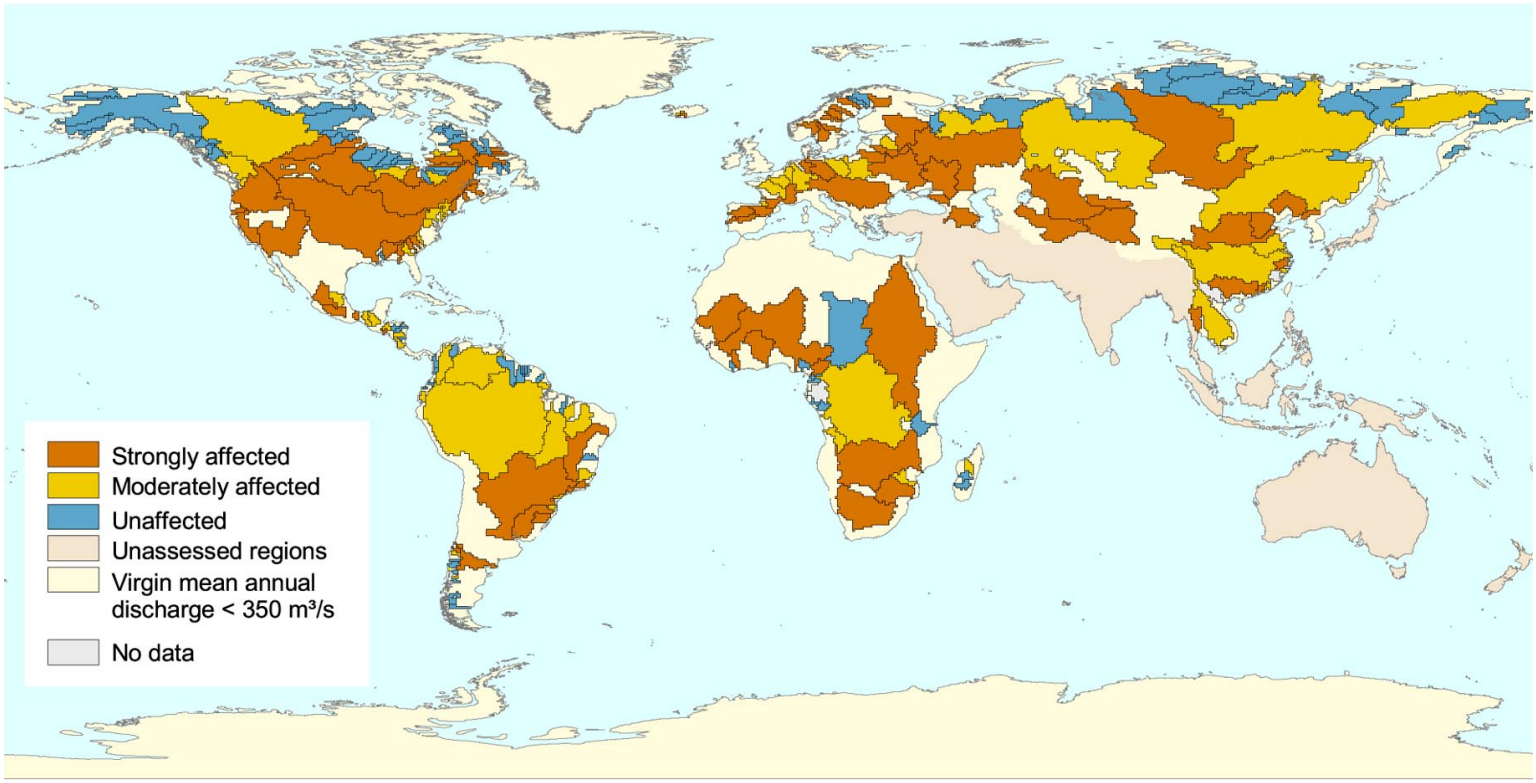
Watersheds of the World : Global Maps

14. Degree of river fragmentation and flow regulation



Map Description

River fragmentation, which is the interruption of a river's natural flow by dams, inter-basin transfers, or water withdrawal, is an indicator of the degree to which rivers have been modified by humans. Freshwater systems have been altered since historical times, but such modifications skyrocketed in the mid-1900s and continue today in many developed and developing countries. These changes have improved transportation, provided flood control and hydropower, and have boosted agricultural output by making more land and irrigation water available. At the same time, these physical changes in the hydrological cycle have significantly impacted freshwater ecosystems and species. Dams disconnect rivers from their floodplains and wetlands and slow water velocity in riverine systems, converting them to a chain of connected reservoirs. This, in turn, impacts the migratory patterns of fish species and the composition of riparian habitat, opens up paths for exotic species, changes coastal ecosystems by limiting sediment and nutrient loads, and contributes to an overall loss of freshwater biodiversity and fishery resources.

This map portrays an indicator of the extent to which dams and canals have fragmented river basins and how water withdrawals have altered river flows. Of the 227 large river basins assessed, 37 percent are strongly affected by fragmentation and altered flows, 23 percent are moderately affected, and 40 percent are unaffected.

14. Degree of river fragmentation and flow regulation

Large river systems are defined as rivers with a virgin mean annual discharge equal to or above 350 m^3 per second. Strongly affected systems include those with less than one quarter of their main channel left without dams, where the largest tributary has at least one dam, as well as rivers whose annual flow patterns have changed substantially. Unaffected rivers are those without dams in the main channel of the river and, if tributaries have been dammed, river discharge has declined or been contained in reservoirs by no more than 2 percent. In this analysis, strongly or moderately fragmented systems account for nearly 90 percent of the total water volume flowing through the rivers. All river systems with parts of their basins in arid areas or that have internal drainage systems are strongly affected.

