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Water Resources and Sustainable Development: Factors and Constraints for Improving Human Well-being in Water-stressed Regions[1]

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Abstract
Water is a crucial natural resource for the sustainable development of world societies. The growing demand of water resources (caused by population and economic growth) and climatic conditions are driving to an increasing water scarcity as well as to the degradation of their quality, which has an acute relevance especially in water stressed regions. In arid and semi-arid regions, the management of surface and groundwater resources creates significant challenges for the development of local populations.

Water and sustainability: an ecosystem approach

Decades of human pressure on natural resources resulted in a new approach to development, which also points to the future but, contrarily to prior approaches, "…to a bleak future of scarcities rather than a bright future of progress…" (Sachs, 2000). Development is only possible when economic fairness, social equity and environmental sustainability are guaranteed. To find solutions to these problems is one of the main challenges of our society for the next decades. This challenge relies on the need to promote and support different tools to face the results of decades of implementation of development models that didn't considered the interlinkages of environment, society and economy (Lourenço et al., 2001). Among such tools, it should be promoted: policies aiming at an equitable distribution of wealth; policies, which incentive environmental conservation rather than regulate resources use; strong public institutions that can operate in the difficult balances of environment / economy relationships; new local adapted agro-technologies aiming at reducing environmental degradation; and the participation of people in the decisions, which imply their education and information (Lourenço et al., 2002 and Machado et al., 2002).

Integrated water resource management is a cross-sectoral policy approach that requires coordination among the different water uses and institutional sectors to respond to the growing demands for water in the context of finite supplies. This process aims at ensuring the coordinated development of water, land and related resources to optimise economic and social welfare without compromising the sustainability of environmental systems. Therefore, it is a complex and multi-dimensional process that must be customised to the specific geographical, environmental, social, cultural,

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political and economic conditions of each region and catchments (GWP, 2000). It involves understanding the interactions of the various social, political, economic and ecological processes that influence choices and strategies within the ecosystem, and addressing issues through the involvement of various stakeholder groups. This ecosystem approaches have been developed, through the concept of integrated watershed management, as a strategy to rebuild agriculture and promote participatory development. (Noronha, 2004). This ecosystem approach is a great tool for an adequate decision-making process, providing stakeholders, decision-makers and policy makers with integrated environmental and socio-economic information to deal with the needs of local populations, and to assess different development options and water management strategies (White et al., 2002).

Managing water scarcity

According with the Millennium Ecosystem Assessment, one-third of the world's population is now subject to water scarcity, and population facing water scarcity will double over the next 30 years. Furthermore, drylands have only 8% of the world's renewable water supply and 10–20% of this ecosystems are degraded (UNEP, 2005). This lack of freshwater resource turns existing sources of surface water, groundwater, and wetland habitats critically important for the population well-being as well as for the ecosystem health (Withe et al., 2002). These water-stressed regions are usually associated with infertile and hostile lands, but they support nearly 2 billion people (about 40%) of the world's population (UNDP/UNSO, 1997 and White *et al*., 2002). Nevertheless, these regions are among the world's most fragile ecosystems, being water one of the most limiting factors. Decrease of water availability, in these regions, can have exponential negative effects on the human population well-being. Water scarcity have a strong burden for women, and to a lesser extent to children, which are the main actors in charge of draw, transport, and store of water for household and animal use. However, their involvement in managing water resource is still nowadays very weak (Morna, 2000; Narayan, 1993).

The agricultural production systems require large amounts of water. The "virtual water" contained in the products is a significant concept, especially for water-scarce regions, in which is important to adapt the production systems to products less intensive in water. Analysing the relations between "virtual water" and physical water can be a significant contribution for achieving a balance of economic and population growth, as well as towards ecological sustainability. The importance of virtual water lies with its potential to balance water-rich and water-poor regions, at national and global levels, through the regional and international trade in agricultural products (Yasser, 2004). Naturally, this process implies socio-economic changes that should be thoroughly analysed. Nevertheless, "virtual water" trade must be faced as an instrument to achieve water security and efficient water use (Hoekstra, 2003).

Agricultural systems in drylands are at the root of specific ecological, economic and social concerns that should to be addressed to move towards more sustainable agricultural practices. Water is the principal resource to support the development of agriculture, and it has been a major limiting factor when is scarce or mismanaged. Negative effects of current agricultural practices are a growing problem, and not only in arid and semi-arid regions, and include the following (Khor, 2004): decline in soil productivity and desertification due to overgrazing; salinisation and contamination of ground and surface waters; overuse of surface and ground water for irrigation; little control of farmers over farm prices; loss of small-size farms and farmers, contributing to the disintegration of rural communities and local marketing systems.

In arid and semi-arid regions, some strategies should be stressed: improving water conservation and storage measures; providing incentives for selection of drought-tolerant crop species; using reduced-volume irrigation systems; managing crops to reduce water loss; and in extreme cases not planting at all (Ching, 2002). Sustainable agriculture can deliver substantial increases in food production at low cost. It can be economically, environmentally and socially viable, and contribute positively to local livelihoods.

Water and Governance

According to the United Nations World Water Development Report we are facing nowadays a Global Water Crisis. The access to safe and easily available water is now considered one of the most critical natural resource issues faced by human societies, and it is clear its relations with other critical issues for the sustainable development: sanitation, health, agriculture, energy and biodiversity (UN/WWAP, 2003). However, this Global Water Crisis is also frequently a crisis of governance (Rogers, 2003), resulting from the failure on determining the roles and responsibilities of public, civil and private interests, as well as of integrating policies and practices in the effective management of water resources and development. Therefore, one of the most significant steps for managing water resources is to involve the scientific community and the community of stakeholders, decision-makers and civil society representatives in the discussion of water management experiences towards the definition of sustainable water management strategies and policy options. Furthermore, one of the key challenges in managing water resources is to develop tools, methods, strategies and policy options, in a context of an ecosystem approach, to satisfy water needs for population and agriculture, ensuring the improvement of livelihoods, diversification of income generation and nature conservation.

The Dublin Principles for good water governance (Solanes, 1999) cover the different dimensions of sustainability (environmental, social and economic) and provide a comprehensive and multidisciplinary frame for approaching the definition of policy options for water resource issues. They have been adopted by numerous international, multi-lateral and bi-lateral agencies including the World Bank. Following these principles, the European Water Framework Directive (WFD, 2000/60/EC) sets out, for the first time, a detailed and integrated framework for the improved protection and management of all Europe's water resources and aquatic environments from each catchment to the sea (Teodosiu, 2003). This directive represents the most significant materialisation of the international concerns with the water as a strategic and limited resource that need to be protected for actual and future generations. This water framework directive pursues the achievement of sustainable development by promoting the integrated management of water resource, using the river basin as management unit.

It is a very complex and challenging strategy, which should integrate all the relations between the natural and the socio-economic environment that contribute to water quantity decrease water quality deterioration. This integrated and comprehensive process includes pollution control and prevention, land-use planning, agricultural policy and erosion control, environmental management and stipulates the involvement of all stakeholders within the basin in the process of water resource management.

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