

# **INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS**

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## **THAILAND**

**REPORT ON THE GEODETIC WORK**

PERIOD

1999 – 2002

**THE ROYAL THAI SURVEY DEPARTMENT**

PRESENTED AT THE XXIII GENERAL ASSEMBLY OF  
THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

**THE INTERNATIONAL ASSOCIATION OF GEODESY**

30 June - 11 July ,2003

**Sapporo, JAPAN**

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## **THE ROYAL THAI SURVEY DEPARTMENT**

The Royal Thai Survey Department is responsible for land and air surveying activities and producing topographic maps for official and public use. In addition, it is also engaged in the field of Geodesy and Geophysics of which various activities were conducted during the period under review, 1999 – 2002. These are as follows :

### **1. Horizon Control Network**

#### **GPS Network of The Royal Thai Survey Department**

GPS Satellite System is a system used for determining the positions on the globe with the accurate result by measuring from the known positions to the unknown positions in either earth, sea, space or any positions in WGS 84 datum. The coordinate obtained from this measurement will be the relative point positioning. By this way, the accuracy will be in centimeter level. Therefore, the establishment of GPS Network is more accurate and reliable than Triangulation Network.

Geodesy and Geophysics Division, The Royal Thai Survey Department (RTSD) is responsible for the establishment of Geodetic Network in Thailand using the Global Positioning System. The GPS observation has been performed since 1991 and its networks are continuously developed up until now. Moreover, RTSD had participated in various international projects of GPS observations namely Project on monitoring tectonic motions, THAICA Project done with the German Institut fur Angewandte Geodesic : IFAG, the Project on determination of coordinates in WGS 84 datum using Relative point positioning technique done with the National Imagery Mapping Agency : NIMA, Project on the joint survey and demarcation with the neighbouring countries, Project on Geodesy and Geodynamics Research using GPS data for the purpose of monitoring tectonic motions and deformations which is presently carried out with the Delft Institute for Earth-Oriented Space Research (DEOS), Netherlands.

The results coming out from the participation in the aforementioned projects make the GPS Thailand Network acquire not only the observed data but also the accurate and reliable control stations. At present, RTSD is conducting the L 7018 Recompilation Project. The datum in the new map series will be WGS 84. As a result of this, Geodesy and Geophysics Division, RTSD has performed the network adjustment covering the whole country in order to make the network not only become more accurate and reliable but also reach the unity. This network will be further used as the reference network for other concerned projects and eventually for developing the countries as well as for the scientific and geodetic analysis.

As mentioned earlier, in order to improve the GPS Network of RTSD become more reliable, the adjustment of network is made in accordance with FGCC (Federal Geodetic Control Committee, 1989(USA.) standard. The Network of RTSD is divided into 3 levels as follows :

