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Water use, food security and disease: Achieving healthy outcomes
Report on a Workshop held at World Water Week, Stockholm, 27 August 2019

This meeting was organized by the Agriculture for Nutrition and Health (A4NH) and the Water, Land and Ecosystem (WLE) collaborative research programmes of the Consultative Group on International Agricultural Research (CGIAR), in collaboration with Deltares and The Bridge Collaborative. Participating member institutions of the collaborative programmes included the London School of Hygiene and Tropical Medicine (LSHTM), the International Water Management Institute (IWMI), the International Food Policy Research Institute (IFPRI) and AfricaRice.

The event was selected competitively to be a workshop for the 2018 World Water Week in Stockholm, and held on 27 August 2018. This report presents the rationale behind the meeting, a summary of presentations and discussions, and actions taken following the meeting.

Rationale

The relationship between water use and human health has a long history, achieving particular success in public health interventions in water, sanitation and hygiene (WASH). However, the 21st century has seen a dramatic change in water use associated with the drive to improve food security and nutrition in the face of climate change, which bring new and complex challenges for human health. The direction of water resources into rapidly growing programmes of agricultural intensification is creating new interactions between water, food, nutrition and disease. For instance, rural dam building and irrigation schemes in Africa are increasing malaria risks in regions targeted for malaria elimination, while redirection of wastewater into vegetable and livestock production is creating new risks for food- and vector-borne disease in dense urban populations. An unprecedented collaboration between environmental, agricultural and medical research is needed to understand how to improve water's contribution to food and nutrition security without increasing disease risk.

This workshop brought together experts from all of these fields to present recent interdisciplinary research on the water-food-nutrition-disease nexus. The workshop took a specific case study for examination, the management of malaria and its relationship to crop production and irrigation. It was run as a series of presentations, integrated with participatory sessions for participants, who included participants in World Water Week, representing a breadth of interests and expertise in water management and development. It was one of the few presentations at World Water Week to address this interaction between water, agriculture and disease.

Summary of Presentations

An introductory presentation by Jeff Waage (LSHTM) and Javier Mateo-Sagasta (IWMI) surveyed the relationships between water use, agriculture and infectious diseases. Water and agriculture can influence health in two ways. One is through impacts on food and nutrition – for instance, recent studies in India show that more healthy diets are also far less water demanding. A second route, and the focus of this workshop, is through impacts on food and health, with agricultural water use being a source of pollutants, and a breeding site for vectors of infectious diseases. Work by IWMI in Ghana on pollution of foods by use of waste-water for agriculture shows levels of

microbial contamination on vegetables in markets which are far above WHO recommended levels. Vector borne diseases associated with irrigation include mosquito-borne diseases such as malaria and snail-borne diseases such as schistosomiasis. The presentation concluded with a focus on rice production and malaria in Africa, identifying this as a clear example of a complex interaction between three regional development priorities: improving water resources, increasing food production, and eliminating malaria.

The next three papers presented current evidence regarding the three distinct components of the problem in question, the status malaria in Africa, the current and future drivers of rice production there and trends in African water management for irrigation. Jo Lines (LSHTM) explained that malaria prevalence has fallen dramatically in Africa in recent decades due to widespread introduction of insecticide-impregnated bednets and improved access to malaria drugs. However, resistance to insecticides and anti-malarials is increasing and history shows that relaxing malaria control programmes leads quickly to disease resurgence. To achieve new international and national ambitions to eliminate malaria, new focus must be placed on vector control. The principle vector of malaria in Africa is *Anopheles gambiae*, a mosquito that has a strong preference for breeding in shallow sunny water, making rice fields an ideal breeding site. Hence, rice intensification poses a particular threat to the next steps to malaria eradication.

Kazuki Saito (AfricaRice) explained that rice is grown by 150m farming families worldwide, a quarter of world farmers, using 35% of the water globally used for agriculture. Most of this production is in Asia, but rice production is growing rapidly in Africa, driven by growing GNP per capita and a growing urban population, who prefer the convenience of rice preparation relative to traditional staples. But presently 40% of rice consumed in Africa is imported, and African yields are far below what is achievable, partly due to a lack of good irrigation systems. Africa has substantial potential for improved irrigation, and this will be important to African plans to rapidly intensify rice production towards food security and self-sufficiency in this commodity.

