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SUPPLEMENTARY INFORMATION

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Anthropogenic stresses on the world's big rivers

Jim Best

Departments of Geology, Geography and Geographic Information Science, Mechanical Science and Engineering and Ven Te Chow Hydrosystems Laboratory, University of Illinois at Urbana-Champaign, Urbana, IL, USA. e-mail: jimbest@illinois.edu

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Definition of Big Rivers

There has been considerable discussion in the scientific literature as to which descriptors should best be used to classify river size, and how the terms 'big' or 'large' should be applied. Geomorphic indices largely revolve around measures such as river length, flow discharge, drainage basin area or channel width. However, definitions of size could also refer to other parameters, such as the ecological diversity within a river basin or its economic value to society.

Herein, a simple geomorphological classification of 'big' is adopted and this paper concerns the world's principal rivers that have a river basin area greater than 0.164 million km^2, a mean annual water discharge in excess of 2400 m^3s^{-1} (except for the Murray-Darling River, Australia) and a length greater than 1400km. These simple descriptors allow identification of 32 of the world's big rivers (Table S1), although many of the stressors discussed herein may also affect river basins of smaller scale.

Supplementary Figures

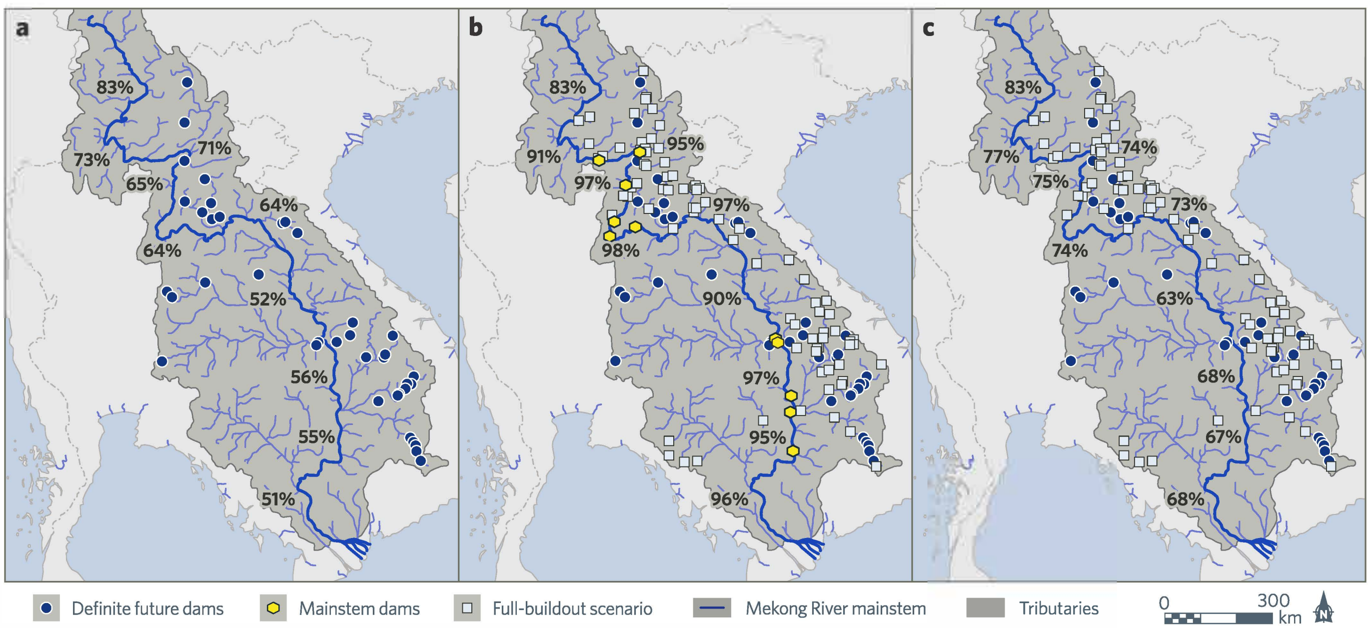

Figure S1 | The Mekong River - Just dammed or doomed? The Mekong River has become one of world's most threatened rivers, with the Lancang Cascade of dams in China already greatly influencing river hydrology[164, 243,244], and future dams being hotly debated[172,245,246]. Recent modelling[214] estimated that up to 96% of the historic sediment load of the Mekong River would be trapped under a full-build scenario of existing and planned dams. Such changes could wreak havoc to the world's most productive freshwater fisheries[92], to the stability of fragile environments like the Tonlé Sap Lake[247], and to the downstream longevity of the Mekong Delta[88, 91, 172] that may undergo extensive changes to its rice cropping yield[90,248]. Although uncertainties exist concerning the exact declines in sediment load predicted, these forecasts suggest that the prime requirement is to construct dams that can pass sediment downstream, and optimise dam locations within the river network to reduce sediment trapping whilst maintaining hydropower output[172,214].

[1]Departments of Geology, Geography and Geographic Information Science, Mechanical Science and Engineering and Ven Te Chow Hydrosystems Laboratory, 1301 W. Green Street, Urbana, IL 61801, USA. e-mail: jimbest@illinois.edu

