C20

Impact of Lancang Cascade Dams on Flow Regimes, Sediment Dynamics and Morphodynamics of the Mekong Delta of Vietnam

○Doan Van BINH, Sameh KANTOUSH, Tetsuya SUMI, Nguyen Thi Phuong MAI

INTRODUCTION

Dams and reservoirs have been increasingly built throughout the world. In the Mekong River Basin (MRB), there are currently 56 hydropower dams of which six mainstream dams are in the Upper Mekong Basin (UMB), known as the Lancang cascade. The total storage capacity of the Lancang cascade dams (LCDs) is over 41 km^3 which is about 1.4 times larger than that of the remaining dams in tributaries of the Mekong River (MR). Dams and reservoirs can have positive impacts on flows downstream by reducing the flood flow and increasing the dry season flow. However, they are also well-known to have enormous adverse impacts on the flow regime, sediment dynamics, morphology, and integrity of rivers. The MR is not an exception.

Stretching over an area of 39,000 km^2 at the last ~200 km of the MR, the flows in the Vietnamese Mekong Delta (VMD) (**Fig. 1a**) were observed to be changed with a remarkable reduction in the rising and falling stages of the flood flows and annual flood peak due to upstream dam development. However, there is no holistic study evaluating the integrated impacts of upstream dam development of the MR on changes in the flow regime, sediment load, and morphology of the VMD. The aims of this research are to investigate (1) the impacts of the LCDs on flow regime and sediment load in the VMD and (2) the evolution of rivers' morphology in the VMD which will be used in numerical simulations in future works.

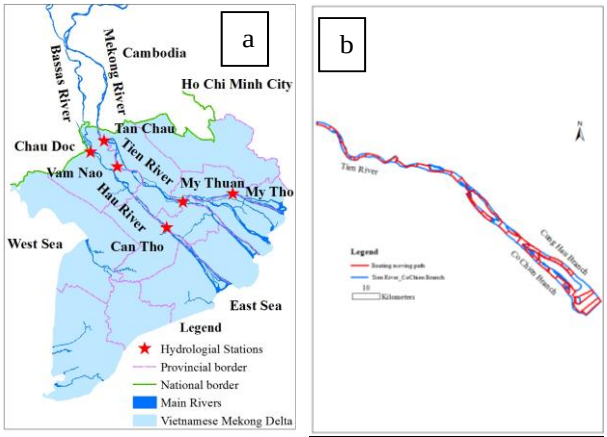

Fig. 1 (a) Vietnamese Mekong Delta (b) field investigation in Tien River

METHODOLOGY

Linear regression between discharges and water levels at TanChau and ChauDoc stations was done to fill missing discharges in 1980-2015. Power regression between suspended sediment concentrations (SSCs) and discharges was carried out to further fill missing values of the SSCs in the same period. Then annual sediment loads were estimated by multiplying SSCs with flow volume. Ultimately, changes in time series of water levels, discharges and annual sediment loads were analyzed.

Two-hundred cross sections of Tien and Hau Rivers, from TanChau and ChauDoc stations to the river mouths were measured in August 2017 using Acoustic Doppler Current Profiler (ADCP) (**Fig. 1b**). In the meantime, the turbidity was continuously recorded for fifty-two cross sections (and in between these cross sections) in the Mekong River from the river mouth to about 130 km upstream by Infinity-ATU75W2-USB turbidity meter. These datasets were analyzed to understand the longitudinal variations and evolution of the morphology and turbidity along Tien River.

RESULTS AND DISCUSSIONS

As two entrances of the MR to the VMD, discharges and water levels at TanChau and ChauDoc stations have been changed due to the LCDs (**Fig. 2**). During the transition period (1993-2011), these parameters are remained stable compared to those in pre-dam period (1980-1992). However, they significantly reduce in the flood season in post-dam (2012-2015) when all six dams in the Lancang cascade are in operation, especially maximum water levels at TanChau (less than 300 cm) remarkably drop below 350-450 cm as an ideal flood level in the VMD. Therefore, floodplains in the VMD may be negatively affected in terms of sediment, nutrient and ecosystem.

