Sediment Related Problems in the Ayeyarwady River, Myanmar

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1. INTRODUCTION

The Ayeyarwady River (length 2170 km; drainage area 413710 km^2) in Myanmar is the major river transportation route and contributes to the Myanmar economy. It is a melt water and rain fed (south-west monsoon) river with the discharge between May to October. Water levels between dry and wet seasons vary up to 10 meters. This variation in water level and planform changes of the river with numerous sandbars create not only navigational problems in the river but also floods in the cities by disrupting the flow in the rainy season along the river. The proper use of dikes and revetments can achieve the desired channel dimension and alignment.

2. GENERAL CLIMATE AND HYDROLOGICAL INFORMATION

The climate of the Ayeyarwady River basin is the tropical monsoon climate. The average annual rainfall is shown in Fig. (1.a).

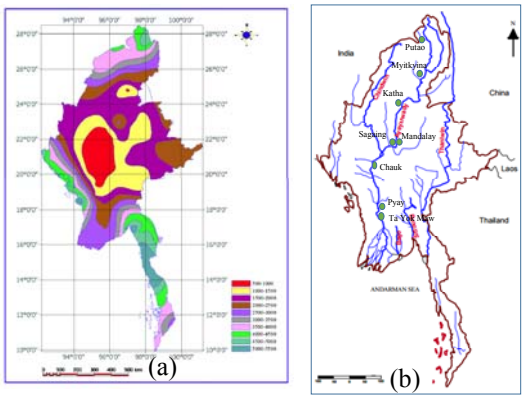

Fig 1.(a) Average annual rainfall map and
(b) Location of the rain gauge stations

The rain gauge stations along the river and the monthly mean rainfall from 2003 to 2013 are shown in Fig.1.b and Fig. 2, respectively. The pattern of rainfall indicates considerable complex. The rainfall amount of Mandalay and Sagaing is lower than that in the rest of the country. The rains in the mountainous areas such as Putao, Myitkyina and Katha are abundant. The data is provided from the Department of Meteorological and Hydrology.

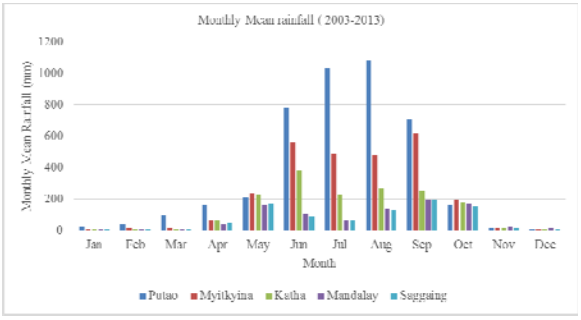

Fig.2 Monthly mean rainfall (2003-2013)

3. TEMPORAL CHANGES OF WATER DISCHARGE AND SEDIMENT LOAD

The increasing of water demand and the high rainfall variability in the central dry zone may cause the construction of more pumping stations for groundwater and river water as well as reservoirs and dams. The mean annual discharge is decreased year by year at Sagaing. The mean annual discharge from 1978 to 1988 is 253x10^9 m^3 and that from 2003 to 2013 is 224x10^9 m^3. The river is classified as braiding channels in Mandalay - Sagaing Region and its planform varies a lot as shown in Fig.3. At Sagaing, the river enters a very narrow passage after that the river has a sinuous pattern, with bars migration along the channel. The river flows with braided pattern with large sandbar and it is wider and shifted to the left eroding the bank near Mandalay.

In Ta Yok Maw and Pyay (Fig1.b), the mean annual discharge from 1871 to 1879 is 407 x10^{9}m^3 and that

from 1966 to 1996 is 379 x$10^9$$m^3$. There is high annual variation of discharge in the Ayeyarwady River as a result of strong variation in precipitation as well as seasonal melting of snow in the headwaters of the river, south-eastern Himalayas and intensified water extraction for irrigation.

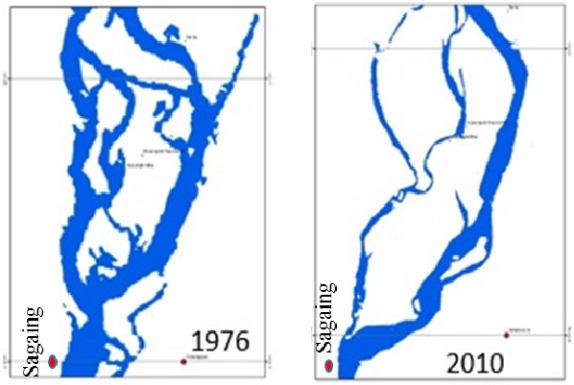

Fig 3. Planform changes of the Ayeyarwady River

During the dry season, the central parts of Myanmar do not have any rainfall contributing to the river flow. Although there are no major dams in the main flow of the Ayeyarwady, the water discharge is changed rapidly as the effects of dams in the tributaries.

The cross-sectional suspended load at Pyay has been estimated by the following equation which is obtained by Furuichi et al. (2009);

$$L = 0.0127\, Q^{1.4264} \quad (1)$$

where L is the cross-sectional suspended load, Q is the water discharge which was obtained by a discharge - water level rating curve. This equation is derived from many measurements of suspended sediment concentration at various depths on several vertical measurements. The mean annual suspended sediment load is estimated as 325 million ton per year between 1966 and 1996.

The daily concentration measurements were performed by Gordon from 1877 to 1878 (52 weeks). The mean annual suspended sediment load at Ta Yok Maw is 261 million ton per year. Robinson et al. (2007) revised its value by considering inappropriate sediment rating curve and loss of the very fine fraction of sediments that the sediment load is as high as 364 million ton per year. According to the rating curve and measured stages, sediment discharge in Chauk (Fig1.b) ranges from 165 kg/s in winter to 18000 kg/s in the southwest monsoon period (10 years average). During high discharge, the river at Chauk carries approximately 3 times as much sediment as that in Sagaing (DMH, 2014).

Land surface erosion is the other problem in Myanmar. The land surface is eroded in upland agricultural areas and dry zones well.

As a result of the production of high magnitude of sediment and decrease in the water discharge, sandbars are formed along the river and getting bigger and bigger year by year. These sandbars clog the water flow and reduce navigable depth and width of the river.

3. METHOD AND COUNTERMEASURES

Dikes are the useful to change the river flow direction and have been used in Myanmar to keep navigation channel. However, the location and the shapes of the dikes are decided on the basis of engineer's experience. In order to set dikes in braided channels under high suspended concentration to keep the navigation channel, the spatiotemporal change of braided channels under the high suspended load must be clarified. Two dimensional bed deformation analysis which can treat suspended sediment is a useful tool to design the suitable locations and shapes of the dikes in braided river.

References:

(1) Discharge and suspended sediment transport in the Ayeyarwady river, Myanmar: centennial and decadal changes by T.Furuichi, Z.Win and R.J. Wasson.

(2) The Irrawaddy river sediment flux to the Indian ocean: the original Nineteenth-century data revised by R.A.J. Robinson, M.I. Brid, Nay Win Oo, T.B.Hoey, Maung Maung Aye, D.L.Higgitt, Lu X.X., Aung Swe, Tin Tun, and Swe Lhaing Win.