WASH, FOOD SECURITY AND THE ENVIRONMENT:

MAKING THE LINKS[1]

BROOKS KEENE –POLICY ADVISER, CARE

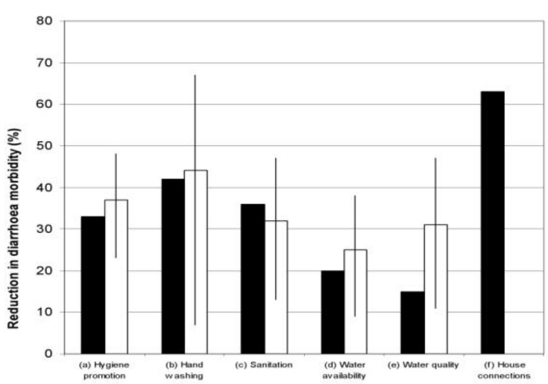
Links among water,[2] food security, and the environment are not a new area of study, but now are gathering increased attention as a result of some very visible drivers. Principal among these are sharp increases in food prices both in 2008 and 2011, increased attention to the current and anticipated impacts of climate change on water resources, acute water shortages experienced by many communities world-wide, and large land/water purchases by states such as Saudi Arabia and China across the developing world. These more visible and news-worthy drivers are accompanied by a growing awareness of the critical roles that safe water, sanitation and hygiene (WASH) play in achieving adequate nutritional levels and averting child mortality.

This discussion paper aims to summarize the primary linkages between food security and water, based on some current data. The paper should foster discussions among practitioner communities that sometimes operate in separate silos, and that it can be used in a common messaging with joint programmatic formulation and implementation, policy positions and advocacy actions. Note that this paper focuses on the issue of the 'what' rather than on the 'for whom' and 'by whom', i.e. it does not address issues of social positioning, nor does it map out a theory of change – these broader issues need to be discussed in parallel.

WASH AND NUTRITION

With respect to food security linkages, organizations and practitioners focusing on WASH have tended to focus primarily on the well-demonstrated impacts that drinking water, sanitation and hygiene can have on nutrition: that is the ability to keep calories in once ingested. The peer-reviewed literature focuses on the ability of WASH interventions to prevent diarrheal disease and, to a lesser extent, neglected tropical disease such as soil-transmitted helminthes (infection by one of a number of species of intestinal worms). In countries with high child mortality rates, diarrhea accounts for more deaths in children under five than any other cause of death – more than malaria and HIV and AIDS combined.[3] Figure 1 (left) shows the results of reviews of the significant effects of WASH interventions on morbidity resulting from diarrheal

Figure 1: Impact of WASH Interventions on diarrhea-caused morbidity (% reduction in lost DALYs)



1 Initial draft prepared by Brooks Keene, Water Policy Adviser, CARE and incorporates comments from Helen Pankhurst, Senior Water Adviser, CARE and John Sparks, Millennium Water Alliance.

