CHAPTER II
THE UPPER GULF OF THAILAND

Environmental Setting of the Study Area

Location

The Gulf of Thailand is part of the Sunda Shelf, located in the westernmost portion of the Pacific Ocean. It extends southeast from the Chao Phraya deltaic plain near Bangkok, approximately 800 kilometers to its mouth. The average width is approximately 400 kilometers. The Gulf is a relatively flat basin with an average depth of about 50 meters. It is a semi-enclosed sea of shallow depth and topography of the coastline combining with riverine and tidal effects. It can be divided geographically into two parts as the Upper Gulf (or the Inner Gulf) and the Lower Gulf (or the Outer Gulf) (Robinson, 1974).

The Upper Gulf of Thailand is located in the tropical region between latitudes 12° 30′ and 13° 30′ N and longitudes 100° 00′ and 100° 50′ E. It is a nearly square bay with an average approximately 90x100 square kilometers. The Location of the Upper Gulf of Thailand is shown in Figure 2.1.

Bottom topography

The Upper Gulf is a relatively shallow embayment. It is shallower than the Lower Gulf with a maximum depth of about 40 meters and an average depth of about 15 meters. The bottom topography slopes gradually downward from the shallow northern coast to depth of 30 meters at its mouth, which is between Sattahip and Hua Hin. The western side of the bay (with an average depth approximately 15 meters) is shallower than the eastern side (with an average depth approximately 25 meters) (Siripong, 1985; Hydrographic Department, 1993). The bottom topography of the Upper Gulf of Thailand is shown in Figure 2.2.