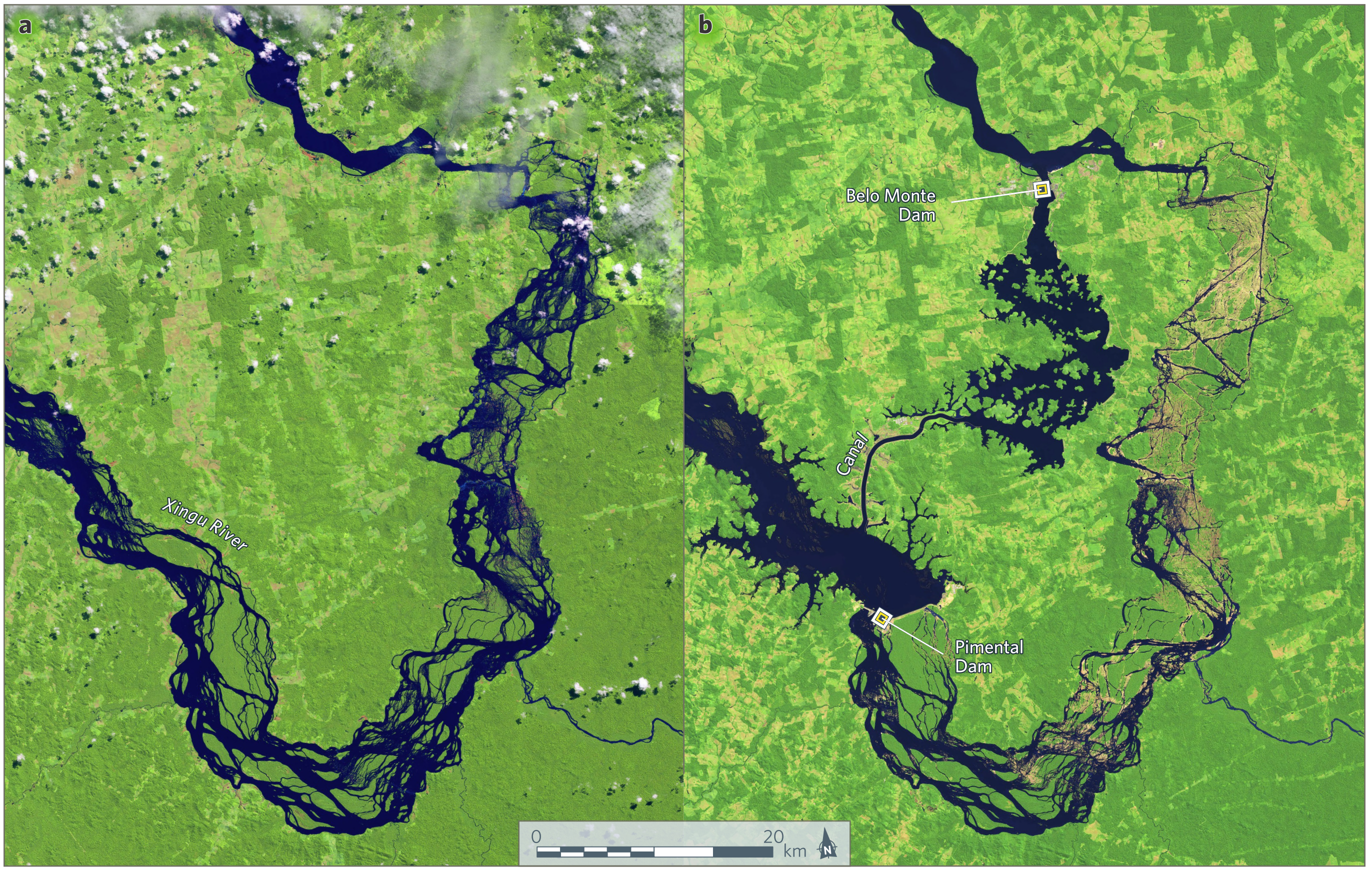

Figure S2 | Landsat images of the Xingu River, Amazon River Basin: a) before and b) after construction of the Belo Monte and Pimental dams. Images courtesy of NASA Earth Observatory (https://earthobservatory.nasa.gov/IOTD/view.php?id=91083).