Eline Bolee (Deltares), and Matthew McCartney (IWMI), in a paper presented by Cees van de Guchte (Deltares), showed how Africa lags far behind other countries in the world in the use of water for agriculture, despite the enormous demands there for increased food production, which irrigation could support. Most of agriculture in Africa is rainfed, only 2% of available water resources are extracted for agriculture, in contrast to 14% in Asia. Fluctuations in rainfall, particularly with climate change, reduce water security and recommend the development of dams for water storage in agricultural areas. While this has been successful around the world, dam building in Africa is still limited. Large dam building, for power generation as well as agriculture, is increasing: more than 2000 large dams have been built, over 200 are currently under construction and many more are planned in sub-Saharan Africa (SSA) but there are many other, more local ways of storing water which will benefit future African food security through dependable water supplies for crop irrigation.

The next set of presentations focused on the evidence for interactions between agriculture, irrigation and malaria. Matthew McCartney (IWMI) presented a paper with IWMI and Deltares colleagues on links between large dams and malaria in Africa. They showed that malaria levels were higher in communities near dams than in areas further away, presumably due to breeding of mosquito vectors in dams and associated irrigation schemes, particularly in areas of unstable malaria. By geo-referencing dams and populations, they predicted that future dam-related malaria cases will grow as dams proliferate and populations increase. They finished by presenting evidence that varying water levels in dams could reduce mosquito populations without necessarily affecting the use of dams for irrigation and power generation.

Kallista Chan (LSHTM) presented a paper on the association between rice production and malaria in Africa. Studies comparing malaria in rice-growing and non-rice communities have been undertaken over recent decades. An analysis of these up to the 1990s reveals a "paddy paradox" – while mosquito biting rates may be up to 300 times higher in rice communities, malaria prevalence was usually the same or lower. Of the possible explanations for this, the most popular is that rice growing also increases farmer wealth, permitting investment at the

household level in malaria prevention (e.g. nets and drugs). However, a re-analysis of these comparative studies with newer sites and data shows that, since the 1990s, as malaria prevalence has fallen overall, rice-growing villages have emerged as hotspots for malaria. The final part of the presentations focused on experiences with implementing irrigations practices to manage malaria. Dr. Rousseau Djouaka from the International Institute of Tropical Agriculture in Benin was unable to participate and present his research in West Africa showing that intermittent irrigation, raising and lowering water levels at roughly weekly intervals, can dramatically reduce levels of mosquito production.

Carmen Cruz Gamboa (DPCEM) from the Peruvian Department of Health presented an inter-ministerial programme developed in rice growing regions where, as in Africa, local malaria vectors bred in irrigated rice fields. This programme involves intermittent irrigation of rice in a water insecure region. Results from one region showed a 30% reduction in water use, a 75% reduction in mosquito numbers and a 20% increase in rice yield. Similar benefits were seen in other rice growing areas. The evolution of this cross-sectoral collaboration, from research started in 1995 to a national programme supported by a governmental executive order in 2014, was explained. Uptake now by farmers' groups supports the continuity of this win-win solution to an agriculture-water-disease challenge.

Discussion and Feedback

The workshop participants then broke into smaller groups to discuss interactions and interventions, led by Kari Vigerstol from the Bridge Collaborative and Claudia Ringler from IFPRI. The Bridge Collaborative is an international initiative coordinated by the Nature Conservancy, IFPRI and others to align action planning and evidence use across conservation, health, and development. On the general water-food-nutrition-disease nexus and the rice and malaria case study, discussion focused on complementary foods in infancy is a principal strategy for reducing stunting, but how much attention is being given to the role that water-borne diseases play in stunting through contamination of these foods and resulting illness, including diarrhoea. Participants identified recent evidence of high levels of infection of children under five with food and water borne diseases, and a number of projects in Asia and Africa on the relationship between complementary feeding and disease were identified, including development of guidelines on best practices from WHO and others.

