Geophysical Research Abstracts
Vol. 15, EGU2013-3781, 2013
EGU General Assembly 2013

The potential of carbon and nitrogen isotopes to conservatively discriminate between subsoil sediment sources

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Moreton Bay, in South East Queensland, Australia, is a Ramsar wetland of international significance. A decline of the bay's ecosystem health has been primarily attributed to sediments and nutrients from catchment sources. Sediment budgets for three catchments indicated gully erosion dominates the supply of sediment in Knapp Creek and the Upper Bremer River whereas erosion from cultivated soils is the primary sediment source in Blackfellow Creek. Sediment tracing with fallout-radionuclides confirmed subsoil erosion processes dominate the supply of sediment in Knapp Creek and the Upper Bremer River whereas in Blackfellow Creek cultivated and subsoil sources contribute $>$90% of sediments. Other sediment properties are required to determine the relative sediment contributions of channel bank, gully and cultivated sources in these catchments.

The potential of total organic carbon (TOC), total nitrogen (TN), and carbon and nitrogen stable isotopes (δ^{13}C, δ^{15}N) to conservatively discriminate between subsoil sediment sources is presented. The conservativeness of these sediment properties was examined through evaluating particle size variations in depth core soil samples and investigating whether they remain constant in source soils over two sampling occasions. Varying conservative behavior and source discrimination was observed. TN in the $<63\mu$m fraction was found to be significantly different than TN in the $<10\mu$m and $<2\mu$m fractions. There were no significant differences reported between particle size fractions of the other sediment properties or between the sampling occasions. δ^{15}N demonstrated high variance in all analyses indicative of potential non-conservative behavior. δ^{13}C significantly discriminated between gully and channel sources in the Upper Bremer River though not in Knapp Creek. In Blackfellow Creek, δ^{15}N significantly differentiated between sources with high manure inputs and sources with low manure inputs. In Blackfellow Creek, TOC and TN significantly discriminated between subsoil and surface sources. In the Upper Bremer River, only TOC discriminated significantly between surface and subsoil sources, whereas in Knapp Creek neither TOC nor TN discriminated between these sources. When applying these carbon and nitrogen properties in a sediment tracing context, researchers must be cognizant of potential limitations, particularly the high variance of δ^{15}N.

In each catchment, sediment and source soil carbon and nitrogen properties were modelled to test hypotheses pertaining to dominant subsoil erosion processes. Distribution modelling indicated channel bank erosion processes were the primary source of sediment in each focal catchment contributing 51% of sediment in Knapp Creek, 55% in the Upper Bremer River, and 46% in Blackfellow Creek. In each catchment the modelled channel bank sediment contributions were greater than predicted by the original sediment budgets. Although the time-scale of the sediment budgets and the modelling in this thesis are not directly comparable, these results indicate channel bank erosion sources contribute a significant volume of sediment in the focal catchments. Therefore, management should target channel bank erosion sources along with other dominant gully and cultivated erosion sources in order to reduce rural diffuse sediment loads in these catchments and ultimately Moreton Bay.