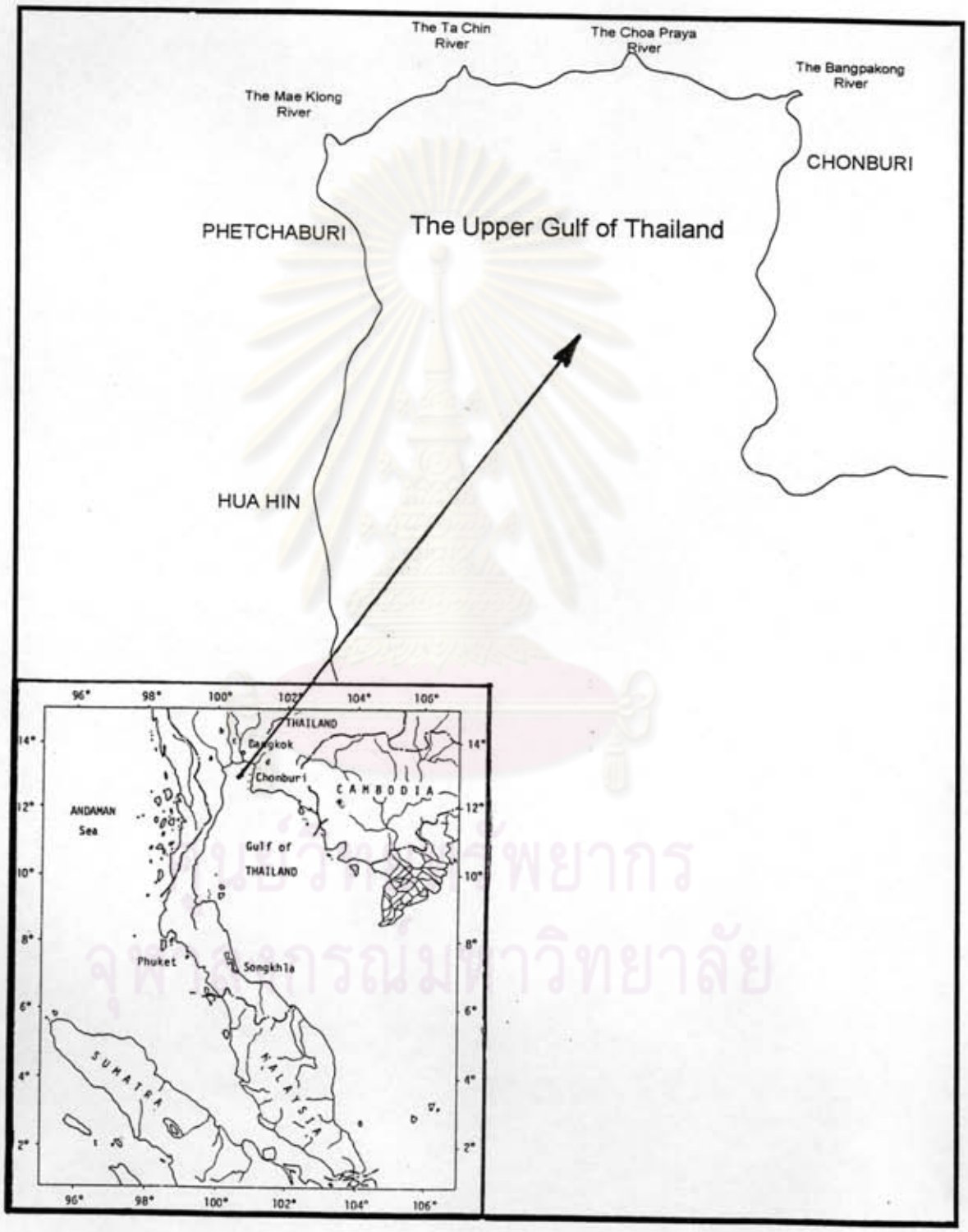

Figure 2.1 Location of the Upper Gulf of Thailand.

