

STATUS AND CHANGE TENDENCY OF RIVER MOUTHS AND LAGOONS IN THE MID-CENTRAL AND SOUTHERN CENTRAL VIETNAM

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ABSTRACT Most of river mouths in the Mid-Central and Southern Central Vietnam have the complicated changes regarding to the time with main change tendency as movement of river mouth. This phenomenon caused by neo-tectonic and coastal hydrodynamic processes prevailed as accretion and erosion processes. Movement of river mouths is always directed toward the lowering shoreline regions.

Dai and Lo mouths (Quang Nam) move southward; Co Luy, Ve river mouths move northward, being directed to the lowering region of volcanic activity zone of Nui Thanh – Binh Son – Ly Son.

The mouths of O Loan lagoon, Da Giang, Da Nong rivers move toward Tuy An lowering region.

In Dinh, Phan river mouths (Binh Thuan), although they have a bit of change, their occurrence is also directed southward, to the lowering region of volcanic activity zone of Southern Central Vietnam.

A typical change of the lagoon and river mouths in this study is the opening – closing processes occurring in the place where they have ever existed.

VEÀ HIỆN TRẠNG VÀ XU THẾ BIẾN ĐỘNG CỦA CÁC CỬA SÔNG, NHÀM PHÀM VEN BIỂN KHU VỰC TRUNG VÀ NAM TRUNG BỘ VIỆT NAM

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TÓM TẮT Hầu hết các cửa sông lớn ở khu vực Trung và Nam Trung Bộ đều có sự biến động phức tạp theo thời gian với xu thế chính là sự dịch chuyển của cửa sông. Đây là hậu quả của quá trình hoạt động kiến tạo và tác động của các yếu tố năng lượng biển và nội bào thể hiện qua quá trình bồi tụ – xói lở. Sự dịch chuyển cửa sông diễn ra theo qui luật rõ ràng: cửa sông dịch chuyển hướng về các vùng bờ biển hạ lưu.

Cửa Nãi, cửa Lôi (Quảng Nam) dịch chuyển về phía nam; cửa Co Luy, cửa sông Ve dịch chuyển về phía bắc hướng về vùng biển hạ lưu tại hoạt động núi lửa Núi Thanh – Bình Sơn – Lý Sơn.

Cửa O Loan, Nãi Giang, Nãi Nông dịch chuyển về vùng biển hạ lưu Tuy An.

Cửa sông Dinh, sông Phan (Bình Thuận) tuy ít biến động vẫn thể hiện xu thế dịch chuyển dần về phía tây nam hướng vào vùng biển hạ lưu tại hoạt

ñông núi löa Nam Trung Böi

Một ñieäm raät ñaïc trong cho cöa sông, ñaäm phaï öü ñaÿ laï quaï trình môï – laïp cöa môï laï dieän ra öü chính ñöi maï tröôïc ñaÿ ñöi ñaï töng toàñ taï.

I. INTRODUCTION

River and lagoon mouth areas are the places where there are a high number of populations and high development of marine economy (exploitation, aquaculture and commercial transportation). For that reason, the investigation for prediction of change tendency of the lagoon and river mouths is very necessary. From the end of 1970s up to now, with the results of investigations (at Da Nong, Da Giang river and O Loan lagoon mouths), together with the research results of KHCN 06.08 project (1996 - 2000), the status and change tendency of the shoreline and coastal river mouths have been obviously understood and predicted.

Recently, in the mid-central and southern central parts of the country, the changes of lagoon and river mouths have occurred with high intensity by many different reasons, which caused a lot of difficulties as well as big social-economic damages for local community. In this paper, the author describes the status of lagoon and river mouths and predicts their change tendencies in order to provide scientific basis for orientating the suitable development plan of territory management.

II. MATERIALS AND METHOD

1. Materials

- The materials of the investigations on lagoon and river mouths in 1998 and 1997 – 2001 (final scientific

report of KHCN 06.08 Project, Institute of Oceanography).

- Charts of USA Navy, scale of 50,000 published in 1967 (93E42-93E16).
- The historical materials of the changes of lagoon and river mouths (secondary data).

2. Methods

- Monitoring, measuring the status of shoreline and relief features of river and lagoon mouth regions.
- Comparing the recorded results with the charts of USA Navy (1967) in order to reveal the changes of the shoreline in general, and lagoon and river mouths in particular.

