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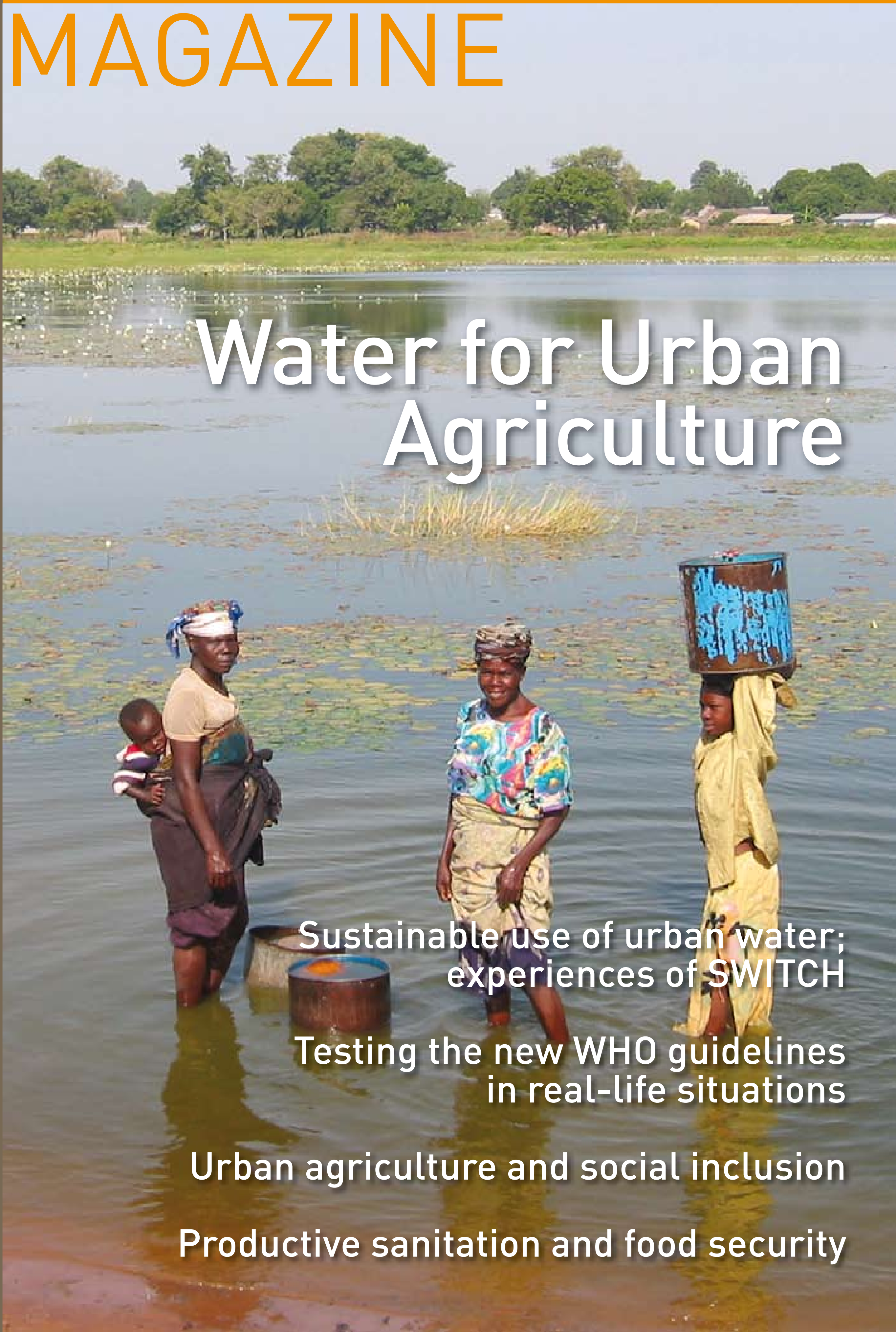

Water for Urban Agriculture

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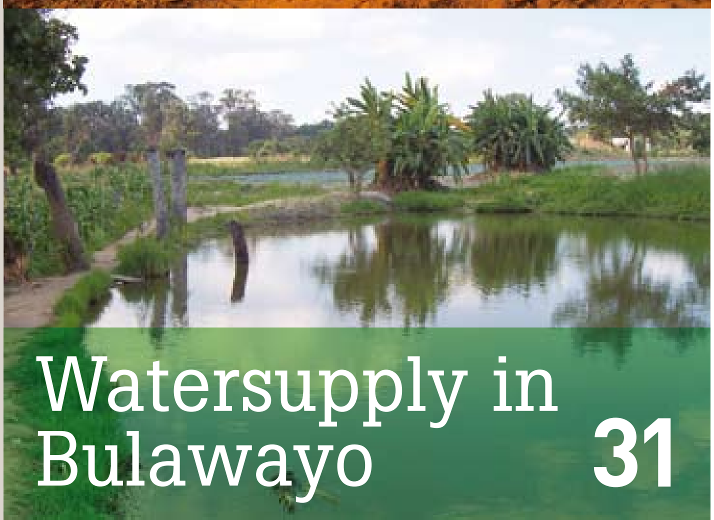

Cover

Water, sanitation and food problems affect people directly. Cities need a longer-term and broader vision of the use of urban space and access to affordable water, good sanitation and food. In this issue of the UA Magazine, which is a collaborative effort of RUAF, SWITCH and SuSanA, the importance of water-sanitation-agriculture nexus is highlighted.

