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Trent R. Marwick
KU Leuven, Heverlee, Belgium (trentrichard.marwick@ees.kuleuven.be)

Fate of Upstream Anthropogenic Nitrogen Inputs in a Tropical Catchment, Athi-Galana-Sabaki River, Kenya.

Trent R. Marwick (1), Fredrick Tamooh (1), Bernard Ogwoka (2), Cristian Teodoru (1), Alberto V. Borges (3), François Darchambeau (3) & Steven Bouillon (1)

(1) Katholieke Universiteit Leuven, Department of Earth and Environmental Sciences, Celestijnenlaan 200E, B-3001 Leuven, Belgium; (2) Kenya Wildlife Service, Kwale, Kenya;
(3) Unité d'Océanographie Chimique, Université de Liège, Belgium.

As part of a broader study on the riverine biogeochemistry in the Athi-Galana-Sabaki (A-G-S) River basin (Kenya), we present data collected during three climatic seasons to constrain the sources, transformations and transit of multiple N species as they flow through the A-G-S basin ($\sim$47,000 km2), stretching from downstream of heavily polluted Nairobi and surrounds to the outlet at the Indian Ocean. Total dissolved inorganic nitrogen (DIN) concentrations entering the study area were highest during the dry season (1195 $\mu$mol/L), almost completely in the form of ammonium (99.8%), whilst total DIN was an order of magnitude lower during the short and long rain seasons (212 and 193 $\mu$mol/L, respectively). Nitrate was the dominant form of DIN entering the study area during the short and long rain seasons (97.9% and 85.6% of total DIN respectively), with the increased flow conditions resulting in minimal instream N-cycling prior to discharge to the ocean. Conversely, longer water residence time and intense cycling and removal of N in the upper- to mid-catchment during the dry season creates two polarities comparative to wet season conditions, where (1) significantly less DIN is exported to the ocean during the dry season, and (2) dry season particulate N export is significantly enriched in $\delta$15N, strongly reflecting the dominance of organic wastes as the source of riverine nitrogen. The rapid removal of ammonium in the upper study area during the dry season was followed by a quantitatively similar production of nitrate and nitrous oxide downstream, pointing towards strong nitrification over this reach during the dry season. The nitrous oxide was rapidly degassed downstream, while the elevated nitrate concentrations steadily decreased to levels observed elsewhere in African river networks. Low pelagic primary production rates over the same reach suggest benthic denitrification was the dominant process controlling the removal of these nitrates, although large cyanobacterial blooms downstream highlight the significant role of primary producers assimilating DIN lower in the drainage network. The intense upstream N-cycling leads to a significantly enriched $\delta$15NPN during the dry season (mean: 16.5 $\pm$ 8.2‰ comparative to the short (7.3 $\pm$ 2.6‰ and long (7.6 $\pm$ 5.9‰ rain seasons. The strong correlation found between seasonal $\delta$15NPN and $\delta$18OH$_2$O ($\delta$18OH$_2$O as a proxy of discharge; p = 0.0258, n = 26) presents the possibility of employing a combination of proxies such as $\delta$15NPN of sediments, corals and bivalves, to build the foundation of how historical land-use changes have influenced nitrogen cycling within the catchment whilst potentially providing foresight for future land management decisions.