HYDROLOGICAL SURVEY OF THE HUONG RIVER IN 2005

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INTRODUCTION

March and May in 2005 we carried out a hydrological survey of the Huong River in Hue city (see photo 1 and 2). Initially we set two targets, the problem of the salt wedge and the flood control. In the dry season sometimes the salt wedge comes up till point J where the river water is taken for drinking, which makes the water unavailable. Now, a dam construction at the upstream of Ta Trach river(TT) will soon start; one of the aim is pushing out the salt water by discharge of the water stored in the dam during the wet season. Thus we should postpone the survey till we see the effect of the dam. Another aim of the dam construction is the flood control. A total amount of average annual discharge of TT is nearly 700 million ton as shown on Table 1; the volume of the dam is 400 million ton; it is expected to lower the water level of floods 1m. However, in 1999 flood the depth became 2-3m in Hue city, so the effect is not enough. An idea for the flood control is shown in #2. In #3 we will observe the morphology of the Huong River, which will concern the flood controls. In #1 we analyze the sand movement which concerns to #2. and #3. Sand waves on the river bed is caused by the sediment transportation. Because of important affects of them on the resistance to the flow and the river morphology, studies on the sand waves is a fundamental field of research in the river engineering.

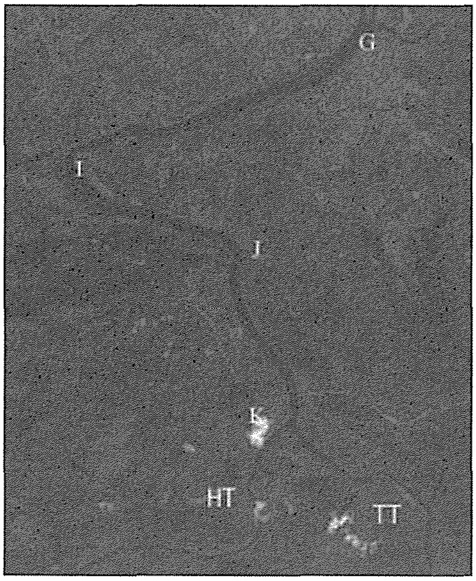

Photo 1 Southern part of the Huong River

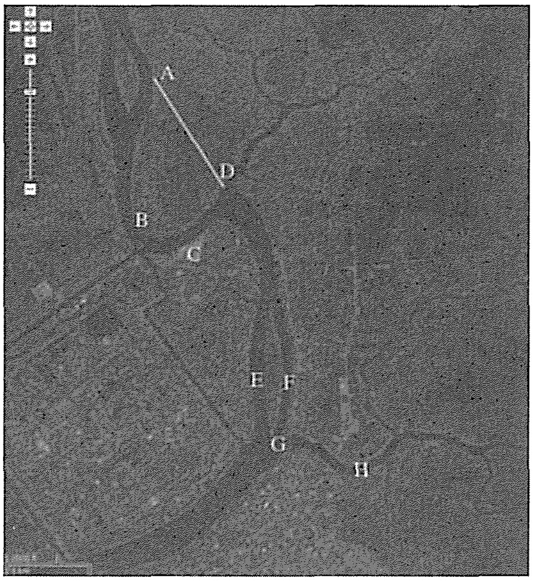

Photo 2 Northern part of the Huong River

Table 1 Hydraulic data of Tributaries of the Huong River

	A (km²)	L (km)	z_B(m)	z_c(m)	i	$\bar{Q}$(m³/s)	Q_T (m³/y)
Ta Trach	717	54	700	-1	0.0147	15.2	679×10^6
Huu Trach	570	47	1100	8	0.0204	41.1	1296×10^6

Data : from 'Thua Thien Hue Centre for Hydro-meteorology forcasting'

1. Sediment Transportation

Sediment of the Huong River may be mainly yielded from the upstream of Huu Trach(HT), which is suggested from the value of z_c on Table 1, the elevation of the bed near the confluent point of the both river(Point K). Two groups of sizes d , diameter of the sediment, were observed in Huu Trach, one is about d=0.2mm and the other is about d=10cm. It seemed that only the former is transported into the Huong River, and the most part of it might be picked up by small boats between J-K for the use of construction material. The amount of the sediment picked up by them is probably nearly the same to the total amount of the sediment yield, which is estimated as follow:

The amount of the gathering per one time $4m^3$
× the number of he gathering per day $2.5 time/day$
× the total active days in a year(8months in the dry season from Feb. to Sep.) $240 day/year$
× the number of the boats $147 boat$
$= 352{,}800 m^3/year$

Even if the total of the sediment yield is supplied into the dam of TT, it may be no problem for long year more than 100years. Such gathering of the sediment may transport almost no sediment except wash road to the downstream of the point G. Downstream G the bed material is mainly composed of mad which may be the deposition of the wash load due to the coagulation by mixing with the salt water.