The only remaining large free-flowing rivers in the world are found in the tundra regions of North America and Russia, and in smaller coastal basins in Africa and Latin America. It should be noted, however, that considerable parts of some of the large rivers in the tropics, such as the Amazon, the Orinoco, and the Congo, would be classified as unaffected rivers if an analysis at the subbasin level were done. The Yangtze River in China, which currently is classified as moderately affected, will become strongly affected once the Three Gorges dam is completed.

Mapping Details

The analysis presented here builds on analyses carried out by Dynesius and Nilsson (1994) and Nilsson et al. (2000). For the regions analyzed, rivers with a historical virgin mean annual discharge equal to or above 350 m3 per second were selected. The measures used to assess river fragmentation and flow regime modification include: dams, reservoirs, interbasin transfers, and irrigation consumption. Irrigation consumption refers to the water that is evaporated or used by crops through transpiration, but excludes the amount of water returned to the river after irrigation.
Inventories of dams and the degree of flow regulation in each of the selected river systems were carried out and the results combined into a fragmentation index (strongly affected, moderately affected, and unaffected). The results of the analysis were then transferred to a geographic information system and combined with a river basin coverage to make the final map.

Map Projection

Geographic

Sources

Dynesius, M. and C. Nilsson. 1994. “Fragmentation and Flow Regulation of River Systems in the Northern Third of the World.” *Science 266:* 753–762.

Revenga, C., J. Brunner, N. Henninger, K. Kassem, and R. Payne. 2000. Pilot analysis of global ecosystems: freshwater systems.
Washington DC: World Resources Institute. Based on Nilsson, C., M. Svedmark, P. Hansson, S. Xiong and K. Berggren. 2000. River fragmentation and flow regulation analysis. Unpublished data. Umeå, Sweden: Landscape Ecology, Umeå University. Basin boundaries are from Fekete, B., C. J. Vörösmarty, and W. Grabs. 1999. Global, Composite Runoff Fields Based on Observed River Discharge and Simulated Water Balance. World Meteorological Organization Global Runoff Data Center Report No. 22. Koblenz, Germany: WMO-GRDC.