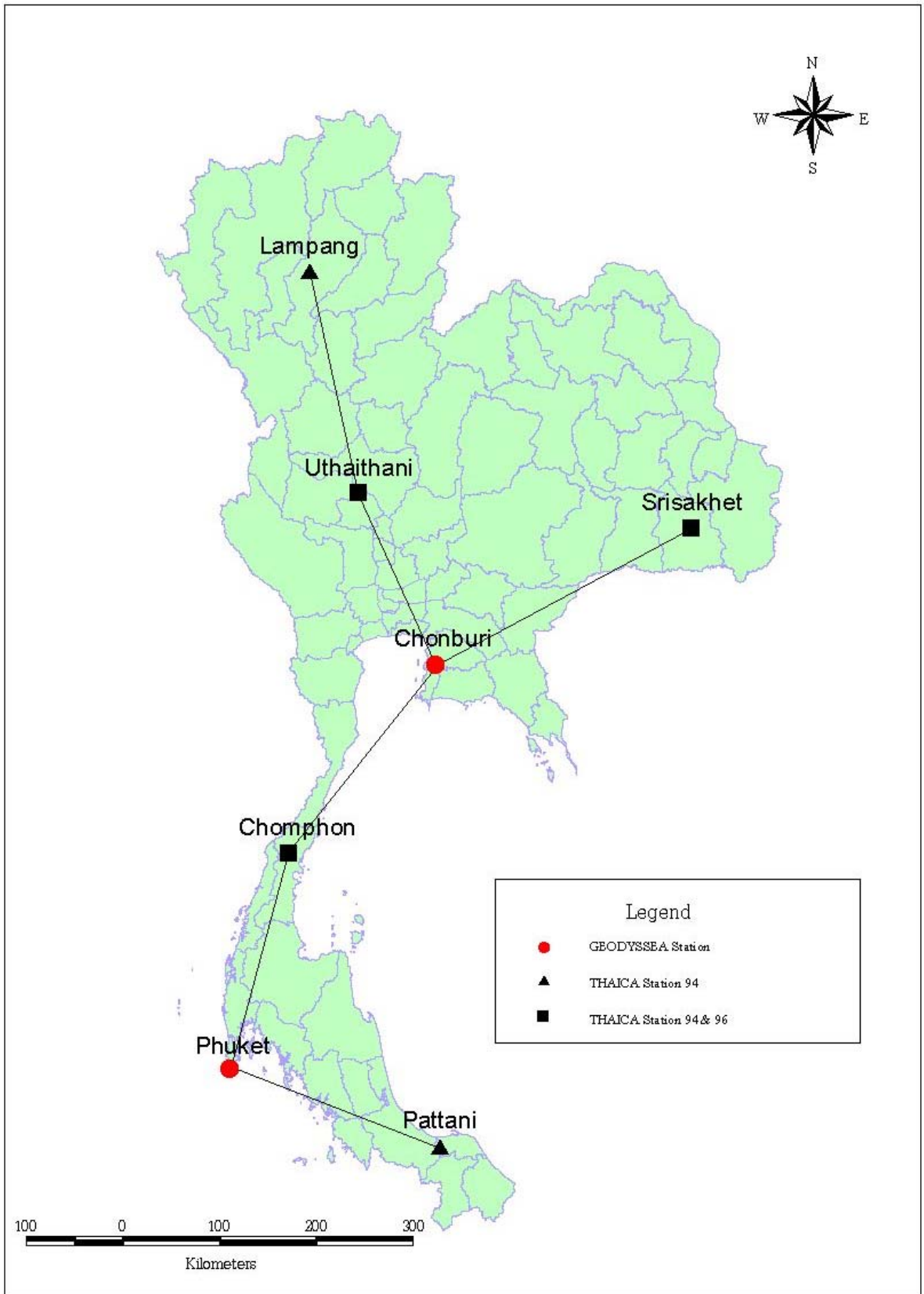
1. Reference Frame (Zero Order Network) use for the Project on monitoring tectonic motions, THAICA and GEODYSSSEA Projects consisting of 7 stations such as GPS 3001 Uthai Thani province, GPS 3052 Srisaket province, GPS 3217 Lampang province, GPS 3315 Chumphorn province, GPS 3405 Pattani province, GPS 3427 Chonburi province and GPS 3657 Phuket province. Reference coordinates are in ITRF system during the time of 1996.3. At present, GPS station in Pattani province (GPS 3405) was destroyed. As a result of this, there are only 6 control stations remaining in this Network.
2. Primary Network (First Order Network) It is determined in Class A as standardized by FGCC. This network which is extended from the Zero Order Network was first observed in 1999. There are 18 stations included in the First Order Network (including 6 stations as specified in item 1). The interval in each station is about 250 kilometers.
3. Secondary Network (Second Order Network) It is determined in Class B as standardized by FGCC. This network is extended covering the entire country with the total of 692 stations. The said network has been observed from 1991 until now. The interval in each monument is about 20 – 50 kilometers.

Data containing in the Thai GPS Network are from various projects. The said data coming out from each project is so accurate that can be used as the Thailand network. However, in selection of reference Network of Thailand, the accuracy is mainly considered. Therefore, the Secondary Network is selected to use as the national reference network because this network which consists of 692 stations was already adjusted. The network adjustment is divided into 2 steps. The first adjustment is used as the Control Network with inclusion of 18 stations extended from GEODYSSSEA and THAICA Projects. In the second adjustment makes the Network of Thailand become unity, reaches the international standard accuracy and consistent with the reference datum of L 7018 topographic map series.

