# CHAPTER III

# METHOD OF STUDY

## 3.1 Rationale of coastal measurement

The old shoreline maps are available from maps dating back to the late 1800's. Not only in Thailand, but also in the world coastal studies, topographic maps are most useful for examining long – term trends in shoreline change since the maps are produced in – frequently, limiting the amount of detail that can be obtained about short – term physical processes. However, errors in shoreline location derived from maps may be attributed to surveyor error in identifying the shoreline feature, distortion of source maps (folding, tearing, shrinkage), and changes in the reference datum (e.g., Anders and Byrnes, 1991; Choowong and Charusiri, 2005).

In Thailand, since the 1990's, aerial photographs have been used to document shoreline position and changes (e.g., Vonwisetsomjai, 1992). Precisely, aerial photographs needed to be first transformed to map co – ordinates using ground control points and then a proxy for the shoreline are digitized (Crowell et al., 1991). Aerial photographs were generally collected more frequently than maps were made and, therefore, may be used to develop a more detailed understanding of short – term shoreline variability. For unrectified aerial photographs, accuracy within or between images is limited by scale differences, by camera geometry, by ground relief (e.g., Crowell et al., 1991; Dolan et al., 1980; Hapke and Richmond, 2000), and by the precision of the digitizing equipment and of the operator in following the trace of the HWL (Anders and Byrnes, 1991). Since the errors in measuring a shoreline from aerial photographs are not independent, cumulative errors will also be associated with inaccurate in interpretation of the location of the shoreline at low tide, high tide or mean tide level.

Many of the errors associated with aerial photographs can be eliminated or reduced before features are identified within the image by using recent techniques involving softcopy photogrammetry where digital stereo images are used to georeference the image and remove distortion (Hapke and Richmond, 2000). Elevation contours are generated on the photograph trough the creation of a digital terrain model and shoreline position, or a specified contour, can be measured from the stereo pair (Overton and Fisher, 1996). The accuracy of the extracted features depends on the known camera parameters, flight elevation, accuracy of ground control point and the resolution of the image (Hapke and Richmond, 2000). While the use of accurate digital images eliminates much of the error associated with aerial photographs, the process of identifying a shoreline and then extracting it from an image is very labor intensive and makes the analysis of large areas more difficult.

Shorelines have also been measured from ground – based surveys of cross – shore profiles of beach elevations. Since these surveys are relatively inexpensive to perform, closely spaced profiles can be collected frequently and used for detailed studies of short – term variation in shoreline change over a limited region (Morton, 1991). While ground – based profiling techniques may yield an accurate measure of shoreline location, the measurements are spatially limited due to the intensive labor requirement of profiling. More recently, shoreline position has been measured using vehicle – mounted, ground – based GPS surveys. All terrain vehicles equipped with GPS antennae can quickly survey shore – parallel and shore – normal profiles (Morton et al., 1993), a single transect along the length of the beach (100 km or more in length), or a complete, detailed mapping of beach topography (4 km or more in length) (Plant et al., 1996; Ruggiero et al., 1999; Ruggiero and Voigt, 2000). Horizontal accuracy of shoreline positions measured using these techniques depends on, among other things, GPS accuracy, proximity of survey line to the exact location of the shoreline, and beach slope.

Beach steps are relatively small morphological features usually found on steep, coarse-grained sand or gravel beaches, although they have been identified on gently-sloping, fine-grained sand beaches (Greenwood and Davidson-Arnott, 1972: Short, 1979; Sunamura, 1989). Beach steps comprise three segments: (1) a step face or steep, seaward-facing slope facet with dip-angles slightly less than the angle of repose of the sediments; (2) a crestal region that grades smoothly from the top of the angle-of-repose slope (the crest) landward to the mid-foreshore slope; and (3) a nearly-horizontal base segment that abuts the angle-of-repose slope and often extends well into the surf zone. In profile, a beach step resembles a submerged scarp at the base of the foreshore (cf., Sherman and Nordstrom, 1985). Step height is typically less than 0.3 m measured vertically from the slope discontinuity at the base of the angle-of-repose slope to the break in slope at the step crest, although steps greater than 1.0 m on cobble beaches are not uncommon. Sometimes the only visible evidence of a beach step or incipient beach step is a narrow alongshore-trending deposit of coarse sediments or shell fragments manifest as a subtle textural gradation across the lower foreshore slightly below mean water level.