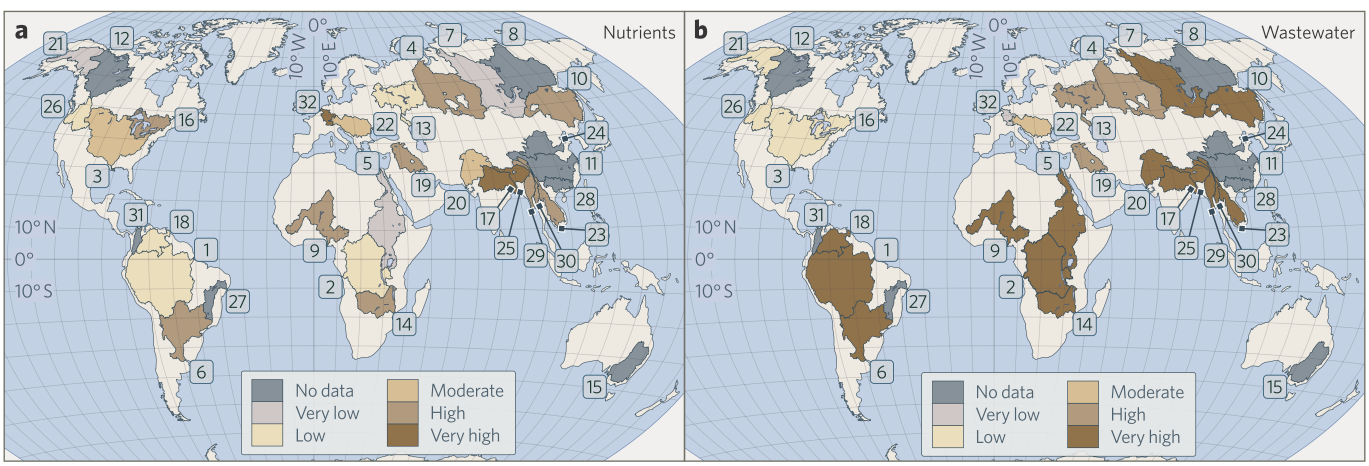

Figure S3 | Indices of risk for: a) Nutrient and b) Wastewater pollution in the world's largest transboundary rivers (from TWAP[9]). Numbers refer to river basins defined in Figure 1 and Table S1.

