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Climate variability induced shifts in nitrogen loading from terrestrial to aquatic ecosystems

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Nitrogen is a critical nutrient linked to degradation of freshwater and marine ecosystems. The nitrogen inputs to terrestrial ecosystems and subsequent loadings to aquatic ecosystems have been doubled and changed the nitrogen cycle as population and human activities increased over the past century (Filoso et al., 2006; Howarth and Marino, 2006; Smil, 1999; Vitousek et al., 1997; Larsson et al., 1985). One of the consequences of human alternation of the nitrogen cycle is the eutrophication of marine and freshwater ecosystems (Rabalais, 2002; McIsaac et al., 2001).

We tested if climate variability can change nitrogen loading from terrestrial to aquatic ecosystems. We used stream nitrogen concentrations from 2,125 sites and climate data from 301 stations from 30 eco-regions across British Columbia, Canada, to test our objective and to compare it with anthropogenic loading of nitrogen in the same regions. We show that elevated air temperature and associated precipitation resulted in increase in nitrogen loading from terrestrial to aquatic ecosystems. Furthermore, inorganic nitrogen (IN) loading increased more rapidly than organic nitrogen (ON) with increasing air temperature. Each °C increment annual air temperature caused a 24% increase in nitrogen loading to aquatic ecosystems and a 22% increase in ratio of IN: ON concentrations in stream water. We also show that the coastal mountains ecosystems seem to be more vulnerable to temperature induced nitrogen loss than the interior ecosystems. We suggest that climate warming and elevated loading of nitrogen from terrestrial to aquatic ecosystems will have major implications for the quality of water in freshwater and coastal marine ecosystems.

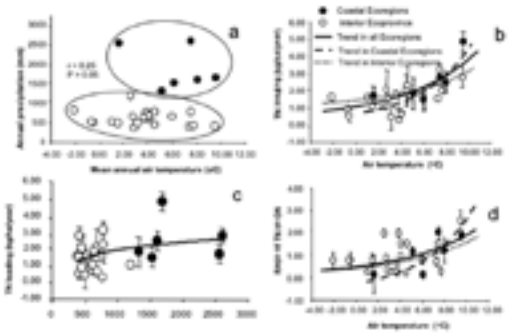

Figure 1: Impact of climate conditions on the component and loading of stream nitrogen: Panel a is the relationship between temperature and precipitation; Panel b is the relationship between temperature and stream total nitrogen loading; Panel c is the relationship between precipitation and stream total nitrogen loading; and Panel d is the relationship between temperature and the ratio of stream inorganic nitrogen (IN) to organic nitrogen (ON) concentration.

Recent Publications

1. Jacques St Laurent, and Asit Mazumder 2014. Influence of seasonal and inter-annual hydro-meteorological variability on surface water fecal coliform concentration under varying land-use composition. Water Research 48: 170-178.
2. Hurley, T. and A. Mazumder 2013. Spatial scale of land-use impacts on riverine drinking water source quality. Water Resources Research 49: 1591-1601.

3. Zhanxue Zhu, Klaas Broersma, Asit Mazumder 2012. Impacts of land use, fertilizer and manure application on the stream nutrient loadings in the Salmon River Watershed, South-Central British Columbia, Canada. J. Environmental Protection 3: 809-822.
4. Zhu, Z, K. Broersma and A. Mazumder. 2011. Model Assessment of Cattle and Climate Impacts on Stream Fecal Coliform Pollution in the Salmon River Watershed, British Columbia, Canada. Water, Air and Soil Pollution 215: 155-176.
5. Zhu, Z. R. Nordin & A. Mazumder. 2008. Soil and vegetation as the determinants of lake nitrogen concentrations in forested watersheds. Ecological Indicators 8: 431-441.

Biography

Dr. Asit Mazumder, Professor of Biology at the University of Victoria, is considered a world leader for his pioneering research on aquatic ecosystems in terms of water quality, nutrient dynamics, foodweb structure, contaminant transport and public health risks. His research showed how land-use and climate variability affect chemical and microbial quality of water, and developed several new technologies to track sources of chemical and microbial contaminant. He had been awarded the Chandler-Misener Award by the International Association for Great Lakes Research, and the Miller Institute Professorship for Basic Science at the University of California Berkeley 2011, and Ruth Patrick Award by American Society of Limnology and Oceanography (ASLO) in 2013 for his contributions to solving water quality problems with sound aquatic sciences concepts and a 1000 talent award from the Government of China. He has published over 140 international peer reviewed journal publications.

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