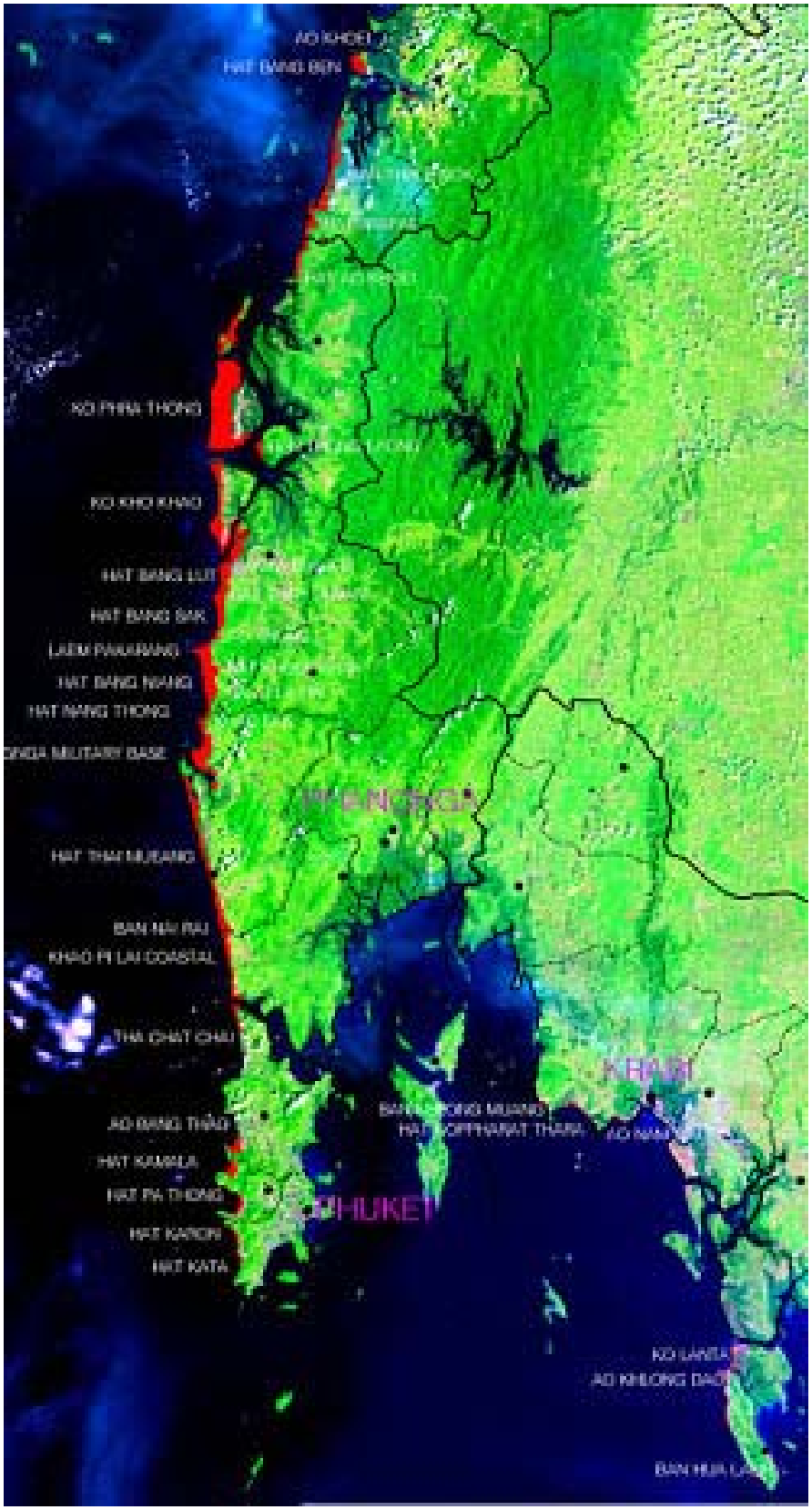
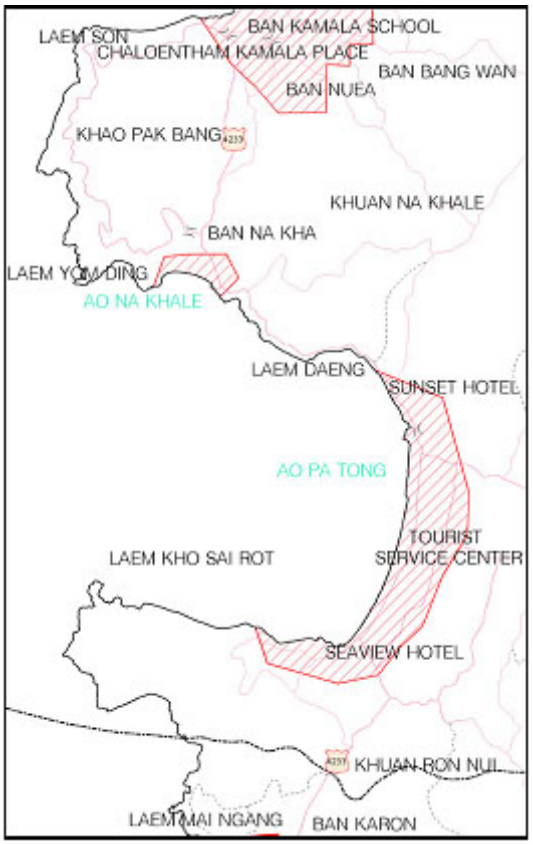