III. RESEARCH RESULTS

1. The status and change tendency of lagoon and river mouths

In Central Vietnam, it is known that most of rivers are usually short and sloping; their flows are usually low and only high in rainy season. The sea – river interaction of this area are different from that of Red river and Mekong river plain areas. Therefore, the development of river mouths in this area has typical features.

In the Mid-Central Vietnam (Fig. 1), there are many lagoons and river mouths such as Thuan An (Thua Thien - Hue), Dai (Thu Bon river), Lo mouth (Truong Giang river, Quang Nam), Dai mouth (Co Luy river), Lo (Ve river, Quang Ngai), Lai Giang and Ha Ra (Binh Dinh), O Loan, Da Giang (Da Rang river), Da Nong (Ban Thach

river, Phu Yen). The regions of lagoon and river mouths have high density of population and high development of economic branches, especially marine economics.

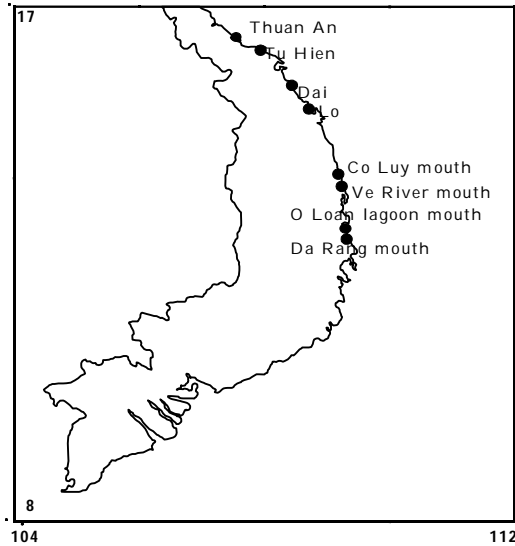


Fig. 1: Sheme of study areas

The investigated results show that the development of river mouths of Central Vietnam always relates to the accretion - erosion processes. The features of the accretion - erosion processes depends on wind monsoon. Usually, there are an accreted mouth side and an eroded one, which caused movement and opening - closing processes of lagoon and river mouths. However, the accretion - erosion processes at all river mouths are not prevailed. The occurrence of the accretion - erosion processes depends on morphology, location of lagoon and river mouths and their flow direction... Some river mouths are relatively stable as Cai river in Ninh Hoa and Cai river in Phan Rang.

The rivers without movement of mouths usually have flows directed into lagoons and bays. Otherwise, the rivers

running directly to open sea often have movement of mouth. The movement direction of lagoons and river mouths depends on neotectonic activities of adjacent shoreline regions. A general rule of lagoon and river mouth movement in Central Vietnam is that the movement is always directed toward the lowering region.

Thuan An mouth (Photo 1), after setting up in 1904, always has a northwards movement, but with low speed. Profile of mouth changes according to wind monsoon, in SW monsoon, the mouth is narrowed by accretion in southern mouth side, and in NE monsoon, it is widened by erosion at the southern cape of sand dune. In recent years, change tendency is more complicated by sequences of climate changes, leading to occurrence of strong activities of coastal hydrodynamics. The accretion - erosion process occurs with high speed in both of mouth sides: from 1998 to 2001, the rate of the accretion - erosion was about 25 - 30m/year, that destroyed the lighthouse and hundreds of houses of Hai Duong village in the north mouth side and some houses of provincial police and trade-union.

Loc Thuy mouth was set up after Tu Hien mouth was closed in 1994. In its existing time, this mouth was protected by stone jetty in the north side (built in 1996, 400 meters in length (Photo 2). So, its activity was normal. In 1999, a deluge occurring in central provinces made activity of this mouth stopped because narrow passage in front of river mouth was closed while Tu Hien mouth and a series of small mouths were opened in the adjacent area. Therefore, according to natural rules and its development tendency, these small mouths would be

closed just a few days after the flood and Tu Hien mouth would be too, but with longer time (in period of the survey in January, 2000, some sand-barriers in front of this mouth were formed and exposed even in highest tide level). Surely, Loc Thuy will be acted again.