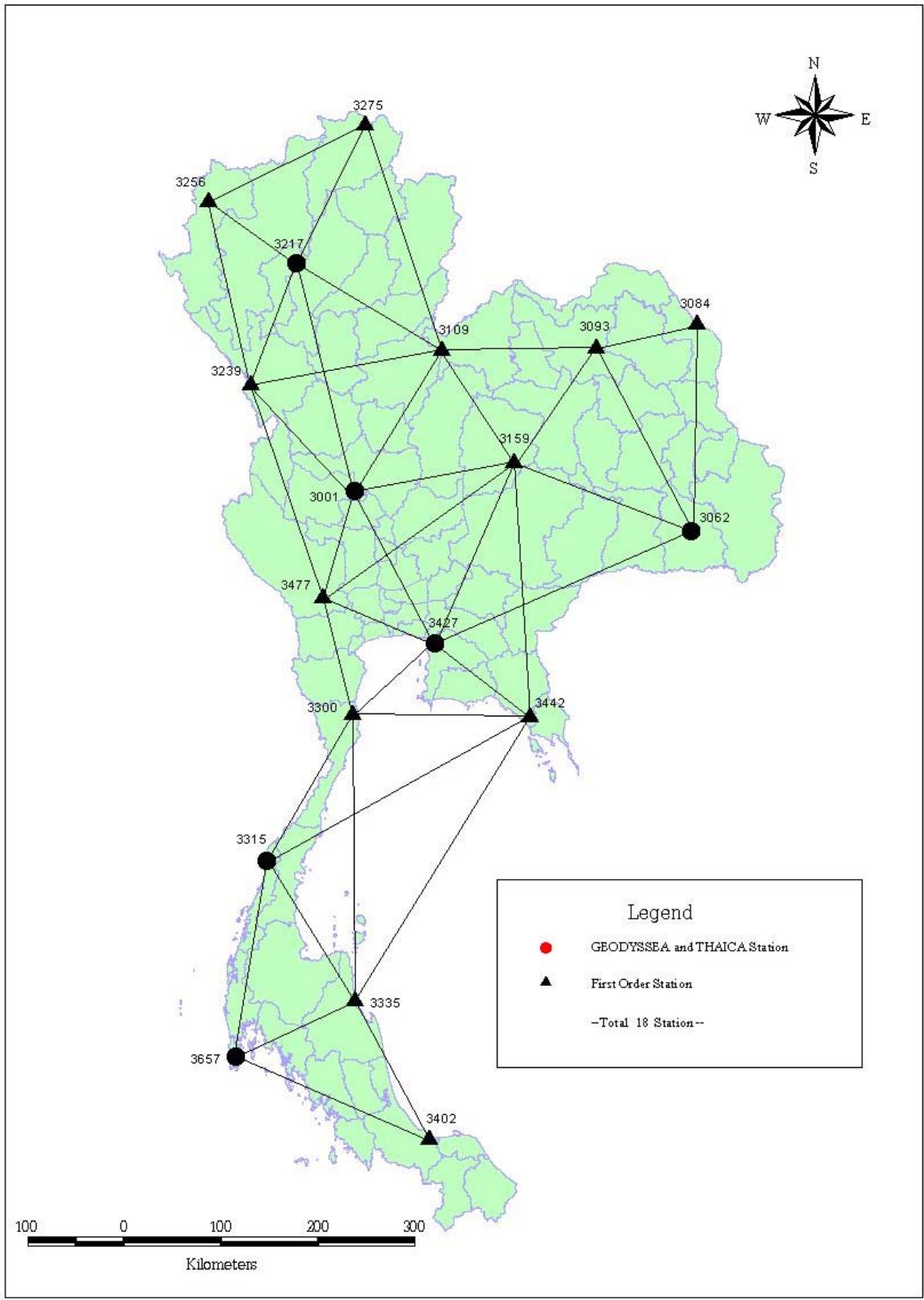
The earlier Network of Thailand had been adjusted for several times. But the limitation in each adjustment was that there is only one control point (GPS 3001 Uthai Thani province) containing in the network. The said control point still has horizontal error of 1.5 meters and vertical error of 4 meters. This is the cause of cumulative distortion. As a result of this, the Reference Coordinates System of Thailand has to be developed and improved for the acquisition of high accuracy. This system is presently adjusted with satisfactory outcome.

In conclusion, RTSD Network is highly reliable and consistent with FGCC's standard. All stations from GEODYSSSEA and THAICA Projects in ITRF system during the time of 1996.3 are used as the Control stations. RTSD Network is use for studying the geodynamics with DEOS, the Netherlands Institute.

