Water Footprinting for Sustainable Development and Wise Management of Global Water

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All organisms, including humans, require water for their survival. Therefore, ensuring that adequate supplies of water are available is essential for human well-being.Any change to the Earth's climate system, hydrological cycles, and social systems has the potential to increase the frequency and severity of water-related hazards, such as: storm surges, floods, debris flows, and droughts (Oki and Kanae, 2006). Global population is growing, particularly in the developing world and is accompanied by migration into urban areas. This urbanization threatens to increase the risks of urban flash floods. Global economic growth is increasing the demand for food, which further drives demands for irrigation water and drinking water. Can we manage the water on the Earth wisely, adapt to these anticipated changes in the future, and maintain water security?

In order toassess the sustainability of the Earth's water resources, water footprinting could become a powerful tool. The water footprint (WFP) is a concept imitating the carbon footprint, sometimes appearing on mass media in order to amaze non-scientists by illustrating how much freshwater is required for the production of basic commodities. Such commodities include: vegetables, fruits, meats,cotton T-shirts and foods, like a hamburger, even though it is meaningless for example to say 200g of beef steak requires 3,000-4,000 liter of water without specifying the water source(i.e.,from rain or fossil ground water) orthe state of the water reserves relative to meteorologic, agricultural, or societal demand at the time of withdrawal.. Nevertheless, such a usage of WFP concept could be beneficial to attract the attention of ordinary people to water, the value of which tends to be largely underestimated.

On the other hand, WFP could be used to assess the sustainability of all the water usages that support healthy and wealthy lifestyles. Estimating WFP is equivalent to knowing the quantity, source, and timing (i.e. seasonal) of water withdrawal used for supporting the daily lives and commodity productions. In this sense, we can use WFP coupled with inputs from the best-available projections of climate and water usage to forecast the risks for sustainable water use in the future.

The real hydrological cycles on the Earth are not natural anymore.Global hydrological model simulations of the water cycle and available water resources should have an ability to consider the effects of human interventionon hydrological cycles. Anthropogenic activity modules (Hanasaki et al., 2008), such as: reservoir operation, crop growth and water demand in crop lands, environmental flows, and ground water level fluctuations (Yeh et al., 2005) were incorporated into the MATSIRO (Takata et al., 2003) land surface model, to form a new model, HiGW-MAT.

HiGW-MAT was used to identifying the source of the water used to produce the commodities, such as precipitation or soil moisture (green water) and irrigation water (blue water). Blue water was further subdivided into three categories: streamflow, medium-size reservoirs, and nonrenewable and nonlocal blue water. As reported before (Hanasaki et al., 2010), green water evapotranspiration from rainfed, irrigated cropland, and blue water evapotranspiration from irrigated cropland were estimated as 7820, 1720, and 1530 km3 yr-1, respectively. The global virtual water export (i.e., the volume of water that an exporting nation consumes to produce the commodities that it exports) of five crops (barley, maize, rice, soybean, and wheat) and three livestock products (beef, pork, and chicken) is 545 km3 yr-1. Of the total virtual water exports, 11% is blue water and 5% is nonrenewable and nonlocal blue water. The hotspots where ground water extraction is far beyond the natural recharge from surface soil layers to ground water reservoir are identified by the latest simulation using HiGW-MAT and should be paid attention in order to develop sustainability in water management.