Water, sediment and nutrients fluxes in the Saigon Dong Nai Rivers (Vietnam)

Flux d'eau, de sédiment et de nutriments dans les rivières Saigon et Dong Nai (Vietnam)

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RÉSUMÉ

En 2017 le laboratoire CARE a initié une collaboration avec le Department of Natural Resources and Environment (DONRE) de la province d'Ho Chi Minh (Sud Vietnam). Le centre de monitoring (CEM) du DONRE est en charge du suivi de la qualité de l'eau et de l'hydrologie du bassin versant des rivières Saigon et Dong Nai. Le CEM a mis en place 26 sites de mesures qualité de l'eau à une fréquence bi mensuelle et 15 sites de mesures de débits à une fréquence mensuelle. Dans cette présentation, nous proposons une analyse de cette base de donnée sur la période 2005-2016 pour les paramètres Matière en Suspension (MES), Nutriments (Azote et Phosphore) et débits. Pour cette analyse et pour quantifier les flux, dix sites ont été sélectionnés. Neuf sites le long de la rivière Saigon et un site sur la rivière Dong Nai sont utilisés pour identifier l'état amont de référence avant le passage dans la ville d'Ho Chi Minh et mettre en évidence l'accroissement des flux de l'amont vers l'aval. Ce travail permet de dresser un premier bilan de flux sur cette zone d'étude et d'évaluer les contributions des deux rivières et de la ville d'Ho Chi Minh aux flux totaux vers l'estuaire et la zone côtière. La saisonnalité est aussi discutée au travers du calcul des flux mensuels moyens.

ABSTRACT

In 2017, a collaborative work was initiated between the CARE laboratory and the Department of Natural Resources and Environment (DONRE) of Ho Chi Minh City Province (South of Vietnam). The Center of Monitoring (CEM) of DONRE is in charge of the water quality monitoring program of the Saigon-Dong Nai Rivers basin. CEM has implemented 26 monitoring stations along the two rivers, allowing the acquisition of bi-monthly data for water quality and monthly data for hydrology. In this presentation, we attempt to analyze the nutrients (Nitrogen and Phosphorus), suspended sediments and water discharges database from 2005 to 2016. To quantify the water, sediment and nutrients fluxes, ten monitoring sites were selected from this database. Nine sites along the Saigon River and one site in the Dong Nai River are used to identify the reference water status before Ho Chi Minh City (HCMC) and the increasing fluxes from upstream to downstream. The calculated fluxes allow drawing a first sediment and nutrients budget at the scale of Saigon Dong Nai Rivers and discussing the contribution of each sub basins to the total fluxes to the estuarine and coastal zones. Seasonal and inter annual variability of these fluxes will also be presented and discussed in regards to HCMC contributions and its impacts.

KEYWORDS

Hydrology, sediment, nutrients, Saigon River, flux calculation

1 INTRODUCTION

Ho Chi Minh City (HCMC) is one the most dynamic megacity in the world. With more than 8.4 million inhabitants and a high economic and urban growth, the impact of waste waters of the city is of major concern for local authorities (Tran Ngoc et al 2016). Less than 10 % of domestic waste waters are treated in HCMC before the release to the Saigon River (basin area of 4700 km^2). Downstream HCMC, this river joins the Dong Nai River (basin area of 40 000 km^2) to form the estuarine zone about 60 km from the coastal area (figure 1). Both rivers are then influenced by tides, leading to the flow current inversion twice a day. The hydrology of the two rivers are also influenced by tropical climate typical of the South of Vietnam (wet season from June to November, mean annual precipitation = 1900 mm). The purpose of this paper is to estimate the water, Total Suspended Sediments (TSS) and nutrients fluxes of the two rivers in order to evaluate the contribution of each river and of HCMC to the total inputs to the estuarine and the coastal zones.

