Abstract

This study was conducted in Mwache creek mangrove wetland (ca. 17 km2) situated within the Port-Reitz Ria in Mombasa District, Kenya. The aim of the study was to examine sediment and tidal water transport and exchange dynamics in the creek with a view of establishing the main factors that affects the long-term sustainability of the mangrove wetland. The study was implemented in the period between 1999 and 2001. The study involved the determination of the total suspended sediment concentrations (TSSC), particulate organic sediment concentrations (POSC), salinity, temperature, current velocities, tidal elevations, ebb-flood tidal discharges, river discharges and sediment fluxes. Tidal elevations and current velocities in the main channel were measured in the front water (Station 6) and backwater zone (Station 1) of the creek using multi-purpose MicroTide Pressure Gauges and Aanderaa Doppler Recording Current meters. Aanderaa Doppler Recording Current meters (RCM-9) and MicroTide Pressure gauges equipped with the Optical Backscatter Turbidity sensors were used for the long term monitoring of TSSC variations in relation to the variations of the semi-diurnal tide and current velocities in the front water and backwater zones of the creek. These instruments recorded TSSC, current velocities, current directions, temperature and water level at 5-minute interval. The recording instruments were moored monthly at stations 1 and 6 for periods ranging from 3 days to 4 weeks in both dry and wet seasons. For the determination of the spatial distribution of TSSC and POSC, water samples at ten (10) sampling stations were drawn at 0.2, 0.6 and 0.8 depth using Niskin water sampler. TSSC were then determined in the laboratory through.filtration using pre-weighed Whatman GFIC filter papers. The filters were dried in oven for 12 hrs at a temperature of between 80 and 120°C. POSC was determined by toe ignition technique in which sediment samples were ignited in oven at a temperature of 550°C for 3 to 4 hours. The vertical distribution of water temperature and salinity at the ten stations were determined insituatiain interval of O.1m using Aanderaa Salinity-Temperature meter. Within the mangrove forest, tidal elevations were measured using a Tide pole and the velocities by tracking trajectories released on water. The determination of ebb-flood tidal and river discharges were based on the standard procedures involving the determination of the channel cross-sectional areas and velocities. The results showed that during wet seasons when the river discharge is high, backwater zone water column was poorly mixed with both salinity and sediment stratification. During such periods, the vertical salinity and sediment gradients were significant. However, in the front water zone, water column

was mostly well mixed throughout the year with minor vertical gradients in rainy seasons. This was attributed to high rates of water exchange and prevalence of strong tidal currents in the front water zone main channel. The backwater zone experiences wide salinity variations (10 to 40 PSU) as compared to the front water zone where variations are relatively minor (25 to 38 PSU). The backwater zone TSSC was much higher than of that of the river in dry seasons. However, in periods of high river discharge, the river TSSC was relatively higher than that in the backwater zone main channel. The decrease of TSSC from the backwater zone to the front water zone was also exponential in wet season and linear in dry season. The mean near surface TSSC in the backwater zone is 0.l6 g.rl while that in the front water zone is 0.03 g.rl. The bottom water TSSC is usually high reaching to g.rl in the frontwater zone. However, in the backwater zone, the bottom TSSC is of the order 7 g.r I. The resuspension of the fine bottom sediments by strong currents (0.90 ms") resulted in the formation of the frontwater Turbidity Maximum Zone (TMZ) where TSSC range between 0.10 and 4.0 g.rl. Low magnitude current velocities «0.50 ms") in the backwater zone did not cause major resuspension of the bottom sediments. In the heavily degraded backwater zone mangrove forest, the ebb and flood tide total sediment fluxes were of same order of magnitude with the ebb tide sediment fluxes being slightly higher than flood ones. However, in them moderately degraded frontwater zone mangrove forest, the flood tide sediment fluxes were higher than the ebb tide sediment fluxes. For the entire wetland, ebb tide sediment fluxes ranged from 33 to 3,206 kg.tide' and the flood ones ranged from 139 to 3,304 kg.tide". In case of particulate organic sediments (PaS), the flood period pas fluxes ranged from 8.3 to 587 kg.tide' while the ebb period ones were relatively higher ranging from 2.5 to 1,316 kg.tide-I. In the moderately vegetated frontwater zone mangrove forest, net sediment import is of the order 63 g.mi.tide' and net pas import is of the order 5.4 g.mt.tide". In the highly degraded backwater zone mangrove forest, the net sediment import is 8 g.m 2.tide-1 and the net particulate organic sediment import is 1.1 g.mi.tide'. The backwater and frontwater zone mangrove forest trap 40 % and 60 % of the incoming sediment respectively. Relatively low trapping capability in the backwater zone forest was attributed to the degradation of the wetland, mainly through smothering of mangrove roots due to heavy siltation. Because of low trapping efficiency in the highly degraded backwater zone mangrove forest, the net sedimentation is relatively much lower compared to that in the frontwater zone mangrove forest where vegetation cover is relatively higher. The trapping of sediments in the mangrove forest results in accretion which, in the

frontwater zone mangrove forest (35 cm.lOO years") is relatively higher than sea level rise (20 cm.IOO years"), However, accretion rate in the highly degraded backwater zone mangrove forest (22 cm. 100 years") is of the same order of magnitude as the rate of sea level rise. Within the main channel, sediment fluxes in the backwater zone averages 1,364 and 649 kg.mi.tide' during flood and ebb tide respectively. In the frontwater zone main channel, the flood and ebb tide sediment fluxes averages 933 and 480 kg.mi.tide' respectively. Because the backwater zone main channel is usually flood tide dominant in dry seasons, the import of sediments occur in dry season. However, during rainy season, increased river discharge converts the backwater zone main channel into ebb-tide dominance. This causes net export of sediments to the frontwater zone main channel. As compared to the backwater zone main channel, the frontwater zone main channel is , essentially ebb-tide dominant, but in dry season during spring tide, resuspension of the bottom sediments during flood tide leads to the import of sediments in the frontwater zone. During wet season, the ebb tide dominance in the frontwater zone is enhanced by the residual flow induced by the river discharge. This causes a net export of sediment amounting to 14,400 tonnes.year' out of the creek in wet season. Sediment import in dry seasons amounts to 5,000 tonnes, which means that the net sediment export out of the creek is 9,400 tonnes.year'. Sediment exported out of the creek is much larger than the river sediment input of 4,800 tonnes.year' implying that there is remobilization of sediments deposited into the creek during the previous storms. The study recommends an integrated management of the greater Mwache Basin encompassing both the mangrove wetland as well as the river basin.