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Name	Hydrological forcing of a recent trophic surge in Lake Winnipeg

Field	Value
Description	Nutrient enrichment leading to eutrophication of lakes is frequently attributed to increasing anthropogenic loading to the watershed. We use a phosphorus mass balance model to demonstrate that a discharge increase in a major tributary contributed more than increased anthropogenic loading to a recent sudden doubling of total phosphorus (TP) and a shift to a cyanobacteria-dominated plankton population in Lake Winnipeg. Runoff from the Red River watershed rose abruptly during the mid-1990s. The decadal mean discharge has since been more than 50% higher than for any previous decade in the century-long record. Widespread spring flooding has become common. TP concentration roughly doubles during floods, magnifying the effect of higher runoff on downstream phosphorus loading. Concentrations of both dissolved and particulate phases are raised by flooding. Over 90% of dissolved phosphorus downstream of flooded farm land in one tributary was in the form of highly bio-available orthophosphate. From 1994 to 1999, TP in the lake rose from less than 30 to more than 50 mg m− 3. It has since remained over 50% higher than before the mid-1990s. We use the phosphorus model to demonstrate that the change in Red River discharge alone would have caused a sustained 32% increase compared to when phosphorus was first routinely monitored in the 1970s, while direct increases in the rate of anthropogenic loading alone would have caused only a 14% increase. It required both increased loading to the land and higher runoff to produce the observed increase in TP in the lake.
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