Dai and Lo mouths (Quang Nam province) change continuously with time and always have movement tendency to the south. From last 40 years, the distance of mouth movement was about 4 km. In 1997, its rate of movement was faster; in Dai mouth, the rate of movement was about 60 – 70 m in average, the maximum in 2001 was about 200 – 250 m; in Lo mouth, the rate of movement was about 50 – 60 m in average, the maximum about 150 – 200 m that destroyed the 5th hamlet of Tam Hai village.

Tra Khuc and Ve (Quang Ngai province), Lai Giang (Binh Dinh province) river mouths have movement tendency to the north, in which Ve mouth was interested best by its seasonal changes and bottom exposition (in ebb-tide) in some places that caused many difficulties to local communities in marine economies and habit life activities. In 1999, at this mouth region, there was small mouth opened in the south side at the end of the sand dune, but it was closed quickly 3 months after. Based on the results of the survey, movement tendency directs toward the lowering region of volcanic activity zone of Nui Thanh – Binh Son – Ly Son.

O Loan mouth was formed by continuous northward development of the sand barrier in front of the mouth. The location of the mouth is relatively stable because of the bottom and shore structures, across-profile and flow

velocity through the mouth. The interested problem is formation of some sand barriers in front of the mouth and of some paralleling shorelines that affected widely to the transportation and ecological environment; reduced the water exchange rate between the sea and river and decreased biological resources.

Da Giang and Da Nong river mouths usually change very complicatedly and have tendencies of moving north (but with low rate) to the lowering regions of Tuy An volcanic activity zone. At Da Giang river mouth, sandbars with various shapes are always formed inside the mouth, which caused many difficulties for the transportation and reduced the water exchange rate between the sea and river, causing the inundation in lower basin of this river. In Da Nong, water flow is low, excepting in the rainy season (because of natural conditions of Central Vietnam and encroachment of bottoms of both riverbanks for aquaculture). So it caused immediately self-close of the mouth many times per year that created many difficulties for the economic activities of the local communities.

In Dinh and Phan river mouths (Binh Thuan province), the change rates are low but with movement tendency to the southern west, directed toward volcanic activity zone of south central part.

Generally, all the above mentioned river mouths express a general rule, that is at this mouth side the alternative accretion – erosion processes occur with the excess of sediment materials and at the other one the continuous accretion – erosion processes occur dementedly with the mouth movement toward the regions

which are insufficient of sediment materials.

In the last few years, the erosion process of shoreline as well as lagoon and river mouth areas in central part caused many damages to the life and wealth of local communities. And the accretion process also caused many difficulties in economic development (blocking transportation, inundation in lower basin, changes of the ecosystem...). For that reason, it is one of natural disasters that is necessary to be researched.

Comparison between the survey results (from May 1997 to July 2001) and the USA Navy charts in 1967 (scale of 1:50,000) shows that the changes of the mouths occur continuously and have moving tendency as mentioned above. Similarly to the lagoon and river mouths with opening – closing processes, their mechanisms and changing tendencies have typical characteristics.

2. Mechanism of changing process of lagoon and river mouths

2.1. Accretion mechanism

Owing to influences of wave and current dynamics, the sediment materials were accumulated up by domination of across-shore alluvial currents and lasted to the mouth by alongshore current. Moreover, the affection of river flow plays an important role and it is also an assistant factor that causes some following cases in the river mouth area:

- If the energy of wave is stronger than that of river flow, the sediment materials will be brought to the inside mouth; meanwhile, sandbars have the hook shape (Photo 3).

- If the energy of wave equals to that of river flow, but both with high

intensity, the cape of sandbar is the place where there is high convergence of wave energy and the sandbar is raised up like a dyke lasting to the river mouth. Meanwhile, inside the mouth, there is a hollow submerged canal as a missed-pond that often found in the northern side of Dai mouth and in the southern side of Co Luy mouth (Photo 4). With time, this missed-pond was filled in by wind and wave factors.

2.2. Erosion mechanism

Erosion mechanism of the mouth is similar to that of the shoreline. After breaking, waves crawl up to feet of sand shore and erode out a surface sand layer, forming "wave hallow chain". The eroded materials were brought up by waves and river flows and deposited in mouth sides (artificial deposit form), then brought up to outside of the mouth and deposited in the sand barriers in front of the mouth or accreted in the shoreline. This process occurs continuously as to the wave turn and the shoreline is backwards to the shore because of lack of material. This type of shoreline is usually found in southern side of Dai mouth, Hoi An and northern side of Ve river mouth.