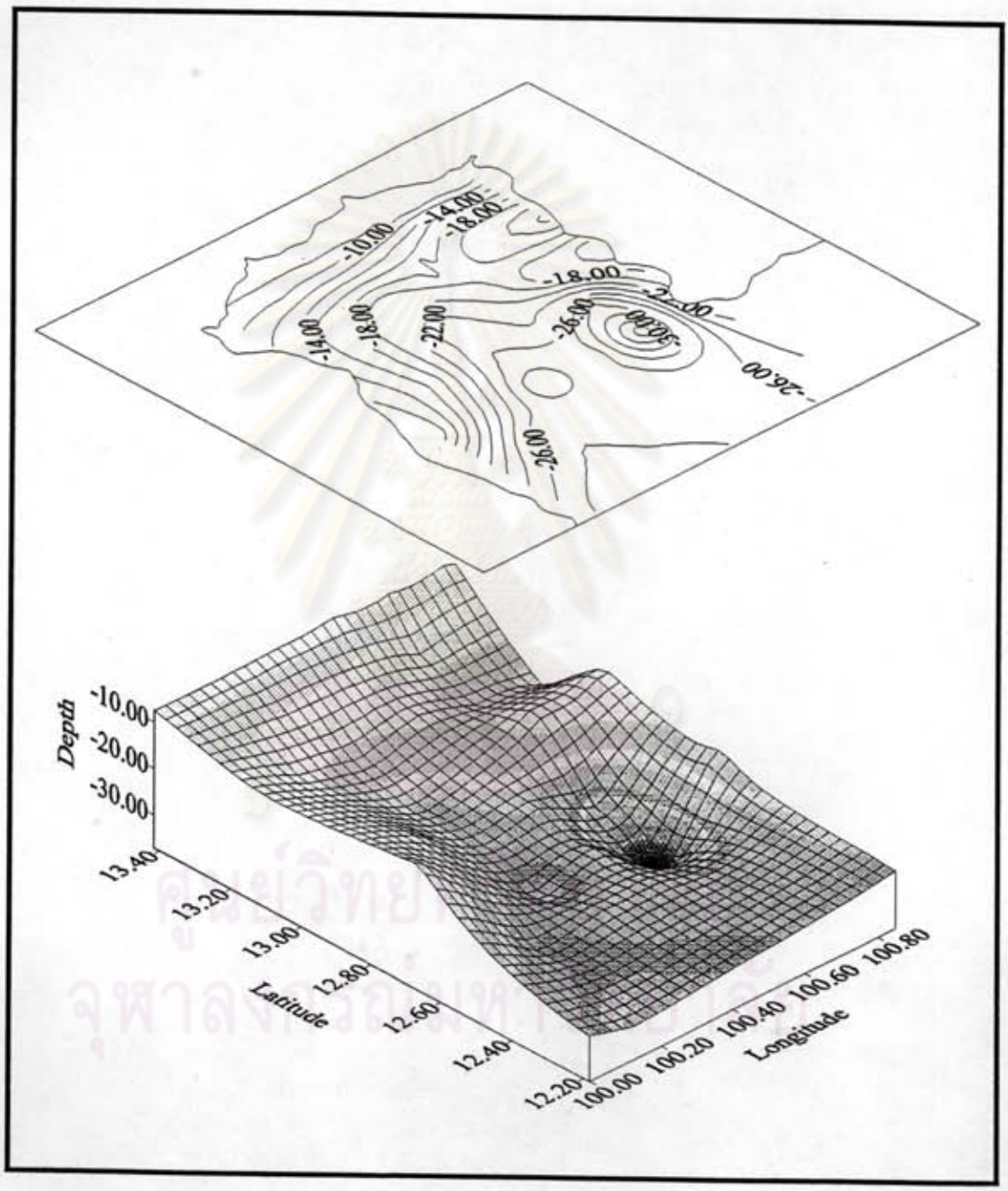

Figure 2.2 The bottom topography of the Upper Gulf of Thailand (data from Hydrographical Department, Royal Thai Navy 1993).

Climate

The climate of the Upper Gulf of Thailand is strongly influenced by two major Asiatic monsoons, the southwest and northeast monsoon. The southwest monsoon is usually dominant during May-September. It brings high moist air originating from the Bengal Bay into the region, resulting in heavy rainfall. The northeast monsoon is usually dominant during November-February. Normally, the wind blows from the east. It brings cool and dry air from the Siberian anticyclone into the Gulf, resulting in cool weather and dry condition. During February-May (the transition period), the shifting from the northeast monsoon to the southwest monsoon occurs. The northeast monsoon starts shifting to east and southeast directions in the beginning of February. It becomes the southeast wind with rough sea surface condition. This wind originates from the high pressure area in the South China Sea. In May, the southeast wind shifts to south and southwest directions. It become the southwest monsoon. During the monsoon transition period, wind patterns are highly variable and difficult to predict (Meteorological Department, 1985, 1987 and 1992).

The climate of the Upper Gulf may be divided into 3 seasons. The rainy season, or the southwest monsoon season begins in mid-May and end in October. The winter season, or the northeast monsoon season begins in October and ends in February. The summer season, or the transition periods of changing from the northeast monsoon season to the southwest monsoon season begins in February and ends in mid-May.

Rainfall

During November-February, the northeast monsoon normally sets over the Upper Gulf. First, it gradually develops during the transition period and reaches its maximum during December and January. Cool and dry weather appears within the area from the Gulf of Thailand northward. Thus, the November rainfall amount decreases sharply relatively to those in previous month. The following month, December, the amount of further decreases to one-fifth of those in the previous month. December is the driest month that the rainfall amount exactly show the agreement to the maximum

development of the Siberian high. The rainfall amount generally begins to increase slightly in January.

The summer season starts from March to May, the transition periods of shifting from the northeast monsoon season to the southwest monsoon season. The wetness within the Upper Gulf during March-April begins to increase gradually, but still less than 100 mm. By the end of the summer season, the rainfall amount increases within the range of 100-200 mm.

The southwest monsoon normally begins to prevail over the Upper Gulf in May. The wind brings the moist air to the Upper Gulf. The monsoon significantly affects the Upper Gulf particularly the eastern part much more than it does to the western part. Since the intense of the monsoon during this period, together with the topographic effect, the eastern part receives much more substantial rain with the maximum amounts in August and September.

October is the transition month of shifting from the southwest monsoon the northeast monsoon. The rainfall amount in the Upper Gulf begins to decrease, but it are still in a wet condition, with the rainfall amount of greater than 200 mm.