Figure 3.1 Beach step shown in Wanakorn beach area.

## 3.2 Methodology

The data collection phase of this research began with critical studies of previous works on coastal change in the Gulf of Thailand done by local researchers. Most previous studies did not explain how to evaluate the detail of coastal hazard or high – risky zone. However, those previous studies benefited this research by providing some basic guidelines for coastal change study. Likewise, a detail interpretation of remote sensing data was firstly carried out in this research in order to examine the coastal and beach geomorphology.

One important method of this research is the measurement of coastline, beach and shoreface vertically and horizontally. This research focuses in Pranburi truncated beach ridges plain, Prachuap Khiri Khan Bay, and Wanakorn beach ridge plain where there are differences in geomorphology. Remote sensing data (series of aerial photographs taken in different period of time) were used to integrate and select the appropriate areas for evaluating sediment cycle and currents. Annual checks and measurement of shoreface profiles were designed in order to understand the changes in sediment budget in different seasons.

The methodology of this research is divided into 4 steps.

1. Previous work studies
2. Remote sensing interpretation
3. Field investigation and observation
4. Data analysis

### 3.2.1 Previous works

In Thailand, previous studies have not been shown much of the detail coastal changes. Most researchers have focused on the approximation of rate of erosion and deposition mostly relied on aerial photos interpretation (e.g., Vongvisesssomjai, 1992) and/or some short-term surveys. Less attention has been paid to study annual change in shoreface sedimentary cycle (i.e., deposition and erosion). Some previous studies relate to this research can be summarized as follows.

Vongvisesssomjai (1992) calculated rate of coastal erosion in the Gulf of Thailand. Prachuap Khiri Khan Bay is one of the areas that show erosion features in the southern part; on the other hand, deposition occurred in the north (see Figure 3.2).

Sinsakul et al (2002) reported the rate of coastal erosion in Prachuap Bay and positioned the erosional shoreline similar to Vongvisesssomjai (1992). They also reported that the erosion occurred in Pranburi was more than 5 m/y (see Figures 3.3 and 3.4).

Numee (2003) and Choowong and Charusiri (2005) proposed new idea to study coastal erosion. They suggested that annual sedimentation along the beach depends on beach morphology and current direction. Exact rate of erosion or accretion needs to be calculated after the better understanding of annual equilibrium of sedimentation was examined. They also applied survey technique to examine the change in shoreface morphology and used oblique photos to compare the changes in morphology of tidal channel in Prachuap Khiri Khan Bay.

