Linking water, sanitation and agricultural sectors for food and nutrition security

Discussion brief

August 2017

Introduction

The Sustainable Development Goals (SDGs), envision that "all people should have access to safe water and sanitation and to safe, nutritious and sufficient food", emphasizing that development challenges are numerous and interacting, underlining the need for integrated solutions.

"The advantages of integrated water, sanitation and food system management is that the concept links key thematic issues that are the root causes of poverty, disease, hunger and malnutrition in developing countries. This holistic view eliminates treating each theme in a silo and creates a nexus approach that ensures policy-makers can have a unified platform for action in project intervention initiatives."
– Noumbissi Tenku, Eco-Relief

Water is crucial to human survival and well-being. The micronutrients in water contribute to nutritional security, water is important for cleaning food as well as for personal hygiene. However, water can easily become contaminated through e.g. use of poor or non-existent sanitation infrastructure. If present in drinking water, pathogens from human faeces can cause diseases, such as diarrhoea and intestinal infections, which reduce the body's ability to absorb essential nutrients from food, leading to undernutrition. Safe water, sanitation and hygiene are therefore considered essential to nutritional security, especially for children (WHO et al. 2015).

Moreover, irrigation water can improve agricultural productivity and food security and make crops less vulnerable to dry weather conditions. Yet irrigation water as well as fertilizers is generally expensive and not available to many poor farmers. On the other hand, human excreta also contains many of the plant nutrients important for food production. On average, a person annually excretes 4.5 kg of nitrogen, 0.6 kg of phosphorus and 1.2 kg of potassium -enough to produce 250 kg of cereal, the equivalent of a person's average annual consumption (Drangert 1998). Subsequently there is growing interest in nutrient recovery from sanitation waste.

Understanding the context-specific linkages between water, sanitation and food production enables stakeholders to take advantage of synergies between them and to optimize strategic (policy) interventions to meet multiple needs. Integrated management of these sectors can enable a coordinated approach whereby nutrients are recycled for increased food production while contaminants are kept out of water and food supplies, as well as natural ecosystems.

In Sweden, the water and sanitation sectors are well integrated. However, the link between water quality and food, as well as between sanitation and food production is weaker, although there is certain agreement regarding the need to close the loop and recycle wastewater and nutrients. However, the most common reuse option for wastewater in Sweden is energy generation and producing biogas from sewage sludge. A closely related trend is that utilities that used to handle water and wastewater only are now increasingly managing other types of household waste, especially organic food waste, which is also converted to biogas.

KEY FINDINGS

- **Sanitation is both an opportunity and a threat: well-managed sanitation can promote food and nutrition security, while poor sanitation is a source of contaminants endangering health, environmental and nutritional security.**
- **Integrated management of water, sanitation and hygiene offers critical opportunities for promoting food and nutrition security.**
- **Integrated management is technically feasible. However, it is hampered by several barriers, including silo thinking, lack of cross-sectoral communication, and lack of working models.**
- **To promote integrated management, there is a need for cross-sectoral goals, knowledge-sharing and dissemination of well-illustrated case studies of cross-sectoral management experiences.**

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Throughout 2016, a group of researchers and practitioners in the Swedish International Agricultural Network Initiative (SIANI) examined issues related to the links between water, sanitation, and food and nutrition security. The Expert Group's aims were to a) better understand the links between water, sanitation and agricultural food production; b) learn from Swedish experiences in cross-sectoral collaboration; and c) to develop recommendations for integrated management of water-sanitation-food and nutrition management[1]. This brief presents some of the main insights from the work of the Expert Group, which included workshops, surveys and interviews with a wide range of actors from civil society, research institutes, private and public sector. The Expert Group comprised a diverse membership from academia, NGO and private sector, and was led by: KTH Royal Institute of Technology, Stockholm Resilience Centre (SRC), Stockholm Environment Institute (SEI), and the Salvation Army (Sweden and Kenya-East).

[1] While food security commonly refers to access to safe and nutritious food, the concept of nutrition security includes utilization and absorption of nutrients.

