Impacts of Reservoir Flooding
1991 to Present

Reservoirs represent a significant portion of the freshwater surface on the planet. In Canada, most reservoirs are constructed to provide stable water supply for the generation of hydro-electric power. Particularly in the relatively low topography of the Precambrian Shield, the creation of reservoirs often results in the flooding of large areas of former wetland and upland forest.

By the late 1970's, researchers recognized that fish populations in many newly-flooded reservoirs were subject to significant increases in tissue concentrations of methyl mercury. Humans relying of these fish for regular food supply were at risk of developing mercury poisoning, which can result in severe damage to the nervous system. What was causing this mercury problem and how could it be mitigated?

In the early 1990's, some ELA researchers noted that flooded organic material in northern wetlands produced significant amounts of carbon dioxide and methane, both important greenhouse gases, and released them to the atmosphere. They began to wonder whether wetland areas flooded by reservoir creation were also capable of producing significant amounts of these gases that can cause climatic warming. They decided to put together an international team of researchers who would conduct an experimental flooding study on a small wetland at the ELA to investigate the impacts of flooding on methyl mercury and greenhouse gas production. The ***ELA Reservoir Project (ELARP)*** was born.

Following two years of background study on Lake 979 and the surrounding wetland system, flooding of this ecosystem commenced in the spring of 1993. It has continued during each open-water season since that time. Intensive study continued through 1998, and monitoring was repeated in 2001. Physical, chemical, and biological aspects of the system were carefully studied and analyzed. The reservoir has been flooded in each of the subsequent years, and we plan to resample it in 2006.

This study demonstrated dramatic increases (10X to 20X) in both methyl mercury and greenhouse gases (carbon dioxide and methane) production in response to flooding of wetland vegetation. Clearly, the microbial breakdown of dead plants and organic soils resulted in the methylation of mercury already present in the system, and the production of significant quantities of carbon dioxide and methane.

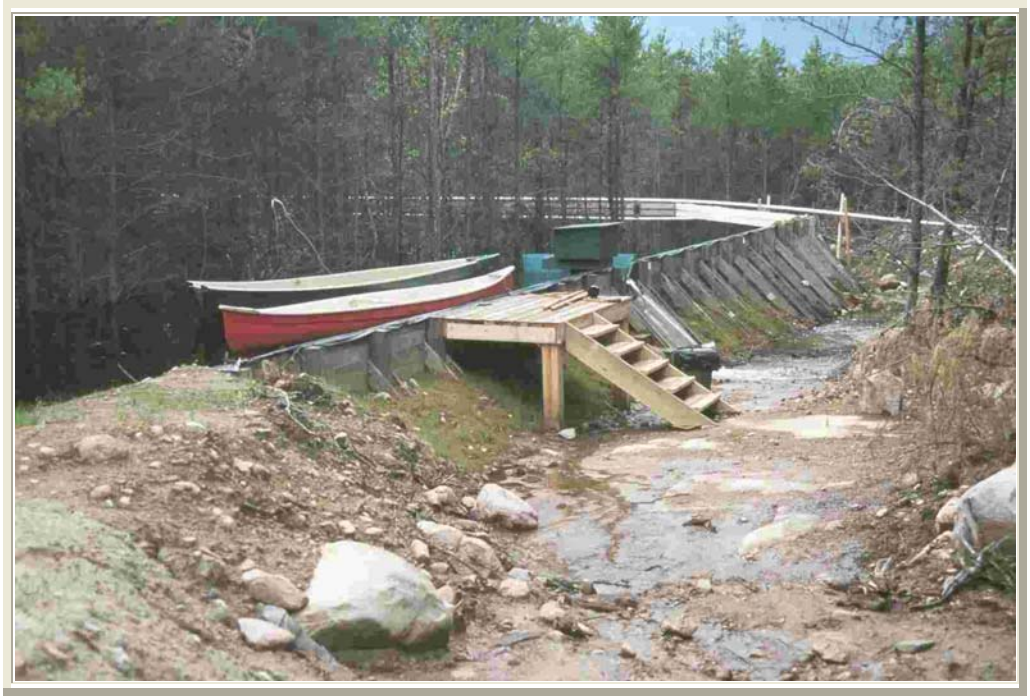
Aerial view of the experimentally flooded 979 wetland in July 2001. The control structure at lower right is used to raise the water level by 1.3 meters.

The water control structure installed at the outflow of the 979 wetland. Water levels have been raised each summer and allowed to drop each winter for the past few years. Mobilization of methyl mercury and release to the atmosphere of greenhouse gases are being studied.

A student research assistant samples from an insect emergence trap at the flooded 979 wetland. These insects are a major food source for fish. (Photo by Karen Scott)

A question remained, however, as to whether flooding of drier upland soils and vegetation would produce similar results as to those seen in the flooded wetland. A follow-up study, the ***FLooded Upland Dynamics EXperiment (FLUDEX)*** was designed and implemented at the ELA to try and answer this question.

Three forested uplands, a moist forest and two dry forested areas located in the watershed of Roddy Lake, were experimentally flooded, beginning in June 1999, to create experimental hydroelectric reservoirs. The three areas, each about $^{2}/_{3}$ ha in area, were flooded by pumping water from a nearby lake, low in mercury and dissolved organic carbon. Flushing rates were equalized among the reservoirs by maintaining pumping rates proportional to estimated reservoir volumes. Greenhouse gas fluxes before and during flooding were measured at all three sites. Carbon dioxide, methane and nitrous oxide were monitored. Fluxes were compared to the previously flooded boreal wetland and to existing hydroelectric reservoirs to determine the potential greenhouse gas contribution of global, freshwater reservoirs. The production of methyl mercury from flooded soils and the bioaccumulation of methyl mercury through the food chain were measured in the experimental reservoirs.



A view of flooded Reservoir 1

With the approach of freezing each fall, water was drained from the reservoirs. The reservoirs were refilled each June and flooding repeated each summer through 2003. The reservoir walls have now been removed and the flooded areas are being rehabilitated.

Aerial view of Reservoir 1, July 2001

After five years of flooding, the experiment confirmed that flooded upland soils and vegetation could also produce significant quantities of methyl mercury and greenhouse gases. However, the production of greenhouse gases seems to dissipate more quickly than in wetland systems, probably because there is less stored carbon, particularly in a form that is readily decomposed by bacteria.

These results are now being used by Hydro utilities to influence the design and site selection of future large reservoirs. Mitigation strategies with direct planning application are now being investigated by ELA researchers.