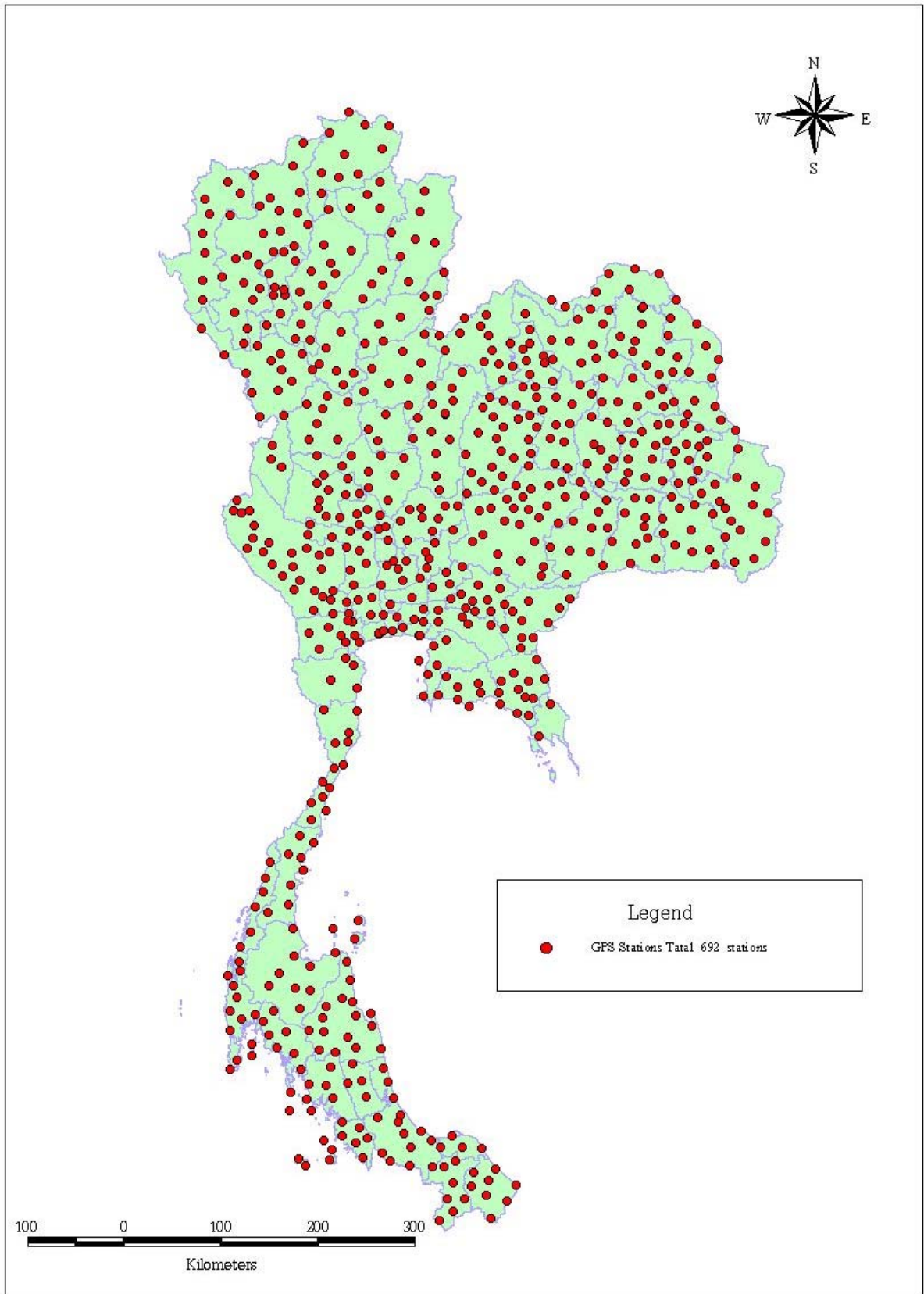
In the future, RTSD will use GPS satellite technique for the identification of Mean Sea Level (MSL) instead of using Leveling technique. At present, Geodesy and Geophysics Division, RTSD is studying and developing the local datum using data obtained from GPS and Leveling Network for adjustment.