Fig. 1 False Color Composite LANDSAT 5-TM images indicate coastal damage in the red boundary after the tsunami impact along the Andaman Sea, Thailand.

5.3 The suitable location of Tsunami Warning Tower



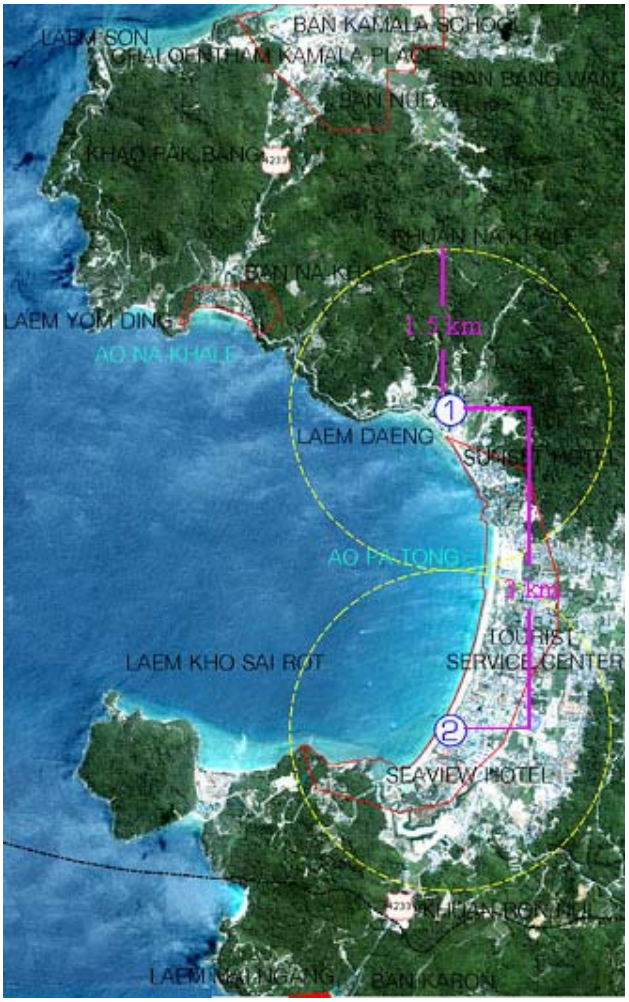


Fig. 2 IKONOS natural color image acquired on April 21, 2005 overlaid with affected area in Phuket coastal plain indicated by red boundary covering kamala beach-Patong Beach, Phuket province. The two sites have warning tower installed about 3 km. from each other and communities can hear the warning sirens within 1.5 kilometers radius.

