# Extensive nitrogen loss from permeable sediments off N-W Africa

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The upwelling area off North-West Africa is characterized by high export production, high nitrate and low oxygen concentration in bottom waters. The underlying sediment consists of sands that cover most of the continental shelf. Due to their permeability sands allow for fast advective porewater transport and can exhibit high rates of nitrogen (N) loss via denitrification, especially in anthropogenically eutrophied regions. However, N-loss from sands underlying upwelling and thus naturally eutrophied waters is poorly studied, and despite the favorable local conditions N-loss from the N-W African shelf is not well constrained. During 2 research cruises in April/May 2010/11, sediment was sampled at 16 stations along the N-W African shelf and potential denitrification was measured in sediment layers down to 8 cm depth using slurry incubations with $^{15}$N-labelled nitrate.

Denitrification rates in sandy sediments were similar down to 8 cm depth suggesting efficient transport of nitrate into the sediment. Areal denitrification rates were calculated by integrating volumetric rates down to the nitrate penetration depth derived from porewater profiles. Areal rates were neither correlated with organic carbon content nor with bottom water nitrate. However, areal rates were strongly correlated with the sediment grain size ($R^2$ 0.91 $p<0.0001$). Grain size is a proxy for porewater advection as it determines sediment permeability and reflects the strength of prevailing bottom water currents that drive porewater flow.

The found empirical relation between areal denitrification and grains size suggests that porewater advection is a main regulating parameter for benthic denitrification in sands and further allowed extrapolating rates to an area of 50,000 km$^2$ using detailed sediment maps. Denitrification from this region amounts to 800 kt per year (on average 3 mmol/m$^2$/d) which is 5 times higher than previous estimates based on diffusive porewater transport. Considering that 70% of the continental shelf is covered by sands, these sediments may significantly contribute to the global benthic N-loss.