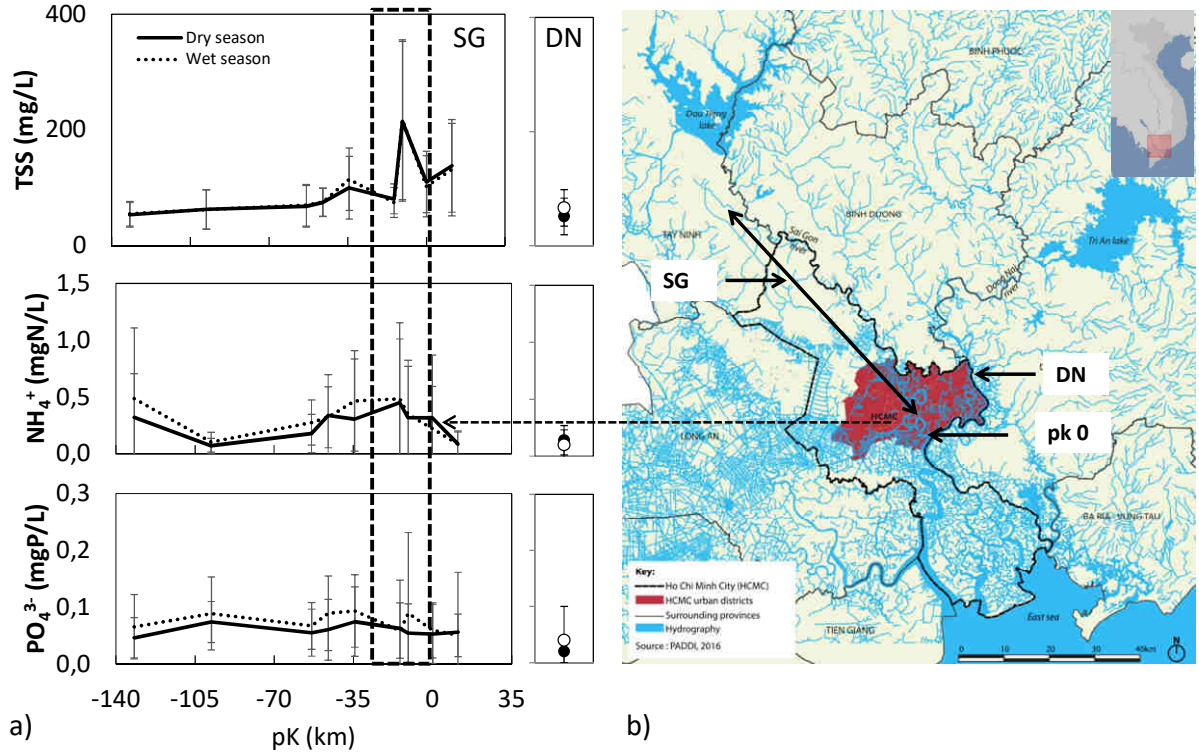

Figure 1 : a) Mean TSS, NH_4^+ and PO_4^{3-} concentrations in wet and dry seasons over the period 2012-2016 along the Saigon River (SG) and in the Dong Nai River (DN) : pK 0 indicates the confluence between the two rivers b) Map of the Saigon Dong Nai Rivers basin

2 MATERIAL AND METHODS

Since 2005, the Center of Monitoring (CEM) is in charge of 26 sites for water quality every two weeks and 15 sites for 24 hours discharge measurements every month in the Saigon Dong Nai Rivers basin (HCMC province). The selected period 2012-2016 allows getting homogenous and usable database of TSS, NH_4^+ and PO_4^{3-} for flux calculation. The fluctuation range of mean concentrations between wet and dry seasons is in the same order of magnitude whereas spatial variation of concentrations can be observed from upstream to downstream (Figure 1). The rivers discharge is deduced from the integrative flux between the tide inflow and outflow measurements during 24 hours. Even with the low frequency measurement of the discharge (i.e. 1 per month), the hydrological seasonality is observed. Mean annual flux (period 2012-2016) is calculated as the mean of the product between mean annual discharge and mean annual concentration. Additionally, mean monthly flux is calculated over the same period 2012-2016 at the outlets of the two rivers. Fluxes are presented with standard deviations (SD) highlighted the interannual or intermonthly variabilities.

3 RESULTS AND DISCUSSION

These fluxes budgets are the first attempted in the study site (Figure 2 illustrates for TSS fluxes). They are calculated independently for each site. Through the crossing of HCMC, the TSS flux doubles to reach 280 10^3 t/year at the outlet of the Saigon River. However, this flux is four times lower than the flux from Dong Nai River (1123 10^3 t/year). The discharge ratio is ten between Saigon (50 $m^3/s \pm 21$) and Dong Nai Rivers (613 $m^3/s \pm 218$) indicating then TSS concentrations are much higher in Saigon River due to HCMC waste waters release (see also figure 1). The TSS flux seasonality is strongly driven by the regional climate. More than 75 % of the annual TSS flux is transported during the wet season (from June to November). The same ratio between Saigon and Dong Nai Rivers can be observed for nutrients fluxes, but the contribution of HCMC is less marked than for TSS, evidencing than nutrients inputs occur also upstream of the city. In total the global TSS flux to the estuarine and coastal areas is about 1500 10^3 t/year with a 25 % contribution of Saigon River. Total NH_4 and PO_4 fluxes are estimated at 2700 tN/year and 880 tP/year (with 25 % and 16 % contribution of Saigon River, respectively).

