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Water for Food Systems and Nutrition

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Abstract

Access to sufficient and clean freshwater is essential for all life. Water is also essential for food system functioning: as a key input into food production, but also in processing and preparation, and as a food itself. Water scarcity and pollution are growing, affecting poorer populations, particularly food producers. Malnutrition levels are also on the rise, and this is closely linked to water scarcity. Achievement of Sustainable Development Goal 2 (SDG 2) and Sustainable Development Goal 6 (SDG 6) are co-dependent. Solutions to jointly improve food systems and water security outcomes that the United Nations Food Security Summit (UNFSS) should consider include: 1) Strengthening efforts to retain water-based ecosystems and their functions; 2) Improving agricultural water management for better diets for all; 3) Reducing water and food losses beyond the farmgate; 4) Coordinating water with nutrition and health interventions; 5) Increasing the environmental sustainability of food systems; 6) Explicitly addressing social inequities in water-nutrition linkages; and 7) Improving data quality and monitoring for water-food system linkages, drawing on innovations in information and communications technology (ICT).

Introduction

Water is essential for all life and is integral to the function and productivity of the Earth's ecosystems, which depend on a complex cycle of continuous movement of water between the Earth and the atmosphere. Water is integral to food systems and improved food systems are essential to meet Sustainable Development Goal (SDG) 6 on water and sanitation. As described by the High Level Panel of Experts on Food Security and Nutrition (HLPE)[1] and illustrated in Figure 1, the key dimensions of water that are of importance for humanity are its availability, access, stability, and quality. These have multiple, close linkages and feedback loops with food systems – which can be defined as the activities involved in the production, processing, distribution, preparation, and consumption of food within a wider socioeconomic, political, and environmental context[2]. For example, waste streams from food processing often re-enter water bodies, affecting other components of food systems, such as drinking water supply (water is itself essential for all bodily functions and processes, and is an important source of nutrients)[3], as well as water-based and water-related ecosystems.

More than 70 percent of all freshwater withdrawals are currently used for agriculture, and about 85 percent of withdrawn resources are consumed in irrigated agricultural production. With these resources, irrigated crop areas generate 40 percent of global food production on less than a third of global harvested area[4]. Another key water-food system linkage is water supply for WASH (water, sanitation and hygiene), which is important for human health, can support nutrition outcomes, particularly if combined with other interventions[5], and is a basic human right; as is the right to food. Water is also essential for agricultural processing and for food preparation.

Climate change and other environmental and societal changes (e.g. land use

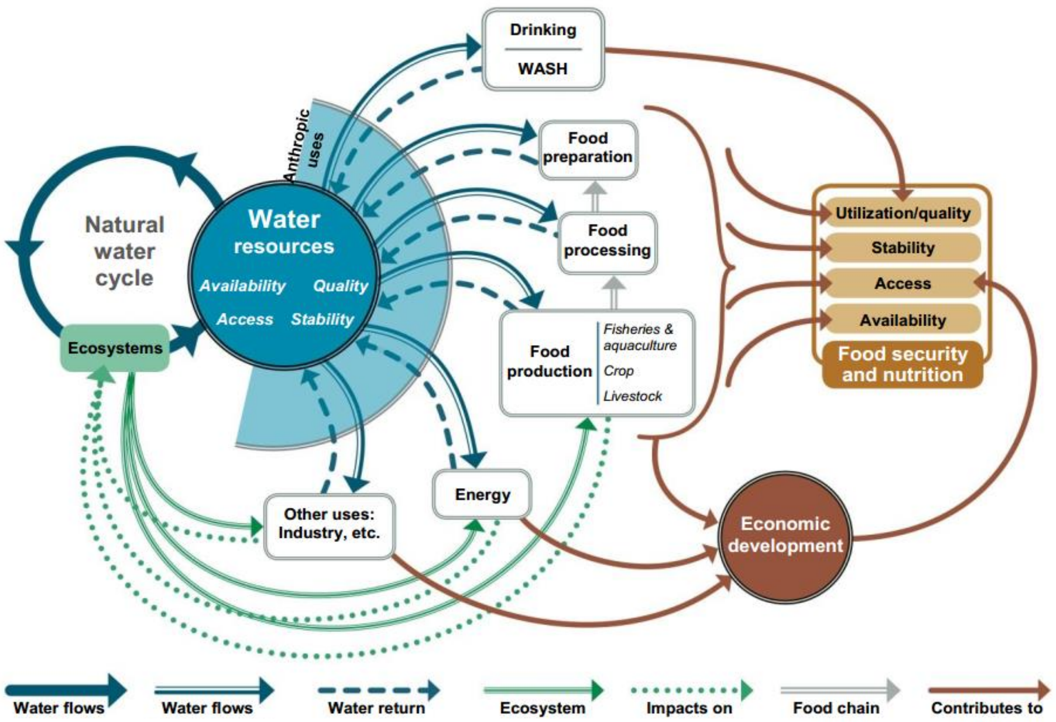

Figure 1. *The linkages between water and food systems* (Source: HLPE 2015).

