Tropentag 2014, Prague, Czech Republic
September 17-19, 2014

Conference on International Research on Food Security, Natural Resource Management and Rural Development
organised by the Czech University of Life Sciences Prague

Looking at Food Security through the Agricultural water poverty Index

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Introduction

While the world as a whole may arguably have sufficient water to support its inhabitants, it is not equally the case for developing countries located in arid and semi-arid regions of the world, i.e. North Africa, Middle East, Central and South Asia (Yang and Zehnder, 2002). Dry areas, cover 41% of the earth's surface (Solh, 2008), are the home to 38% of the developing countries' poor and 75% of whom live in rural areas (Wani et al., 2009). They are very fragile and highly vulnerable to environmental changes because of droughts, or periods of unusually low rainfall (Goueili, 2008). While agriculture remains the center of gravity of rural families' livelihoods in the countries located in these areas, and claims the largest share of the work force in these areas, its relative contribution to overall GDP in most of these countries is low and has been declining. However, agriculture is by far the dominant user of water, where in some countries like Iran, Morocco, Syria and Yemen, agriculture consumes close to 100 percent of all available water resources (Shetty, 2006). Because of the correlation between poverty, hunger and water stress (Falkenmark, 1986, cited in: Wani et al., 2009), water, not land, is now the limiting factor for improving agricultural production (Shetty, 2006). Food insecurity and the current water crisis which are the most immediate challenges of countries located in dry areas will result in threatening sustainable livelihood of farmers' household, especially poor families. This paper offers a glimpse of the vulnerability contexts related to agricultural water in dry areas of developing countries and then introduces the Agricultural Water Poverty Index (AWPI). It also emphasizes on the AWPI's components and their potential to address the two important dimensions of farmers' sustainable livelihood, namely the vulnerability context and capitals needed for improving livelihood with regard to agricultural water.

Vulnerability in agricultural context and food security

Huge climatic variability and uncertainty, frequent drought, water poverty and misuse, salinity, land degradation and desertification, higher temperatures, decreases in annual rainfall, increases in mean annual temperature, and new climate change challenges such as changes in pest and disease distributions along with other socio-economic factors including high population growth, poverty, weak institutions and lack of proper policies to sustain use of resources are the major interwoven problems of dry lands regarding sustainable development (Wyn Jones, 2008; Goueili, 2008; Solh, 2010).
In sub-Saharan Africa more than 96% of the farmed land is rainfed, while the corresponding figure for Latin America is almost 87%, for South Asia about 58%, for East and South East Asia 65% and for the Near East and North Africa 66% (FAO, 2008, cited in: Wani et al., 2009). Even in regions with low variable rainfall, only 70–80% of the rainfall is available to the plants as soil moisture, and on poorly managed land the fraction of plant-available water can be as low as 40–50% (Falkenmark and Rockström, 2004, cited in: Wani et al., 2009). Therefore, groundwater has shown the major importance to rural development in many developing countries. Countries like the UAE, Saudi Arabia and Oman are almost exclusively reliant on groundwater resources while other countries such as Syria, Tunisia, Yemen and Jordan derive more than 50 percent of their water resources from groundwater (Shetty, 2006). Water quality problems can often be as severe as those of water availability but have yet to receive as much attention in developing countries (Wani et al., 2009). However, in many those countries water quantity per se is not the limiting factor for increased productivity but its management and

efficient use are the main impediment (Wani et al., 2009; Oweis, 2010). Most of such water loss can be saved by applying proper and efficient strategies (Ehsani, 2005).

Due to high population rate in developing countries water will be diverted to domestic, industrial and other priority sectors from current allocations for agriculture causing a continuous declining in agriculture share. This decline comes to challenge the attempts to increase food production and to enhance food security in the future (Oweis, 2008; Wilhite, 2010). It is estimated that by 2020, food grain requirement in Asia would be almost 30-50% more than the current demand. The UN Millennium Development Project has identified the 'hot spot' countries in the world suffering from the largest prevalence of malnourishment. These countries coincide closely with those located in the semi-arid and dry areas in the world, where water constitutes a key limiting factor to crop growth (Wani et al., 2009). Unfortunately, most water scarce countries rely on imports to provide domestic food (Yang and Zehnder, 2002). Over the last two decades, Middle East and North Africa was the largest grain importing region in the world (Shetty, 2006). So, farmers' immediate concern is how to increase crop yield, income, and food security and reduce the risk of crop failure due to water scarcity. Because under water scarcity situations, they naturally are forced to decrease their cultivation areas and consequently their income will be diminished (Forouzani and Karami, 2010). This means that availability of agricultural water has a positive effect on food security and also sustainable livelihoods of many rural families.