Nutrient and contaminant flows through water, sanitation and agricultural systems

The linkages between water, sanitation and agricultural systems through flows of contaminants and nutrients are extensive, and affected by a large number of factors, such as behavioural patterns, culture, economic incentives and geology (see Figure 1). Examples of beneficial nutrients include trace metals that are important for human health (e.g. calcium and selenium) as well as nutrients that promote agricultural productivity (e.g. nitrogen, phosphorus and potassium). Such nutrients are present in both freshwater and wastewater. However, fresh- and wastewater can also carry contaminants, including chemicals, heavy metals, pharmaceuticals, microplastics, pathogens, that can negatively impact human and ecosystem health. Pesticides and fertilizers used in agriculture can contaminate surface water and groundwater, affecting both ecosystems and the quality of drinking water. Groundwater can also contain high concentrations of toxic trace metals and humans can be exposed to these harmful metals and elements in different ways, highlighting the need for multiple pathway monitoring. Recently, the Swedish Food Agency highlighted the risk of arsenic exposure in Sweden through imported rice (Kollander and Sundström 2015), demonstrating that water challenges in the Global South can have impacts around the world. With the focus of attention being on arsenic and fluoride, possibly similar linkages for elements like uranium, boron, manganese and lithium require further research.

When untreated or insufficiently treated wastewater is discharged into surface waters, the plant nutrients it contains contribute to eutrophication resulting in oxygen depletion that adversely impacts aquatic life. In an alternative scenario, wastewater, sewage sludge and other waste products can be used as substitutes for agricultural fertilizers and thereby both increase resource efficiency and soil fertility, while reducing flows of plant nutrients into surface waters (Andersson et al. 2016). The reuse of wastewater and treated excreta in agriculture is gaining increasing acceptance as a way to improve resource efficiency and boost food security. However, there are concerns over how soil quality and food safety are affected by the possible presence of contaminants in waste-derived fertilizers, such as pathogens, heavy metals (e.g. cadmium) and pharmaceuticals. To address this issue, Sweden created the REVAQ certification scheme. REVAQ focuses on upstream work to reduce contaminants entering wastewater streams in the first place, and aims to raise farmers' confidence in the quality of sludge. In addition, recent technologies like fly larvae composting for treating sludge and other organic wastes may address the challenge of certain emerging contaminants (Lalander et al. 2016).