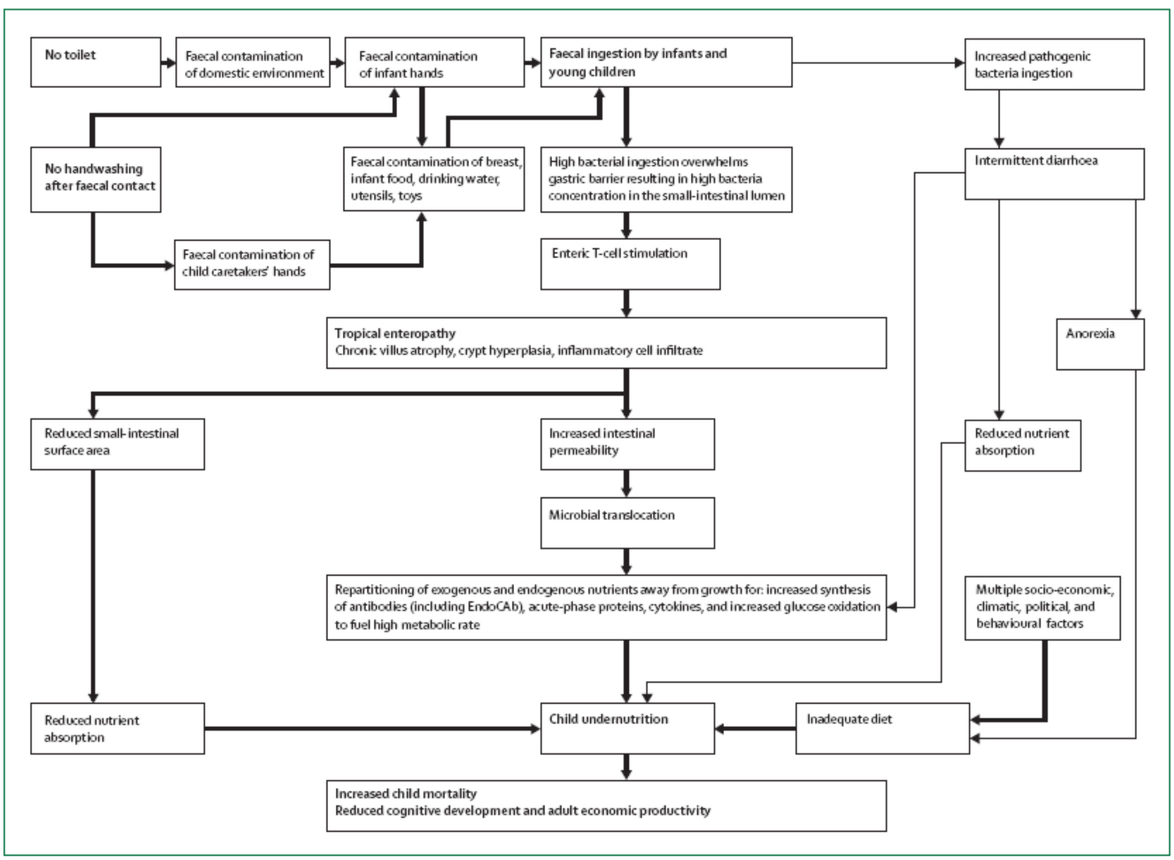
2 For the purposes of this discussion paper, "water" is occasionally used to refer to a broad spectrum of issues, incorporating household water, sanitation and hygiene (WASH); productive uses of water such as irrigation and livestock husbandry; and sustainable ecological management of water resources.

3 UNICEF (2006) Children and Water, Sanitation and Hygiene: The Evidence, occasional paper for the Human Development Report.

disease, as measured in disability-adjusted life-years.[4] In an analysis of demographic and health survey data from 8 countries, Esrey found that improvements in sanitation alone were associated with length-for-age improvements similar to those gained from dietary interventions such as nutrient-dense feeding or infant feeding behavior-change strategies, which account for about a third of stunting.[5]

It is increasingly believed that even the large contributions of diverted diarrheal disease through WASH interventions could be underestimating the impact on malnutrition. The Lancet published a paper in 2009 suggesting that the value of WASH interventions in preventing childhood malnutrition resulting in stunting is undervalued, perhaps significantly. The paper points to the importance of sanitation and hygiene in preventing tropical enteropathy, a condition where children experience a hyperactive immune response as a result of a large pathogens load at a young age. The suspicion is that children who have adopted such a hyperactive immune response chronically task nutrients away from growth and towards synthesis of antibodies. They might also experience reduced nutrient absorption due to decreased surface area of the small intestine. The chronic nature of enteropathy might well mean that its sum impact on nutrition dwarfs that of diarrheal disease, which occurs in short, acute spells. Figure 2 (below) shows the different pathways by which poor hygiene and sanitation can lead to malnutrion in children.[6]

Figure 2: Pathways for child malnutrition and mortality resulting from poor sanitation and hygiene



4 Bartram J, Cairncross S (2010) Hygiene, Sanitation, and Water: Forgotten Foundations of Health. PLoS Med 7(11): e1000367. doi:10.1371/journal.pmed.1000367

5 Humphrey, Jean. "Child undernutrition, tropical enteropathy, toilets, and handwashing." Lancet 2009; 374: 1032-35. September 19, 2009.

