Nearshore Sediment Dynamics in Sri Lanka

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Abstract

Coastal environment is a unique morphodynamic system for diverse changes. The present study estimated coastal morphodynamic changes and sediment transportation directions at locations of Uswetakeiyawa beach nourishment and Colombo harbour expansion project areas. In addition, heavy mineral occurrences were studied in beach sediments altogether parameters of mineralogical and geochemical compositions to identify depositional environments. Moreover, time series satellite images were used to identify seasonal coastal sediment accretion and depositional trends. Uswetakeiyawa beach nourishment project area indicates complex sand accretion or erosion, and a net reduction of overall beach widths with reference to the initial field visit. This site records bi-directional sediment transportations by longshore currents during the monsoon periods. Similarly, Colombo harbour expansion project area shows that the cumulative beach erosion has increased after the construction of the breakwater (rate = 0.7 m/year from May 2000 to April 2011 and rate = 28.2 m/year from April 2011 to June 2012). The cumulative and site-specific sand accretion and erosion patterns show clear influence with the monsoon seasonality. Beaches were wider during the stormy south-western monsoon, whereas beaches were narrower during fair weather of north-east monsoon. In contrast, ilmenite, zircon, garnet, monazite and rutile were identified as main heavy minerals in beach sediments. The heavy mineral potential of the north-eastern coast was high (average about 45-50% in the Verugal and 70-85% in the Pulmoddai deposits and 3.5-5.0% in the offshore samples from Nilaveli to Kokkilai), compared to the south-western sediments (average about 10% in onshore and 2% in offshore Gin River mouth). Observed high concentrated heavy minerals in beach and low concentrated offshore sediments suggest the panning system in the surf zone to form enriched placer deposits. The whole rock major and trace compositions of beach sediments were marked enrichment of TiO_2, Fe_2O_3, Ce, Cr, Nb, Th and V compared to the average upper continental crust values. The analysis of prominent coastal longshore transport patterns shows that clockwise flows in the eastern and north-western coasts. In the south-western coast, transport directions were divided into two branches of anti-clockwise and clockwise. Therefore, the schematic representation of monsoon-derived longshore currents suggests that the sources of heavy minerals in the Pulmoddai and Verugal deposits may have probably influenced by clastic sediment supply in eastern India and Sri Lanka (the Mahaweli River), respectively. Heavy minerals in the western coast can probably derive from Precambrian metamorphic rocks, and supplied to coast through river systems in Sri Lanka.

Keywords: Beach width, Beach profile, Beach erosion, Longshore current, Sri Lanka