**Fig. 1** Reference Frame of GPS station of Thailand



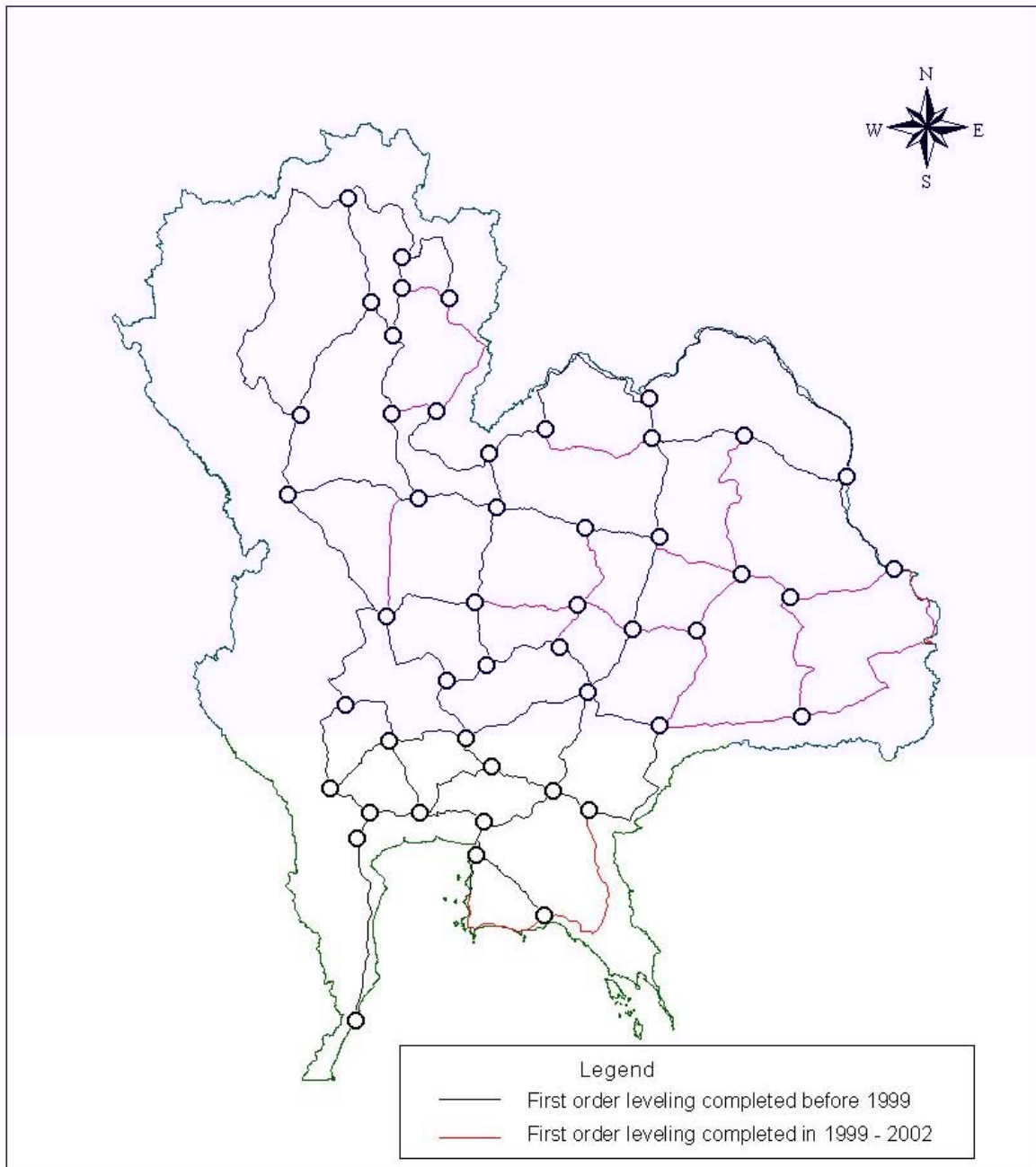
**Fig. 2** Primary Network of GPS Stations



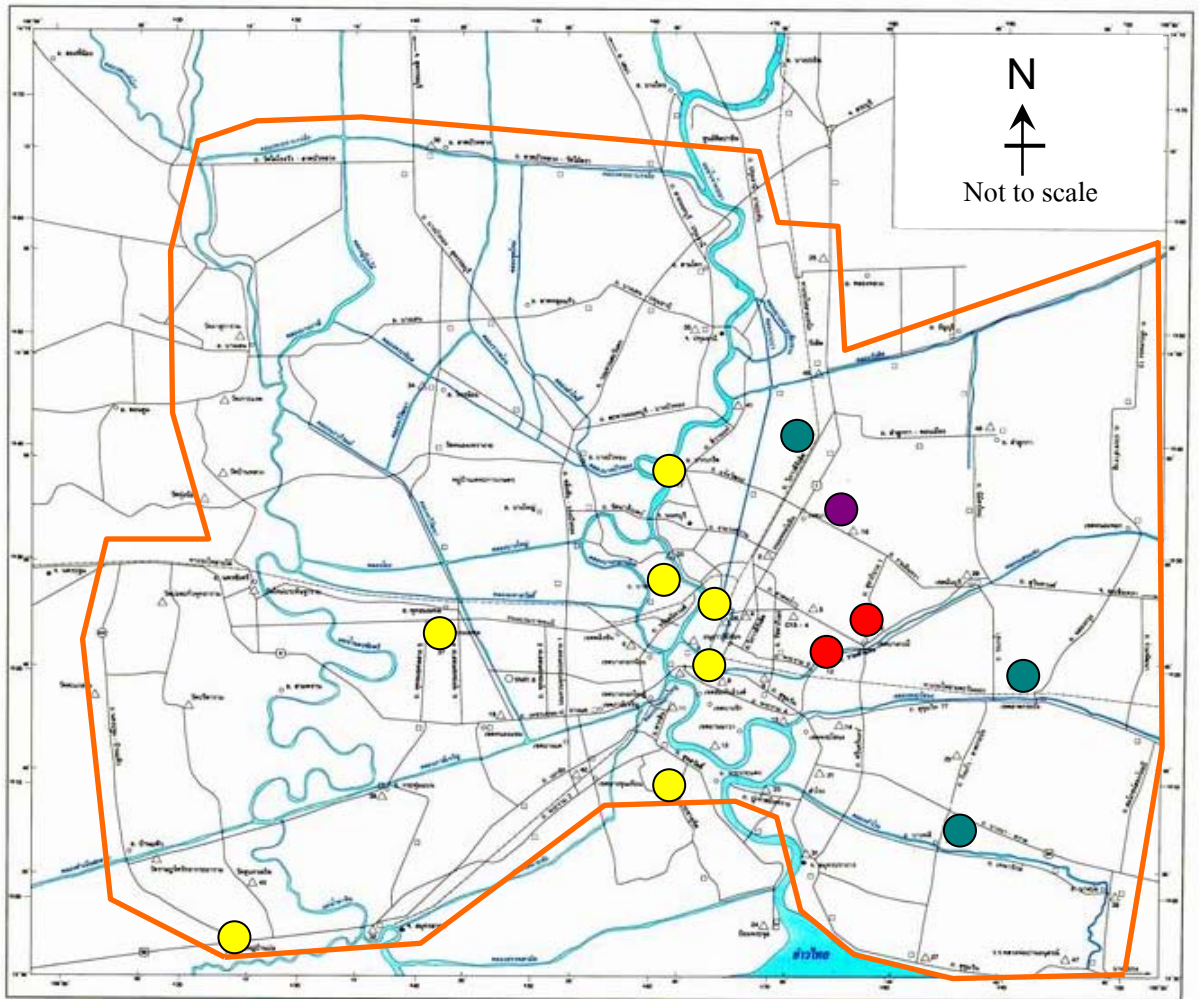
**Fig. 3** Secondary Network of GPS Stations

