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Preliminary data on the recent evolution of the *Ban Laem Phak Bia* barrier spit (Gulf of Thailand)

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Abstract

The aim of this paper is to present the preliminary data on the evolution of the *Ban Laem Phak Bia* barrier spit (Fig. 1), from its origin to the most recent changes, in relation to the adjacent coastal systems of *Phetchaburi* tidal flat and *Cha-Am* sandy beaches.

Barrier spits are dynamic and accretional coastal features that change considerably over the time. These ephemeral accumulation bodies develop when alongshore moving sediment is deposited at locations where an abrupt change in the direction of the coastline does occur (Trenhaile, 1997). They are defined as beaches with associated backshore and dunes that are tied to the coast at one end and free at other (Komar, 1998). Spit morphologies and stratigraphies are controlled primarily by the balance between onshore and alongshore sediment supplies, and by other factors such as sea level rise, wave refraction and angle of wave approach and tidal currents.

The management of these areas should take into account their dynamism instead of attempting to fossilize the features in their current state (Baily et al., 2002).

Near *Ban Laem Phak Bia*, between the tidal flat system of *Phetchaburi* to the North and the sandy beaches of *Cha-Am* at South, local conditions have fostered the formation of a barrier spit, similar to those in other areas throughout the world. It is situated on the western coast of the Gulf of Thailand, which is generally characterized by tidal flats and mangrove swamps with NW-SE inner ancient beach ridges and NE-SW recent sandy beaches (Chaimanee, 1994).

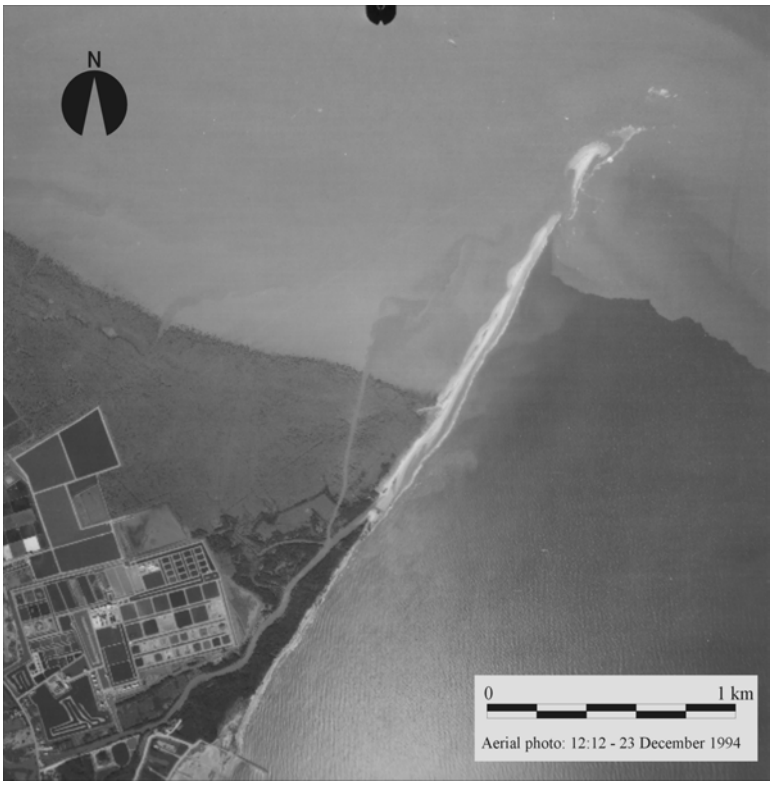

Figure 1. Aerial photograph of 1994, showing the Ban Laem Phak Bia barrier spit.

The landscape of the *Phetchaburi* tidal flat developed during the Holocene marine transgression and subsequent coastal progradation from about 11,000 to 3,000 years BP, as fluvial and coastal processes adjusted to the rising relatively stable sea level (Dheeradilok, 1995). Instead, at South of the site area, a broad Holocene coastal plain with a series of long beach ridges has formed in response to the postglacial marine transgression and subsequent coastal progradation with sand transported by rivers and the east longshore current (Dheeradilok, 1995).

Therefore, the Holocene sea transgression with some intermediate regressive phases was surely the main factor controlling the geomorphological change of the western coast of the Gulf of Thailand with a steady rise in sea level between 8,000 and 7,000 years BP, when it reached a height of about 2 - 4 m above MSL (Tanabe et al., 2003). From this maximum Holocene position, sea level probably lowered in a series of short to medium-long periods of regressions and transgressions (Tjia, 1996). The last regression period then occurred until present sea level was reached about 1,500 years BP (Sinsakul, 1992). Local climate is classified as a tropical savanna climate, characterized by a longer dry season and a prominent but not extraordinary wet season.