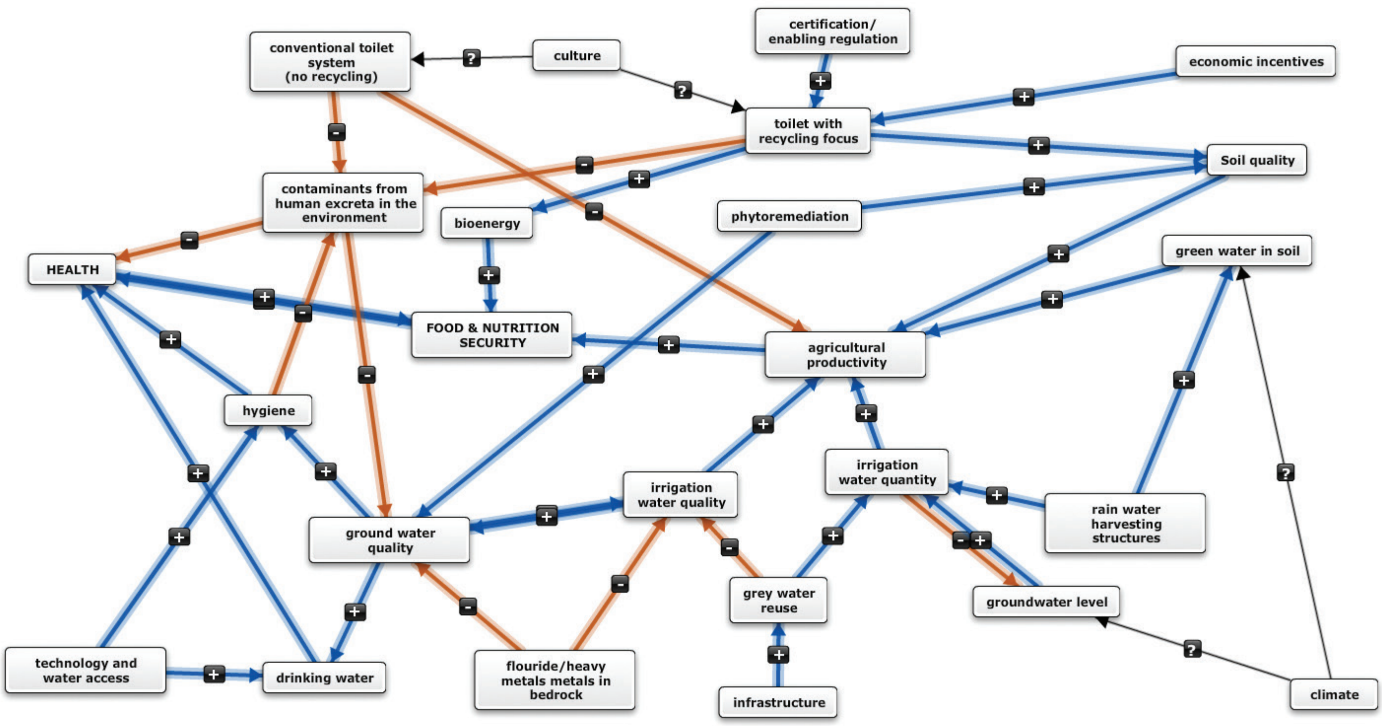

Figure 1. Causal loop diagram, showing links between water, sanitation and food production for human "health" and "food and nutrition security". Note: an arrow with "-" indicates that the source variable has a reducing influence on the end variable, while a "+" arrow indicates an increasing influence.

In a workshop organized by the Expert Group bringing together researchers and practitioners, participants designed several "causal loop" diagrams visualizing the interactions between the variables "water", "sanitation", "food production" for "health" and "food and nutrition security" and mechanisms that affect their relationships[2]. A resulting composite diagram identifies important variables and their interactions (Figure 1). An important message emerging from this exercise was that water, sanitation and food systems are linked in an intricate way with complex and dynamic interactions. In such a context, focusing on one sector only can have unanticipated side-effects for other sectors and success of interventions can be limited due to effects on other sectors. This would seem to confirm the hypothesis that an integrated approach dealing with multiple sectors as well as scales simultaneously and adopting a systems perspective is appropriate.

Overcoming challenges and barriers to integrated management of water, sanitation and food production systems

Consultation of practitioners showed that an integrated approach to management of water, sanitation and agricultural food production is generally considered positive, technically feasible, and an important contribution towards achieving the SDGs. However, important barriers to an integrated management approach were identified.

The primary barrier identified was "sector-focused thinking". This could be interpreted as a precautionary approach, as many practitioners also mentioned important knowledge gaps and

[2] The workshop took place 22 March 2016, at the KTH Royal Institute of Technology Dome of Visions, Stockholm.