In this respect, Shah (2010) suggests that there is an urgent need for comprehensive science-based assessments of the potential and limitations of agriculture in the dry lands in the context of climate change impacts. Shetty (2006) also recommends that governments need to address the issue as a structural phenomenon linked with the socio-economic production system and within the context of scarce, declining and degraded water resources. But it seems that before anything else to do it is crucial to obtain accurate recognition of the state of agricultural water resources at a range of spatial and temporal scales from regional to national to local. This leaves us free to consider water related factors which prevent rural stakeholders to have an acceptable access to security of production.

Agricultural water poverty index and food security

The sustainable livelihood framework basically was offered to address a secure livelihood for poor rural people. According to the core premise of this framework what make the rural people poor are the vulnerability contexts which include shocks and lack of capitals. In this respect, water as the main physical and natural capital drives the production process in rural areas and, therefore, water poor farmers should not be neglected. Water is one of the main factors that constrain their agricultural output and income. To ensure a sustainable livelihood for rural people, the constraints and also the capacities of their production system must be respected. Using the Sustainable Livelihood framework, current vulnerability context and capitals which lead to un-sustainability of the livelihoods for water poor people in dry rural regions, are demonstrated (Fig. 1).

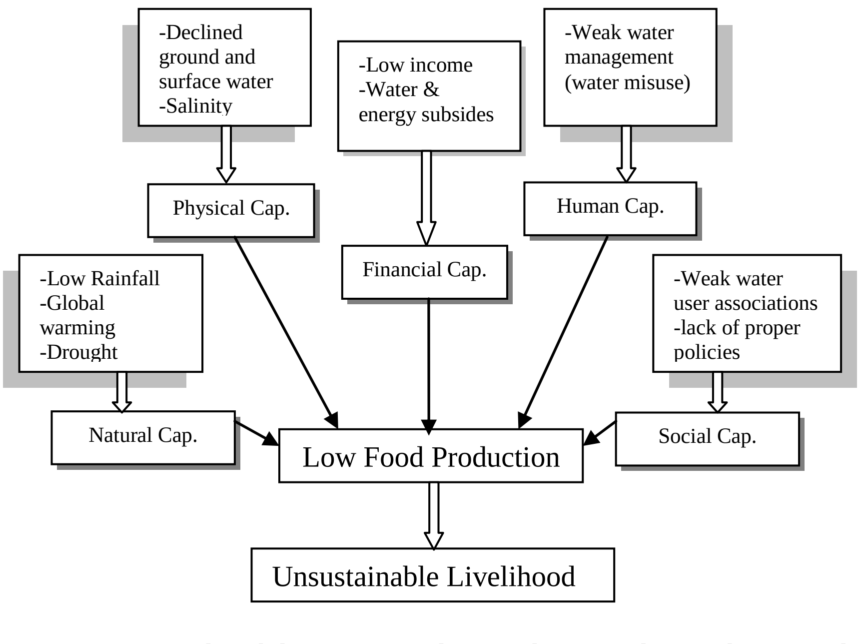

Figure 1: Vulnerability context and incomplete capitals regarding agricultural water

Concern for food security has prompted an increased attention for more effective ways of water management and accurate assessment of the water situation in agriculture. This movement resulted in introducing an index which is called Agricultural Water Poverty Index (AWPI) to measure agricultural water situation by Forouzani and Karami (2010). Therefore, to address food security and according to Sustainable Livelihood framework, AWPI can be taken into account as measuring index which considers vulnerability contexts regarding agricultural water and also the capitals needed for improve the situation. Based on the most crucial factors influencing vulnerability of farmers' households regard to agricultural water, the developers of AWPI, Forouzani and Karami (2010), introduced five components which forms the whole index. Each component in turn can be measured by a group of indicators. The main components of AWPI are as follow:

Resources: the amount of agricultural water (Surface and Groundwater) that is currently available in a given region.