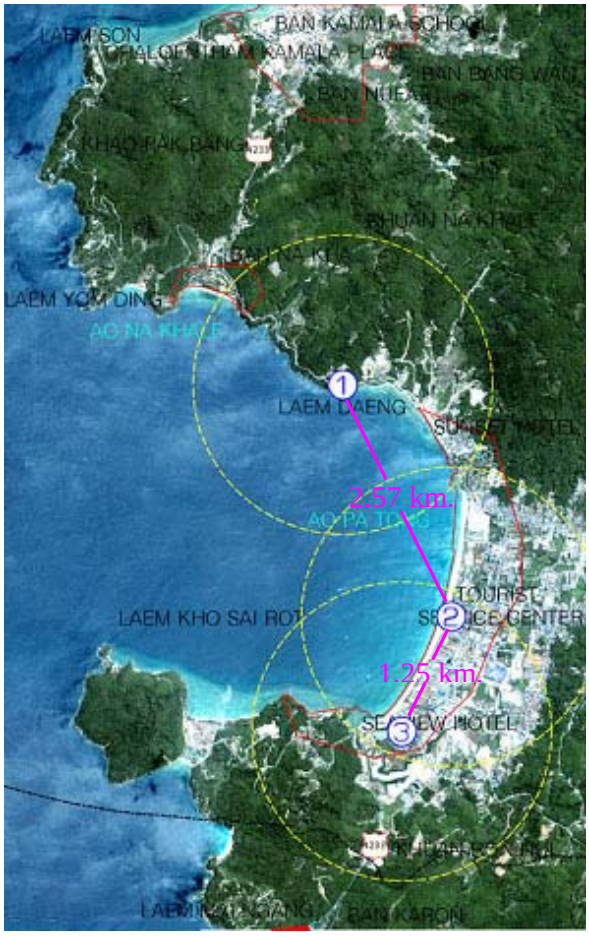


Fig. 3 IKONOS Natural Color image acquired on April 21, 2005 overlaid with affected area in Phuket coastal plain indicated by red boundary covering kamala beach-Patong Beach, Phuket province. Three sites were selected with each warning tower located about 1.25-2.57 km. from each other and people can hear the warning siren within 1.5 kilometers radius.

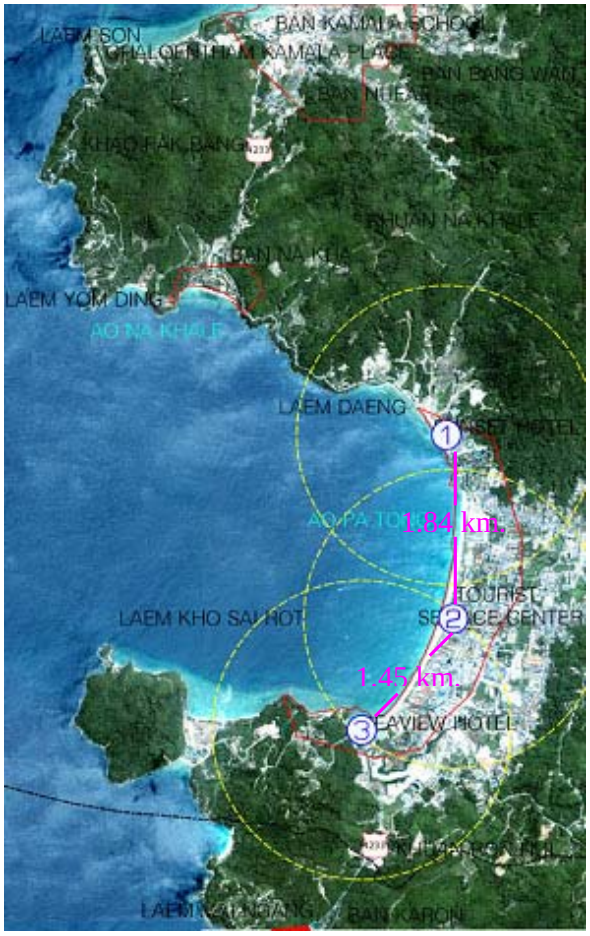


Fig. 4 IKONOS Natural Color image acquired on April 21, 2005 overlaid with affected area in Phuket coastal plain indicated by red boundary covering kamala beach-Patong Beach, Phuket province. The suitable positions of the warning tower at Patong Beach are three sites. The first is Sunset Hotel, the second is Tourist Service Center and the third is Seaview Hotel. Each warning tower is located about 1.45 – 1.84 km. distance and people can hear the warning sirens within 1.5 km. radius.

6. Results and Discussion

Table 2. Number of tsunami warning tower in provinces along the Andaman Sea south of Thailand.

