Estimating yield is key to obtaining global material flux via the submarine groundwater discharge

*Chen-Tung Arthur Chen[1,2], Ting-Hsuan Huang[1], Hon-Kit Lui[1], JING ZHANG[3]

1. National Sun Yat Sen University, 2. Zhejiang University, 3. University of Toyama

Excess nutrients have been discharged into the oceans by rivers, making many coastal regions hypoxic or even anoxic. Most people do not realize that a substantial fraction of the freshwater on land also enters the oceans directly from the seabed, unseen by human eyes. This process is called submarine groundwater discharge (SGD) and it amounts to 0.2-10% of global river discharge. The SGD releases nutrients, alkalinity (TA), and dissolved inorganic carbon (DIC) into the oceans while reducing their dissolved oxygen (DO) content and pH but the results are largely unknown quantitatively. A case study indicates that the freshwater component of the SGD equals around 5.2% of the annual river discharge in Taiwan, where the over-pumping of groundwater has been a serious problem. Further, the SGD exports N, P, Si, TA, and DIC in amounts equivalent to 12.7, 0.9, 9.3, 21.1 and 19.6%, respectively, of those in riverine fluxes. Unfortunately, such results cannot be generalized to a region - let along to all coastal seas around the world - because the total area of Taiwan is too small. Whereas rivers have been extensively studied, only a handful of reports concerning nutrients, TA and DIC fluxes have focused on SGD. Worse, the relevant literature is mainly concerned with the flux per unit area of SGD discharge into oceans. Such data cannot be extrapolated to the global oceans as the discharge area is unknown. On the other hand, the yield, which is the flux per unit area of the river basin, can be extrapolated from readily available river basin data but to the best of our knowledge the yield has been reported for only three river basins. An accurate estimate of the SGD flux is essential to predicting coastal environments in an era of rapid global change but most - if not all - coastal biogeochemical models have no SGD component. Substantial errors may arise if SGD is ignored, especially in estuaries, bays, inland seas, deltas and salt marshes. Since the areas of thousands of river basins worldwide are known, with a knowledge of even a limited number of data on the yield the global amount of material flux by SGD may be reasonably estimated and its effect on the coastal biogeochemistry better evaluated.

Keywords: Submarine Groundwater Discharge, nutrients, carbon cycle