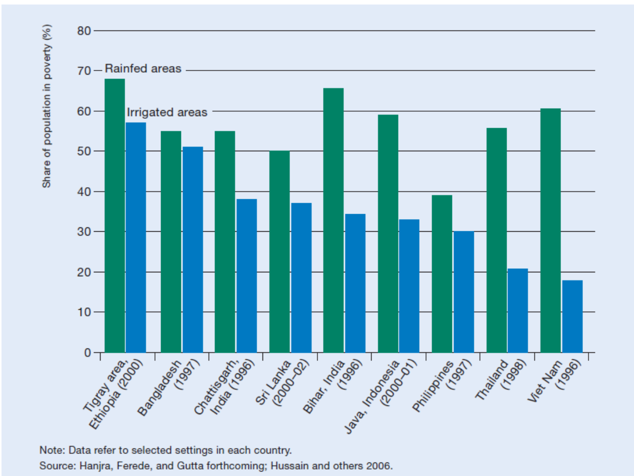
6 Ibid.

WATER FOR AGRICULTURAL PRODUCTION

Communities concerned with food security, while often acknowledging water's role in agricultural production or intensification often leave it out as a substantive area for intervention. Likewise, many water-focused organizations tend to focus almost exclusively on the irrigation aspect of agricultural water use, neglecting a focus on soil or crop varieties as primary pathways for using water efficiently and productively.

It is clear that water is essential to food growth, whether through animal husbandry or crop production. But the impact on crop intensification and, by extension, food supply and farm income can be profound. For example, a study of irrigated and non-irrigated lime production on small-holder farms in Brazil, found an economic return of over 3.5 times for the irrigated farms.[7] Figure 3 (left) compares poverty levels between irrigated and non-irrigated land across a number of studies in varying countries, showing that productivity of irrigated land can be more than twice as high in some locations.[8] In Sub-Saharan Africa, only approximately five percent of cultivated area is irrigated.

Figure 3: Poverty is generally lower in irrigated areas



Likewise, there exists significant potential for gains in the productivity of existing water: getting more crop (or animal) per drop. Productivity gains can be made through a variety of pathways: improved governance of water resources, improved or more appropriate crops and animals, improved farming techniques that maximize water-holding capacity of soil, or infrastructure or earth formations that harvest rain and keep it on the farm.

Figure 4 (right)[9] presents the dramatic increases in yield and decreases in water use that can result by shifting to efficient watering methods such as drip irrigation.

Figure 4: Drip irrigation increases the productivity of water.

RESULTS FROM INDIA IN SHIFTING FROM CONVENTIONAL TO DRIP IRRIGATION

Source: IWRA

Crop	Change in yield (%)	Change in water use (%)	Water productivity (%)
Banana	+53	-45	+173
Cabbage	+2	-60	+150
Sugarcane	+39	-60	+205
Sweet Potato	+39	-60	+243
Tomato	+50	-39	+145

---

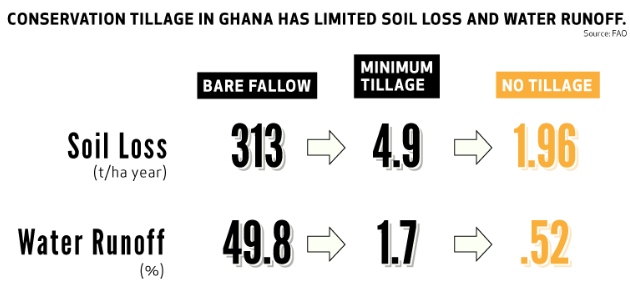
7 "Water management across scales in the Sao Francisco River Basin: Policy Options and Poverty Consequences." CGIAR Challenge Program on Water and Food. UC Davis and Embrapa.