changes, biodiversity loss, urbanization, and changing lifestyles and diets) are impacting the dynamics of natural water cycles and water resource availability with impacts on food systems. More than half of all natural wetland areas have been lost due to human activity since 1900 and forest degradation affects streamflow regulation[6]. At the same time, the growing frequency and severity of floods and droughts in many regions of the world[7] increase competition over water resources. This calls for changes in water management, including increased water productivity, integrated storage solutions, accelerated land restoration as well as smarter water distribution to support food systems, while also reducing impacts on the domestic, industrial, energy, and environmental water use sectors.

SDG 2 and SDG 6 can only be achieved if the water and food systems communities work together

Water scarcity and pollution are growing, affecting poorer populations, particularly food producers

Freshwater-related ecosystems include wetlands, rivers, aquifers, and lakes sustaining biodiversity and life[8]. Although they cover less than 1 percent of the Earth's surface, these habitats host approximately one third of vertebrate species and 10 percent of all species[9], including mammals, birds[10], and fish[11]. Water-related ecosystems are also vital for the function of all terrestrial ecosystems, providing regulating, provisioning, and cultural services[12]. Furthermore, water is essential for energy production – accounting for 85 percent of global renewable electricity generation in 2015[13], and is also key for commerce and industry[14]. Notably, de-carbonizing the energy system can also impact the water system, particularly in the case of increasing hydropower and biofuel. Progress on achieving the water and sanitation targets of SDG 6 has been unsatisfactory and uneven (see Appendix 1 for SDG 6 targets). More than 2 billion people live in places with high water stress[15,16]; by 2050, every second person, half the world's grain production, and close to half the globe's Gross Domestic Product might well be at risk from water stress[17]. In 2017, approximately 2.2 billion people lacked access to safely managed drinking water, and 4.2 billion people lacked access to safely managed sanitation services. One in 10 people lacked basic services, including the 144 million people who drank untreated surface water, mostly in sub-Saharan Africa[18]. Poor women and girls, who are responsible for more than 70 percent of all water collection, spend about 200 million hours a day on this task, reducing their learning opportunities and undermining their health and livelihood opportunities[19,20].

Farmers across the world, but particularly in sub-Saharan Africa, continue to rely heavily on rainfall for food production. More than 62 million hectares of crop and pastureland experience high to very high water stress and drought, affecting about 300 million farm households[21]. With climate change, temperatures and crop evaporation levels are increasing and there is growing uncertainty about the timing, duration and quantity of rainfall, increasing the risks of producing food and undermining the livelihood security of the majority of rural people[22]. With respect to the other SDG 6 targets, such as water quality, water use efficiency, water dependent ecosystems, and integrated water management, progress has been slow and is often not well understood due to the lack of effective monitoring mechanisms and insufficient data. New, integrated approaches and reinforced efforts are urgently needed[23].

While water availability differs dramatically around the globe, differences in access are more often due to politics, public policy, and flawed water management strategies as well as exclusions due to geography (i.e. remote rural areas), gender, ethnicity, caste, race, and class. In many cases, water does flow uphill to power and money[24]. Furthermore, increasing urbanization and changing diets are changing the demand and supply of water resources for food systems and aggravating water stress in many parts of the world, particularly in water-scarce areas of low/middle income countries where coping capacity is often insufficient.

Malnutrition levels are on the rise and are closely linked to water scarcity

An estimated 690 million people or 8.9 percent of the global population were undernourished in 2019, prior to the COVID-19 pandemic; this number has certainly gone up since[25]. Moreover, 144 million children below the age of five were stunted, 48 million were wasted, and another 38 million were overweight[26,27]. Climate change, associated conflict, and lack of sufficient water for food production, including irrigation for fruits and vegetable production, are key contributors to unaffordable diets and overall levels of undernutrition. At the same time, overweight continues to dramatically increase around the globe, including in children. Latin America, in particular, suffers from the associated public health burden. Overall, rural areas currently experience the most rapid rate of increase[28]. Given these trends, neither the 2025 World Health Assembly nutrition targets nor the 2030 SDG nutrition targets will be met. As with inequities in access to water, inequities in access to food and nutrition are highest in rural areas[29].

