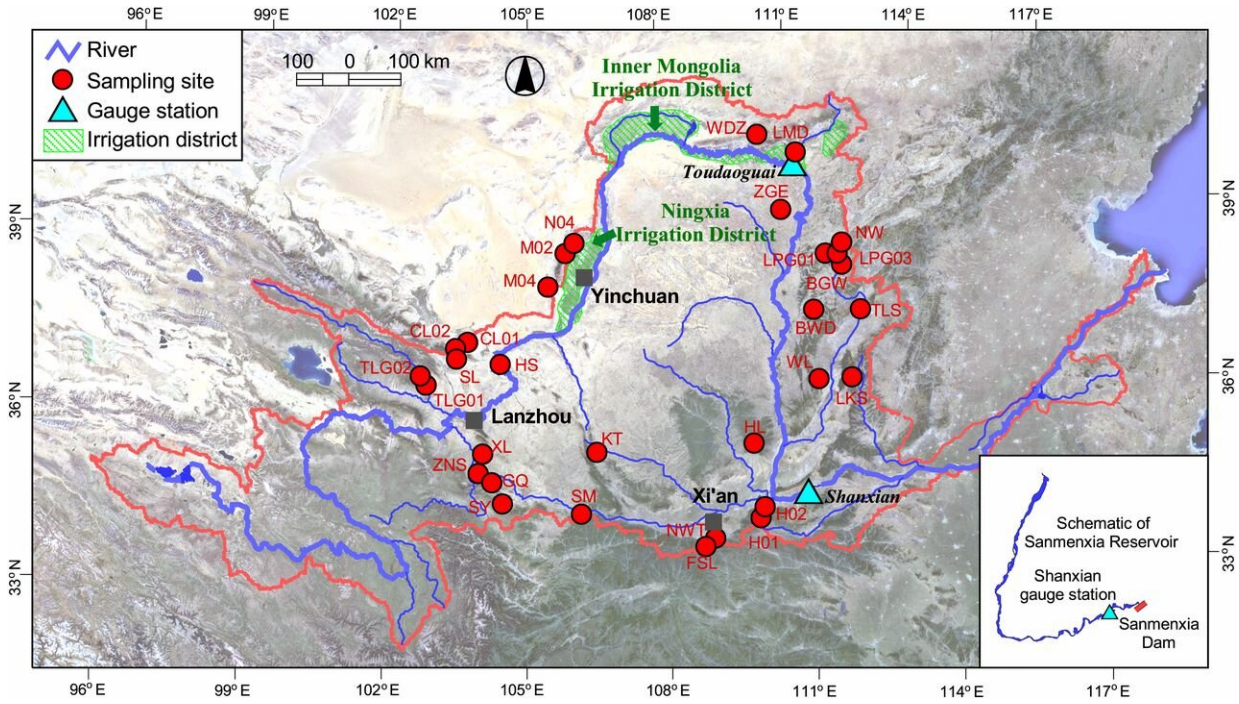
New study provides valuable historical dataset for Yellow River water management

July 27 2020, by Li Yuan



Thirty-one tree-ring sites (red dots) in the middle-upper reaches of the Yellow River (YR). Thick blue line denotes the YR, while the thin blue lines denote the large tributaries the YR; blue triangles represent the streamflow gauge stations in the main channel; green shaded areas are irrigation districts. Credit: LIU Yu, et al.

The Yellow River (YR) is the fifth-longest and the most sediment-laden river in the world. Although the YR accounts for only 3% of China's

water resources, it irrigates 13% of its cropland.

Since the 1960s, an increasing number of large-scale dams and reservoirs have been built in the main YR channel, and water consumption by agricultural irrigation along the YR middle course has risen sharply. In recent decades, YR runoff and sediment load have fallen sharply.

The earliest observational record of YR runoff began in 1919 at the Shanxian gage station, which is too short to study centennial-scale variability. Researchers led by Prof. Liu Yu from the Institute of Earth Environment of the Chinese Academy of Sciences and their collaborators reconstructed natural runoff history for the middle reach of the YR from 1492 to 2013 CE to assess the effects of human activities.

The study was published in *Proceedings of the National Academy of Sciences* (*PNAS*) on July 20.

Tree rings, with the merits of accurate dating and annual resolution, have been widely used in runoff reconstruction worldwide. In this study, the researchers collected 31 moisture-sensitive tree-ring width chronologies, including 860 trees and 1707 cores, within the upper-middle YR basins.

They found that the YR runoff in 1781 is the highest, and prior to anthropogenic interference that started in the 1960s, the lowest natural runoff over the past 500 y occurred during 1926 to 1932 CE. These two extreme values could be regarded as a benchmark for future judicious planning of YR water allocation.

Since the late 1980s, the low observed YR runoff has exceeded the natural range of runoff variability, which is caused by the combination of decreasing precipitation and increasing water consumption by direct and indirect human activities, particularly agricultural irrigation.

"This reduced runoff has resulted in an estimated 58% reduction of the sediment load in the upper reach of the YR and 29% reduction in the middle reach," said Prof. LIU.

Human activities, mainly expansive agricultural irrigation in the upper course, have contributed to reduced runoff and sediment load in the upper-middle course of the YR. If these human activities continue to intensify, future YR runoff will be further reduced, and this will negatively impact agriculture, human lives, and socioeconomic development in the middle and lower basins of the YR.

To reduce the risk of recurring cutoff of stream flow in the YR lower basin, water should be allocated judiciously. Policies should balance water allocation among the needs of agriculture, industry and ecosystems.

In addition, the study also provides an important model of how to distinguish and quantify anthropogenic influence from natural variability in global change studies.

More information: Yu Liu et al. Recent anthropogenic curtailing of Yellow River runoff and sediment load is unprecedented over the past 500 y, *Proceedings of the National Academy of Sciences* (2020). DOI: 10.1073/pnas.1922349117

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