Access: the extent to which farmers have access to agricultural water resources in the region. This component can be divided into two parts: a) farmers' access to water; and b) potential and quality of land.

Use: estimated physical water use efficiency of the available agricultural water. This component is concerned by the ability of farmers to use agricultural water effectively.

Capacity: points to the farmers' current potential in managing agricultural water at farm level. AWPI considers this component as having capacity for sustaining access and optimal use of agricultural water and implies the farmer's ability to manage water for the sake of effective water usage. The crucial issue for water security is not whether water is 'available' but whether the monetary and nonmonetary capitals are sufficient to allow farmers' access to adequate quantities of water. Capacity can be divided into three categories: a) human capital, mostly in the form of farmer's water management knowledge, education and other abilities; b) real capital, mainly technological and financial (saving and investment); and c) social capital which interacts with real capital to provide a capacity to improve water use efficiency.

Environment: environmental factors influencing the quality and quantity of agricultural water.

The most fundamental function of AWPI is to measure the level of agricultural water poverty as the most important construct that influences agricultural water management.

As Mlote et al. (2002) noted "poverty is a relative concept that can be defined as capability deprivation". Agricultural water poverty also can be emerged in the form of lacking capitals in rural areas. However, water availability is a necessary, but of itself not sufficient basis for achieving food security. The conceptual framework of the AWPI covers the capitals of the Sustainable Livelihood and their key aspects, providing a holistic perspective on how agricultural water poverty may be measured and recognized in more explicit ways between different rural areas; therefore be improved through more efficient systems of water management.

Considering Livelihood Sustainable framework at the core, it can be said that AWPI addresses such capitals which are important to have a sustainable livelihood for rural households regard to agricultural water. Natural resources are addressed well by the "Resource" component in the AWPI. AWPI would enable one to identify water resources of a given community or farm in more explicit way. The other four capitals provided by sustainable livelihood framework i.e. physical, financial, human and social capital are considered all together by the "Capacity" component in the AWPI. Indeed, AWPI includes other important components i.e. Access, Use and Environment which are useful for assessing the agricultural water situation regard to the current vulnerability contexts i.e. population of users, potential of land, water use efficiency and the quality of available water stemming from environmental factors.

Based on a holistic approach, AWPI was developed to meet the water related dimensions in a unique index. It addresses also the interrelations between capitals.

Conclusions

Water scarcity will threaten the fragility of arid and semi arid with serious consequences for crop and livestock production and food security. The distribution of rainfall as well as its amount is the major natural factor restricting agricultural production in arid and semi arid regions. Lack of sufficient recharge of ground waters due to low rainfall, has caused serious damages of water resources in these areas. It seems that the water availability is not any more as the only indicator for recognizing water situation in a region. These concerns have prompted an increased attention for more effective ways of water management in agriculture, particularly water assessment aspect. Before anything else to do, achieving a real recognition of water situation is of great importance. In this regard some prerequisites must be considered: First, new movement toward assessing water situation will be needed which requires moving away from the old practice of treating each of the conditions causing agricultural water poverty separately and towards dealing with them in a holistic way. As revealed in this paper, the vulnerability contexts related to agricultural water formed the central core of Agricultural Water Poverty Index (AWPI) to provide a framework for analysis of water situation. AWPI is an attempt to precisely define which conditions and factors affect the agricultural water situation in a community. It was developed as a holistic tool for effective water management. Second, new agricultural practices and systems will be needed in which more attention is given to the capitals instead of water resources. Forouzani et al., (2013) by applying AWPI to analyze agricultural water situation in Iran found that increasing water access can no longer be the driving force beyond crop production, however, increasing human (knowledge), real and social capitals are the real alternatives for improving agricultural production in dry and semi dry areas. Therefore, rethinking current water and agricultural practices is necessary if the food security of countries in those areas is to be sustained or enhanced (Oweis, 2010). Third, regarding poverty of water resources and movement toward sustainable livelihood, new production practices will be required which are in line with the requirements of optimal usage of agricultural water to achieve food security.