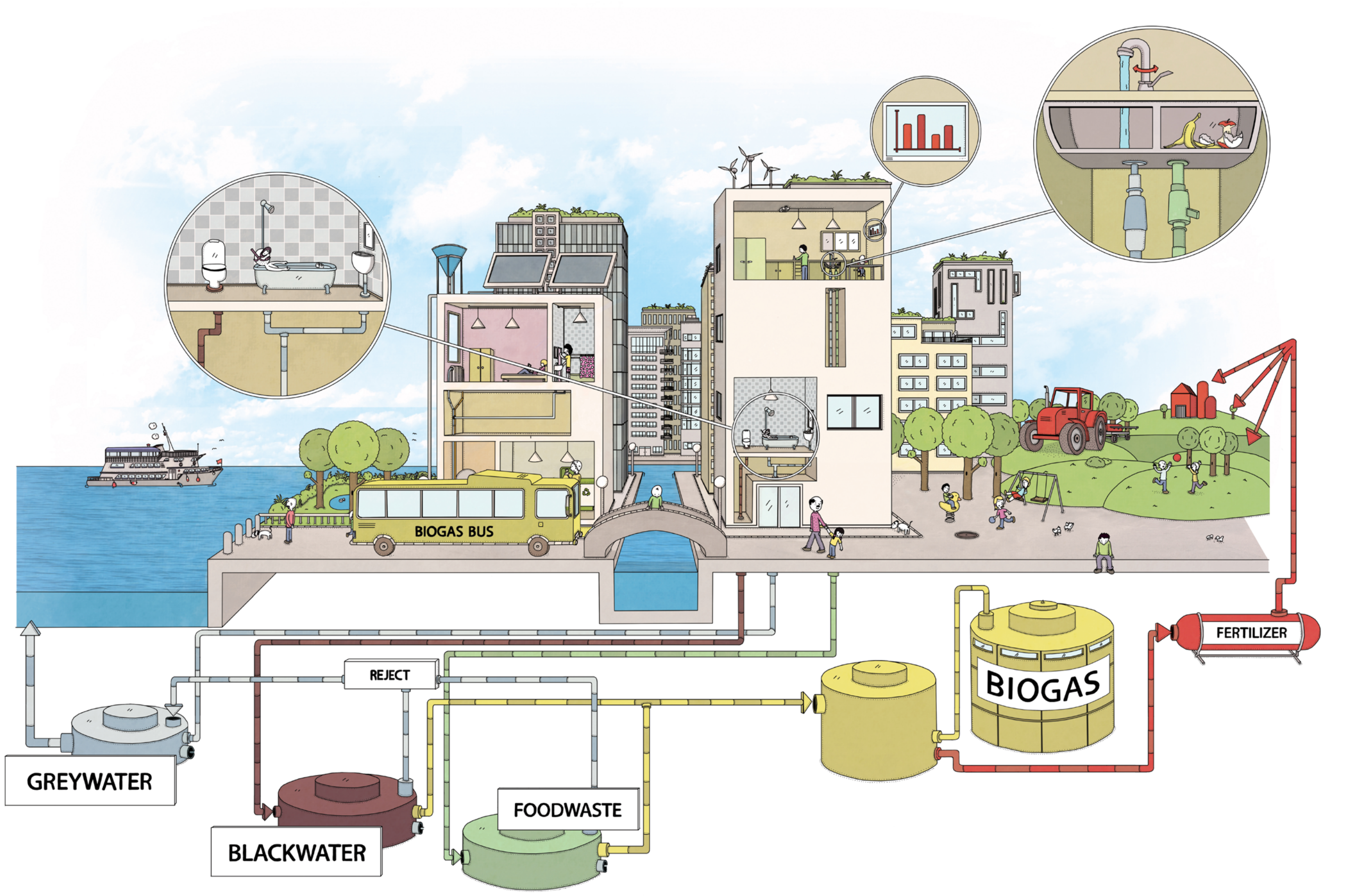

Figure 2. In Helsingborg, H+, a system has been developed which source separates grey water, black water and food waste and treats these separately. Nutrients, heat and biogas is recovered (H Kjerstadius, Lund University, pers. comm.). Schematic provided by NSVA AB.

uncertainty around handling of regulations applying to the different sectors. Further knowledge gaps discouraging practitioners to engage in cross-sectoral collaborations related to the risk of contamination, uncertainty regarding nutrient content of different reuse products, and quality standards for reuse products. As an example, the Swedish Environmental Quality Objectives were described as contradictory, since e.g., recycling nutrients as a way of meeting the Generation Goal is sometimes difficult to reconcile with the goal of a "Non-Toxic Environment", owing to contaminants present in sludge.

Integrated management requiring collaboration between diverse stakeholders with different backgrounds can be a complex process, especially if long established thinking and management approaches are questioned. Despite the challenges, practitioners remained positive about integrated management and suggested that an important starting point would be to develop common goals across water, sanitation and agricultural food production sectors. To set common goals and work towards them across sectors can be challenging, as has been experienced in Sweden, where 16 Environmental Quality Objectives are governed by different sets of regulations and have different authorities responsible for their implementation. For example, the Chemical Inspectorate is responsible for the objective "a Non-Toxic Environment", the Environmental Protection Agency is responsible for the Generational Goal[3] as well as several other objectives, and the Swedish Agency for Marine and Water Management is responsible for "Zero Eutrophication" and "Flourishing Lakes and Streams". However, none of these authorities is directly responsible for food production, despite linkages to "their" goals.

Box 1. H+, Helsingborg: a new model to follow?

H+ is a new urban development project in the city of Helsingborg in southern Sweden. In 2012, the City of Helsingborg put together a working group consisting of the municipal utilities for energy, water, wastewater and waste (EVAA). The major actors in EVAA were the major utility companies, Lund University and a few private companies. EVAA was charged with coming up with innovative integrated systems for H+'s utilities, and after careful investigation, the project team concluded that H+ should have source-separation systems, with three pipes out of each home for greywater (washing water not including excreta), blackwater (wastewater including excreta) and blended food waste (from waste disposal units). The implemented system will recover heat from greywater, nutrients from blackwater, and biogas from food waste and a portion of the blackwater. EVAA's ability to agree to such an innovative solution has been attributed to a collaborative approach bringing together stakeholders from the water, energy and waste utilities along with academia, public-sector and private-sector players. The team engaged the Swedish Federation of Farmers in the planning process for nutrient recycling and also utilized knowledge gained from previous Swedish research efforts. (see https://hplus.helsingborg.se/miljo/).

