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Urban water transactions: the search of a comprehensive framework for interactions between water and urban systems

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United Nations global demographic prospects show that from 1950 to 2050, the number of people living in cities will increase from 0.7 to 6.3 billion, which represents a 9 times fold in 100 years. In contrast, human population as a whole doesn't show the same trends of the urban subset. For instance, rural population is in some regions almost stalled or reducing at small rates, with an average growth rate 50% less than the urban population. This progressive change in global population structure, with more people living mostly in urban areas, already places urban settlements as the main node driving the interaction of human population and other earth systems, at local, regional and global scales.

This population dynamics is a major source of concern, mainly because the need to comprehensively understand the two apparent contradictory faces of the urbanization phenomena: Despite cities tend to perform more efficiently in terms of mass and energy requirements as function of population size, the agglomeration process in cities typically implies an increase of overall throughput of mass and energy over time. Thus, a central question is to understand how the apparent per capita energy and material flows minimization occurring in cities can propagate its effects towards other geosystems in future population scenarios. The magnitude of scaled (temporal and spatial) effects is crucial to determine if limits of supporting systems capacity is or will be exceeded for a system of cities, or if otherwise is within steady limits.

The Urban Water Transaction (UWT) framework aims for the study of the above question from the perspective of water. Typically between 50 and 70% of mass throughput in urban areas is water, however, that figure doesn't account for other teleconnected flows, such as energy production (hydropower facilities) and food production (virtual water), etc. Therefore, a comprehensive view of actual dependence of urban areas and water faces – in the view of the authors – faces two main limitations: (1) Most of water urban-water interactions occur at temporal or spatial scales associated with groups of cities – *the urban system* – rather than at the scale of an individual city, (2) Water, as a renewable resource, imposes some conceptual difficulties to quantify its availability if seen only through the lens of "metabolism" or "budget", because many water related activities use, but don't consume water. Understand this changes requires the integration of complementary metrics, such as variations in flow, energy or quality regime of a water systems. The Urban Water Transaction (UWT) framework is proposed as conceptual tool to set a common ground for the different types of direct and indirect interactions of urban systems and water, and to study the urban system properties associated with water integration. Import and export flows constitute the primary and most common examples of UWT that fundamentally occur at the Watershed level, and are mediated mostly by physical hydroclimatic water cycles and human basic water needs. However, with the advent of more complex systems of cities and their supporting water dependent systems, ***indirect, wider range and legacy flows*** such as hydrological regimes redistribution, virtual water flows and quality changes, are integrated through the concept of water transactions.

In the view of the authors, the importance of this framework deals three aspects of study of the urbanization phenomena: The coupling characteristics urban systems and hydrological systems, the patterns in urban system as a result of the influence of water related constraints and the identification of urban systems properties that result critical towards the long-term viability of water resources.