Walailak J Sci & Tech 2005; 2(2):127-134.

The Inner Area Change Detection in Pak Panang Bay Before and After the Operation of the *Uthokawiphatprasit* Watergate using Aerial Photographs and Geographic Information System

Pipop PRABNARONG and Suthira THONGKAO

School of Engineering and Resources, Walailak University, Thasala, Nakhon Si Thammarat 80160, Thailand.

ABSTRACT

This study investigates coastal changes in Pak Panang Bay, Nakhon Si Thammarat Province before and after the operation of the *Uthokawiphatprasit* Watergate over the Pak Panang River by using aerial photographs and geographic information system techniques. The aerial map on 1:15,000 scale produced by The Royal Thai Survey Department in 1974 was compared to the aerial photographs acquired in 1995, 1999 and 2003. The results revealed that from 1974 to 2003, the inner area of Pak Panang Bay increased by a total of 7 km^2 (4,375 rai). However, it was found that between 1995 and 1999, 4 years before the operation of the watergate, coastal area increased by 1.89 km^2 (1,181.25 rai) compared to 0.19 km^2 (118.75 rai) of area expansion from 1999 to 2003, 4 years after the watergate was in operation. Sediment reduction due to the watergate operation may benefit the Pak Panang Bay by delaying the sediment filling of the bay. However, debate over the watergate as the main factor of sediment reduction calls for further investigation.

Key words: Geographic Information System - Aerial Photograph - Watergate - Pak Panang Bay

INTRODUCTION

Pak Panang Bay, Nakhon Si Thammarat Province is approximately 14 kilometers long with a width of 3 kilometers at the mouth of the Pak Panang river to nearly 10 kilometers at the entrance to the bay, covering an area of nearly 126 square kilometers. The morphology of Pak Panang Bay is dominated by an elongated hook called Laem Thalumpuk, which in 1962 Typhoon Harriet with a wind speed of 90 kilometers per hour swept through this area killing more than 1,000 lives and injuring 422. Pak Panang Bay is now a shallow basin that has an average depth of 1.5 m but up to 5 m in the middle of the bay's navigation channel **(Figure 1)**. There are three rivers emptying into the bay: Pak Panang River, Khlong Bang Chak and Khlong Pak Nakhon, but only the Pak Panang River is a major source of sediment for the inner bay (1). Before the watergate was built, it was reported that riverine sediments transported into the bay were estimated to be 350,000 tons per year over 11,500 tons of which were deposited in the first four kilometers of the bay just beyond the river mouth (2,3). The distribution and

deposition of sediments is not only a result of the bay becoming shallow but also a result of an expansion of the inner bay coast. Two areas, the west and the east side of the mouth of the Pak Panang River, have undergone extensive shoaling; especially the delta of the east side which has nearly doubled since 1961 (1).

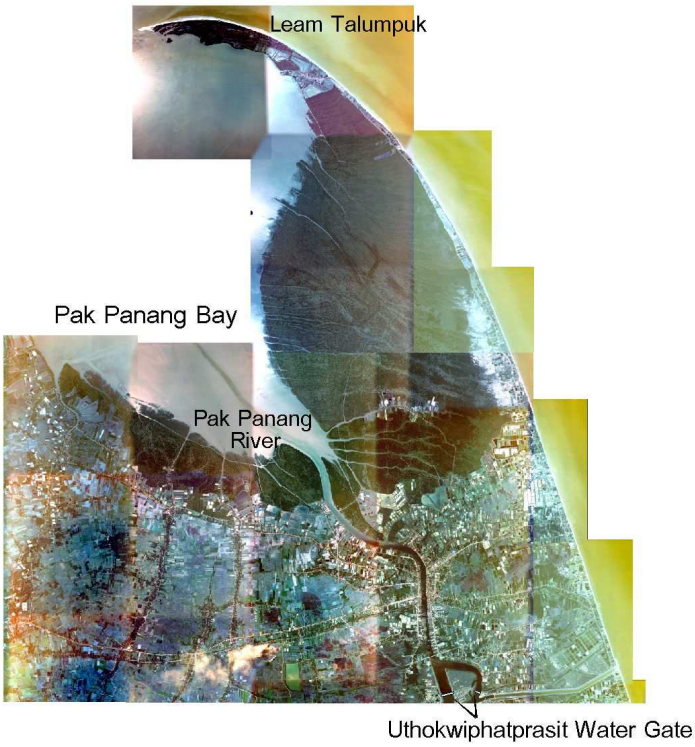

Figure 1. An aerial photograph of Pak Panang Bay.