The long-term average of monthly rainfall and evaporation in the Upper Gulf of Thailand are shown in Figure 2.3. These information were observed at six meteorological stations along the coastline and one stations on the island in the Upper Gulf of Thailand: pilot station at Samut Prakhan (to the North), Chonburi, Ko Sichang (the island stations), Patthaya, Sattahip (to the East), Phetchaburi and Hua Hin (to the West) by Climatology Division, the Royal Thai Meteorological Department. It clearly showed the seasonal variation. The annual rainfall and evaporation vary between 597-1362 mm and 1681-1841 mm, respectively.

Air Temperature

The annual mean temperature along the coastlines vary slightly at about 2°C within the range of 26-28°C. The monthly mean temperatures in the Upper Gulf are minima during the winter. The maxima temperatures, of course, occur in Summer, April. The difference between the hottest and coolest months or the monthly mean

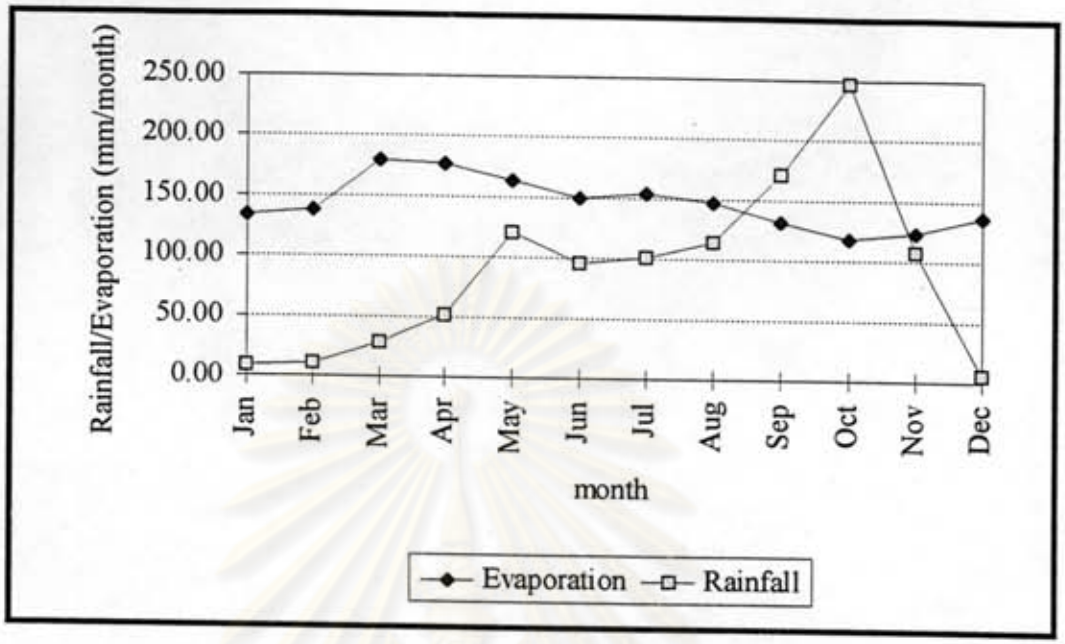

Figure 2.3 The long-term average of monthly rainfall and evaporation of seven stations around the Upper Gulf of Thailand (data from the Meteorological Department, 1992).

temperature ranges vary in the scale of 4°C. The mean monthly temperatures from January to April increase rapidly, about the average 1°C/month, due to the prevailing of the southeast wind. During the rainy season, the temperatures tend to drop gradually from about 28-29°C at the beginning of season to 27-28°C at the end of the season. This is because cloudiness blocked the intense heating of the surface. The mean monthly temperatures for the rest of the year, October to December, also decrease slightly to 26°C due to the prevailing of the northeast monsoon.

Oceanographical Features

The Upper Gulf of Thailand is surrounded by land at all three sides: northern, eastern and western. It opens to the Lower Gulf via the southern border. The Gulf is affected by the freshwater of the four major rivers along the northern boundary. Thus,

the transportation of water mass is mainly controlled by the combined effect of river runoff and tidal current (Jarusombat, 1978).

