Ecosystems (2005) 8: 248–266
DOI: 10.1007/s10021-003-0094-3

ECOSYSTEMS

Impacts of Reservoir Creation on the Biogeochemical Cycling of Methyl Mercury and Total Mercury in Boreal Upland Forests

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Abstract

The FLooded Upland Dynamics Experiment (FLUDEX) at the Experimental Lakes Area (ELA) in northwest Ontario was designed to test the hypothesis that methylmercury (MeHg) production in reservoirs is related to the amount, and subsequent decomposition, of flooded organic matter. Three upland forest sites that varied in the amounts of organic carbon stored in vegetation and soils (Low C, 30,870 kg C ha^{-1}; Medium C, 34,930 kg C ha^{-1}; and High C, 45,860 kg C ha^{-1}) were flooded annually from May to September with low-organic carbon, low-MeHg water pumped from a nearby lake. Within five weeks of flooding, MeHg concentrations in the reservoir outflows exceeded those in reservoir inflows and remained elevated for the duration of the experiment, peaking at 1.60 ng L^{-1} in the Medium C reservoir. We estimated the net production of MeHg in each reservoir by calculating annual changes in pools of MeHg stored in flooded soils, periphyton, zooplankton, and fish. Overall, there was an initial pulse of MeHg production (range = 120–1590 ng m^{-2} day^{-1}) in all FLUDEX reservoirs that lasted for 2 years, after which time net demethylation (range = 360–1230 ng MeHg degraded m^{-2} day^{-1}) began to reduce the pools of MeHg in the reservoirs, but not back to levels found prior to flooding. Rates of MeHg production were generally related to the total amount of organic carbon flooded to create the reservoirs. Large increases in MeHg stores in soils compared to those in water and biota indicate that flooded soils were the main sites of MeHg production. This study should assist hydroelectric utilities and government agencies in making informed decisions about selecting sites for future reservoir development to reduce MeHg contamination of the reservoir fisheries.

Key words: methylmercury; mercury; MeHg production; reservoirs; Experimental Lakes Area.

Introduction

An important environmental consequence of flooding landscapes and creating reservoirs is the bioaccumulation of methylmercury (CH_3Hg^+; MeHg), a strong vertebrate neurotoxin, through the food web into fish. The health of people

Received 28 June 2003; accepted 24 November 2003; published online 31 May 2005.
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