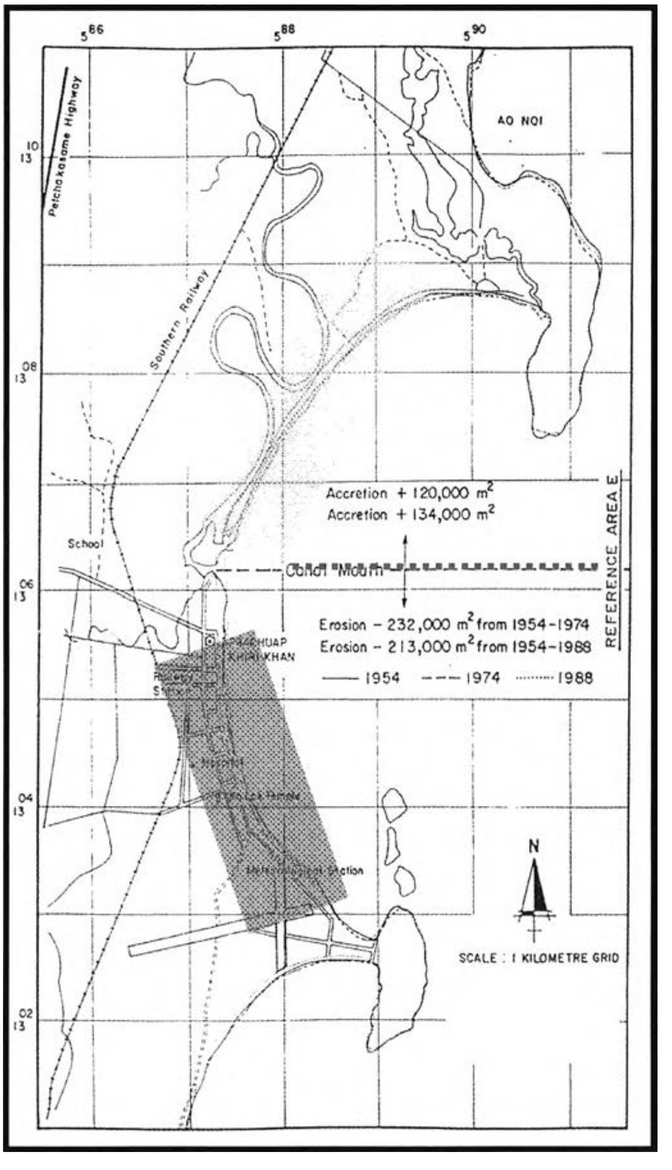


Figure 3.2 Map showing erosion (orange shade) and accretion (blue shade) between the years 1954-1988 of the coastline in Prachuap Khiri Khan Bay (Vongvisesssomjai, 1992).

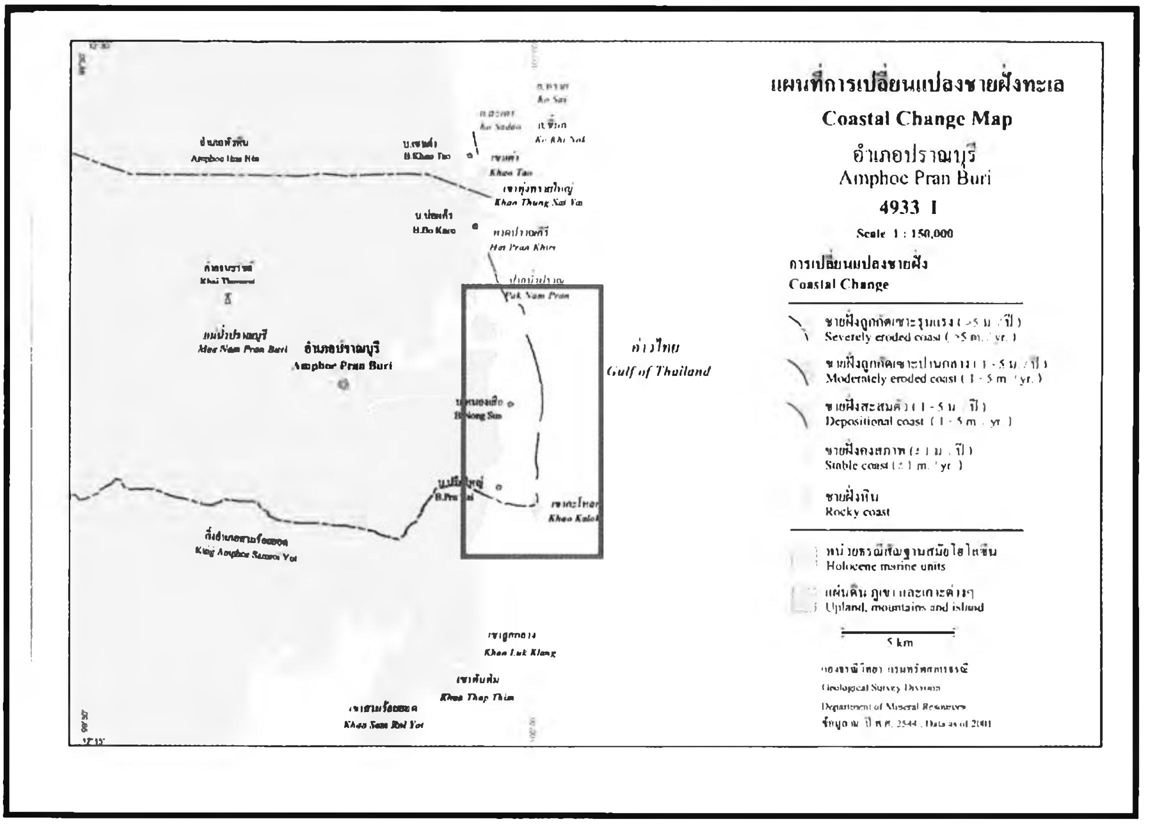


Figure 3.3 Coastal change map showing the shoreline change in Pranburi area (Sinsakul et al., 2002).

