

Long-Term Spatiotemporal Assessment of Riverbed Evolution in the Vietnamese Mekong Delta

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The Vietnamese Mekong Delta (VMD) is one of the most pristine and highly productive agro-aquaculture deltas worldwide (Binh et al., 2021). However, its exceptional significance is offset by challenges stemming from natural and anthropogenic factors. The interplay of these factors directly causes morphological degradation which plays a role in intensifying saline water intrusion into freshwater zones, jeopardizing agricultural productivity and the purity of drinking water sources. Such alterations in the delta's morphology pose challenges to aquatic ecosystems, imperiling fish habitats and overall biodiversity. Ultimately, the sustenance of the vast populace dependent on the delta's resources for farming and aquaculture hangs precariously in the balance.

This study aims to provide a quantitative evaluation of long-term spatial and temporal morphological changes in the VMD by utilizing field data and geographic information systems (GIS). We collected field bathymetric datasets for 1998, 2005, 2017, and 2020 (**Fig.1**). The 1998 riverbed cross-sectional profiles were obtained from Thuyloi University and the Southern Institute of Water Resources Research, Vietnam (Binh et al., 2021). Subsequently, 2005 datasets were sourced from the Southern Institute of Water Resource Planning (SIWRP). The 2017 bathymetric data collection conducted in August and September of that year was facilitated by financial support from the Japan-ASEAN Science, Technology, and Innovation Platform (JASTIP) under Kyoto University's auspices (Binh et al., 2021). For the 2020 data, a comprehensive collection was undertaken across 2020 and 2021, produced by SIWRP. The

bathymetric data were interpolated by employing universal kriging, using the kernel function available in the Geostatistical Analyst module within ArcGIS 10. Our subsequent analysis delved into morphological variations in terms of volume (m^3), segmented across three intervals: 1998-2005, 2005-2017, and 2017-2020. The Geomorphic Change Detection (GCD®6) tool within ArcGIS®10 was used to compute the disparities in riverbed elevations for these time intervals.

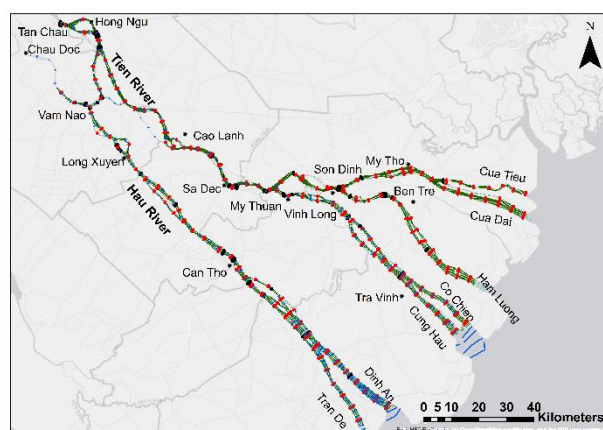


Fig.1. The VMD study area shows field survey transects and tracks conducted in 1998, 2005, 2017, 2020, and 2021.

The analysis unveiled that the net annual incision volume across the entire VMD was estimated to be $-119 \text{ Mm}^3/\text{year}$, $-69 \text{ Mm}^3/\text{year}$, and $-66 \text{ Mm}^3/\text{year}$ during the time intervals from 1998 to 2020 (Ahmed et al., 2025). The Tien River experienced more pronounced incisions than the Hau River did during each period (**Fig. 2**). This discrepancy is attributed to approximately 61–81 % of the SSL in the Hau River being redirected from the Tien River through the Vam Nao diversion channel during the flood season.

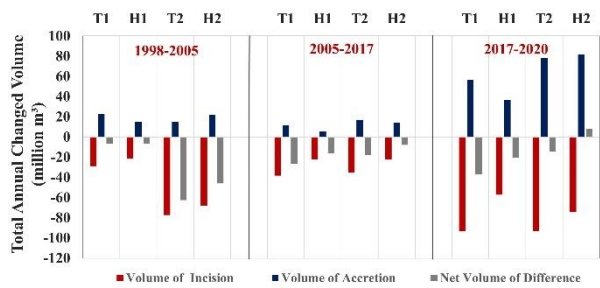


Fig. 2. Annual volume of incision, accretion, and net volume of difference in Mm^3 for riverbed evolution in the three-time intervals of 1998–2005, 2005–2017, and 2017–2020 across the respective reaches (T1) from Tan Chau to My Thuan along the Tien River, (H1) from Chau Doc to Can Tho along the Hau River, (T2) and (H2) from My Thuan and Can Tho down to the southern coastline, respectively

Our analysis further highlighted significant incisions in the upper reaches of the Tien and Hau Rivers, with an increasing trend over the years (**Fig. 3**). The total net annual incision volume for the upper reach of the Tien River was substantial at -7 Mm^3 , -27 Mm^3 , and -37 Mm^3 for 1998–2005, 2005–2017, and 2017–2020, respectively. Similarly, for the upper reach of the Hau River, the corresponding values were -6 Mm^3 , -16 Mm^3 , and -20.5 Mm^3 . This trend is attributed to the repercussions of human interventions, such as sand mining and sediment reduction resulting from dam construction. In contrast, sediment accretion manifested in the lower reaches. The total annual net riverbed incision volume for the lower reaches of the Tien River totaled -62 Mm^3 , -18 Mm^3 , and -14 Mm^3 for the periods 1998–2005, 2005–2017, and 2017–2020, respectively. Comparatively, for the lower reach of the Hau River, the values were -46 Mm^3 , -8 Mm^3 , and 8 Mm^3 across the three time intervals. These alterations were influenced by geomorphological and natural hydrological processes, resuspended sediment transported by waves and tides, and upstream erosion dynamics.

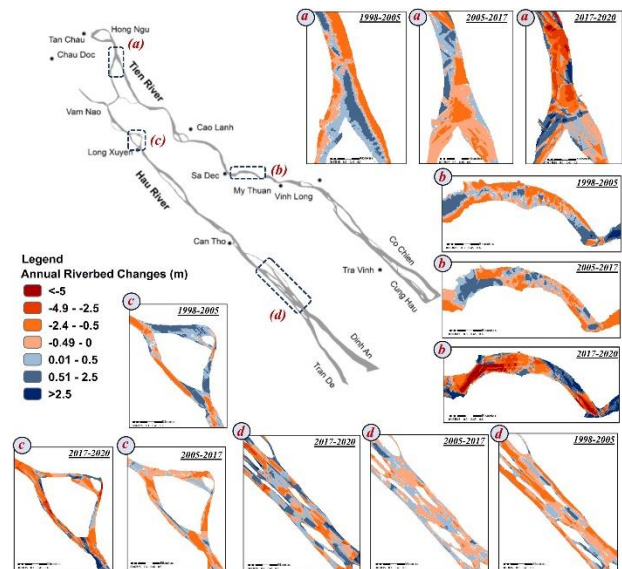


Fig. 3. Analysis of annual morphological changes: for 1998–2005, 2005–2017, and 2017–2020 with typical zones: (a) 12 km downstream of Tan Chau, (b) in the vicinity of the Sa Dec area, (c) upstream of Long Xuyen city, and (d) 20 km downstream of Can Tho city.

In conclusion, our study displays a comprehensive long-term examination of morphological alterations within the VMD, providing a valuable foundation for policymakers and stakeholders to develop evidence-based management strategies, aimed at fostering a more resilient and sustainable future for the delta and its communities.

References

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