SDG 2 and SDG 6 targets are co-dependent

Ending hunger and malnutrition requires access to safe drinking water (SDG 6.1) as well as equitable sanitation and hygiene (SDG 6.2). The underlying productivity (SDG 2.3) and sustainability (SDG 2.4) of agricultural systems are also dependent on adequate availability (SDG 6.4 and 6.6) of good quality (SDG 6.3) water. Moreover, water and related ecosystems (e.g. wetlands in SDG 6.6), which are embedded in sustainable landscapes, are important contributors to sustainable agriculture (SDG 2.4)[30].

A key contributor to poor nutritional outcomes in subsistence farming households in low-income countries is the seasonality of production, leading to seasonality of diets, which can affect pregnancy outcomes and child growth[31,32]. Well-managed irrigation systems can buffer seasonal gaps in diets – contributing to improved food security and nutritional outcomes, for example, through homestead gardening[33,34].

It is equally important to stress the importance of changes in food systems for meeting SDG 6 targets: through reducing food loss and waste in food value chains (SDG 12.3), lowering pollution from slaughterhouses, food processing, and food preparation, and considering environmental sustainability in food-based dietary guidelines. All these actions will be essential to meet SDG 6 targets (Appendix 1)[35].

Solutions to Improve Food Systems Outcomes and Improved Water Security

Based on the above assessment as well as on recent water-food system reviews[36], the following actions are proposed for uptake by governments, the private sector, and civil society.

1. Strengthen efforts to retain water-based ecosystems and their functions

The ecological processes underlying the movement, storage, and transformation of water are under severe threat from deforestation, erosion, and pollution, with impacts on local, regional, and global water cycles[37]. In addition to a direct halt to deforestation and destruction of water-based ecosystem, nature-based solutions that use or mimic natural processes to enhance water availability (e.g., groundwater recharge), improve water quality (e.g. riparian buffer strips), and reduce risks associated with water-related disasters and climate change (e.g. floodplain restoration) should be strengthened[38]. Setting limits to water consumption, particularly in water-stressed regions, will be necessary to stay within sustainable water use limits[39].

2. Improve agricultural water management for better diets for all

Around 3 billion people on this planet cannot afford a healthy diet, particularly dairy, fruits, vegetables, and protein-rich foods[40]. Both rainfed and irrigated systems play essential roles in lowering the prices of nutrient-dense foods, growing incomes to afford these foods, and strengthening diversity of foods available in local markets[41].

2.1 Strengthen the climate resilience of rainfed food systems

Rainfed systems produce the bulk of food, fodder, and fiber; and most animal feed is produced under rainfed conditions[42]. These systems are under severe and growing stress from climate change, including extreme weather[43]. This can be addressed, to some extent, through structural measures (e.g. terracing, soil bunds), investment in breeding, improved agronomic practices, better incentives (e.g. payments for watershed conservation), and strong institutions (e.g. watershed committees)[44,45].

2.2 Strengthen the nutrient density of irrigated agriculture

As irrigation accounts for the largest share of freshwater withdrawals by humans, the potential for water conservation is also largest in this sector. Irrigation development needs to take place keeping environmental limits – which are increasingly affected by climate change – in mind; this includes reining in groundwater depletion. The potential for increasing water and nutrition productivity in irrigation remains large. It includes crop breeding for transpiration efficiency, climate resilience and micronutrients, integrated storage solutions—such as joint use of grey and green infrastructure—advanced irrigation technology, and automated irrigation systems[46]. There are clear tradeoffs between nutrient density of foods and irrigation water use. Fruits and vegetable yields depend on frequent water applications in many parts of the world (but the water content of the end product also tends to be high); and tend to receive high pesticide applications that pollute water resources[47]. Many livestock products are highly water-intensive due to animal feeds. Awareness raising and social learning interventions can help internalize the water externality of water-intensive diets. Improved coordination of water with other agricultural inputs can also enhance yield per drop of water. This requires access to technology packages as well as to better agricultural information[48], which is increasingly supported by ICTs[49]. Moreover, subsidies for water-intensive crops, such as rice, milk, and sugar should be removed. For water-scarce countries, importing virtual water via food and other commodities will remain essential[50].

