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Climatic and Anthropogenic Contribution to Century's Declines in the Yangtze River flows

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The Yangtze River ranks third in river length, fifth in discharge and first in basin population in the world. It also hosts over 50,000 reservoirs, including the world's largest dam in hydro-power, and five of nine China's food bases, producing more than 40% of China's gross domestic product. At the beginning of the 21st century, the Yangtze River declined sharply, accompanying with downstream lake shrinkage and more frequent droughts. The hydrological declines produced substantial ecological, environmental and social impacts. Here we scrutinize the recent sharp declines of the Yangtze River with data records for 1901-2016. The river discharge showed difference stationarity, with a long-term declining trend significantly for upstream (Yichang) and midstream (Hankou) and insignificantly for downstream (Datong). The river discharge experienced sharp declines in 1969 and 2006 at Yichang, 1956 and 2006 at Hankou, and 2003 at Datong. The declines are attributable to both climatic change and anthropogenic influences. Decreased precipitation in upper reaches, increased precipitation in middle reaches and increased regional water consumption accounted for the major declining trends in up- and mid-streams. The sharp declines in the river discharge stemmed primarily from increased water consumption and reinforced surface solar radiation rather than increased air temperature. Increased reservoirs raised up regional water storage elevating the baseline of river-flow regimes, and contributed to the regime shift in 2006. As external forces, climate regime shifts regulate decadal variability of regional precipitation, and decadal change in radiation alters the long-term trend of surface evapotranspiration, jointly accounting for 30% of the discharge declines. With the enhancing north Atlantic oscillation, the shifting regime of Pacific decadal oscillation and the advocating ecological protection strategy, the river-flow will likely preserve the current regime in the coming decade. The findings provide meaningful linkages between large-scale hydrological change and global climatic change in combination with local anthropogenic influences. It highlights the importance of integrative interactions between human and nature hidden in nonstationary hydrological processes in the Anthropocene.