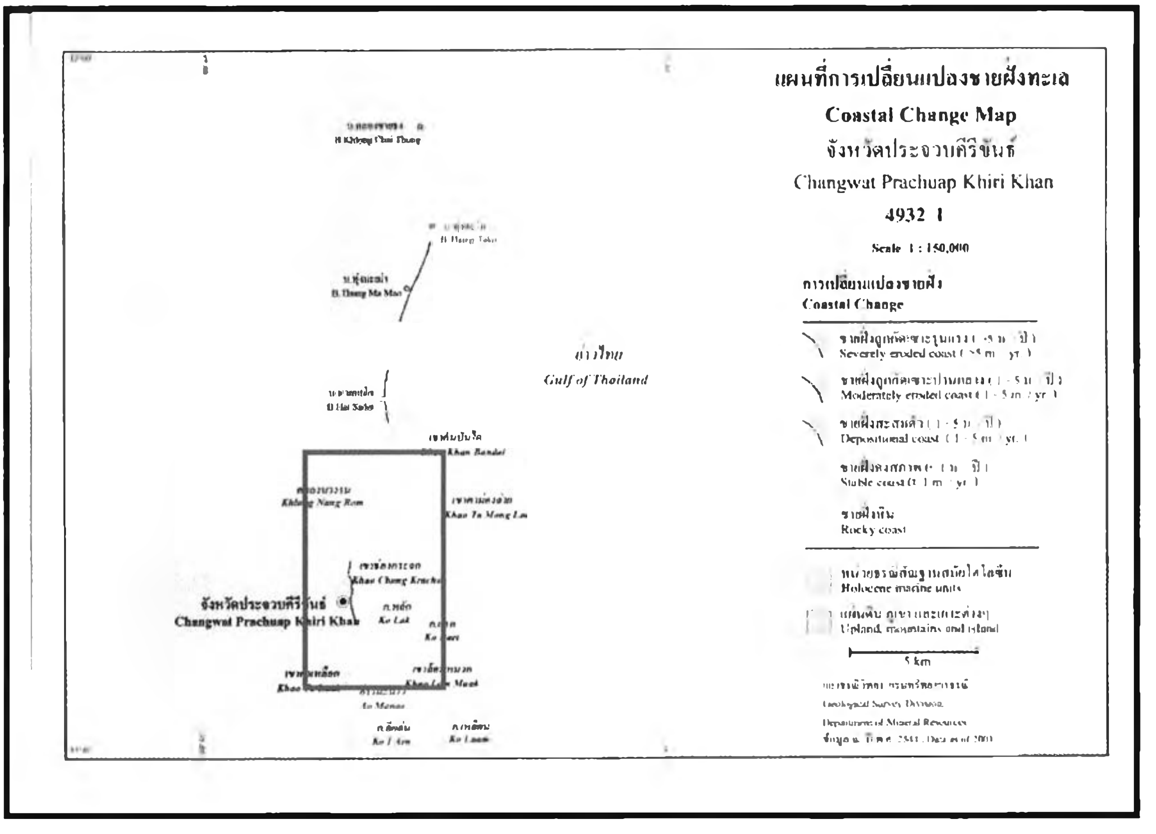


Figure 3.4 Coastal change map showing the shoreline change in Prachuap Khiri Khan Bay (Sinsakul, et al., 2002).

### 3.2.2 Remote sensing interpretation

Data from aerial survey and topographic map are applied as first step of research approach. Aerial photograph information provides the characteristic of landforms and beach geomorphology. Major remote sensing data used in this research is the series of aerial photographs in several periods and various scales. Interpretation of remote sensing data results helps in mapping of coastal geomorphology such as, barriers, beach ridges, back barrier lagoon and other related landforms. Those coastal geomorphology features can be encouraged to understand beach behavior, particularly, the changing in shoreline position. Remote sensing interpretation also helps in locating the profile of sediment coring in this research fieldwork. However, the use of remote sensing data in explaining the effects of wave action and movement of long – shore current are limited in this research.

