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The Water Management in the Present Century

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Water covers 2/3 of the earth surface, but it is mainly available as saline water (approximately 97%). The reaming amount is partially locked up in ice and glaciers, while the total annual precipitation on earth's surface (approximately 108,000 km^3) is divided in green water, total volume evaporated and transpired that is about 61,000 km^3, and blue water, total volume of water flowing in the river systems 47,000 km^3. Given the strong temporal fluctuations of the stream flow, only a portion of the blue water (a value between 9,000 km^3 and 14,000 km^3) can be ultimately controlled. At the present, we are already using 1/3 (about 3,400 km^3) of the total amount of controllable water [1].

These values are computed at the global scale, but climate and hydrology modifies spatial distribution of water resources producing different level of water stress across the globe. Nevertheless, each country faces different problems, because the water resources may be limited for physical limitations (insufficiency or depletion) or for economic reasons. At present, 1.6 billion people live in areas of physical water scarcity or where the limit to water resources is approaching. In addition, about 1 billion of people live in area with economic water scarcity [2].

The water stress is obviously also influenced by the water demand that changes dramatically from place to place. According to Falkenmark and Rockstrom [3], it reaches its maximum in North America (with a value of 1800 m^3/person/year) and a minimum in Africa and Asia (850 m^3/person/year). These values represent the water amount used per person according to direct and indirect uses and are affected by dietary preferences and meat consumption. For instance, the average water footprint of one kilo of bovine meat ranges between 14.5 m^3/kg (in US) and 10 m^3/kg (in UK), while the one kilogram of cereal grains requires about 1 m^3 of water for evapotranspiration [4]. This highlights the impact played by dietary preferences on the total water demand.

The assessment of water resources distribution is even more complicated by the so-called "virtual water trade" that tend to redistribute virtual water (in the form of food commodities) among different countries. These global exchanges, which are mainly controlled by multinationals and powerful countries [5], lead to a complex system where private interests may induce an unsustainable water use. According to Mekonnen and Hoekstra [6], that traced the fluxes of virtual water along shipping lanes in relation to wheat, the biggest net exporters of virtual water are the US, Canada, Brazil, Argentina, India, Pakistan, Indonesia, Thailand and Australia while the biggest net virtual water importers are North Africa and the Middle East, Mexico, Europe, Japan and South Korea. This may be particularly critical, because globalization (world exchange of virtual water through food commodities) reduces the societal resilience with respect to water limitations [7].

The water management will face new challenges in the present century, because global water demand is increasing dramatically over time with the increase of population, rising of incomes, and changes in dietary preferences. At the same time, water availability has been reduced by several aspects such as concentration of population in large metropolis, pollution, and climate changes. Considering all these aspects, many countries are entering a century of severe water shortage.

In this context, the role of hydrology will be crucial in order to address new strategies to understand and quantify river basin responses under non-stationary conditions. In particular, the river basin is a dynamic organism influenced by climate (change in rainfall dynamics and temperature), human activities (e.g., urbanization, agricultural use, industrial activities, etc.), and vegetation pattern (e.g., deforestation, vegetation colonization, etc.). All these aspects interact together within the hydrological river basin producing a complex system. As a consequence, innovation in the prediction of water quality and quantity can be gained by interdisciplinary approaches that provide a comprehensive description of all phenomena involved.

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