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Hydrological variability and suspended particulate matter in the middle river Niger bassin

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In the Sahel, climate variability and high population growth have led to changes in surface conditions that resulted in increased runoff coefficients and discharge in the major Sahelian rivers. The mid reaches of the Niger river have experienced significant increases in the Red flood, or local flood, that occurs during the rainy season between June and September, relative to Black flood, or Guinean flood that arrives in Niamey from December onwards.
The objective of this work was to characterize suspended particulate matter (SPM) during the Red and Black floods in the Niamey area and analyse their spatio-temporal dynamics. Two approaches are used : the first one consists of regular in-situ measurements of SPM concentration and in their physical and mineral characterization by electron microscopy; the second is based on monitoring water color by both in-situ and satellite (Sentinel 2) radiometric measurements.
SPM are characterized by very fine particles (with a major mode around 0.1-0.2 micrometers) mainly composed by kaolinites (iron oxides are also observed during the Red flood). This, combined with the very high levels of SPM concentration reached during the rainy season, results in very high values of reflectance in the visible end infrared bands. Radiometric measurements in the nir band by both the in-situ SKYE sensor and the Sentinel2 sensor are found to be significantly correlated to in-situ SPM, allowing efficient monitoring of SPM concentration in time and space.
SPM-discharge curves, reveal a complex relationship : SPM increases very rapidly at the beginning of the rainy season when soils are washed out after the long dry period, reaching a peak before the first discharge peak (Red flood). SPM continues to decrease during the second discharge peak (Black flood) from December to February, providing a distinct and unique signature. Analysis of satellite data allowed identifying the main sources of SPM and to quantify the significant contribution of the right bank river tributaries to sediments in the middle Niger river bassin. This contribution may further increase in the context of global changes (climate and anthropogenic) with important consequences on sediment transport but also on water quality and bacterial concentration which are strongly influenced by high SPM.