8 Comprehensive Assessment of Water Management in Agriculture. 2007. Water for Food, Water for Life: A Comprehensive Assessment of Water Management in Agriculture. London: Earthscan, and Colombo: International Water Management Institute. Page 154.

9 Graphic from http://www.farmingfirst.org/green-economy/. Postel, Sandra et al. "Drip Irrigation for Small Farmers." International Water Resources Association. Water International, Volume 26, Number 1, Pages 3-13, March 2001.

A variety of farming practices have been shown to increase the water-holding capacity of soil. Among these could be counted a variety of agro-ecological approaches rooted in organic and permaculture methodology. For example, a 22-year study by David Pimentel at Cornell University found that "organic farming produces the same yields of corn and soybeans as does conventional farming, but uses 30 percent less energy, less water and no pesticides."[10] The study also found that in drought years, yields from legume-based fertilization (green manures) were 22 percent higher than from conventional farming systems, suggesting that the soil held water for longer periods of time. Conservation agriculture, which emphasizes minimum or no-till approaches, can also have a large impact on water-holding capacity and runoff from farms. Figure 5 (left), shows the results of one study in Ghana from conservation tillage. Water loss was reduced by almost two orders of magnitude, while soil loss decreased even more dramatically.[11] A variety of traditional agricultural techniques such as use of stone bunds and grass strips for erosion control, when combined with improved soil fertility in arid areas have been shown to increase crop yields.[12]

Figure 5: Limiting tillage decreases soil and water loss.



Biochar, or organic material burned in the absence of oxygen (pyrolysis) has also been shown to increase the water-holding capacity of soils.[13]

Similarly, with respect to animal-based systems, the CGIAR Challenge Program on Water and Food is currently researching ways to get more "animal per drop" in the Nile Basin across Uganda, Ethiopia and Sudan.

NATURAL RESOURCES UNDER STRAIN

Longer term, water quantity will be one of the primary drivers of the gap between demand and supply of food in the near future. It is estimated that food production will have to increase between 70 and 100 percent by 2050 to feed a growing population, and one that is also consuming increasing amounts per capita.[14] Figure 6 (next page, right) shows the predicted global water gap through 2030. The vast majority of current water use as well as a large majority of the world's future water will be agricultural, even as the gap grows to an estimated 2700 billion m^3.[15]

---

[10] Lang, Susan. "Organic farming produces same corn and soybean yields as conventional farms, but consumes less energy and no pesticides, study finds." 7/13/05. http://www.news.cornell.edu/stories/july05/organic.farm.vs.other.ssl.html

[11] Graphic from http://www.farmingfirst.org/green-economy/. Opara-Nadi, O.A. "Conservation tillage for increased crop production." UN FAO: http://www.fao.org/docrep/t1696e/t1696e09.htm.

[12] Zougmoré, Robert et al. "Rôle des nutriments dans le succès des techniques de conservation des eaux et des sols (cordons pierreux, bandes enherbées, zaï et demi-lunes) au Burkina Faso." SCIENCE ET CHANGEMENTS PLANÉTAIRES / SÉCHERESSE. Volume 15, Numéro 1, JANVIER-FÉVRIER-MARS 2004.

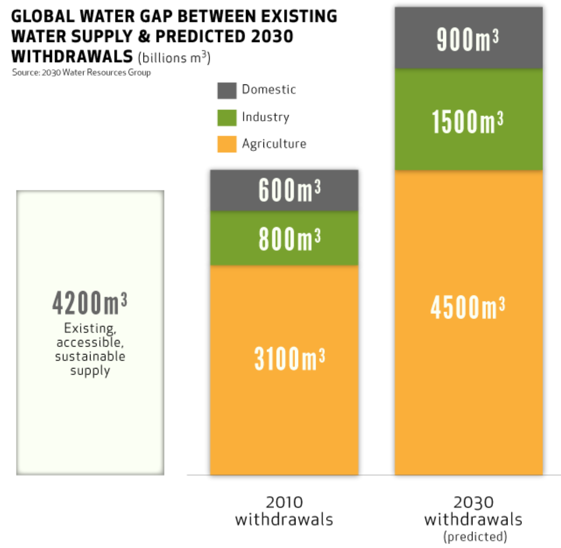
[13] Shackley et al. "Biochar, reducing and removing CO2 while improving soils: A significant and sustainable response to climate change." UK Biochar Research Centre. Working Paper 2. May 2009. Page 5.

