Actual and Potential Role of Blue Water Resources to Improve Efficiency in Irrigation

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Synopsis

Feeding a growing and, generally, more prosperous world population requires the mobilisation of all sources of water in all kinds of agriculture. Blue water resources, i.e. water in rivers, lakes and groundwater aquifers were developed and utilised especially during a couple of decades after the introduction of the green revolution. With a substantial increase in the demand for food and other agricultural commodities coupled with more irregular rainfall pattern and higher temperature as a result of climate change, controlled water provisioning to agriculture will be increasingly significant. Actual and potential role of blue water resources will be discussed in detail. What kinds of innovations may lead to improved efficiency in irrigation? What is the potential for an expansion of supplementary irrigation? What investments are needed in blue water for food security in a context of multiple and competing uses?

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1. Introduction

1.1. Why is water a key to food security?

Food security exists when all people at all times have both physical and economic access to sufficient, safe and nutritious food that meets their dietary needs for an active and healthy life. People who have better access to water tend to have lower levels of undernourishment. The lack of water can be a major cause of famine and undernourishment, in particular in areas where people depend on local agriculture for food and income. Erratic rainfall and seasonal differences in water availability can cause temporary food shortages. Floods and droughts can cause some of the most intensive food emergencies.

1.2. How much water is needed to produce our food?

All the food from crop and livestock production, inland fisheries or aquaculture, forest products, requires water. This water comes from rain and moisture stored in soils (green water) or from withdrawals in watercourses, wetlands, lakes and aquifers (blue water). 70% of the blue water withdrawals at global level go to irrigation. Irrigated agriculture represents 20% of the total cultivated land but contributes 40% of the total food produced worldwide.

It takes about 1500 liters of water to produce 1 kg of wheat, but it takes 10 times more to produce 1kg of beef! Producing feed crops for livestock, slaughtering and the processing of meat, milk and other dairy products also require large quantities of water. This makes the water footprint of animal products particularly important. Fish production from rivers and, increasingly, from aquaculture contribute about 25% to the world's fish production and aquaculture is the fastest growing food producing sector: the average annual per capita supply of fish from aquaculture has increased at an average rate of 6.6% per year between 1970 and 2008. Both fisheries and aquaculture require a certain quantity and quality of water in rivers, wetlands, lakes and estuaries and are therefore important water users.

Water footprint - All human activities use water: drinking, cooking, washing, but also and mostly, for producing food, paper, clothes, etc. The water footprint is a way of measuring our direct and indirect water use. The water footprint is the total volume of freshwater that is used to produce the goods and services consumed by an individual or a community or produced by a given business.

1.3. How is the global demand for food evolving?

There are over 7 billion people to feed on the planet today and another 2 billion are expected to join by 2050. This means that 70% more food will be needed, up to 100% in developing countries.

Besides, with rapid urbanization and incomes increase, diets are shifting. Meat consumption in particular is expected to rise from 37 kg per person per year in 1999/2001 to 52 kg in 2050 (from 27 to 44 kg in developing countries), implying that much of the additional crop production will be used as feed for livestock production. For example, 80 percent of the additional 480 million tons of maize produced annually by 2050 would be for animal feeds, and soybean production would need to increase by a hefty 140 percent, to reach 515 million tons by 2050.

2. Water scarcity and the food security

2.1. How does water scarcity affect our food security?

Water scarcity already affects every continent and more than 40 percent of the people on our planet. By 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water stressed conditions. The lack of water limits farmers' ability to produce enough food to eat or earn a living. South Asia, East Asia and the Middle East for example are already close to their resources limits, and their population is still growing.

2.2. What effect does climate change have on our food security?

Climate change is expected to impact both rainfed and irrigated agriculture, including feed and fodder for livestock, as well as forests and aquaculture. Severe reductions in river runoff and aquifer recharge are expected in the Mediterranean Basin and in the semi-arid areas of the Americas, Australia and Southern Africa, affecting water availability and quality in already stressed regions. High latitude areas will see an increase in their potential, whereas regions near the equator will experience more frequent and severe droughts, excessive rainfall, and floods which can destroy crops and put food production at risk. Populations who live in fragile environments and depend on agriculture for their livelihoods face an immediate and increasing risk of crop failure or loss of livestock.

2.3. Is the competition for water increasing?

With population increase and economic growth, water demands for cities and for the industry are growing much faster than those of agriculture. In some regions, increasing competition for water is constraining both current availability of water for irrigation and further expansion of the irrigated area. In agriculture alone, staples, livestock, inland fisheries and aquaculture, and non-food crops - including liquid biofuels – already compete for water resources. The steady increase of inland aquaculture also contributes to the competition for water resources.

Increased competition for water often translates into loss of access to water for the poor and other vulnerable groups. For millions of smallholder farmers, fishers and herders, water is one of the most important factors of production: without water, they cannot make a living.

3. Role of Blue water

3.1. How has the Green Revolution degraded our land and water while allowing to-supply more food?

The Green Revolution and its three pillars - high yielding varieties, chemical inputs like fertilizer and pesticides, and irrigation – has had a very positive effect on global food production but also had negative impacts on the environment. The way water has been managed has contributed to harm the environment: groundwater depletion; degradation and contamination of land and water; forest resources, ecosystem and biodiversity losses.