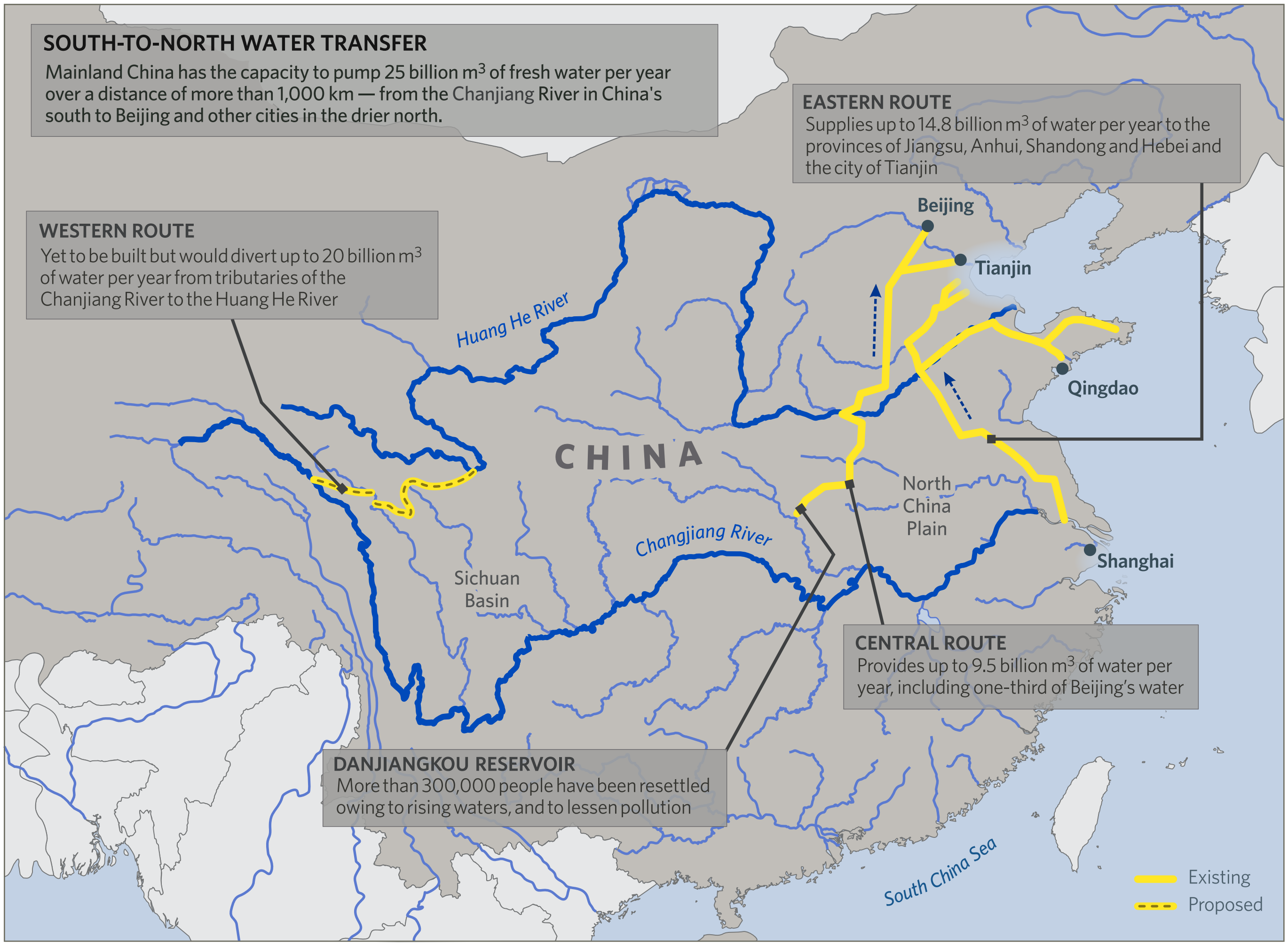

Figure S4 | Engineering new rivers in China's South-North Water Transfer Project (SNWTP)[249]. China is underway in one of the largest engineering projects in the world to move water from the wetter south to the drier north in the South-North Water Transfer Project (SNWTP). This scheme will connect four major river basins (including the Changjiang and Huang He rivers), three major cities, six provinces and hundreds of millions of people[138], and is estimated to have cost over US$80billion to date[138]. Considerable hydrological, environmental and socio-political challenges still remain in the SNWTP, with concerns over increased pollution, doubts as to whether the SNWTP will address China's water needs[249], and considerations that Shanghai will have to reduce its dependence on the Changjiang River if some of its discharge is routed to the north, or build new infrastructure to deal with saline water intrusion[138]. Whatever the outcome, the SNWTP essentially involves remaking the geography of China and its great rivers[138].