## 2. Vertical Control Network

The network of first order leveling was extended from the tidal datum (Mean Sea Level) at Ko Lak to every part of the country. During the period under review, the first order leveling were carried out to densify the network with a total establishment of 333 PBMs and 1,612 SBMs. All observation data in the leveling network were prepared and ready for simultaneous adjustment.



**Fig. 4** First order leveling network of Thailand (Upperpart Ko Lak)

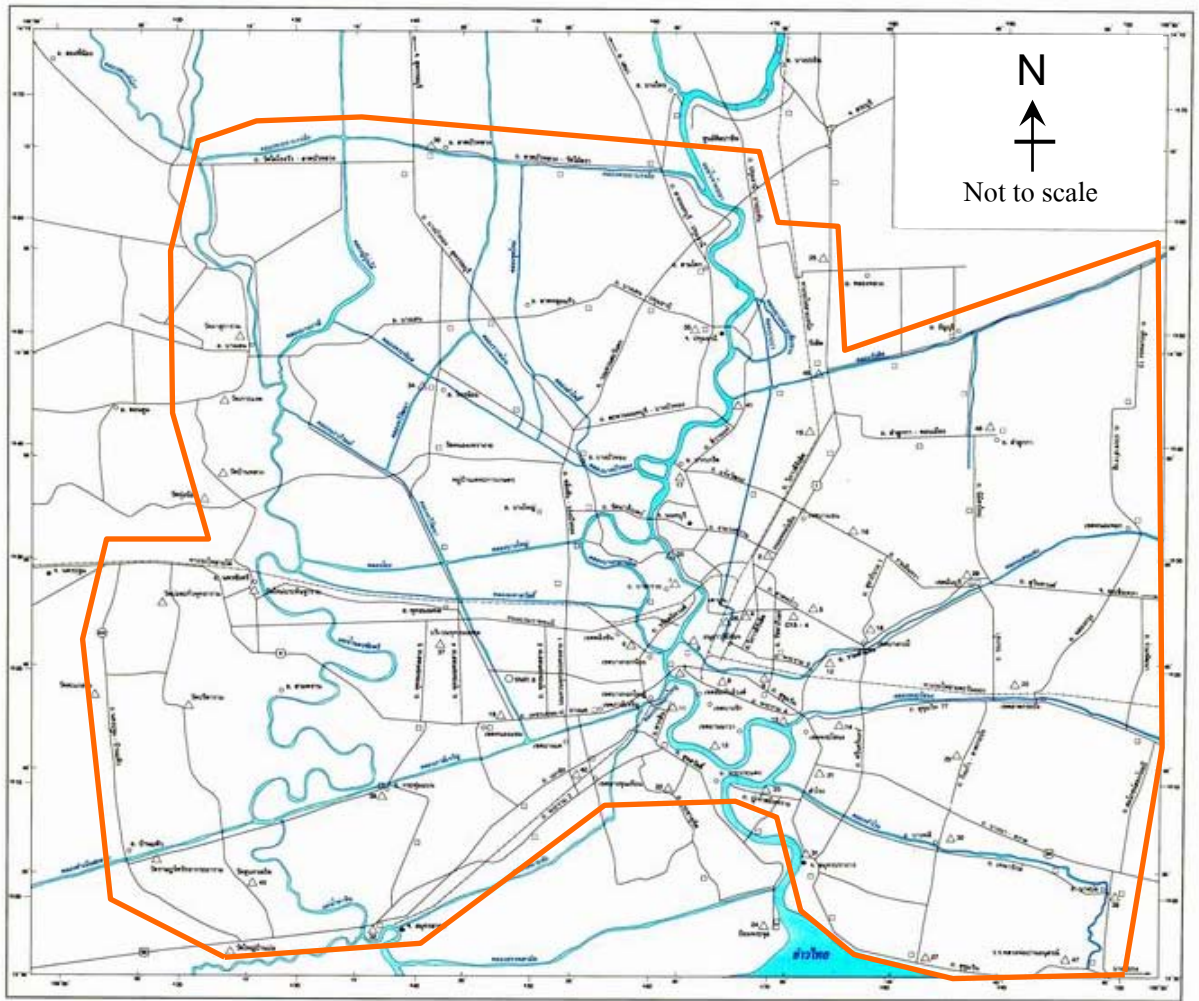


Legend

- Area boundary
- Leveling line
- Subsidence magnitude greater than 100 cm.
- Subsidence magnitude 75-100 cm.
- Subsidence magnitude 50-75 cm.
- Subsidence magnitude 25-50 cm.

**Fig. 5** First order leveling for Investigation of land subsidence in Bangkok; showing magnitude of land subsidence between 1978-1999

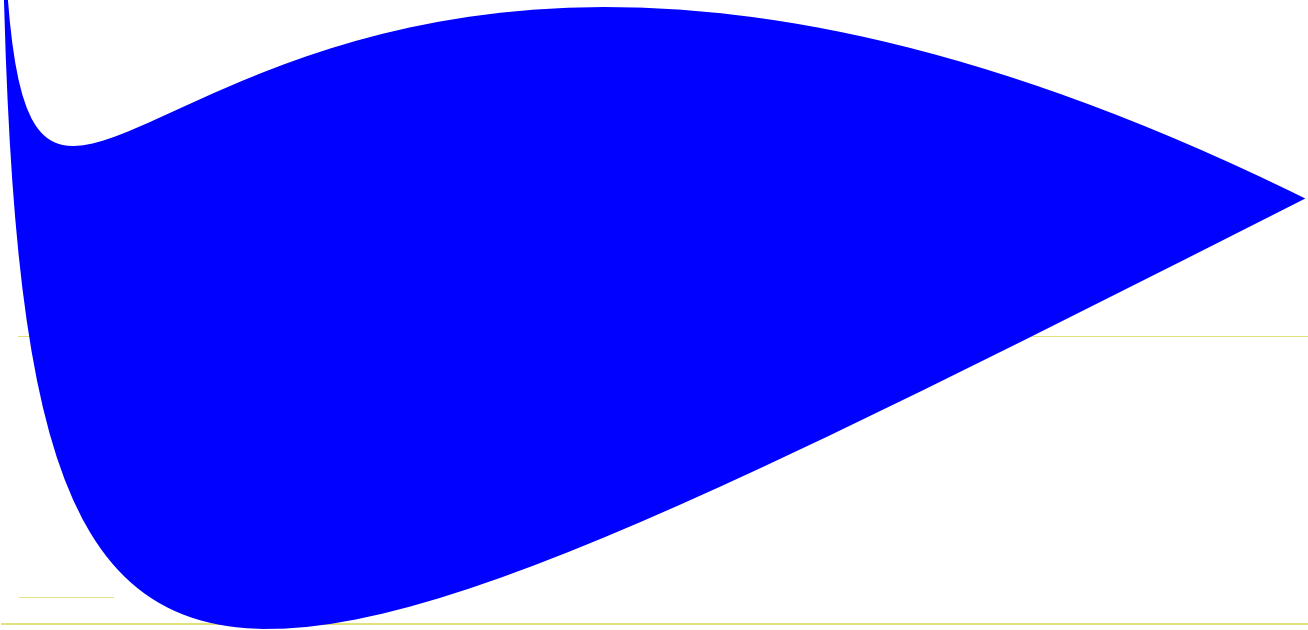
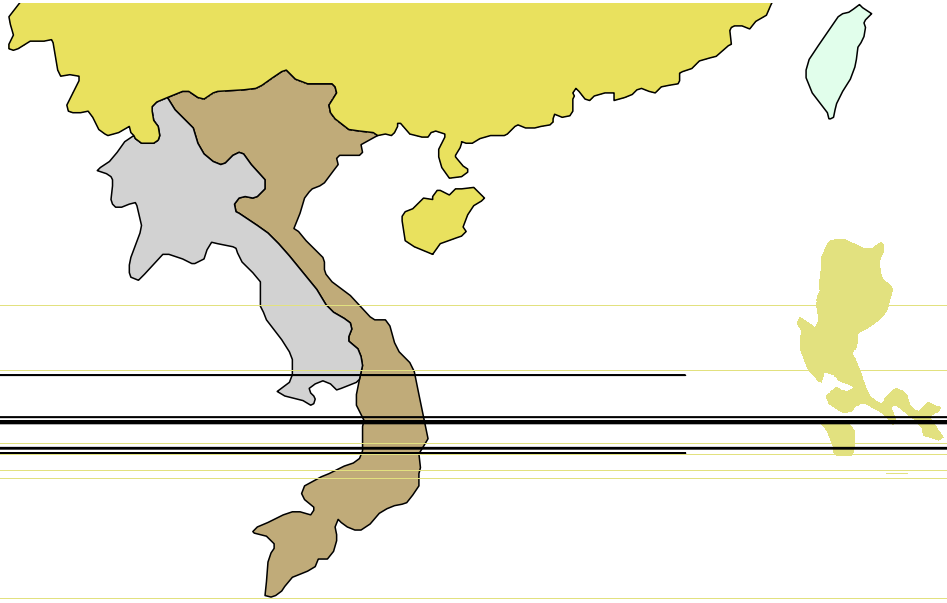