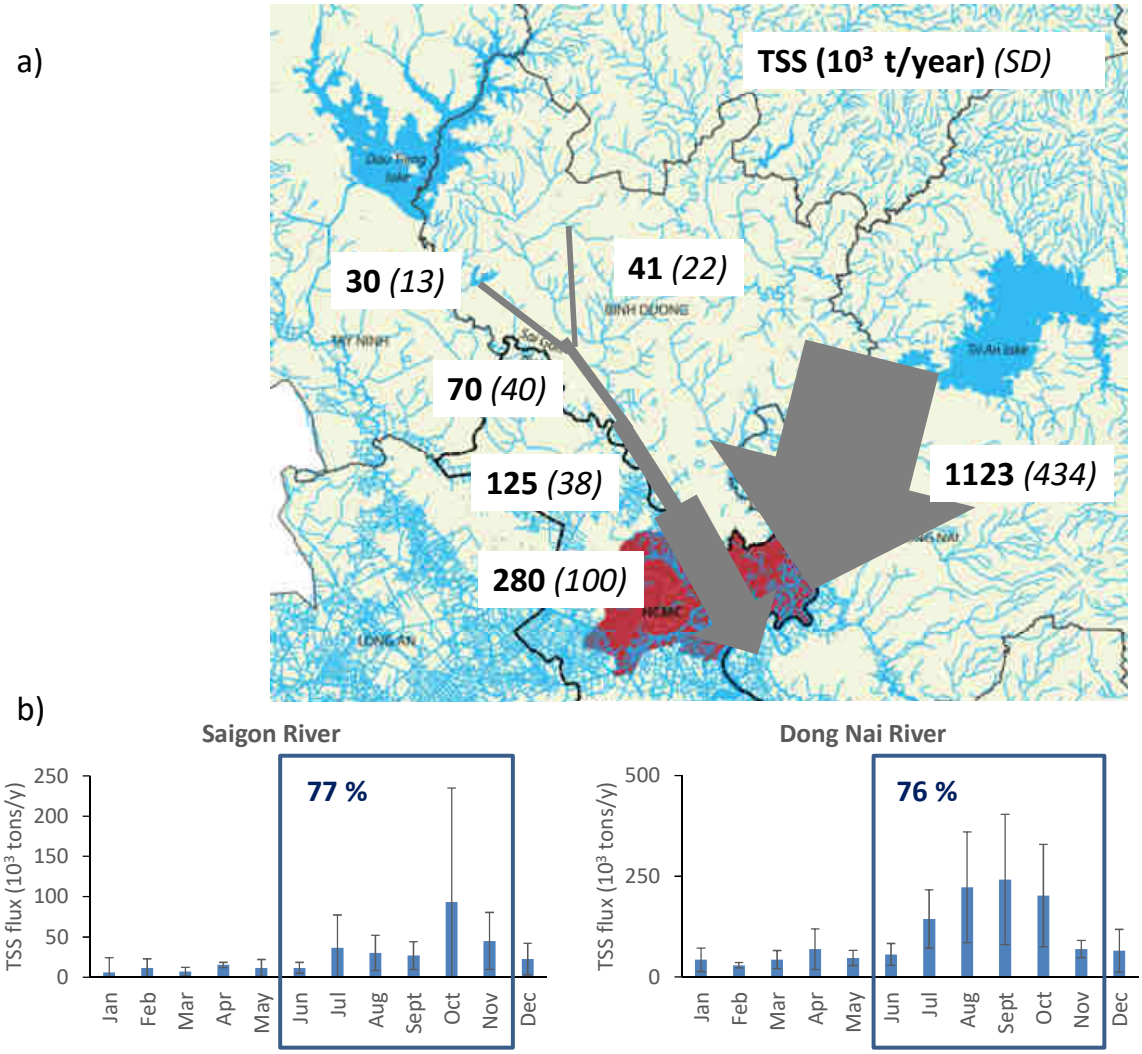

Figure 2 : a) Mean annual TSS fluxes and b) mean monthly TSS fluxes and proportion of the flux during the wet season in the Saigon Dong Nai River basin (period 2012-2016)

LIST OF REFERENCES

Tran Ngoc, T.D. Perset, M. Strady, E. Phan, T.S.I. Vachaud, G. Quertamp, F. Gratiot, N. (2016). Ho Chi Minh City growing with water related challenges, UNESO Press, 27p, available online http://eaumega.org/wp-content/uploads/2016/05/HCMC-MonographyEN.pdf