Large scale (1:15,000; NS3 Project) aerial photographs were used in this research to produce detailed geomorphological features (Table 3.1).

Table 3.1 List of aerial photographs with approximate scale 1:15,000 (NS 3 Project) used in this research.

| Strip | Aerial Photograph number |
|---|---|
| C 38 | 9167 |
| C 45 | 3689, 3691, 3693 |
| E 69 | 004, 188, 190 |
| E 70 | 76, 78, 274 |
| E 71 | 231, 233 |
| E 72 | 49, 50, 282, 285 |
| E 73 | 79, 80, 81, 111, 114, 211, 213, 220, 222 |
| E 79 | 98, 109, 246, 255 |
| E 80 | 199, 202 |
| E 82 | 91, 93 |
| E 84 | 008, 009, 010 |
| E 86 | 007, 009 |
| M 12 | 090, 102, 110, 161 |

### 3.2.3 Field investigation and observation

A shoreline change analysis in this stage was performed using the methodology initially developed by Foster and Savage (1989) and Foster (1992). In brief, with the often record of shoreline change versus time by reference points, consistent with observed coastal processes. This stage of the research was modified from several methods to be fit in the study areas. The first and important one is the measurement of beach and shoreface slope vertically and horizontally. Reference points making on land was set up, so that the beach profiles will be measured in the same point (Figure 3.5). This method makes clear in beach sediment change both in horizontal and vertical. Beach profile will be displayed as shore perpendicular to cross sections that are repeatedly resurveyed three time periods in a year, to complete one cycle of season in annual year.

The second step of field method was the collection of beach ridge sediments by using Precision Clement Sediment Corer (Figure 3.6). This method was aimed to study long-term coastal evolution, in particular, Pranburi area. Only Pranburi truncated barrier area was selected to collect the beach ridge sediment sample in detail. As the interested beach geomorphology that shows the very sharp and clear truncated barrier, this feature showed severe erosional line. Seven drills hole were located on this beach ridge, especially on the erosional surface that is very clearly interpreted in aerial photograph.

The observation and field checking from field area were also carried out during fieldwork periods in all of study areas. The changing in beach geomorphology and shoreline change was observed in several periods in annual year.