With respect to the case study on rice and malaria, the following suggestions were made:

- We should consider how reducing water use on rice, to address malaria risks, will impact on other water-demanding activities in a particular area, in order to get a full impression of the costs and benefits of that activity
- We should consider water use from the "bottom up", that is, "what do rice farmers want?" as well as considering the conflicting plans and policies of a number of development sectors (water, agriculture, health). This will be important to creating an enabling environment for any outcome of our research. Farmers organizations are a good contact.
- We should consider where we focus research. The link between rice growing, disease and poverty is an important one and may be strongest in particular regions. Also a focus on rice production near urban areas may allow us to identify particular situations of intense competition for water, malaria risk and the demand for rice by growing urban populations.
- If we would like to investigate geographical patterns of irrigation and malaria in Africa, new technologies (e.g. from the European Space Agency) allow satellite measurement of irrigation activity.
- We should consider vector control strategies using water more widely, including the raising and lowering of dams to reduce vectors, and existing rice-water technologies, such as Alternate Wet and Dry (AWD) to reduce water use and greenhouse gas generation.

Follow up to the Workshop

Besides introducing novel and important health dimensions to the global water and development dialogue, the workshop had a separate aim of bringing together for the first time researchers from four continents working on the rice-malaria-irrigation nexus. Discussions following the workshop identified areas of collaboration and a workplan going forward.

Shortly before our workshop, the Wellcome Trust launched a funding call on Climate Change and Health. This created an opportunity for collaboration, by linking irrigation and malaria work the importance of water management in agriculture on climate change mitigation and adaptation. We discussed possibly collaborations and projects, leading in the following month to two proposal submissions, one led by IWMI on malaria, climate change and dams in Africa, involving LSHTM, Deltares and others, and one by LSHTM on rice irrigation, AWD and malaria in Africa, involving Africa Rice and the International Rice Research Institute. The latter proposal was funded and will start in 2019. While focused on specific field trials in West and East Africa comparing AWD with intermittent irrigation, this project also has provision for two international meetings that will facilitate the continued interaction of the group assembled at the workshop.

We identified a number of current initiatives where our collaboration and ideas might gain more attention. IWMI and Deltares mentioned that there is a new working group in Roll Back Malaria which is specifically considering none conventional approaches to malaria reduction, including ecological ones. LSHTM has since become involved in its meetings.

IWMI and Deltares have established a consortium called Many Dams One Health and produced a brochure on costs and benefits of dams in Africa. The consortium has as its members – IWMI, Deltares, STPH, ICIPE, LSTM, School of Global Health (University of Copenhagen), IFPRI, University of KwaZulu Natal and University of California at Irvine.

Possible collaboration on mapping water use in agriculture and malaria was discussed, as both IWMI and LSHTM have been exploring this area. IWMI has been getting measures of irrigated rice and times of irrigation in Ethiopia from satellite imagery, generating which records evaporation patterns. This approach could be extended. Work is also being done on mapping water use and schistosomiasis, involving Deltares and the Swiss Tropical Research Institute, and area of interest to several participants.

Workshop Programme

Time	Title	Presentation	Presenter(s)
09:00	Welcome and meeting objectives		Jeff Waage
09:05	Agriculture, water and disease overview and introduction to case study		Jeff Waage & Javier Mateo-Sagasta
09:15	Bridge introduction and instructions		Kari Vigerstol & Claudia Ringler
09:20	Setting the scene: trends in water use, crop development and disease management	Malaria and related vector-borne diseases: present status and future elimination	Jo Lines
		Rice production in low and middle income countries: present status and future development	Kazuki Saito
		Agricultural water management in Africa: present status and future development	Cees van de Guchte, Eline Boelee & Matthew McCartney
09:35	Interactions between water, crops and malaria – what is the evidence?	Links between large dams and malaria in Africa	Matthew McCartney, Jonathan Lautze, Solomon Kibret & Eline Boelee
		Rice production, malaria and the paddies paradox	Kallista Chan & Jo Lines
09:55	Bridge Questions		Kari Vigerstol & Claudia Ringler
10:00	Addressing the problem: interventions and their results so far	Intermittent rice irrigation introduction in Peru: From a health oriented feasibility study to a sustainable development policy	Carmen Cruz Gamboa
10:15	Interventions, questions and generating new ideas		Kari Vigerstol & Claudia Ringler
10:25	Summary and close		Jeff Waage & Kari Vigerstol

Copies of the powerpoint presentations from the meeting are available from the LSHTM Improving Human Health programme of CGIAR A4NH, please contact Maria.Fernandez@lshtm.ac.uk.