[3] The Generational Goal (miljömålet) states that: "The overall goal of Swedish environmental policy is to hand over to the next generation a society in which the major environmental problems in Sweden have been solved, without increasing environmental and health problems outside Sweden's borders." On the Generational Goal and Environmental Quality Objectives see https://www.miljomal.se/Environmental-Objectives-Portal/.

Other key messages were the importance of political will for holistic management, as well as the need for communication between sectors. There was also an expressed need for appropriate management models that promote cross-sectoral collaboration. For example, in Sweden, individual municipalities have their own approaches to the management of the water, sanitation and food sectors, with different roles lying within different departments. Some may already have a high level of cross-sectoral coordination, others substantially less. With different municipalities being organized differently, integrated management requires context-specific solutions. Further, the Swedish water and sanitation sector is characterized by largely centralized infrastructure that is designed around a linear approach to resource management. However, innovative designs are starting to be adopted by new infrastructure developments, such as "H+" in Helsingborg (see Box 1) where an integrated management structure was incorporated and is better suited for recycling. Closely related to infrastructure issues is the fact that opportunities for economically viable nutrient recycling also depends on geographical context. For instance, there is less demand for sewage sludge in northern Sweden because of the predominance of dairy farms, who generate their own manure, while in southern Sweden crop farming is more common, for which fertilizer has to be purchased.

Opportunities for more integrated management

Unlike Sweden, many low- and middle-income countries are not yet locked in by conventional water and sanitation infrastructure. Thus they have an opportunity to link water, sanitation and food production cycles in an integrated manner. If successful, this could, for example, lead to improved water management within a catchment, as farmers and households conserve water, as well as decreased contamination of water resources with pathogens and chemicals.

On several occasions, the importance of awareness of local context and integrating local knowledge into projects was raised by both researchers and practitioners. There is much to gain from combining local knowledge with scientific expertise, particularly in identifying context-appropriate solutions, as well as building local capacity if community members are involved in a project from the start (see e.g. von Brömssen et al. 2007).

Extensive knowledge has been generated in Sweden over the years regarding the integrated management of water, sanitation and food systems and nutrient recycling, for both Swedish and international contexts. For instance within research programmes like the current SEI Initiative on Sustainable Sanitation (www.sei-international.org/sustainable-sanitation) or EcoSanRes (2000–2011), and from pilot projects like Hammarby Sjöstad, Stockholm, where biogas from the wastewater treatment plant is used to warm households and as fuel for public transport (www.sjostadsverket.se). To capitalize on this knowledge, there is a need for platforms to share knowledge and expertise across sectors, including the agricultural sector. In Sweden, trade associations like the Swedish Water and Wastewater Association and the Swedish Waste Management Association have a strong membership base and can mobilize a wide range of stakeholders. Other useful avenues for knowledge sharing and development are centres that have been set up by local authorities, which attempt to gather actors from research, private sector and public authorities (e.g. www.vattencentrum.se). Similar information-sharing hubs might also be relevant for actors in low-income countries. A major benefit from the work of this interdisciplinary and cross-sectoral Expert Group was that it facilitated discussions between sectors that do not normally interact. In particular, these interactions indicated that the links between sectors dealing with water quality and human health and nutrition need strengthening, as well as the link between sanitation and food production. The systems are complex, and context-specific solutions and tailored management that can adapt to changing circumstances are important.

About this brief

This brief is based on the work of a SIANI Expert Group "Linkages between water, sanitation and food production for food and nutrition security" between January and November 2016. The findings are derived from seminars, workshops, interviews with experts, a panel at the 2016 Development Research Conference (Stockholm University, Sweden) and an online survey of key stakeholders. The core membership of the Expert Group comprised researchers and practitioners from: KTH Royal Institute of Technology, Stockholm Resilience Centre (SRC), Stockholm Environment Institute (SEI), and the Salvation Army (Sweden and Kenya-East). The group benefited from input from a wide range of actors from civil society, research institutes, private and public sector. We wish to thank all who contributed with presentations, interviews and who answered our survey questions!

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