Water-soluble ionic species in river-bottom sediments of the Pangani Basin, Tanzania

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Introduction: Chemical analysis of sediment is a sensitive indicator in assessing potential contamination of an ecosystem, in this context the water-soluble forms of chemicals are of particular importance. In this study, concentrations of the water-soluble ionic species; sulphate (SO_4^{2-}), nitrate (NO_3^-), fluoride (F^-), bromide (Br^-), chloride (Cl^-), nitrite (NO_2^-), phosphate (PO_4^-) ammonium (NH_4^+), and base cations (Li^+, K^+, Na^+, Mg^{2+}, Ca^{2+}) were quantified in river-bottom sediments of the Pangani basin in Tanzania, together with their fluxes, spatial distributions and seasonal variations. Sediments physicochemical characteristics were also determined using standardized methods. The aim was to study the effects of urban and agricultural run-offs on water-quality in the area. The river basin, covering an area of about 43,000 km^2, is one of the largest in the country. The main Pangani river, which flows for about 500 km before draining into the Indian Ocean, rises as a series of small streams on the southern sides of Mt. Kilimanjaro and Mt. Meru. Along its course the river and its tributaries supply a number of urban centres, rural settlements, agricultural activities and industries with water and related resources. Recently there have been concerns over the increasing degradation of its water quality and the general environment due to large expansions of human activities. Concentrations of water-soluble ions in fluvial sediment, which is an important parameter for river basin environmental quality, has not received any attention in this area.

Methods: Sediment samples were collected from 12 stations along the main Pangani River and five of its tributaries. The stations are those periodically monitored by the Pangani Basin Water Office (PBWO). Two sampling campaigns were conducted in September 2009 (dry season) and April 2010 (rainy season). Samples were collected from exactly the same locations during the two seasons.
Samples were leached in 5 mL of Milli-Q water in a ultrasonic bath (Bransonic, 2210, USA) for 15 minutes and then left to stand for an hour. Each leachete was then filtered by a Millex-GC filter unit (Millipore, Ireland), transfered into 2 ml vials (Dionex, USA) and analysed by a Dionex DX-120 Ion Chromatograph (Sunnyvale, USA) equiped with an AS50 autosamper.

Results: Sediment samples from the 12 stations are characterized by sand (52 – 91 %) followed by silt (7.6 – 39 %) and clay (1.3 – 11 %). Organic matter content ranged between 5.2 to 22 %. Concentrations of the individual ions at the 12 stations varied from 0.1µg/g (NH_4^+) to 51.7µg/g (SO_4^{2-}). Species concentrations were dominated by SO_4^{2-} in almost all of the stations, followed by Na^+. NH_4^+ was detected only during the dry season and in three stations; S10, S11 and S12 and. Br^-, PO_4^- and Li^+ were not detected at all.

Discussion: SO_4^{2-} and Ca^{2+} were positively correlated indicating that they might be from the same source, probably gypsum in the bedrock. However, concentrations of SO_4^{2-} increased significantly at S2, S3, S6, S8, S10 and S11 during the dry season compared to the rainy season, suggesting some anthropogenic inputs, probably from fertilizers and animal wastes. S1 which is the most upstream station had the lowest total ionic concentration, whereas the most downstream station, S11, the main Pangani river at the entrance to the Indian Ocean, had the highest total ionic concentration. Comparison of species concentration profiles between the two seasons shows no definined seasonal variation trend.

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