The maximum and minimum values of air temperature are between 20°C and 38°C, with a relative humidity interval of 50-100% (Khedari et al., 2002).

In the site area, the coastal processes are dominated by waves and tides. Wave action is influenced by the monsoons and is most active during the southwest monsoon from May to October (Sinsakul, 1992). Along the western half of the Gulf, surface currents are westward toward the coast but the mid-depth water flows in the opposite direction (Hungspreugs et al., 2000).

According to the tide table provided by the Royal Thai Hydrographic Department (1988), the tide is diurnal with an average mean spring tidal range of about 2.5 m. Flood and ebb-tidal currents and counterclockwise water circulation regulate the bottom sediment distribution in the Gulf of Thailand (Chaimanee et al., 2000). Besides, the western Gulf of Thailand is influenced by four principal rivers: *Chao Phraya, Mae Khlong, Tha Chin* and *Bang Pakong*, accounting for more than 80% of the total discharge of river water into the Gulf of Thailand with approximately 108 m^3/year (Hungspreugs et al., 2000). These rivers also supply high sedimentation rate of 7 mm/year at the river mouths and 2 mm/year offshore (Chaimanee et al., 2000). Two different methodological approaches were used for the reconstruction of geomorphological and sedimentological evolution of the barrier spit.

At long-term temporal scale, the site area was described and investigated by means of surface samples and three shallow cores (southern and northern sides and distal end of the barrier spit) in order to understand the processes of spit formation.

The length of cores recovered, using vibracoring techniques with 75 mm diameter iron pipes, is between 3.75 and 5.10 meters. At short-term temporal scale, the site area was analysed in terms of most recent morphological changes and its future tendency was investigated using aerial photographs complemented with field observations.

Some samples with organogenic fraction were collected from the cores to evaluate the approximate time of spit formation and temporal variations, and sent for radiocarbon dating to a laboratory for AMS determinations.

The *Ban Laem Phak Bia* barrier spit separates two physiographic units characterized by different sedimentary environments and hydrodynamic regimes. At North, a semi-enclosed bay occupied by a wide tidal flat system and by shallow bottoms with abundant muddy sedimentation due to the near river discharge; at South an open and exposed sandy beaches suitable for local tourism and recreation, where the longshore drift is the most common process because waves ordinarily approach the shore at an angle moving northward the sediments.

In relation to geomorphological and sedimentological characteristics, the site area can be divided into five zones:

- *Mangrove zone.* It extends landward and is characterized by swamps marked by a defined ecological succession related to frequency and depth of flooding. In the northern side, it exhibits good-health conditions, whereas it is undergoing evident and possibly irreversible erosion processes in the southern part. A national project focused on mangrove trees transplant is presently run at the mouth of the tidal channel entering the bay.
- *Embryo dune zone.* It develops adjacent to the mangrove zone and along the central axis of the barrier spit and consists of a limited back-shore area where the wave and tide action is lacking. It is stabilized and partially vegetated as first stage in the development of true sand dune ridges.
- *Backshore zone.* It constitutes the upper dry part of the beach, with incipient blow-outs and overwash fans. It is occasionally flooded by storm waves and weak currents, that can be able to submerge almost the entire barrier spit. Evident berm ridges are present on rapidly accreting areas, mainly at the distal end of the spit.
- *Foreshore zone.* It surrounds the spit and is the most extensive area, periodically flooded by tide and characterized by some typical wave and tidal sedimentary structures as small-current ripples, swash marks, bifurcating rill marks, etc. The sediment largely consists of medium to coarse quartz sands with shell debris which is more abundant in the northern side, around a 150 m wide and curved tidal channel stretching SW-NE and flowing in a broad low-tide terrace.
- *Tidal flat zone.* It is a low-tide terrace bordering the northern foreshore zone and merges into the *Petchaburi* tidal flat system. It contains variable interbedded ripple cross-laminated and bioturbated fine sand and mud.

According to field observations, the barrier spit is approximately 1 km long and averages about 70 m in subaerial width, reaching a maximum width of about 130 m in its middle part. It is characterized by different slopes on the two sides, its gradient being greater northward than southward.

Along the southern side, the increasing input of shells and skeletal debris creates organogenic swash bars parallel to the shoreline. Instead, evidence of stratifie sands, with embedded organogenic layers, does exist along the steeper northern side.

Eastward spit progradation and high muddy sedimentation on the sheltered northern side were also noted.

In conclusion, the *Ban Laem Phak Bia* barrier spit is a good example of tide-dominated coastal feature, characterized by enduring evolution and unstable equilibrium, which protects the adjacent *Phetchaburi* tidal flat system from the influence of the wave action.

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