In October 1999, the *Uthokawiphatprasit* Watergate began its operation over the Pak Panang River in order to prevent salt-water intrusion into the inner area along the river and to keep fresh water for mainly agricultural purposes **(Figure 2)**. Since then, debates over the pros and cons of the watergate in operation have been raised many times. A main area of debate is sediment reduction due to the watergate and calls for investigation. The objective of this research project is to examine changes in the coastal area in the inner Pak Panang Bay before and after the operation of the *Uthokawiphatprasit* Watergate by using a combination of aerial photographs and geographic information system techniques.

Figure 2. The *Uthokawiphatprasit* Watergate.

MATERIALS AND METHODS

Materials and Equipment

- Aerial photographs in digital form of 1974, 1995, 1999 and 2003 on 1:15,000 scale, pertaining to the Pak Panang Bay, produced by The Royal Thai Survey Department.
- Topographic map on 1:50,000 scale, pertaining to the Pak Panang Bay, produced by The Royal Thai Survey Department.
- Computer software, including PC ArcInfo version 3.5.1, Arcview version 3.1 and Intergraph.

Methods

Preliminary methodology involved the rectification of digital aerial photographs by using Ground Control Points (GCPs) of a topographic map. Once the aerial photographs have been rectified they could be transformed into the ArcInfo format. Further methodology involved the delineation of the Pak Panang Bay boundary by digitizing the aerial photographs from four periods; 1974, 1995, 1999 and 2003. With the overlaying technique provided by ArcInfo, the boundary of a #1974 map was overlaid with a 1995 map and then a 1999 map and a 2003 map respectively. The result led to an expansion area map of Pak Panang Bay.

RESULTS AND DISCUSSION

The results of overlaying the boundary of a 1974 map with those of 1995, 1999 and 2003 map showed that the inner area of Pak Panang Bay has continuously

increased along 29 years from 1974 to 2003 by a total of 7 km^2 (4,375 rai) with a 70% (4.9 km^2 or 3,062.50 rai) increas on the east the mouth of the Pak Panang River. It is noteworthy that between 1995 and 1999, 4 years before the operation of the *Uthokawiphatprasit* Watergate, the inner area of Pak Panang Bay increas by 1.89 km^2 (1,181.25 rai) compared to a 0.19 km^2 (118.75 rai) expansion from 1999 to 2003, 4 years after the watergate was in operation **(Figure 3, Figure 4 and Table 1)**. This would show the effect of the watergate, as the rate of area expansion has explicitly decreased. However, the pattern of area expansion could also result from the combined influences of tidal currents and the geometry of the bay (1).

