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Predicting the Navigability in Meandering River

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1. Introduction

The natural hydrology has decisive influence on the inland waterway system. The natural bed topography with alternative bar of the meandering river has been considered from the navigation point of view. The bed topography, which formed during high water stage, can be predicted. The result shows that the optimal route for navigation extends from the pool at one bank diagonally to the next pool at the other bank. The shoaling takes place at this diagonal and becomes an obstruction for navigation in dry season. The water level available for navigation in dry season could not afford to full load of the operating vessels. The payload of operating vessels over the year has been predicted.

2. River Morphology

In attempting to study the rivers for transportation purposes, it is most appropriate to adopt a hydraulic approach. There is a large number of rivers in the world which have two distinguished seasons in the year. The high water season usually lasts in the raining or melting of snow period and the rainless period leads to a dry season. The variation in discharge is extremely large especially for rivers, which locates in the regions with monsoon weather.

Another important factor may be the river morphology.

River morphology is normally determined by the conditions at the annually maximum or bankfull discharge. As for the frequently flooding rivers, the conditions just before the bank collapse may be influential.

Many theories have been developed to predict the characteristics of the fluvial morphologies: straight, meandering and braided. Meandering is caused by alternative bars, whose downstream is normally eroded. With proceeding of the erosion, the river gradually meanders. Alternative bars, therefore, are always seen in the meandering river channel.

Parker (1976) has combined the analytical results and proposed the meander/braid/straight regime diagram. Parker's diagram can be empirically used to predict the regime of the rivers from depth-width H/B and slope-froude number S/F ratios.

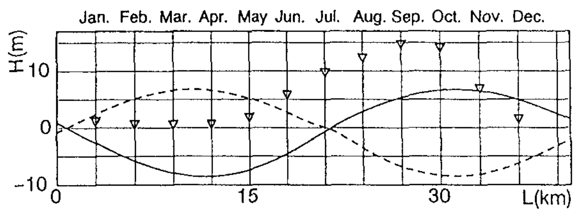

Fig. 1. Calculated Bed Profile along the Mekong River from Kratie.
(——) One Bank, (- - -) Another Bank, ∇ Monthly Average Water Levels.

The formation of meanders and their related bars heights can be predicted with some degree of accuracy which has important applications for the inland waterway transport. Ikeda and Nishimura (1986) have made the mathematical model for defining three-dimensional flow and bed topography in sinuous channels with suspendable bed material. The three-dimensional flow is separated into the depth average two-dimensional flow component and the secondary flow component. The model for bed topography is derived by considering the sediment balance for bed load and suspended load, the transport rate and direction. For rivers under meandering regime, the bed topography in high water season can be predicted with the help of Ikeda and Nishimura's model.

The deep pool takes place at one bank and changes to another bank corresponding to the bending direction of the channels. The optimal route can be drawn from the pool along one bank diagonally to the next pool at the other bank. The shoaling, therefore, takes place only at the bending change points of the channel.

An example application of the model for South-East Asian Mekong river at Kratie was carried out. The bed profile along the downstream of the river from Kratie were obtained in the figure 1 together with the monthly average water level. Based on the obtained bed morphology and the monthly average water level the navigation capacity can be studied.

3. Vessel's Payload

Based on the obtained bed profile, water level at shoaling place and the payload characteristics of the vessel, the limited payload of selected vessel types can be predicted. The results giving by figure 2 indicated the maximum possible loading of the four typical vessel types in percentage over the year in the example of the Mekong river. The navigation capacity clearly reduced in the dry season along this route. The obtained results show that typically barges can be fully loaded only for 6-7 months from late May to November. During the lowest water level, which normally lasts 2-3 month, the navigation becomes critical for large tones vessels. The small tones barges can be operated with payload not exceeding 25 % the deadweight during the lowest water level from February to April.

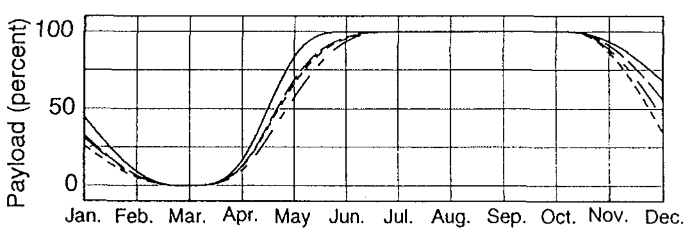

Fig. 2. Predicted Payload of the Barge on Mekong River at Kratie. (——) 50 Tones Barge; (- - -) 80 Tones Barge; (— — —) 300 Tones Barge; (— - — -) 700 Tones Barge.

4. Conclusion

As far as transportation in concerned, the hydraulic characteristics of the rivers under the natural condition are important factors, especially for rivers located in the monsoon areas.

The meandering could be confirmed in the regime diagram proposed by Parker and bed morphology could be predicted by the Ikeda and Nishimura's model. The results lead to the predicting the limited payload of the vessel used in these rivers over the year. The vessel payload may be significantly reduced at shoaling place during the low water season.

References

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