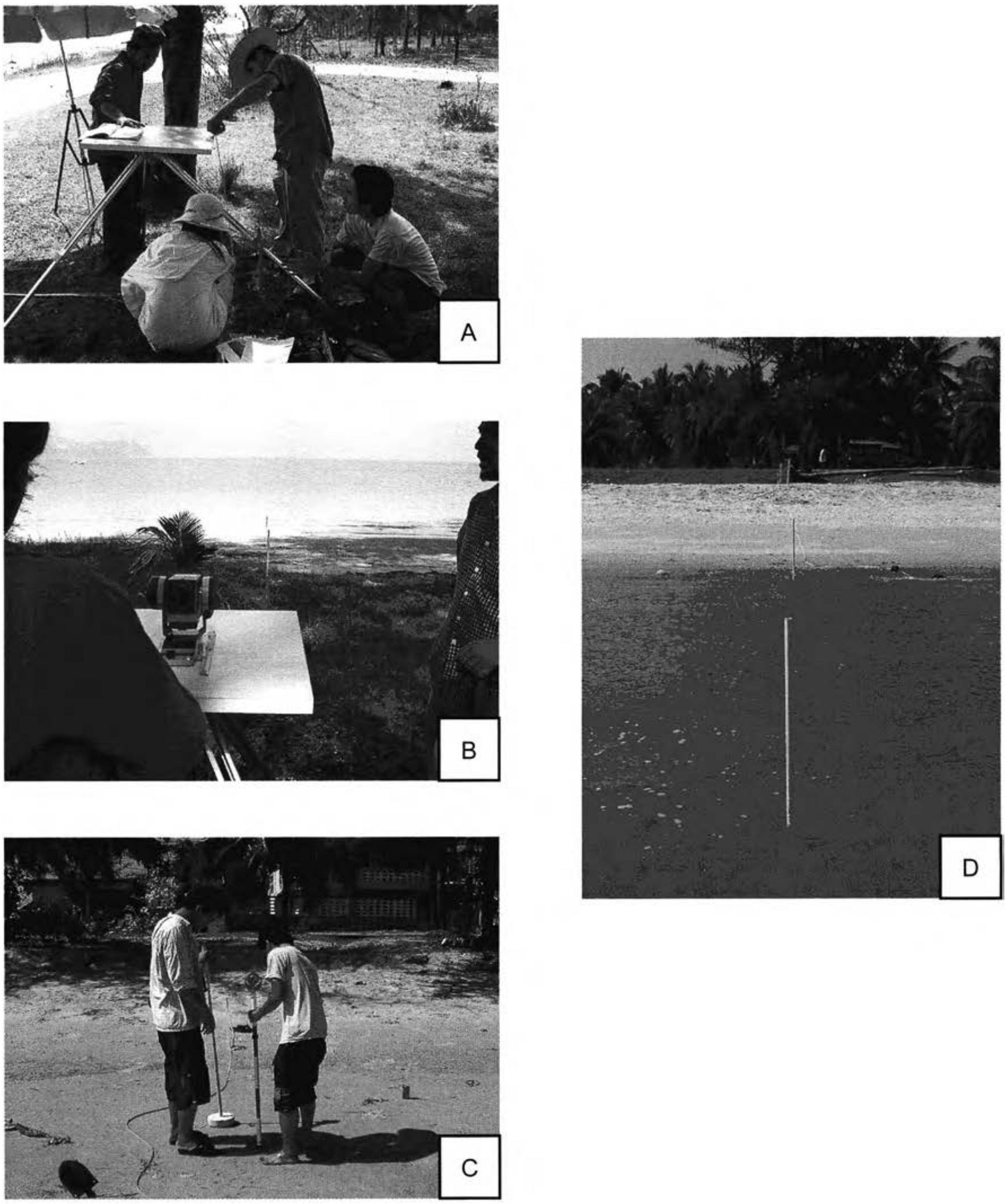


Figure 3.5 Photos showing the use of survey camera to measure shoreface position and slope. Picture A and B show how to set up survey camera and fix direction of shoreface profile. Picture C shows how to design and set up reference point, and the picture D shows the shoreface measure line perpendicular to the coastline.