A quarter of the world's lands are degraded. Many large rivers run dry during part of the year, with serious impacts on aquatic biodiversity. Large lakes and inland seas have shrunk, and half of the wetlands of Europe and North America no longer exist. The number of regions across the world that cannot satisfy the basic food needs of their growing populations is increasing, and in many of these places the impacts on the environment are beyond repair.

3.2. But can we produce more food with less water?

The future production of food and other agricultural products will not be possible without increased efforts aiming at better using water in the fields. For a long time, progresses in agricultural production have been assessed in terms of 'yield', the amount of production that could be extracted from a

given area of land. Now, in many places, maximizing the yield per unit of land should give way to achieving the maximum yield per unit of water used. This requires a better control and application of irrigation water, and a sharper combination of the use of rain and irrigation water, combined with good agricultural practices to ensure the highest possible productivity.

3.3. Can we re-use and recycle water in food production?

Drainage water, treated wastewater, brackish and desalinated water can be used in agriculture, especially in the arid and semi-arid zones and in rapidly growing peri-urban areas. Cities' wastewaters are in fact a precious source of water and nutrients for agriculture that have to be properly managed to minimize environmental and health risks.

Utilizing residues and by-flows of the food sector rather than growing crops specifically to produce bioenergy would limit the pressure on water resources and competition with food crops. It would even increase water productivity: the same water would have produced food and bioenergy.

Many forms of aquaculture such as cage culture, flow-through systems and integrated agri-aquaculture represent food productions systems that do not significantly increase water consumption. Recirculation of water in aquaculture can reduce water use by 90%.

3.4. How can we protect this precious resource?

Water pollution is a main cause of reduced water availability and can have serious impacts on the environment and on human health. Pollution stems for inappropriate industrial and agricultural practices as well as from urban waste production. In agriculture, overuse of chemical fertilizers and of pesticides leads to contamination of water bodies (rivers, lakes, underground aquifers). Intensive livestock production can also impact the quality of water resources if measures are not taken. New, more integrated approaches to food production can substantially improve the situation and limit pollution.

Protection also means conservation. A good soil, well maintained, can capture much of the rainwater, and avoid surface runoff which causes erosion and the loss of soil nutrients. *Conservation agriculture* is a farming practice that makes best use of available water, increases the resistance of plants to droughts and at the same time contributes to improving both the quantity and quality of groundwater and rivers.

Management of watersheds and the protection of water sources are also important. Forests can play an important role in protecting water resources.

3.5. How can we prepare for climate changes and natural disasters?

Adapting water management policies and practices to climate change and other natural disasters reduces the risk of these phenomena. Improved water harvesting and retention (such as pools, dams, pits, retaining ridges, etc.), supplementary irrigation for rainfed crops, highly efficient irrigation systems and best practices are fundamental for addressing increasing irregularity of rainfalls, and increasing water productivity and food production. A particular saving potential exists for irrigated rice, which is currently flood irrigated leading to very high water use and at the same time to high greenhouse gas emissions.

Changing rice cultivation to aerobic conditions can reduce the water use by 50%, while cutting emissions and increasing yields. Proactive drought and flood management strategies minimize the devastating impacts of these events, the frequency and severity of which is expected to increase with climate change.

In Africa, where only 4% of cropland is irrigated, small-scale supplementary irrigation with rainwater harvesting provides a great potential for securing food supply, increasing yields and reducing vulnerability to erratic rainfall.

3.6. Are there ways to improve the integration of different food production systems and increase water productivity?

Several integrated production approaches have developed that combine best practices in sustainable land and water management, adapted to the local ecosystems. They incorporate improved soil and water management techniques in a way that intensifies production through integrated soil fertility management, improved water-use efficiency and crop diversity. Integrated rice-fish farming is also a promising option. All these approaches offer opportunities for farmers to improve productivity sustainably.

The multiple uses of water for improving both diets and incomes. Growing numbers of farmers, particularly in Asia, are finding that they can both increase rice yields and add a valuable source of protein and income by using the water in their rice paddies to raise fish.

3.7. Finally, how can we reduce the waste?

Roughly 30% of the food produced worldwide – about 1.3 billion tons - is lost or wasted every year. In many developing countries, large shares of the production are lost between the farmers' field and the market because of poor storage and transportation facilities. In developed countries, and in particular in cities, food is wasted by the consumer who is not aware of, or sensitive to, the resources needed to produce it. Diets with excessive food intake are also a source of waste and a cause of growing heath costs. A change in consumers' attitude towards this issue is necessary: limiting the waste means reducing the water needed to produce our food.

3.8. Reduce food wastage to save water

A 50% reduction of food losses & waste at the global level would save 1,350 km3 of water (for comparison, the mean annual rainfall over Spain is 350 km3; water passing Bonn in Die Rhine is around 60 km3 per eyar; the storage capacity of Lake Nasser nearly 85 km3).

4. References

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