Annual sediment load entering the VMD was estimated as 160 Mt yr^{-1} of which about 50% is contributed by the UMB. However, annual sediment loads significantly reduce since 1993 in the VMD (**Fig. 3**). It may be due to impoundments of the LCDs which were estimated to trap ~83% of sediment generated in the UMB. **Figure 3** shows that annual sediment load is especially low since 2003 (41.2 Mt yr^{-1}) when the second dam, Daochaoshan, completed. Compared to discharges, cumulative impacts of the LCDs on sediment load in the VMD is faster because hydropower dams mainly shift the timing of the flow but may trap all bedload and huge portion of suspended load.

The morphologies of Tien River in 2017 has been significantly changed compared to those in 2014. In general, the river bed along Tien River in 2017 is deeper

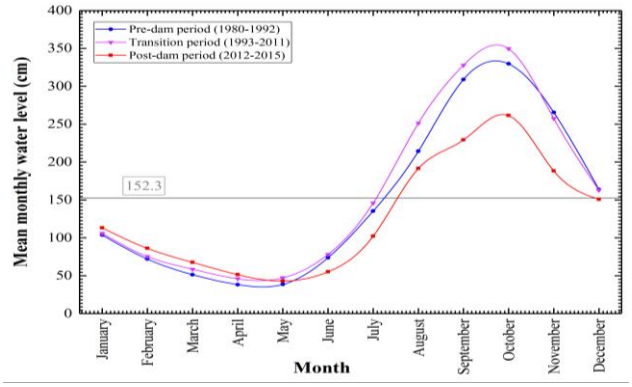

Fig. 2 Mean monthly water levels at ChauDoc

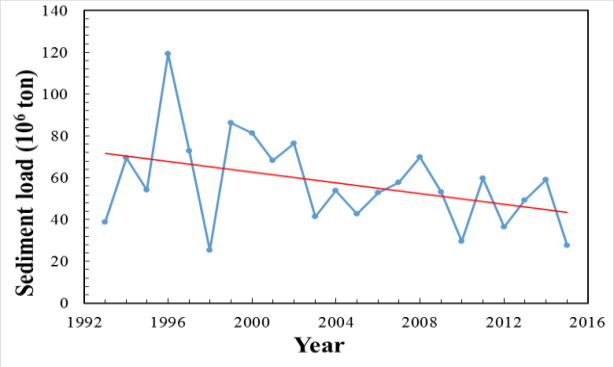

Fig. 3 Annual sediment load in post-dam in the VMD

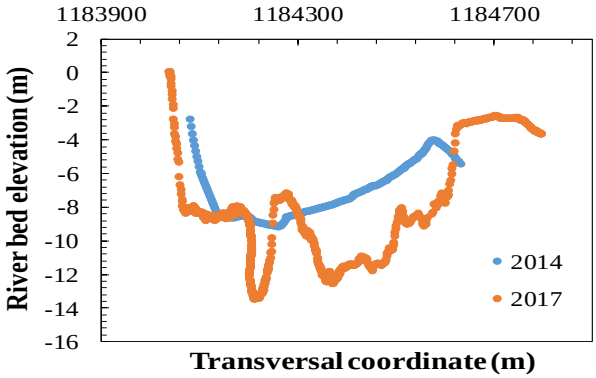

Fig. 4 River bed comparison at cross-section about 11 km downstream of TanChau

than that in 2014. For example, a cross section about 11 km downstream of TanChau station in 2017 is much deeper than that in 2014 (**Fig. 4**), maximum reduction is ~4.4 m. A reduction of more than 10 m can be found in many cross-sections. However, there are also some cross-sections where the river bed is quite stable (e.g. cross-section about 6 km downstream of TanChau).

CONCLUSIONS

Flow regimes, sediment dynamics in the VMD have been changed due to the construction and operation of the LCDs. Cumulative impacts of the LCDs on annual sediment load are much faster than on flow regime. The first four dams still have insignificant impact on flow regime while the first two dams have caused remarkable reduction in annual sediment load. Morphologies of Tien River is generally reduced in 2017 compared to those in 2014. The measured bathymetry is important for future works using numerical simulations.