Besides the above erosion type, there is an erosion type caused by the flood. Strong flood flow coming from inside of the river eroded seriously both riverbanks and cut off sandbars to widen the mouth. The materials were brought to the sea and then deposited in front of the mouth where there is a energy balance of flood flow and marine dynamics. Meanwhile, a sand barrier was formed in front of the mouth.

In the lower basin of rivers, when a heavy rain appears, the river flow is increased quickly and the volume of

water flowing via the mouth is quite high that makes the mouth widened. But a few days after flood, the mouth expansion stops and comes back as normally as its previous accretion – erosion mechanism.

The mouths with opening – closing process often lie in sections which have the razed abrade - deposit shorelines and are consequences of neo-tectonic activity. Hoa Duan and Tu Hien mouths (near the Bach Ma rising geoblock with its activity indicator through the fault of the metamorphic rock in Dap Da, Phu Loc, Thua Thien - Hue) are examples. Otherwise, quantity of the materials coming from the river is inconsiderable. In Hoa Duan mouth, materials deposit in Tam Giang lagoon, and in Tu Hien mouth, they deposit in Cau Hai lagoon.

Material volume in the place with the opening – closing process is much higher than in the adjacent region. And the breadth of land belt with this process is much narrower than the adjacent region.

2.3. Closing mechanism

This mechanism can occur in storm and rainy season or in period of low river water level and strong wave. The materials in both river mouth sides move along the shorelines, and set up two sand capes that narrow the mouth and make the mouth shallower. Meanwhile, long profile of the mouth is much larger than across one and river section is narrower that makes water flow decreased considerably. On the other hand, the materials from the bottom are brought to the shore by the waves with across shore direction and set up sand-edges in front of the mouth. These sand-edges are rolled gradually to the shore and day-by-day,

a sand barrier is formed in front of the mouth that limits water exchange between the river, lagoon and sea. When there are strong waves, these sandbars will be piled up quickly, “rolled inside the mouth” and close the mouth completely.

2.4. Opening mechanism

When there are heavy rains and high floods, mouth opening often occurs at the places with breath of sand dune smaller than both its sides (Hoa Duan, Tu Hien) or at the end of sand dune, very closed to the rock capes (O Loan, Da Nong mouths). The place where the mouth is opened is usually where it used to exist before. After opened, these mouths act about few months or few years, then may be closed again. Some of them are closed just after the flood (as mouths near Tu Hien mouth at the end of 1999).

The mechanism is described as follows: at the places with coarse sediments of the sandbar getting apart between sea and lagoon through which the water is easy to flow with high speed when there is disparity of water level between the sea and lagoon. In the heavy rain and high flood seasons, the water level of the river and lagoon increases quickly that forms a force to make the water permeability through the pores of sediment in sandbar higher more and more, when the pressure gets maximum, the water flows freely from the higher water level place to the lower water level one. At that time, this sandbar section is eroded at two shore sides; dug deeper to bottom; and opened widely and as a result, a new mouth is formed.

Typical mouths of this process are Hoa Duan, Tu Hien, and O Loan mouths. However, their periods of

occurrence are different and depend on many exogenous factors. According to available materials (Tran Duc Thanh et al., 1998), the period of opening - closing process of Hoa Duan mouth is less than 100 years; and that of Tu Hien and O Loan mouths is often unstable.

IV. CONCLUSION

Most of river mouths in mid-central and southern central parts of Vietnam have complicated changes regarding to the time with main changing tendency as movement of river mouth. This is caused by neotectonic and coastal hydrodynamic processes and prevailed as accretion and erosion. Movement of river mouths occurs according to obvious rule that movement is always directed toward the lowering shoreline regions.

Dai, Lo mouths (Quang Nam) move southward; Co Luy, Ve river mouths move northward, directed to lowering regions of volcanic activity zone of Nui Thanh - Binh Son - Ly Son.

The mouths of O Loan lagoon, Da Giang, Da Nong rivers move toward Tuy An lowering region.

In Dinh, Phan river mouths (Binh Thuan), although they have a bit of change, their occurrences are also directed southward, to the lowering regions of volcanic activity zone of south central part.