2.3 Address water pollution to improve food production, food safety, and water-based ecosystems

Globally, 80 percent of municipal sewage and industrial wastewater with heavy metals, solvents, toxic sludge, pharma-ceuticals, and other waste, are directly discharged into water bodies, affecting the safety of food, particularly vegetable production, and also, directly, human health[51]. Agriculture also directly pollutes aquatic ecosystems and risks food production with pesticides, organic matter, fertilizers, sediments, pathogens, and saline drainage[52]. Key measures to address agricultural and overall water pollution include breeding crops with higher crop nutrient use efficiency, better agronomic practices, the expansion of nature-based solutions for pollution management, low-cost pollution monitoring systems, improved incentive structures for pollution abatement, and continued investment and innovation in wastewater treatment, including approaches such as the 3R (reduce, reuse, and recycle) of the circular economy across the entire food system[53].

3. Reduce water and food losses beyond the farmgate

Irrigated agriculture is often focused on high-value crops with a higher share of marketed surplus compared to rainfed agriculture[54]. At the same time, many irrigated crops, such as fruits and vegetables, are time-sensitive perishable products that require efficient market linkages to consumption centers. Strengthening market linkages includes investment in physical infrastructure that supports on-farm production (irrigation, energy, transportation, pre- and post-harvest storage), efficient trading and exchange (telecommunications, covered markets), value addition (agro-processing and packaging facilities), and improved transportation and bulk storage[55]. Investments are also needed in ICTs that facilitate farmers' access to localized and tailored information about weather, water consumption, diseases, yield, and input and output prices[56].

4 Coordinate water with nutrition and health interventions

4.1 Strengthen institutional coordination and develop joint programs

Governance and management of water for various uses and functions, as shown in Figure 1, follow different institutional arrangements. Similarly, professionals engaged in various roles within water-related institutions have different kinds of training and experiences. Few irrigation engineers have a professional background or skills related to WASH, and few WASH professionals have the technical skills needed to design water infrastructure for multiple uses. The notion of Integrated Water Resources Management (SDG 6.5) has been promoted as a principle to overcome problems due to sectoral division. Coordination at the lowest appropriate levels is urgently needed between WASH and irrigation for improved food security, nutrition, health outcomes and also to strengthen women's agency.

Multiple use water systems can increase food security and WASH outcomes[57]. A further example is the MiAgua program in Bolivia supported by the development bank of Latin America (CAF), which included rural water supply, climate change adaptation measures such as watershed protection, and micro-irrigation projects for small-scale agriculture. MiAgua benefited 2.25 million people and contributed to increasing rural water coverage from 52 percent in 2011 to 80 percent in 2020.

4.2 Implement nutrition-sensitive agricultural water management

Nutrition and health experts need to join forces with water managers at the farm household level, at the community level, and at the government level to strengthen positive transmission pathways between both rainfed and irrigated agriculture, and food and nutrition security. A recent guidance[58] describes eight actions to increase the nutrition sensitivity of water resources management and irrigation as well as indicators for monitoring progress.

5. Increase the environmental sustainability of food systems

The water footprint of diets varies dramatically between rich and poor countries, but also by socioeconomic group within countries[59]. More work is urgently needed on the impact of current dietary trends on environmental resources, including water. Food-based dietary guidelines should consider the environmental footprint of proposed diets; government regulations and consumer awareness should be strengthened to reduce over-consumption of food, and further efforts are needed to reduce post-harvest waste and losses[60].

6. Explicitly address social inequities in water-nutrition linkages

Vulnerable groups need to be proactively included in the development of water services, including incorporating their needs and constraints into initial infrastructure design. For rural smallholders who most lack water and food security, irrigation design should consider multiple uses of water, such as drinking, irrigation, and livestock watering to meet women's and men's needs. While women make up a large part of the agricultural workforce, they often lack recognition and formal rights, and farmers are often considered to be 'male' in many parts of the world. Women's productive roles should be promoted, and they should be trained in irrigation and water management. It is also important to ensure that women and disadvantaged social groups (e.g. lower castes, stigmatized social groups) have equal access to credit, irrigable land, labor, and markets to buy agricultural inputs and sell their produce[61].

7. Improve data quality and monitoring for water-food system linkages, drawing on innovations in ICT

Better data are needed to truly understand the water footprint of diets, and devise policies that co-maximize water and food security and nutrition goals. Challenges include poor water and poor food intake data and a lack of indicators connecting the two; but improvements are emerging.[62] Better and more data will support better water management and food systems and increase transparency in decision making. This requires sustained investments in monitoring of a wide range of hydrological and food-related parameters worldwide. Modern Earth observation methods can support larger-scale assessment[63], but need to be complemented by dedicated field measurements.

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Appendix 1. SDG 6 targets on water and sanitation

SDG 6 targets
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
Implementing mechanisms
6.A By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies
6.B Support and strengthen the participation of local communities in improving water and sanitation management