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Fate of terrestrial organic carbon and associated CO_2 and CO emissions from two Southeast Asian estuaries

D. Müller et al.

Correspondence to: D. Müller (dmueller@iup.physik.uni-bremen.de)

1 Total organic carbon export

For the TOC export, we multiplied discharge with an assumed zero-salinity end-member. We calculated the DOC and POC export slightly differently, the reasons are detailed in the following.

Dissolved organic carbon export

Since we showed that the DOC in the estuary is a mixture of two different zero-salinity end-members, we used the end-member calculated from the regression between DOC and salinity in the estuary (EM_{calc}). The standard error of the intercept was taken as the uncertainty of this estimate. DOC was then multiplied with discharge.

$$DOC_{export} = EM_{calc} f_1 \cdot Q, \tag{1}$$

where f_1 is a conversion factor (from μmol L^{-1} to g m^{-3}) and Q is the discharge (m^3 yr^{-1}).

Particulate organic carbon export

POC was not correlated with salinity, but exhibited maximum concentrations in the mid-estuary. Calculating a POC export would actually require an estimate of how much POC is deposited within the estuary. We do not have such an estimate. In order to still get an order of magnitude, we used the median POC concentration (POC_{median})and the standard deviation as uncertainty. The large standard deviation already reveals the spatial heterogeneity, and it was more than 100 % for both Lupar and Saribas. Therefore, the results for the POC export are very preliminary and require further investigation. For the present study, we calculated the POC export according to

$$POC_{export} = POC_{median} f_1 \cdot Q. \tag{2}$$

2 Estuarine carbon dioxide emissions

The Lupar and Saribas river plumes extend beyond the coastline. Since we delineated the estuary by connecting the coastline (see below), we used only flux estimates for the mid-estuaries and neglected the estuarine surface area and flux of the outer estuary. The estuarine surface area was determined using ArcMap 10.1 (ESRI, USA). The coastline was taken from the Global self-consistent Hierarchical High-resolution Geography (GSHHG, Version 2.2.2, `http://www.soest.hawaii.edu/pwessel/gshhg/`) at full resolution. The estuary was delineated by connecting the coastline at the river mouth (Fig. S1a). However, this shapefile did not contain the entire estuary. Therefore, we used a second shapefile that displays water areas in Malaysia (from `http://www.diva-gis.org`, see yellow areas in Fig. S1a). A missing connection between the Lupar estuary and

this water area was manually inserted based on a satellite image taken from Google Earth (see Fig. S1b). The area of the different parts was determined and added up to derive the estuarine surface area (Fig. S1c).

The largest error that this method might introduce is caused by the extent that is appointed at the river mouth. We estimated that by shifting the coastline connection by 1 km downstream, the estuarine surface area of the Lupar would change by 10 km^2, which corresponds to 4.5 % of the estimated value. Therefore, we consider a 5 % uncertainty for our estimate of the estuarine surface area.

The total flux for the mid-estuary (ME) was calculated using

$$F_{ME} = F_{ME,areal} \cdot f_2 \cdot A, \tag{3}$$

where $F_{ME,areal}$ is the average areal flux in the mid-estuary, f_2 is a conversion factor from mol m^{-2} yr^{-1} to gC m^{-2} yr^{-1}, and A is the estuarine surface area (in m^2).

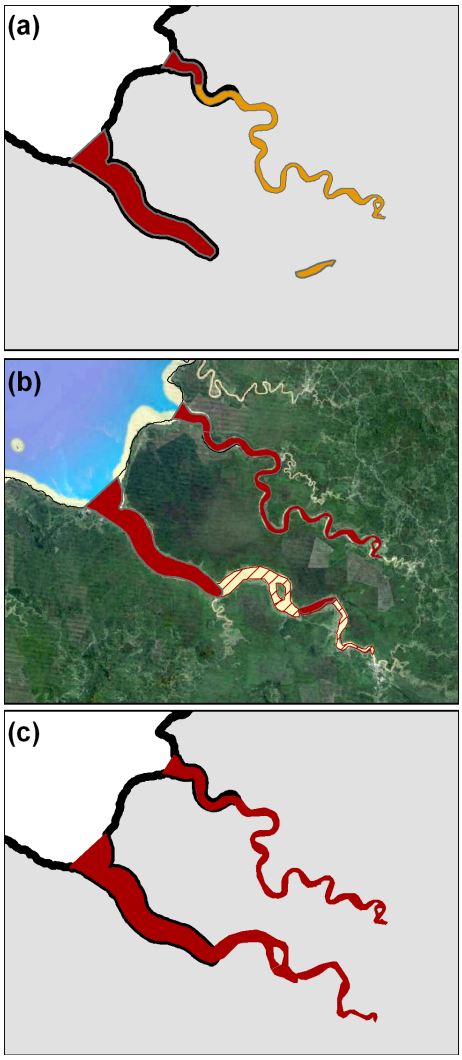

Figure S1: The figure depicts the three steps taken to derive the estuarine surface area of the rivers Lupar and Saribas. (a) Coastlines were connected (red), the water surface areas were added (yellow). (b) For the Lupar, the coastline outline and the water areas were connected based on a satellite image. (c) The combination of these fragments comprises the estuarine area.