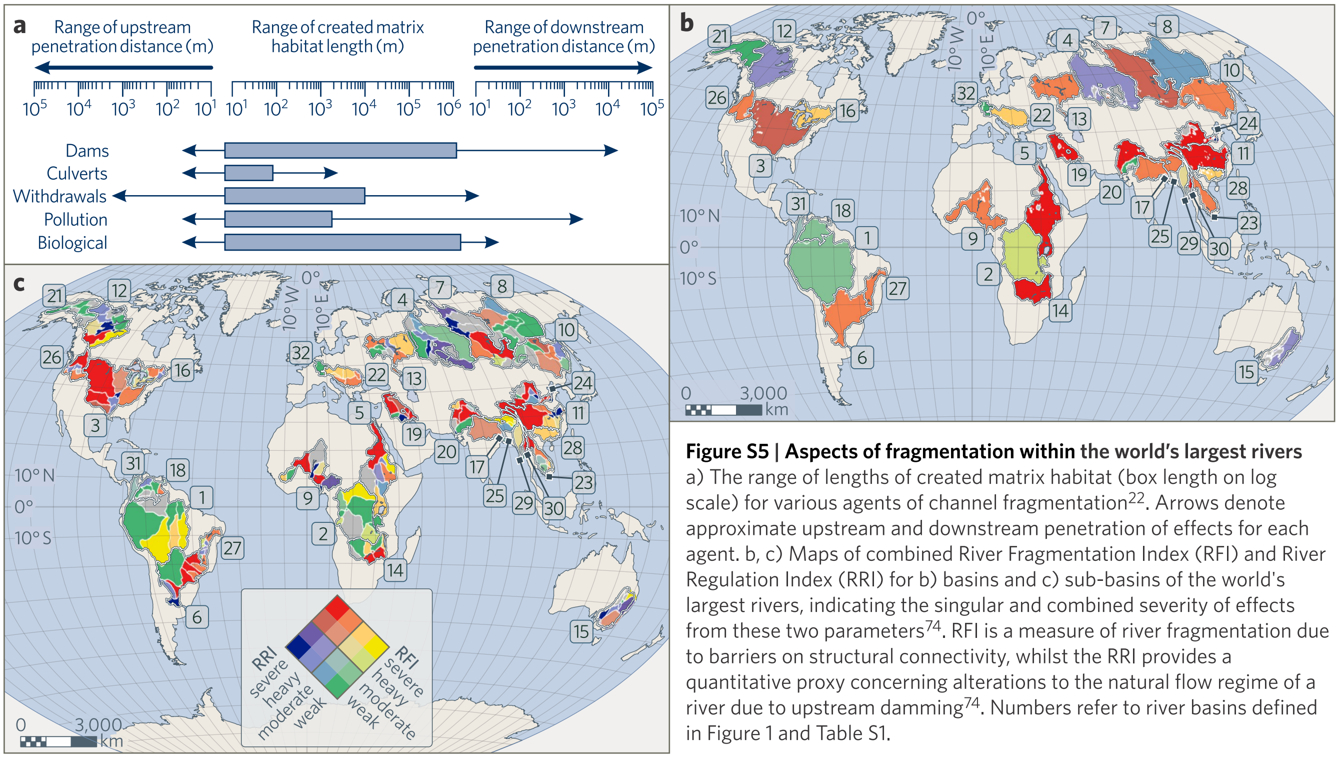

Figure S5 | Aspects of fragmentation within the world's largest rivers
a) The range of lengths of created matrix habitat (box length on log scale) for various agents of channel fragmentation[22]. Arrows denote approximate upstream and downstream penetration of effects for each agent. b, c) Maps of combined River Fragmentation Index (RFI) and River Regulation Index (RRI) for b) basins and c) sub-basins of the world's largest rivers, indicating the singular and combined severity of effects from these two parameters[74]. RFI is a measure of river fragmentation due to barriers on structural connectivity, whilst the RRI provides a quantitative proxy concerning alterations to the natural flow regime of a river due to upstream damming[74]. Numbers refer to river basins defined in Figure 1 and Table S1.

Figure S6 | Gravel and sand mining in the Brahmaputra-Meghna river basin, Bangladesh. a,b) Gravel and sand mining in the Surma River, a tributary to the Meghna River, northern Bangladesh. c,d) Extensive sand dredging, Meghna River, Bangladesh.

