

The Future of World Rivers

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Rivers have, over geologic times, a key role in land-ocean transfers of energy, water, sediments, carbon, nutrients, salts, in the distribution of freshwater biota, in the shaping of the Earth's surface. Since the last 5 000 years, they are also used for multiple purposes by riparian population. One of the earliest uses is for waste disposal and transfer downstream, thus, impacting the downstream uses. In addition to the upstream-downstream interaction, river basins perform a space and time integration: ideally a sample of water or sediment at a station provides integrated information on the upstream basin, up to 6 millions km² for the Amazon, over years to millennium. Rivers are, therefore, more and more used to detect environmental changes.

Rivers have globally evolved much faster in the past 50 years than in the last 5 000 years, mostly due to direct human impacts. In the next decades, they will be exposed to: (i) evolving water demand due to population and land use growth, (ii) regulation policies of both water and land use, (iii) technological developments and innovations and, (iv) global Climate Change. The combined effects of these drivers will be very different on each river basin: the global scale they can be described as a giant puzzle of few hundred pieces that evolve separately from each others. The largest basins (Amazon, Mississippi, Yang Tsé) should be in turn subdivided into their major tributaries, which are interconnected. Water quality trends are known from regular survey and from sedimentary records: they reveal multiple and contrasted types. For instance, in W. Europe and the USA, the worst quality has often occurred in the 1950's and 1960's, some contaminants, as metal, have peaked at this period, exceeding by one order of magnitude and more the present-day standards; other contaminants are steadily increasing since 1950 as pesticides and nitrates. Finally, new comers – as endocrine disruptors – are detected every year: they will probably be soon regulated.

Our knowledge of rivers and our vision for their appropriate management are constantly evolving and reflect the relationship between societies and the Earth system components. The bad news are: (i) there is no universal reference river, either for water regime, water quality or aquatic biodiversity, each piece of the puzzle has its pre-anthropogenic characteristics, (ii) heritages should be taken into consideration, as channelization history, ancient pollution sources, soil degradation, (iii) some drivers can be external to the basin as atmospheric pollution, water demand for irrigation, demand for hydraulic energy and damming, thus impacting inhabited river basins, (iv) irrigated agriculture is, by far, the number one water consumer, leading to the general decline of all river water discharge – to complete dryness – in the semi-arid belt from the Colorado to the Yellow River, (v) the proportion of urban population which is not connected to sewage collector and treatment facilities is not decreasing, (vi) in some region (eg. Africa) there is a general decline of the river monitoring activities.

Few good news have popped out in the last decades: (i) there is a growing evidence that the general degradation of water quality is reversible for organic pollution (river oxygen depletion), for phosphorus increase, for heavy metals, as observed in regions where technological changes and environmental regulations have been set up, (ii) reservoirs, which can be pointed out for their adverse effects on river fish communities, can store and/or process many contaminants, thus, partially compensating the adverse effects of wetland decline, (iii) in some of the fast developed countries (eg. Brazil, India, China) there is now a growing population of highly-trained river specialists, (iv) there is a general increase of our understanding of river functioning in connection with human land and water uses, specific models (eg. sediment transport, temperature, nitrate) are now developed.

The overall vision of rivers future is therefore difficult. There is no global model of river management that should be imposed. Among the basic principles and rules are: (i) hydrosolidarity within river population from head water to coast, (ii) limitation of water uses, particularly for irrigation, (iii) combination of hard and soft solutions for water storage and waste water treatment and recycling, (iv) avoid construction in river floodplain, (v) establish in each shared river basin a common, equitable and sustainable water management plan between countries, stakeholders and local populations, (vi) allow the free dissemination and exchange of water-related information, (vii) hydro-literacy should be enhanced at the river basin scale.