

## Rivers shrinking: Flow of many rivers in decline

Contributed by Randolph E. Schmid  
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WASHINGTON – The flow of water in the world's largest rivers has declined over the past half-century, with significant changes found in about a third of the big rivers. An analysis of 925 major rivers from 1948 to 2004 showed an overall decline in total discharge.

The reduction in inflow to the Pacific Ocean alone was about equal to shutting off the Mississippi River, according to the new study appearing in the May 15 edition of the American Meteorological Society's Journal of Climate.

The only area showing a significant increase in flow was the Arctic, where warming conditions are increasing the snow and ice melt, said researchers led by Aiguo Dai of the National Center for Atmospheric Research in Boulder, Colo.

"Freshwater resources will likely decline in the coming decades over many densely populated areas at mid- to low latitudes, largely due to climate changes, Dai said. "Rapid disappearing mountain glaciers in the Tibetan plateau and other places will make matters worse."

Added co-author Kevin Trenberth, "As climate change inevitably continues in coming decades, we are likely to see greater impacts on many rivers and water resources that society has come to rely on."

While Dai cited climate change as a major factor in the changes, the paper noted that other factors are also involved, including dams and the diversion of water for agriculture and industry.

Nonetheless, he said, "long-term changes in streamflow should be a major concern under global warming."

Indeed, the researchers wrote that "for many of the world's large rivers the effects of human activities on yearly streamflow are likely small compared with that of climate variations during 1948-2004."

"This is an important paper with new findings that are relevant to the health of river ecosystems and the people who live near or rely upon rivers to meet water needs," said Margaret A. Palmer, director of the Chesapeake Biological Laboratory of the University of Maryland Center for Environmental Science.

"What is important from this study is these authors show that these decreases are due to a changing climate, not human activities like extractions or dam building, yet these changes will have impacts on humans and ecosystems because many of these regions have large populations and drought-stressed ecosystems," said Palmer, who was not part of the research team.

Among the rivers showing declines in flow, several serve large populations. These include the Yellow River in northern China, the Ganges in India, the Niger in West Africa and the Colorado in the southwestern United States.

On the other hand, areas with rising streamflow near the Arctic Ocean tend to have small populations.

There was considerable year-to-year variation in the flow of many rivers, but the overall trend over the period showed annual freshwater discharge into the Pacific Ocean fell by about 6 percent, or 526 cubic kilometers of water. That's close to the 552-cubic kilometer average annual flow of the Mississippi, the researchers reported.

The annual flow into the Indian Ocean dropped by about 3 percent, or 140 cubic kilometers. In contrast, annual river discharge into the Arctic Ocean rose about 10 percent, or 460 cubic kilometers. There was little change in inflow to the Atlantic Ocean, where increases in the Mississippi and Parana rivers were balanced out by decreases in the Amazon River.

A cubic kilometer is a cube one kilometer on each side. A kilometer is about six-tenths of a mile.

Discharge of river water into the oceans deposits sediment near the river mouth and also affects worldwide ocean circulation patterns, which are driven by variations in water temperature and salinity.

In the United States, the flow of the Mississippi River increased by 22 percent over the period because of increased precipitation across the Midwest. On the other hand, the Columbia River's flow declined by about 14 percent, mainly because of reduced precipitation and higher water usage.

Major rivers showing declines in flow included the Amazon, Congo, Changjiang (Yangtze), Mekong, Ganges, Irrawaddy, Amur, Mackenzie, Xijiang, Columbia and Niger.

Declines in the Niger River in the 1970s and 1980s in particular reflected the Sahel Drought, the paper said. In addition, the periodic El Nino cooling of sea surface waters in the tropical Pacific led to lower flows in the Amazon and higher ones in the Mississippi when the phenomenon was in effect.

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