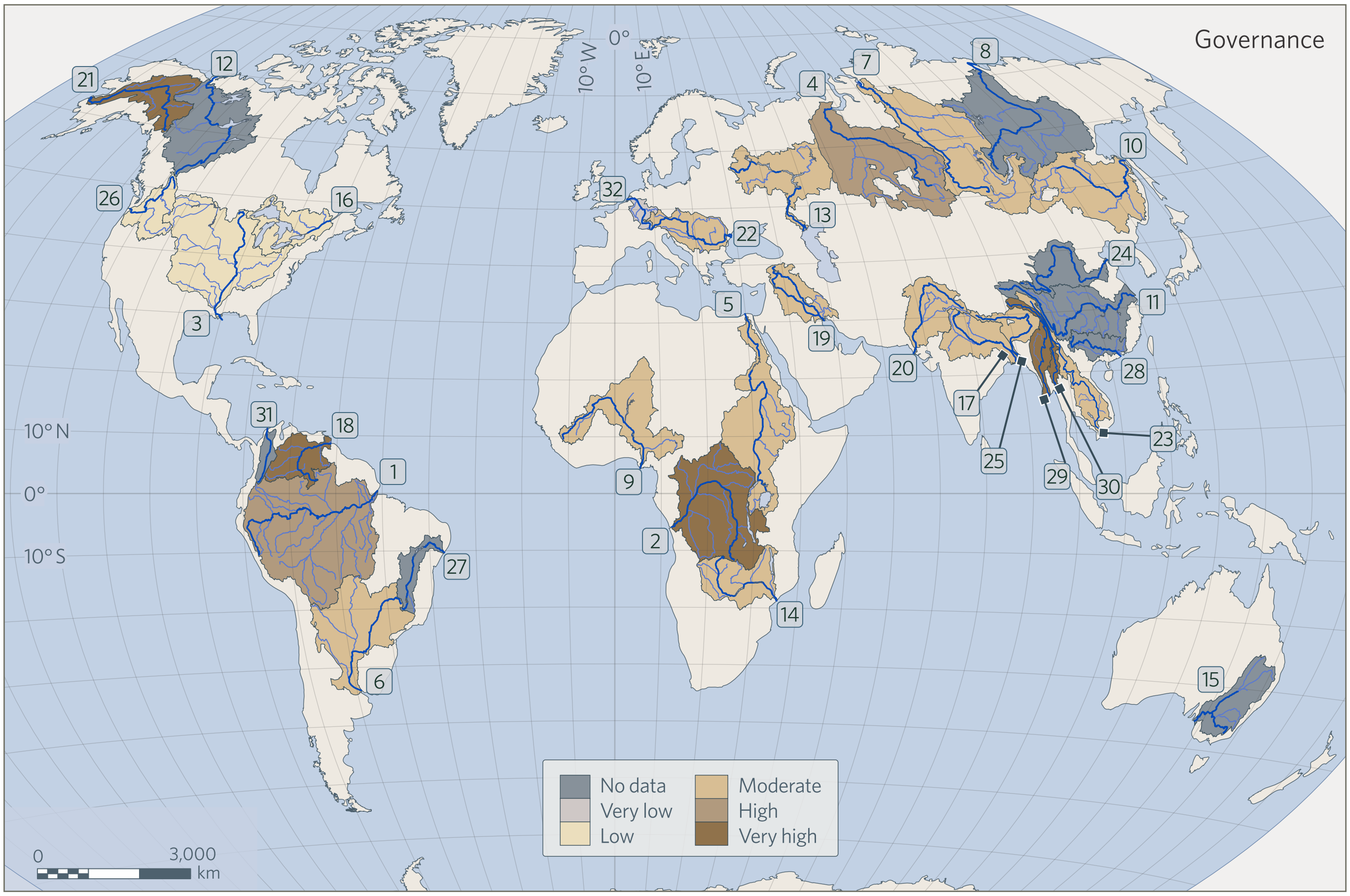

Figure S7 | An index of governance risk for the world's large transboundary rivers (from TWAP[9]). Numbers refer to river basins defined in Figure 1 and Table S1.