14 "World Economic and Social Survey 2011: The Great Green Technological Transformation." United Nations Department of Economic and Social Affairs. New York, 2011. Page 67.

15 Graphic from http://www.farmingfirst.org/green-economy/. "Charting our water future: Economic frameworks to inform decision-making." 2030 Water Resources Group. 2009.

Equally, water quality is also jeopardized by human food production, and especially agricultural runoff, much from industrial confined animal feeding operations. It is estimated that dead zones in marine ecosystems now involve some 245,000 km^2 involving 400 river systems.[16] In the U.S., an analysis from the Government Accountability Office found that, since 2002, 15 government-sponsored or peer-reviewed studies on animal feeding operations have directly linked air and water pollutants from animal waste to specific health or environmental impacts.[17]. China's rising meat consumption is also a significant factor. The average Chinese citizen's meat consumption has quadrupled since 1980 – a trend that will result in greater stress on water quantity due to the amount of grain required to feed the animals.[18]

Figure 6: Agriculture is driving a global water gap



Climatic changes that play out in terms of water availability are further undermining the long-term sustainability of food supplies. While human overuse of water resources will cause shortfalls in itself, climate change is expected to speed up this process through increased unpredictability including droughts that will cut food production and increased flooding that will wash away arable topsoil. Furthermore some estimates suggest that as much as a third of all greenhouse gas emissions are caused in food production which means that industrial agricultural production is also a driver of climate change—and by extension water insecurity.[19]

SANITATION AND FOOD PRODUCTION

Both the food security and WASH communities have a very strong rationale for thinking about the potential for closing the human waste cycle, a field commonly referred to as ecological sanitation. The benefits of designing successful models for doing so could be manifold but two primary benefits stand out for each community.

Food safety is a large concern in the global south as crops are often irrigated or washed with surface water that is contaminated. Global estimates of the total area under raw and diluted wastewater irrigation are still fragmentary, but might range from around 3 to 3.5 million hectares. This is twice the area under formal vegetable irrigation in the whole of Africa. There is little doubt that this wastewater both creates economic benefits as a result of added nutrients and harms health. For instance in Pakistan, wastewater farmers typically earn 30-40

16 Diaz, Robert and Rutger Rosenberg. "Spreading Dead Zones and Consequences for Marine Ecosystems." Science. 15 August 2008. Vol. 321 no. 5891. Pages 926-929.

17 "Concentrated Animal Feeding Operations: EPA Needs More Information and a Clearly Defined Strategy to Protect Air and Water Quality from Pollutants of Concern." United States Government Accountability Office. 09/08.

18 Lindsay, Greg. „The Bacon Uprising: How China's Top-Secret Strategic Pork Reserve Is Burning Down The Amazon." 7/14/2011. http://www.fastcompany.com/1766646/and-bacon-for-all-how-chinas-craving-for-pork-is-burning-down-the-amazon-and-leading-to-a-ri.

19 Lappé, Anna. "The Climate Crisis at the End of Your Fork." The Sustainable Table. 9/2008. http://www.nyu.edu/sustainability/pdf/Climate%20Change%203%20FCSummit-HO-20091204.pdf.

percent more per year than farmers using conventional irrigation water.[20] The downside is increased diseases from microbial contaminants found in human and animal waste.

Many sanitation-focused actors are currently at work on developing technologies and systems that can make use of human waste as a fertilizer while controlling health risks, for example GIZ has had a campaign focused on "sustainable sanitation" since 2001, and the Gates Foundation has recently announced its intention to "Reinvent the Toilet" through its grant making in ways that capture the benefits of human waste.[21] Simple and existing technologies have already been deployed successfully, for example Catholic Relief Services has supported construction of almost 60,000 arborloos in Ethiopia with a high level of acceptance from communities.