In dry season (low peak of river discharge), the distribution of water property is well mixed vertically so that it is homogeneous from top to bottom. Occasionally, it is slightly stratified type, particularly in the beginning of rainy season. In rainy season (high peak of river discharge), the distribution of water property is highly stratified and there is a very strong halocline between the upper water and the deep water (Jarusombat, 1978).

Water Current

The tides in the Upper Gulf are mixed, dominated by semidiurnal tides. The mean tidal range is highest at the bay head (about 1.5 m) and lowest near the mouth (about 1 m) (Siripong, 1988).

The surface circulation in the Gulf is influenced by the patterns of the monsoon wind. The direction and magnitude change according to the northeast wind (November to February) and the southwest wind (May to September). During the two transition periods (March to April and October to November), the directions of current are weak and variable. The strength of surface current is general stronger in the northeast monsoon season than the southwest monsoon season. However, water circulation in the Upper Gulf is driven by the combined effect of river discharge with wind drift and tidal current (Siripong, 1989).

The Upper Gulf was indicated a characteristics of tidal current which related to the local oceanic tide. During the high tidal, The direction of current is northerly, while during the low tidal, the direction of current is southerly. The average velocity of tidal-driven current varies in the range of 1.5-2 knot. The effect of wind and water density on the water circulation in the Upper Gulf is smaller than the tidal current. The wind-driven current velocity is less than 0.5 knot (Neelasri, 1981).

During the transitional period of the northeast monsoon to the southwest monsoon in March and April, a southerly wind blows over this region which consequently induce a wind driven current. The surface current flows in the northeast

direction towards the eastern coast of the Upper Gulf. In deeper layer, the direction of flow deviates to the right of the wind direction more than at the surface until to the opposite direction. The magnitude of current which decreased with depth implies that a transportation of water mass at the surface flowing into the Upper Gulf larger than in the deeper layer which flowing out. The excessive water mass may oscillately pile up along the northern and eastern coast related to the period of a strong southerly wind as the same character of a storm surge (Neelasri, 1981).

Temperature Distribution

Generally, the seawater temperature of the Upper Gulf of Thailand has a little variation in both the horizontal and the vertical planes (Silpipat *et al.*, 1984 and Silpipat 1987). The northeast and southwest monsoon play an important role in the water temperature distribution (Charusombat, 1978). During the northeast monsoon season, it varies in ranging of 27-30°C. The surface temperature increases slightly within the range of 28-32°C during the southwest monsoon season (Silpipat *et al.*, 1984 and Silpipat 1987).

Salinity Distribution

In the Upper Gulf of Thailand, salinity is the predominant in the changing of water density and it obviously shows the seasonal effect to water mass (Charusombat, 1978). The annual salinity varies between 5 to 33 ppt. Salinity variation is extreme only near the rivermouth during the rainy season (wet period from July to December) in the range of 22-32.5 ppt, but there is a small fluctuation in summer (dry period from January to June) within ranging of 28-32.5 ppt (Silpipat, 1987).

The effect of freshwater runoff on the salinity of the Upper Gulf is very significant, particularly the effect on surface salinity. In dry period (January to May), the Upper Gulf is well mixed except in the area near rivermouths. During the wet period (June-December), surface salinity near rivermouths may drop to 1 ppt and in some years, the large amount of river runoff can effect on surface salinity as distant as the middle part of the Upper Gulf (Banpapong and Piyakarnchana, 1987).

Dissolved Oxygen

The dissolved oxygen in the Upper Gulf ranged from 4.53 to 5.08 ml l^{-1}. At the rivermouth, the dissolved oxygen was almost higher than 4 ml l^{-1}, excepted some months at Ta Chin rivermouth which was lower than 2 ml l^{-1} (Chernbumroong, 1987).

Banpapong and Piyakarnchana (1987) complied and analyzed the water quality data (DO, temperature, salinity and pH) collected from 1973-1984 in the Upper Gulf undertaken the Research on Quality of Water and Living Resources in Thailand Water Program. The dissolved oxygen trend increased slightly during 12 year periods, especially at the bottom level during wet period (high runoff). According to this data, most of dissolved oxygen showed higher values than 3 ml l^{-1} (over the toxic levels on aquatic animals).