Submarine groundwater discharge derived nutrients and red tide outbreaks in Tolo Harbor, Hong Kong

Jiu Jimmy Jiao[1], Xin Luo, Wenzhao Liang[1]
[1]Department of Earth Sciences, The University of Hong Kong, P. R. China

ABSTRACT

Multiple tracers, including radium quartet, ^{222}Rn and silica are used to quantify submarine groundwater discharge (SGD) into Tolo Harbor, Hong Kong in 2005 and 2011. Five geotracer models based on the end member model of ^{228}Ra and salinity and mass balance models of ^{226}Ra, ^{228}Ra, ^{222}Rn, and silica were established and all the models lead to an estimate of the SGD rate of the same order of magnitude. In 2005 and 2011, respectively, the averaged SGD based on these models is estimated to be ≈ 5.42 cm d^{-1} and ≈ 2.66 cm d^{-1}, the SGD derived DIN loadings to be 3.5 x 10^5 mol d^{-1} and 1.5 x 10^5 mol d^{-1}, and DIP loadings to be 6.2 x 10^3 mol d^{-1} and 1.1 x 10^3 mol d^{-1}. Groundwater borne nutrients are 1-2 orders of magnitude larger than other nutrient sources and the interannual variation of nutrient concentration in the embayment is more influenced by the SGD derived loadings. Annual DIP concentrations in the harbor water is positively correlated with the precipitation and annual mean tidal range, and negatively correlated with evapotranspiration from 2000 to 2013. Climatologically driven SGD variability alters the SGD derived DIP loadings in this phosphate limited environment and may be the causative factor of interannual variability of red tide outbreaks from 2000-2013. Finally, a conceptual model is proposed to characterize the response of red tide outbreaks to climatological factors linked by SGD. The findings from this study shed light on the prediction of red tide outbreaks and coastal management of Tolo Harbor and similar coastal embayments elsewhere.