Province	Number of tsunami warning tower	Remark
Ranong	3	
Phang-nga	20	
Phuket	7	Installed 3 units
Krabi	12	
Trang	11	
Satun	15	

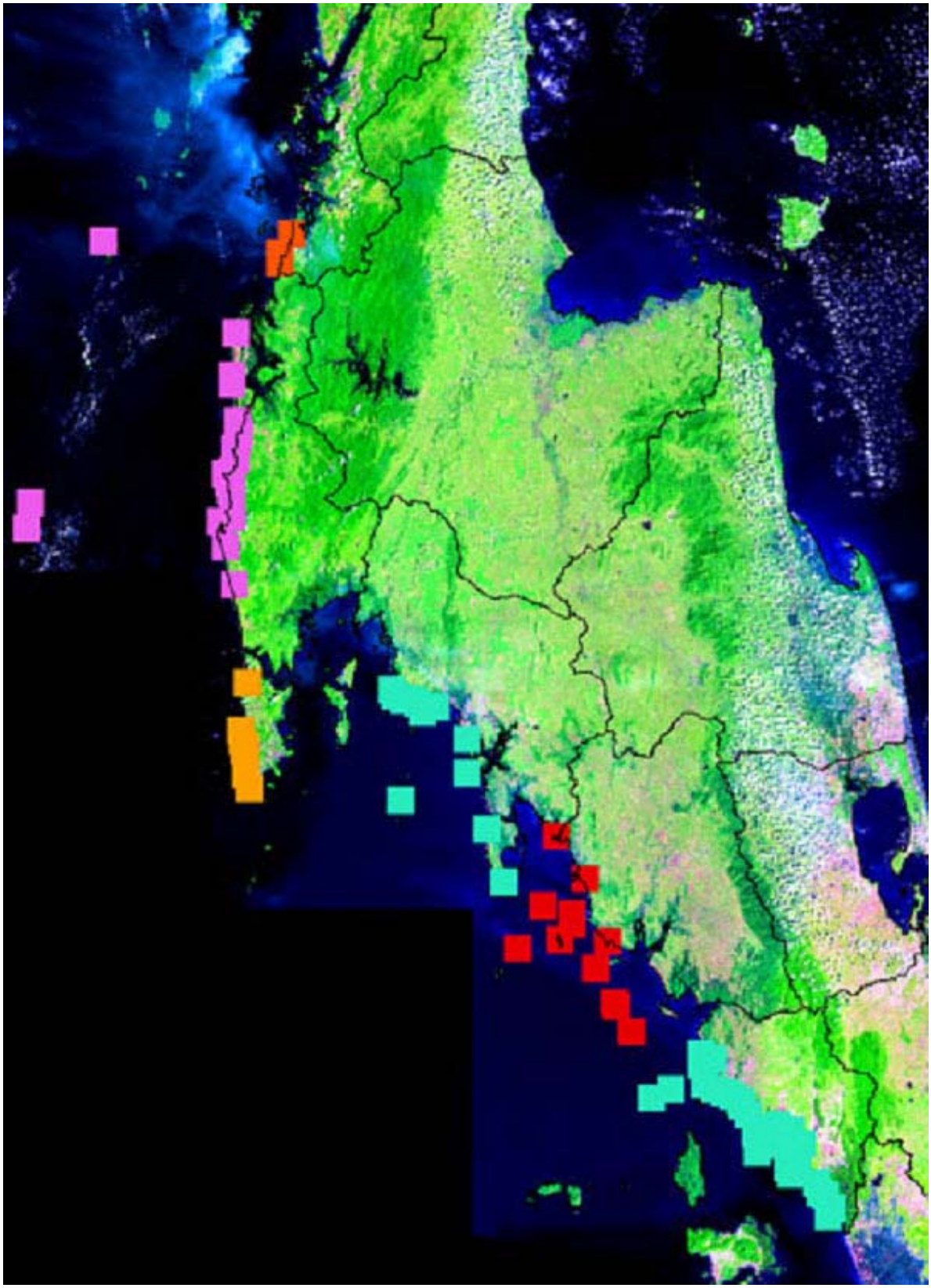


Fig.5 The suitable position of tsunami warning tower in 6 provinces along the Andaman sea south of Thailand.

7. Conclusion

Remote Sensing technology and Geographic Information System can help to locate the site for tsunami warning towers giving a clear broad view and specific location within a short time. Both high and low resolution satellite images with Geographic Information system (GIS) and Global Positioning System (GPS) were applied to locate suitable position of Tsunami Warning Tower. Tsunami Warning Tower can reduce disaster impact if warning is issued promptly, however the help of Tsunami Warning Tower depends largely on community's awareness and strict response to warnings.

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