P16

Sediment Plastic Accumulation and its Transformative Effect on Channel Morphology of Small Urban Rivers: Implications for Biodiversity and Ecosystem Stability.

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Plastic pollution continues to cause adverse environmental impacts globally, contributing significantly to major emerging pollutants such as nano and microplastics. Research has considered its role in freshwater and marine water contamination (Barboza et al., 2019). However, the behavior of plastic debris in fluvial systems remains poorly understood and estimates of riverine plastic flux derived from field measurements and modeling efforts are highly uncertain. This highlights the need for more precise field measurements and modeling to fully understand sediment plastic accumulation's spatial and temporal effects on river morphology. This research aims to investigate sediment plastic debris (SPD) accumulation and its transformative effects on the morphology of the Mfoundi River in Cameroon **(Figure 1)**. To achieve this, (1) plastic accumulation hotspots were mapped from the adjusted plastic index (API) calculated from the 2023 sentinel-2A image of the study area using Equations 1 through 5 (Sakti et al., 2023), where RED, NIR, and SWIR are bands in the sentinel-2A satellite image. This was followed by (2) the extraction and correlation of API values for permanent and long-term riverine plastic hotspots obtained from field surveys and with the aid of the Google Earth Timeline imagery database. Analysis of the point API **(Figure 2)** and visualization of Google Earth Timeline imagery permitted the identification and classification of changes in river channels at respective hotspots, considering channel modifications, flow behavior, and the extent of blockage. (3) An unmanned aerial vehicle (UAV) was obtained for a target plastic accumulation point downstream of the Mfoundi River and used to investigate plastic debris distribution and changes in channel characteristics from interactions between high flow discharge from rainfall and SPD accumulation on the river channel. Finally, (4) accumulated debris were randomly sampled at five different points in the surveyed hotspot to determine the characteristics (debris shape, dimensions, type, and material) of transported sediment plastic debris from the city.

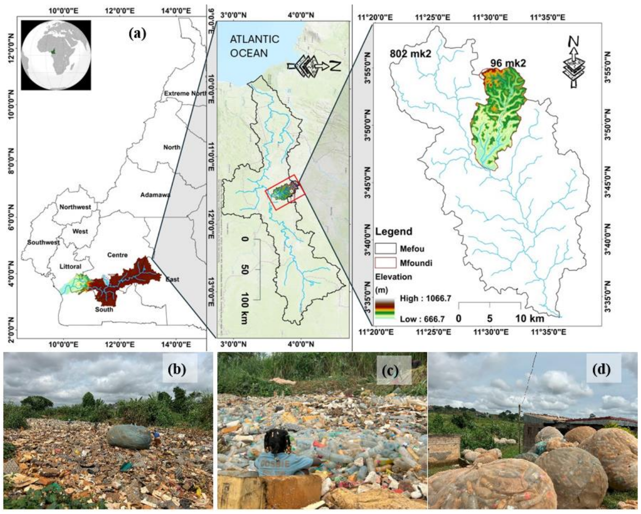

Figure 1. Geographical location of the Mfoundi subbasin (a) and the accumulation of SPDs within the anthropized channel of Mfondi (b)-(d).

$$PI = \frac{NIR}{(NIR+RED)} \quad \text{Eqt. 1}$$

$$NDVI = \frac{NIR-RED}{(NIR+RED)} \quad \text{Eqt. 2}$$

$$MNDBI = \frac{SWIR-NIR}{(SWIR+NIR)} \quad \text{Eqt. 3}$$

$$IF(NDVI > 0)$$
$$PI1 = PI - NDVI, ELSE: PI1 = PI \quad \text{Eqt. 4}$$
$$IF(MNDBI > 0):$$
$$PI2 = PI1 - MNDBI, ELSE: PI2 = PI1 \quad \text{Eqt. 5}$$

Results from this investigation identified five major changes and ways through which SPD accumulation will impact channel morphology: artificial damping, percolation through SPD hotspot, bypass, split flow, and encroachment-erosion of the adjacent banks **(Figure 3).** Also, debris characterization revealed an average surface coverage of about 0.03 m2 with a significant occurrence of 0.2 m2 samples and a rare occurrence of 0.7 m2 samples. Accumulation of sediment plastic debris in small river channels effectively impacts flow characteristics which in turn causes significant changes to the channel morphology.

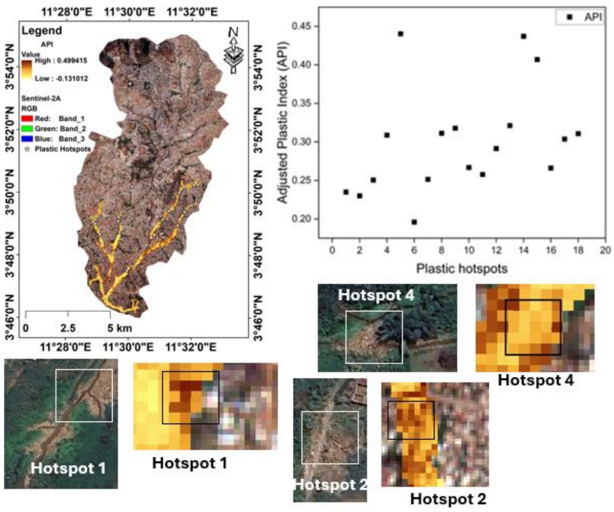

Figure 2. Adjusted plastic index (API) along the river channel and scattered plot of API values at identified hot spots.

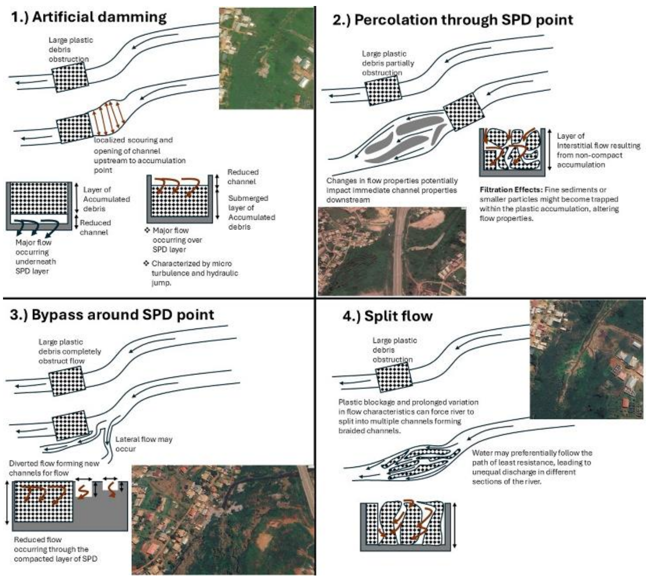

Figure 3. Classification of identified effects of SPD on channel morphology

This has been shown for sediments to play vital roles in habitat characteristics and the type of organisms inhabiting them (Kobayashi et al., 2023). Similar research is therefore recommended on aquatic biodiversity for respective SPD hotspots. Further investigation is also recommended in the flume environment is equally recommended for more insight into accumulation type/extent and effect on channel morphology. A significant amount of water from these rivers is used for irrigation and fish farming, thus posing a great risk of microplastic contamination. Analysis for microplastic presence is therefore equally important to reinforce plastic management policies.

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