Title of dissertation			
Synoptic transport modeling in the Ca River Basin, North Central Vietnam			
RONPAKU Fellow			
Name	**Ho Thi Phuong**		
Position	Lecturer	ID No.	R11604
Department	School of Chemical, Biological and Environmental Technologies		
Institution	Vinh University	Nationality	Vietnamese
Japanese Advisor			
Name	Kenji OKUBO		
Position	Professor	Institution	Okayama University

The study was performed in the Ca River basin, which is the third largest river in north-central Vietnam, located between 18°15′00″N and 20°10′30″N and 103°45′20″E and 105°15′20″E. Ca River basin covers an area of 27,200 km^2 in which the area in Vietnam territory is 17,730 km^2, holding 65.2% of the total drainage area. The trunk river length is 531 km, of which 170 km runs through Lao PDR and 361 km runs through Vietnam. Ca River, like many other rivers around the world, have been impacted by economic development. Various sized reservoirs have been constructed along the rivers for power generation, water supply, and flood control. In addition, other anthropogenic activities (e.g., intensive agriculture, land-use change, and industrial development) may disrupt the dynamic equilibrium between the movement of water and the movement of sediment that exists in free-flowing rivers, resulting in an alteration of natural river regimes, a modification of a river's morphology and riverbed characteristics, and a change in ion constitution. The aim of dissertation thesis is to examine the degree of human-induced alteration of the natural flow regime and the material budgets in the Ca River basin using Synoptic model include the Tank model, regime law and resistance law.

The Hieu River is the largest tributary on the left bank of the Ca River. Here, we use cumulative anomaly tests and Pettitt tests to ascertain the turning points in annual rainfall and discharge during the time period 1962–2014. The results of our statistical analysis reveal a breaking point in 1982 for the rainfall time series and in the late 1970s and late 1990s for the discharge time series. A storage-type hydrological model is used to determine runoff processes for different periods corresponding to detecting points of rainfall and discharge. The results of our model simulation confirm that a two-tank model with monthly input data is the most appropriate tank model for the Hieu River. The difference between the hydrographs improved when we used a rain factor as a function of the month. A comparison between the observed and calculated runoff revealed a drastic decrease between 1999 and 2014. The rate of discharge loss in the Lower Basin was approximately six times higher than that in the Upper Basin, a finding potentially due to reservoir construction and intensive water use for agricultural and residential purposes.

The river regime laws of the hydraulic properties of the cross sections of two hydrological stations (Dua and Yen Thuong) along the Ca River were combined into power functions with exponents of 1.46–1.85 using the Manning roughness coefficient and the settling velocity or the particle size to simulate the suspended sediment load. The Nash-Sutcliffe efficiency, percent bias, and the ratio of the

root-mean-square error to the standard deviation of the measured data were used to evaluate the calibration process for the pre-dam period (1994–2004) and for validation for the post-dam period (2005–2014). Effects of dam construction include a change in the relationship between the Manning roughness coefficient and sediment particle size. The observed sediment load decreased by approximately 20–40% after dam construction at both stations. We used a power function with exponents of 0.968 and 0.992 for the dissolved solid load to calculate the long-term annual total dissolved solids at the Dua and Yen Thuong stations, respectively. After dam construction, the average value of the total suspended solids-to-total dissolved solids ratio decreased from 3.0 to 2.3 at the Dua station and from 4.1 to 2.2 at the Yen Thuong station.

This study investigates the chemical composition of dissolved loads in the Ca River basin. The water samples were collected for 1 year from August 2017 to July 2018 at three hydrological stations located in the mainstream of the Ca River. We found that carbonate weathering is the dominant process controlling the water chemistry in the study area. Bicarbonate and calcium are dominant chemical species, accounting for 84.4% and 62.0% of the total anionic and cationic charge, respectively. The average dissolved-solids concentration is 144 mg/l and generally decrease from the upstream to downstream, resulting in a decrease of the major ions in the downstream basin. The variation of major chemical ions and suspended solids concentration with discharge was also investigated. As a result, major chemical weathering products behave chemostatically, with increasing discharge in the upstream. However, the dilution behavior of solutes is shown in the midstream and downstream. The ion species of NO_3^- and PO_4^{3-} show constant to increasing concentration in the drainage basin, indicating the additional sources of organic degradation and human activities. There is primary evidence that water storage for the reservoirs has impacted on a variation of suspended solids and dissolved solids in the Ca River.

(1) Ho Thi Phuong, Nguyen Xuan Tien, Hidetaka Chikamori, Kenji Okubo：A hydrological tank model assessing historical runoff variation in the Hieu River Basin, Asian Journal of Water, Environment and Pollution, Vol. 15, No. 1, pp. 75–86 (2018).

(2) Ho Thi Phuong, Kenji Okubo, Md. Azhar Uddin: Geochemistry and sediment in the mainstream of the Ca River basin,Vietnam Weathering process, solute-discharge relationship, and reservoir impact, Acta Geochimica, DOI: 10.1007/s11631-019-00327-z

(3) Ho Thi Phuong, Kenji Okubo: Effects of dam construction on total solids in the Ca River, north-central Vietnam, Environmental Earth Science, https://doi.org/10.1007/s12665-019-8394-x

Photos

In the student room of the Laboratory

The final presentation