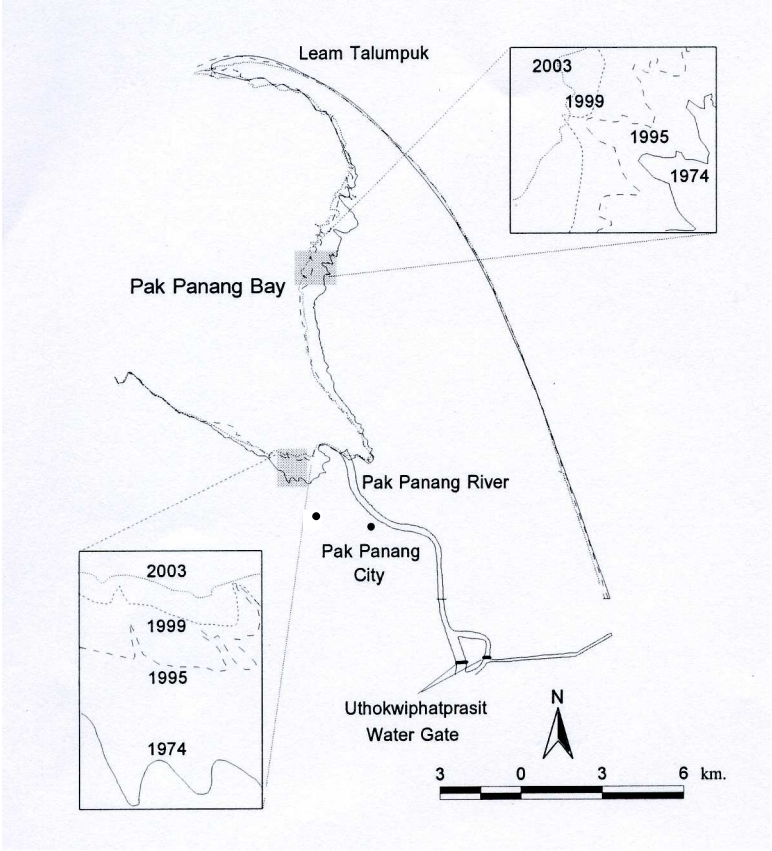

Figure 3. Changes in the borders from 1974 to 2003.

Table 1. Area changes in Pak Panang Bay.

Year	Area* (km^2)	Change (km^2) from 1974	Change (km^2) 1995 to 1999	Change (km^2) 1999 to 2003
1974	167.97	-		
1995	172.89	+4.92	+1.89	+0.19
1999	174.78	+6.81		
2003	174.97	+7.00		

* areas derived from aerial photographs by visual interpretation within the study area

The reduction of sediments from Pak Panang River deposited in the bay might benefit the Pak Panang Bay not only by delaying the sediments filling up the bay but also by reducing the navigation channel dredging through the bay to the river. Without the watergate, the natural process of accumulation of sediments guaranteed that the progressive shoaling would continue, and that mangroves would colonize the intertidal areas, and encroach on the bay. Eventually the entire bay would fill in except for the present channel, which would become the river (1). However, debate over the watergate as the main factor of sediment reduction has been doubted, indeed the watergate might accelerate filling of the bay and shallow the navigation channel (4). The watergate in operation caused stagnation of water in the bay, which led to an accelerated rate of sediment deposition and also caused the waterways to be silted up or clogged up by Water Hyacinth weed (5). Moreover, the stagnation of water in the bay might be inducing more deposition of sand along the east coast of Laem Thalumpuk. As a result, Laem Thalumpuk shoreline would increase in length and extend its curved shape due to the influence of strong winds and currents from the Gulf of Thailand. The more curving its shape becomes, the narrower the entrance to the bay (4). However, this study has found little change in the Leam Thalumpuk shoreline in terms of extension and its curving shape between 1995 and 2003. This assumption has thus called for further investigation over a longer monitoring time period.

Figure 4. Area of sediment deposition.

Apart from the sediment issue, the implementation of the watergate tended to cause dramatic changes in the quality of the water in the bay since the brackish water has become salt water (6). The reason for the problem was a lack of water flow from the Pak Panang River as a result of the watergate. The salty water had an effect on the life cycle of marine life, which has led to a rapid reduction as well as effecting the breeding cycle (5). This change also affected the health of the *Nipa Palm*, which is a prominent plant species in Pak Panang basin and grows in brackish water. Many people cultivated the *Nipa Palm* as their primary source of income in producing various products including roofing, cigarette wrap paper, sugar, vinegar, and whisky (6). A further problem was that of pollution, caused by the use of chemicals in various forms of agriculture including crop planting, raising animals, and especially shrimp farming. Water from shrimp farms resulted in water pollution in the waterways, which led to water use problems and also growth of marine life (5). It was also evident that the operation of the watergate contributed to flood disasters in Pak Panang Municipality due to a lack of flesh water pushing seawater out of the bay during the flood tide period (4).

In summary, the work reported here has discussed how the *Uthokawiphatprasit* Watergate might have an effect on coastal change of the Pak Panang Bay. The increasing of its inner area was detected using aerial photographs and geographic information system techniques. The resulting map provided the bay area changes before and after the operation of the watergate, followed by the debate over the watergate as the main factor of the environmental changes in the bay. The suggestion of this study is that an appropriate management of the watergate needs a further study and also the local communities should be allowed to have more participation in matters relating to watergate control.

ACKNOWLEDGEMENTS

The authors would like to express their sincere thanks to Assist. Prof. Anchalee Chayanuvat for proof reading and helpful linguistic comments on this manuscript, Salayoot Nakrod and Rawiwan Puppong for invaluable assistance in GIS programs.