A typical changes of the lagoon and river mouths in this study are the opening - closing processes occurring in the place where they have ever existed.

From the above results, it is necessary to research in more detail aiming at prediction of development of erosion and accretion in order to orient and plan for suitable and sustainable socio-economic development.

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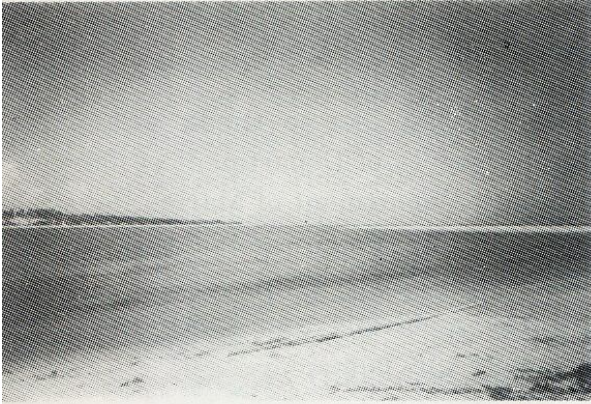


Photo 1: Thuan An mouth,
Thua Thien – Hue
(photo taken by Trinh The Hieu,
Sept. 1999)

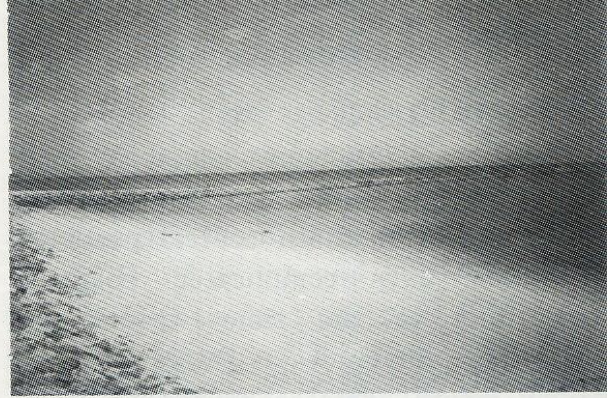


Photo 2: Stone jetty at northern side of
Loc Thuy mouth, Thua Thien – Hue
(photo taken by Trinh The Hieu,
Sept. 1999)

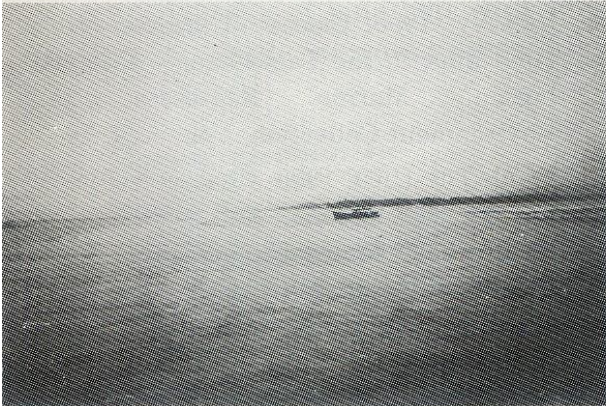


Photo 3: Ve river mouth, Quang Ngai
(photo taken by Trinh The Hieu,
Sept. 1999)

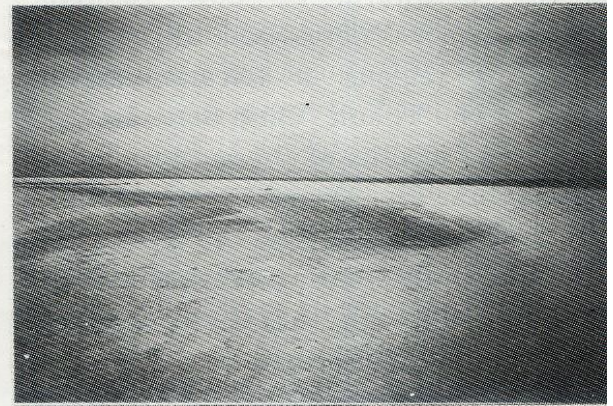


Photo 4: Sandbar at southern side of
Co Luy river mouth, Quang Ngai
(photo taken by Trinh The Hieu,
Sept. 1999)