Impact of variable wave conditions on nitrogen flux to coastal waters via submarine groundwater discharge

CLARE E. ROBINSON[1], MING WU[2]

[1]Department of Civil and Environmental Engineering, Western University, London, Ontario, Canada, N6A 5B9 (crobinson@eng.uwo.ca)
[2] Pells Sullivan Meynink, West Perth, WA 6005, Australia (ming_zhi_wu@hotmail.com)

Nitrogen flux to coastal waters via submarine groundwater discharge is controlled by the complex hydrological and biogeochemical processes occurring in the subterranean estuary. Numerous studies have illustrated the impact of the various physical driving forces (tides, seasonal recharge, waves) on submarine groundwater discharge and the functioning of a subterranean estuary. While recent studies have shown that tides and seasonal recharge can considerably affect the behaviour of nitrogen in coastal aquifers and its subsequent discharge to coastal waters, the impact of waves is poorly understood. Waves are a dominant forcing along most shorelines worldwide, but evaluating their impact is challenging as they are highly irregular and act on multiple time scales. The objective of this study was to evaluate the impact of transient wave conditions (i.e. wave height varying over time) on nitrogen transformation in a nearshore aquifer and associated fluxes to coastal waters.

A numerical reactive transport model was developed in MODFLOW-NWT combined with PHT3D to investigate how variable wave conditions compared with no waves or constant wave conditions impact nitrogen behaviour. A reaction network considering organic matter mineralization, denitrification and denitrification was implemented. Results indicate that consideration of variable wave conditions compared to no waves or constant wave conditions considerably alters the flux of nitrogen to coastal waters primarily due to higher wave-induced mixing in the nearshore aquifer between the discharging land-derived groundwater and recirculating coastal water.

The findings suggest that variable wave conditions need to be considered in estimating nitrogen fluxes from groundwater to coastal waters particularly along shoreline subject to periods of intense wave (storm) conditions. The results also highlight the need to consider antecedent wave conditions in interpreting biogeochemical field data collected in nearshore aquifers.