REFERENCES

1) Coastal Resource Institute. Coastal management in Pak Panang: A historical perspective of the resources and issues. Prince of Songkhla University. 1991.
2) Japan International Cooperation Agency. Basic Design Study Report on the Project for Constructing the Nakhon Si Thammarat Fishing Port in the Kingdom of Thailand. 1987.
3) Paul Consultant and Technology Company. A suitability study and an environmental impact assessment of Pak Panang Basin Development Project. 1994.

4) Ngaothamasan P Pakawanit T Pakamatawee N Song-Iat N Mitprasat M. Socio-Economic of Pak Panang Basin. *In*: Pakawanit T (ed). A seminar on the synthesis of the current body of knowledge concerning the Pak Panang Basin Development Project. Walailak University. Institute of Management Science, Walailak University. 2001: p. 4-31, 4-32 and 4-33.
5) Thammachat S Mikusol P Boonsuaykhwane N and Poopaka S. A study of the order of importance of problems and peoples needs for research into development of the Pak Panang Basin Region : Local Fisheries. Walailak University. 2004.
6) Patrick J Yodpijit N Song-iat N Augjikool K Kotchasaengsan R Suanthong P Sompong T Pakamatawee N and Poopaka S. A study of the order of importance of problems and peoples needs for research into development of the Pak Panang Basin Region : *Nipa Palm* Group. Walailak University. 2004.

บทคัดย่อ

พิภพ ปราบณรงค์ และ สุธีระ ทองขาว

การเปลี่ยนแปลงพื้นที่อ่าวปากพนังตอนใน ก่อนและหลังการปิดประตูระบายน้ำอุทกวิภาช-ประสิทธิ์ โดยใช้ภาพถ่ายทางอากาศและระบบสารสนเทศทางภูมิศาสตร์

การศึกษาการเปลี่ยนแปลงพื้นที่บริเวณอ่าวปากพนังตอนใน จังหวัดนครศรีธรรมราช ก่อนและหลังการปิดประตูระบายน้ำอุทกวิภาชประสิทธิ์ โดยใช้วิธีการซ้อนทับข้อมูลภาพถ่ายทางอากาศมาตราส่วน 1:15,000 ปี พ.ศ. 2517 ปี พ.ศ. 2534 ปี พ.ศ. 2542 และปี พ.ศ. 2546 ของกรมแผนที่ทหารบก ในระบบสารสนเทศทางภูมิศาสตร์ พบว่าพื้นที่ชายฝั่งอ่าวปากพนังด้านในมีการเพิ่มขึ้นอย่างต่อเนื่องในระยะเวลา 29 ปี จาก ปี พ.ศ. 2517 ถึงปี พ.ศ. 2546 รวมเป็นพื้นที่ที่เพิ่มขึ้นประมาณ 7 ตารางกิโลเมตร (4,375 ไร่) ทั้งนี้เมื่อศึกษาในช่วงระหว่างปี พ.ศ. 2538-2542 ซึ่งเป็นช่วง 4 ปีก่อนที่จะปิดประตูระบายน้ำอุทกวิภาชประสิทธิ์ พบว่าพื้นที่ชายฝั่งมีการเพิ่มขึ้น 1.89 ตารางกิโลเมตร (1,181.25ไร่) เปรียบเทียบกับช่วงระหว่างปี พ.ศ. 2542-2546 ซึ่งเป็นช่วง 4 ปีหลังการปิดประตูระบายน้ำ พบว่ามีพื้นที่เพิ่มขึ้นเพียง 0.19 ตารางกิโลเมตร (118.75 ไร่) ผลการศึกษาแสดงให้เห็นถึงผลจากประตูระบายน้ำที่ปิดกั้นตะกอนดินจากแม่น้ำปากพนัง การลดลงของตะกอนดินจากการปิดประตูระบายน้ำ อาจเป็นผลดีในการช่วยชะลอการตื้นเขินของอ่าวปากพนัง อย่างไรก็ตามยังมีข้อโต้แย้งเกี่ยวกับการตื้นเขินของอ่าวปากพนังอันเกิดจากการปิดประตูระบายน้ำ ซึ่งจำเป็นต้องมีการศึกษาต่อไป

สำนักวิชาวิศวกรรมศาสตร์และทรัพยากร มหาวิทยาลัยวลัยลักษณ์ อำเภอท่าศาลา จังหวัดนครศรีธรรมราช 80160