Effect of Cyclonal Precipitations on the Long-term dissolved and particulate fluxes of river in Taiwan

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The burial of particulate organic carbon (POC) in marine sediments and carbonate deposition induced by excess alkalinity in the ocean due to continental silicate weathering represent the geological sinks of atmospheric carbon dioxide (CO_2) while its sources have to be the degassing of solid Earth. Superimposed on this carbon cycle at million year timescale, the exchange of carbon between the deep ocean and the surface ocean and/or between the biosphere and the geosphere are responsible for glacial interglacial variations in the atmospheric CO_2 level.

Understanding the long-term feedback mechanisms requires the quantification of the fluxes of alkalinity and POC. Here, we use example from Taiwan to demonstrate that these fluxes are strongly impacted by the landfall of typhoons. However the response of enhanced precipitation is rather different when POC or products of the silicate weathering are concerned. For instance, a consequence of Typhoon Morakot in August 2009 was the production of vast volumes of driftwood. Combining remote sensing, analysis of forest biomass, and field observations, returned a flux of 3.8-8.4 Tg of coarse woody debris to the oceans, carrying 50-111 tC km^{-2}. Previous estimate of POC flux during typhoon-triggered floods yielded 13 tC km^{-2} and detailed investigation showed that the concentration of POC from vegetation and soils is positively correlated with water discharge. On decadal timescales, 77–92% of eroded non-fossil particulate organic carbon is transported during large, cyclone-induced, floods with a corresponding yield of 16 to 202 tC km-2yr^{-1}. Flood associated to Typhoon Morakot have a recurrence time of more than 200 years but fits within this estimate.

On the other hand, the cyclonic precipitations have less of an impact on the decadal dissolved fluxes. In the steep and well-drained catchment of the Liwu river, the river chemistry at low- to medium-flow reveals a mixing between a deep groundwater component and a rapid surface runoff characterized by the chemistry of first-order tributaries. Samples collected at high-flow, associated to the landfall of typhoons, show the contribution of a third water source not immediately mobile and therefore called slow surface runoff. The 37-yr average estimates that 21±5% of the river discharge originates from this slow surface runoff. The slow surface runoff is the least characterized of the end-members but the modeled evolution of water chemistry along its flow paths suggests that the atmospheric CO_2 consumption rate associated to this end-member could be around a quarter of the decadal rate for this catchment. This suggests that tropical cyclones, which affect many forested mountains within the Inter-tropical Convergence Zone (ITCZ) have a significant impact on the decadal to millennial average fluxes of alkalinity and POC. This strongly advocates for the need to sustain data collection at benchmark sites on long timescales, especially in locations at the fringe of the ITCZ, where recurrence time of these extreme events is greater than in Taiwan.