2. Flood control

Q_T of HT being about twice larger than that of TT, so an another dam construction also in HT will make the water level of the flood further 1m lower. This is very effective, but it costs very much. Contrary an compensation for the narrow part of the channel around B will do at substantially low cost. The effect is roughly estimated as follow. In this reach an average width of the channel $B\approx 200m$ compared to $B\approx 250m$ for the total average(see Fig.1). The depth h_{200} for $B=200m$ is compared to h_{250} for $B=250m$ using Manning's low for the same water discharge Q, assuming the same Manning's coefficient n and the slope of water level i.

$$Q=\frac{1}{n}\sqrt{i}h^{5/3}B$$

as

$$\frac{h_{200}}{h_{250}}=\left(\frac{250}{200}\right)^{0.6}\approx 1.1$$

Taking h_{250} as 10m, the decrease of the flood level becomes 1m. This rough estimate is worthy of noticing, though there are some difficult problems to be solved. Since the extension of the channel around B is not allowed because of high population density along the both sides of the channel, we need to construct a complementally new channel; the bifurcation to the lagoon needs much cost to construct a new dam for the protection of salinity intrusion. Instead, an open of a new channel to connect A and D may be effective. 50m width channel may be sufficient to compensate for the shortage. Generally such two way system includes hydraulically hard problems to be carefully investigated:

A. The slope of the new channel AD becomes about twice larger than that of the present channel ABCD, which induces high velocity of the flow in the new channel. The high velocity and a little supply of the sediment from the upstream make hard the maintenance of the new channel.

B. Usually, the flow of the present channel cannot transport the whole of the sediment distributed to the channel, and thus the channel may be get closed after some floods pass. But in the present case, the most part of the sediment transportation must be composed by wash load, so present channel is probably maintained. Therefore, the gathering the whole sediment in the upstream reach may be very effective for the maintenance.

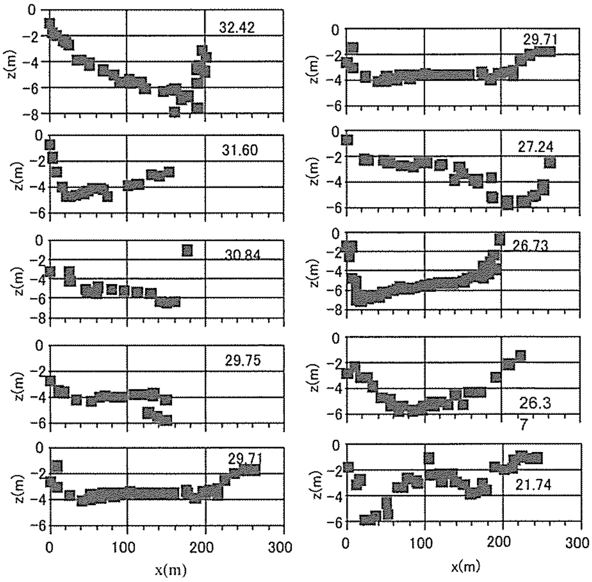

Fig.1 Cross sections. The numbers in the figures are the distance from N16 E107.

3. Sand waves

Sediment transportation will produce sand waves on the river bed. They are roughly divided into two type: 3Dnal alternating bar and 2Dnal dune. From the observation, we think that those for the downstream from Point I must be dune and it seems to be alternating bars for the upstream reach. Here we will check the sand waves for the upper stream reach using

Kroki and Kishi's regime criteria, which is well used to forecast which sand waves will develop when bed load is prominent. The theory says that If $I > I_c = 7$ then alternating bar, and If $I < I_c$ then dune will develop provided that $\tau_* = hi/sd > 0.1$. , where $I = B/h \cdot i^{0.2}$, $s = \rho_p/\rho_f - 1$, ρ_p, ρ_f are the density of sediment and fluid, d is the diameter of the sediment particle. For the reach, $B = 200 - 250$ and h will becomes more than 10m, so B/h may be less than 25. Although we don't know the inclination i of the Huong River, we guess the order of it to be 10^{-4} from the view of the flow . Then $I \approx 4$, therefore the dune will occur.

But for the case of the Huong River where suspended load is prominent because of fine bed material, Kroki and Kishi suggested theoretically that if B/h is around 10, alternating bar will develop, and from the view of the geometry between Point J and I, we thought that they develop. The development of alternating bar also depends on the situation of supply of the sediment. We guess that the small quantity of supply due to the gathering of the sediment produces poorly developed alternating bar as seen. Therefore, no gathering of the sediment may cause the rising of river bed and the development of point bar. Then this makes the deformation of the Huong River active and it extend to the whole of the river. It seems that the cutting off the bed load makes the stable state of the Huong River.