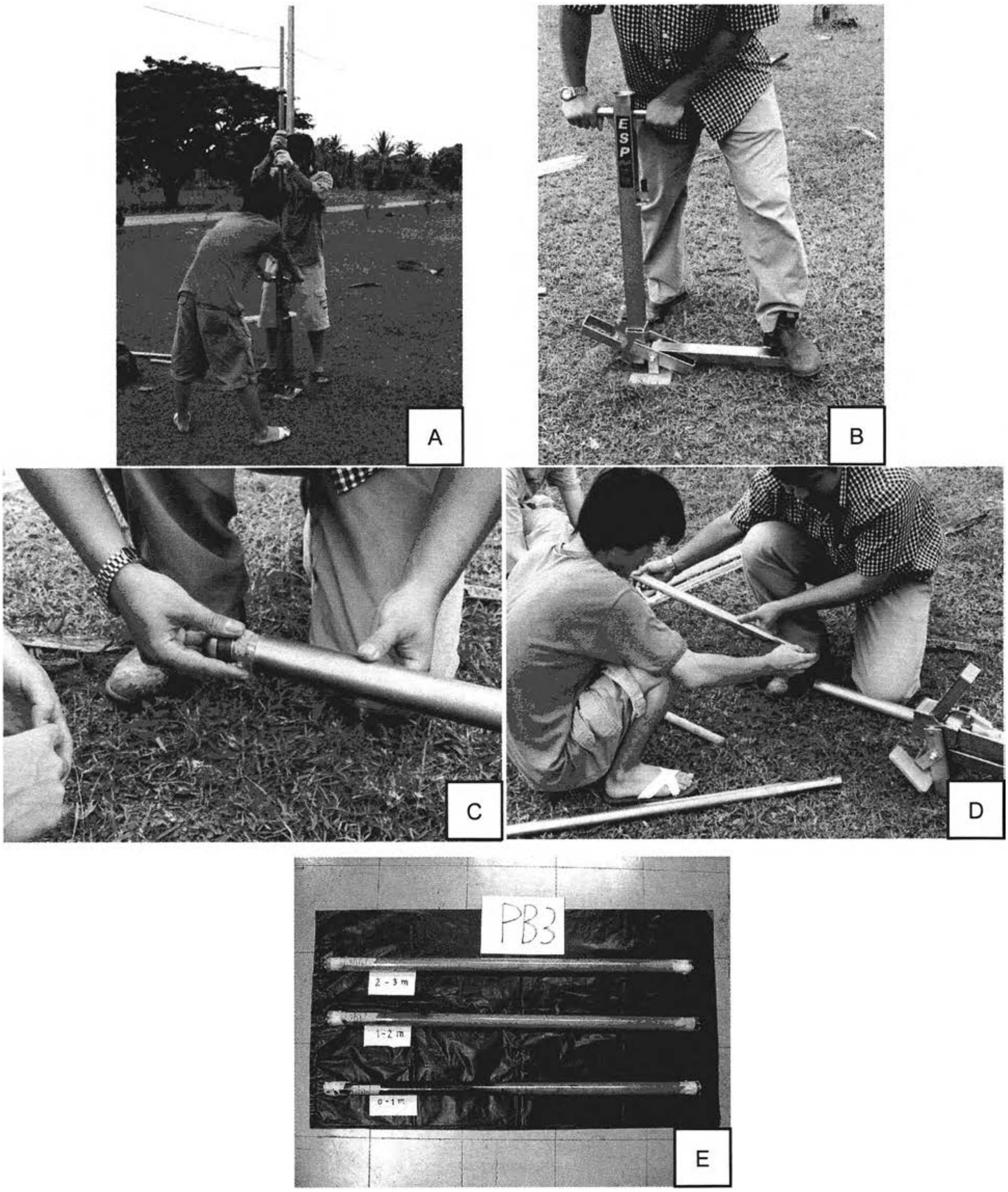


Figure 3.6 A Percussion Clement Sediment Corer was used for collecting coastal sediments from beach ridge. Picture A, B, C and D show how to operate the equipment and picture E shows the complete and continuous sediment tube.

### 3.2.4 Data analysis

This section describes the criteria used in analyzing and interpreting data collected during the research. Comparison from different period of aerial photographs provides the coastal change in large scale. Series of aerial photographs taken in different period of time were used to integrate and select the appropriate areas for evaluating sediments cycle and currents.

Aerial photographs from Vap 61 Project (taken in 1945) with scale approximately 1:50,000 and aerial photographs taken in latest year (2002) were used for comparison in this section (Tables 3.2 and 3.3).

Table 3.2 List of aerial photographs with approximate scale of 1:50,000 (Vap 61 Project) used in comparison for this research.

| Date of photography | Aerial photograph number |
|---|---|
| 18 October 1966 | 027, 028, 029, 030, 031 |
| 22 September 1966 | 066, 067, 068 |
| 04 December 1967 | 100, 101, 102, 103, 104, 105, |
| | 106, 107, 108, 153, 154, 155, |
| | 156, 157, 158, 159, 160, 161 |

Table 3.3 List of aerial photographs that taken in the latest year (2000) with approximate scale of 1:50,000 that used in comparison for this research.

| Strip | Aerial photograph number |
|---|---|
| RTSD.1/42(2) | 007, 008, 009, 010, 011, 012, 013, 014, 022, 023, 024, 025, 026, 027, 028, 029, 030 |
| RTSD.2/43 | 020, 021, 022, 023, 024, 025 |

The study of sedimentology including the description of physical properties of sediment core was also carried out during coring in the research fieldwork. Describing sediment color requires a standard column chart. Thus, Munsell Soil Color Chart was used to describe the color of sediment strata during this research fieldwork. Munsell Soil Color Chart is based on three parameters of color including the wave length of light, brightness based on the relative amount of black versus white and the saturation based on relative amount of pure color versus neutral gray (Jones, 1999).

Roundness is grain morphology of sediments. Roundness is basically concerned with the curative of the corners of the grain and the most common method of describing roundness is by comparison to standard images. (e.g. Krumbein, 1941; Pettijohn, 1957; Barrett, 1980; Graham, 1988). However, roundness of sediments is measured in this research fieldwork based on the comparison chart of Pettijohn (1957).