Legend

- Area boundary
- Leveling line
- Subsidence magnitude greater than 7-10 cm.
- Subsidence magnitude 5-7 cm.
- Subsidence magnitude 3-5 cm.

**Fig. 6** First order leveling for Investigation of land subsidence in Bangkok; showing magnitude of land subsidence between 1999-2002



### **3. Geodesy and Geodynamics Research on the THAICA Network by GPS observations.**

Persuent to the coordination between the Royal Thai Survey Department and DEOS, Delft University, Netherlands , both sides are interested in high accuracy geodetic coordinates to derive the velocity estimates of plates motion and site ties for GPS stations in and around Thailand.

In October 2001, the Royal Thai Survey Department ( RTSD ) has made GPS observations at seven ( 2 GEODYSSSEA and 5 national (THAICA) sites in Thailand concurrently with the fifth GPS remeasurement of a dense geodetic network in Sulawesi ( Sulawesi 2001 GPS Campaign ) by the Delft Institute for Earth – Oriented Space Research ( DEOS). The 2001 data was processed at DEOS , using the JPL GIPSY software package , and the results were combined with previous measurements carried out in Thailand (1994 – 2000 ). Data from 17 permanent sites of the International GPS Service (IGS) were included to obtain the positions and velocities of the Thai sites in the International Terrestrial Reference Frame (ITRF) solution of 2000. The RTSD 2001 THAICA GPS measurement campaign included first (OTRI), second ( BANH , SRIS ) and third (UTHA) repeat measurements of the THAICA network . A new site (PATN) was also measured , to replace the lost site (PATT) in Pattani . The daily coordinate repeatabilities in 2001 are about 1 – 4 mm for the horizontal positions, and 6 -10 mm for the height . The mapping into ITRF – 2000 resulted in IGS station coordinate residuals (RMS values) of 2 – 3 mm (horizontal position) and 6 mm (height) . Therefore the 2001 Thai site coordinates have horizontal and vertical absolute accuracies which are typically better than 6 mm and 15 mm respectively. This means the coordinate time series could be further extended, and also site velocities were further improved ( better than 2 mm/year). A problem with the mapping of the 1996 data set ( also observed for the 1996 GEODYSSSEA data set ) is now clearly identified and needs to be further investigated. A future re - measurement of the THAICA network in 2003 would be very useful to improve the site coordinates and velocities of OTRI and SRIS, and to obtain a first velocity estimate for the new PATN site.

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Reference : W.J.F. Simons and B.A.C. Ambrosius, Delft Institute for Earth – Oriented Space Research ( DEOS ) , Kluyverweg 1, 2629 HS Delft , The Netherlands.

#### **4. Participation in Regional Geodetic campaign**

Due to the resolutions adopted by the 8 th PCGIAP (Permanent Committee on GIS Infrastructure for Asia and Pacific), the meeting requested member countries to join the Regional Geodesy observation campaigns.

Royal Thai Survey Department took part in the campaign on GPS observations during October 2002. five stations from the THAICA Network and two GEODYSSEA stations were observed on the said period.

Thai National Control Network by GPS observations has been adjusted to THAICA and GEODYSSEA stations. In this respect, Thai geodetic control network is partly of regional geodetic network .

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