Humans are one of the causes of water scarcity but also its victim. Concerning water for food security will be a potential source of conflict in the future. Hence, it is hoped that by developing a more holistic and transparent framework for water management decisions, water managers' abilities to deliver water where it is needed will be improved, it also would help water users to effectively use the delivered water, and finally to ensure a more food secure future for the water scarce countries.

References

Ehsani, M., A Vision on Water Resources Situation, Irrigation and Agricultural Production in Iran. *Proc. of the ICID 21st European Regional Conf.* Frankfurt and Slubice - Germany and Poland, 2005.

Forouzani, M.; Karami, E. & Zamani, Gh.H. (2013). Agricultural water poverty in Marvdasht County, Southern Iran. *Water Policy*, 15, pp. 669–690. doi: 10.2166/wp.2013.163

Forouzani, M., Karami, E., Agricultural water poverty index and sustainability. *Agronomy for Sustainable Development*, 31(2), pp. 415-431, 2010.

Food and Agriculture Organization (FAO), *Climate Change, Water and Food Security*. Technical Background Document from the Expert Consultation, FAO, Rome, 2008.

Goueili, A., Strategic governmental perspectives on climate change/current and future water and land use and human welfare. *Abstracts of the 9th Int. Conf. on Dryland Development, Sustainable Development in Drylands–Meeting the Challenge of Global Climate Change*, Alexandria, Egypt, 2008.

Mlote, S.D. M.; Sullivan, C. & Meigh, J., Water Poverty Index: a Tool for Integrated Water Management. *3rd Sym. on Water Demand Management for Sustainable Development*, Dar es Salaam, 2002.

Oweis, T., Achieving 'more crop per drop' in a changing environment. *Proc. of the Int. Conf. on Food Security and Climate Change in Dry Areas*, Amman, Jordan, 2010.

Oweis, T., Improving agricultural water productivity: a necessary response to water scarcity and climate change in dry areas. *Abstracts of the 9th Int. Conf. on Dryland Development, Sustainable Development in Drylands–Meeting the Challenge of Global Climate Change*, Alexandria, Egypt, 2008.

Shah, M., Impact of climate change on agriculture in dry areas. *Proc. of the Int. Conf. on Food Security and Climate Change in Dry Areas*, Amman, Jordan, 2010.

Shetty, Sh., *Water, Food Security and Agricultural Policy in the Middle East and North Africa Region.* Working paper series, No. 47, The World Bank, Office of the Chief Economist, 2006.

Solh, M. Ensuring food security in a changing climate: how can science and technology help?. *Proc. of the Int. Conf. on Food Security and Climate Change in Dry Areas*, Amman, Jordan, 2010.

Solh, M., Enhancing food security and livelihoods in dry areas. *Abstracts of the 9th Int. Conf. on Dryland Development, Sustainable Development in Drylands–Meeting the Challenge of Global Climate Change*, Alexandria, Egypt, 2008.

Wani, S. P., Sreedevi, T.K., Rockström, J. & Ramakrishna, Y. S. Rainfed Agriculture–Past Trends and Future Prospects (Chapter 1). *Rainfed Agriculture: Unlocking the potentials*, eds. S. P., Wani, J., Rockström & T., Oweis, CAB International, pp. 1-35, 2009.

Wilhite, D. A. Impact of climate change on drought in dry areas. *Proc. of the Int. Conf. on Food Security and Climate Change in Dry Areas*, Amman, Jordan, 2010.

Wyn Jones, G., Old problems - new challenges and new opportunities?. *Abstracts of the 9th Int. Conf. on Dryland Development, Sustainable Development in Drylands–Meeting the Challenge of Global Climate Change*, Alexandria, Egypt, 2008.

Yang, H., & Zehnder, A. J.B., Water Scarcity and Food Import: A Case Study for Southern Mediterranean Countries. *World Development*, 30(8), pp. 1413–1430, 2002.