OPPORTUNITIES FOR COLLABORATION

Numerous opportunities exist for increased collaboration between the WASH, food security and environmental communities. Some of the opportunities could be:

- **An advocacy and programmatic alliance between water resource management experts, food security specialists and environmental groups with joint advocacy messaging around important linkages and for combined program funding** – Bilateral and private donors as well as civil society organization are largely taking a piecemeal approach to these issues, and yet there is an inescapable logic to a more harmonized approach. There is also a shared interest in a strong funding environment, in promoting high-quality programming that is effective and sustainable and in innovatory approaches – all this provides an opportunity that can be seized.

  In addition, internally, advocacy communities could also achieve efficiencies by leveraging shared events and lobbying. For example, the WASH community could benefit by playing on food insecurity in the news while food security advocates could leverage a well-organized WASH sector, including large events around World Water Day and other key opportunities.

- **Sharing existing metrics and developing a common set for achieving impact** – Metrics in each part of the equation could usefully be brought together, compared and improved. This could lead to increased understanding of how "stacking" interventions could yield even greater impacts and begin to give some idea of relative cost-effectiveness of different interventions.

- **Development of unified programmatic approaches which combines food security, WASH and environmental protection aspects** – This could be relatively straight-forward. **WASH aspects** of the programs would address the large percentage of malnutrition caused by WASH-related disease while food security aspects would look at the treatment and calorie-in side of the equation.

  Where initiatives are looking at **food production** the issue of opportunities for effective and sustainable uses of ground and surface water supplies should be an area given attention for all the inter-connected

20 Drechsel, Pay et al. "Recycling Realities: Managing health risks to make wastewater an asset." Water Policy Briefing. Global Water Partnership Advisory Center at the International Water Management Institute.

21 See http://www.gatesfoundation.org/watersanitationhygiene/Documents/wsh-reinvent-the-toilet-challenge.pdf and http://www.gtz.de/en/themen/8524.htm.

reasons outlined earlier. For example, ways of producing food that do not over-use water and soil resources are urgently needed and should be supported by technical experts and advocates from the water, agricultural and environmental sectors, especially given anticipated increases in world population and meat consumption. These should be focused on agro-ecological approaches that mimic natural systems, decreasing the need for irrigation and external inputs such as pesticides and highly soluble mineral fertilizers that can pollute waterways. These approaches heavily emphasize preserving and building humus in the soil, a prime medium in itself for water storage.[22]

Not coincidentally, the same agro-ecological approaches to food production that help **conserve natural resources** can both be more resilient to **climatic shocks** as they involve water storage and building soil health and mitigate greenhouse gas emissions as they often involve increasing soil carbon levels. There exists a real opportunity for an alliance between environmental groups, water resource management experts and food security experts to push for a food system that can preserve ecosystem services, ensure that water is used sustainably and that food production is intensified in ways that enrich farmers.

As well as the linkages on the water element, the **sanitation** side of WASH also has potential for a more integrated link with food and the environment through making use of human waste as compost through eco-sanitation or as bio-gas.

CONCLUSION

There is broad potential for collaboration between food security, WASH/water and environmental actors on win/win issues related to the intersection of water and food. This potential exists both in programming and advocacy. While a small amount of collaboration does already exist, it is far below the level that the data would suggest is possible. In order to do so, the three communities will need to dramatically increase the level of energy and dialogue put into defining and aligning collaborative efforts with already overlapping content. Furthermore, this collaboration needs to be framed in terms of what is being undertaken – as presented above - but this, in turn, needs to be framed within a theory of change which articulates a goal and pathways for change – i.e. clarifies the how and for whom.

22 For a discussion of these approaches, see, for example: Collette, Linda et al. "Save and Grow: A policymakers guide to the sustainable intensification of smallholder crop production." UN FAO. 2011.