Cover photo (Fetching water in Tamale) by: IWMI-Ghana

Sustainable Use of Water in Urban Agriculture

Olufunke Cofie
René van Veenhuizen

The number of people in the world who live in and around cities is increasing steadily. The "State of the World Cities" report by UN- Habitat (2004) predicted that by 2030, 60 percent of the world's population will live in cities, while the threshold of 50 percent of the world's inhabitants living in cities was reached in 2007. Most often, this rapid urbanisation is only demographic as it is not accompanied by a similar rate of infrastructural transformation, but rather puts pressure on limited urban resources. Coincidentally, the areas of the world with the fastest-growing population already have severe water problems, and the shortages will get much worse.

Urban producers need water for their crops and animals.
Photo: IWMI Ghana

Challenges of urbanisation

Some of the challenges that go with urbanisation are insufficient access to water and sanitation, rising world food prices, and poor local governance. In addition, climate change will also affect the urban water system and thereby the water supply for urban agriculture. Changes in precipitation patterns towards more dry periods and more intense storms may lead to an increased risk of flooding, and thus economic damage or the spread of diseases.
In developing countries, many cities suffer from water scarcity because the water resources are not sufficient or are polluted, or because the capacity to treat and distribute the water is limited. Although it is assumed that 86 percent of urban areas have access to water compared to 50 percent in the rural areas, much urban coverage refers to vendor supply rather than household connections. Only 16 percent of the population of Sub-Saharan Africa, for example, have household connections while this rate is 20 percent and 28 percent in Southern Asia and South-eastern Asia respectively (WHO/UNICEF, 2006). As a great number of urban dwellers (e.g. 52 million people in urban Africa) lack access to improved domestic water supply, the possibility that this limited water resource will be used for productive activities such as agriculture in and around cities is minimal. Many municipal authorities actually forbid the use of domestic water for irrigated agriculture even at the lowest scale. As a greater proportion of economic activity is concentrated in space-confined urban areas, and competition for scare natural resources increases, the development of new (re)sources of water will be needed. Alternative water resources that could be put to productive use in the city are rainwater or stormwater and wastewater.

Although the proportion of people with access to sanitation services in urban areas is considerably greater than in rural areas, insufficient sanitation facilities in many countries has led to the degradation of the quality of water resources. Moreover, improved living standards and socio-economic conditions have led to the generation of waste and wastewater which are mostly discharged untreated into the environment. Open drains function as sewers for domestic wastewater and surface runoff, and as dumping sites for urban wastes. The volume (and value) of untreated human waste which flows directly into water courses and pollutes the environment is of concern.

At the same time, global food demand is increasing and the current food crisis is hitting the urban areas, thereby seriously impacting the urban poor in particular. This has also pushed agriculture higher on the political agenda in recent times with requests for more applicable, diverse and flexible food systems. Farming in and around urban agglomerations is a way of providing some of this food as well as serving other urban functions.

Water for urban agriculture

The link with water is obvious not only for food production but also for greening the cities, among other services (see the articles on Beijing and Lima). These water uses could become much more efficient if stormwater and wastewater were reused for agriculture. The reuse of wastewater for agricultural purposes is common practice, although not always regulated. Farmers fall back on using wastewater as water sources become more scarce. This appears to be an efficient way to save fresh water which could be used for other purposes, and at the same time protect water sources from uncontrolled pollution. However, there are related health risks (see the article on Nigeria). The introduction of urban water reuse requires changes in policy and infrastructure that would affect various stakeholders. Experiments with such reuse are ongoing in a number of cities, and some of these experiments are presented in this issue.

Water, sanitation and food problems affect people directly. Maintaining a healthy environment calls for sustainable management of urban resources. Cities need a longer-term and broader vision of the use of urban space to reduce poverty and promote sustainability. Access to affordable water, good sanitation and food is essential.

Achieving these goals will require integrated approaches and multi-stakeholder participation in the development of service provision and facilitation, and in the management of urban

The SWITCH approach is designed to contribute to a reduction in the vulnerability of cities and an increase in their capacity to cope with global changes pressures

Capturing rainwater allows for several harvests
Photo: René van Veenhuizen

water. In most cases urban planning, urban water and urban sanitation are managed separately. Consultation, joint planning, and joint decision making will be needed to adapt existing policies or develop new ones. New institutions may also need to be created as most cities have various institutions that are independently responsible for certain elements of the urban water and food system (see the experiences in Beijing).

In this issue of the UA-Magazine, the importance of the water-sanitation-agriculture nexus is highlighted. Increasingly it is realised that urban agriculture may contribute to resolving urban problems related to water and waste/wastewater management as well as poverty, social exclusion, and the environment. This issue is a collaborative effort of RUAF, SWITCH and SuSanA.

Facilitating multi-stakeholder platforms and learning alliances

Urban agriculture is often not recognised as an urban livelihood strategy, often due to perceived and real health risks in the use of wastewater. This constrains the reuse of urban water for agriculture. The RUAF programme on Cities Farming for the Future facil-

Managing water for the city of the future

A consortium of experts with academic, civil society, urban planning, water utility and consulting interests are working directly with stakeholders in twelve cities around the globe, namely Accra, Alexandria, Beijing, Birmingham, Bogota, Cali, Chongqing, Hamburg, Lima, Lodz, Tel Aviv and Zaragoza. The overall goal behind this global consortium is to catalyse change towards more sustainable urban water management in the "City of the Future".

SWITCH activities consist of training, research and demonstration. The research process is a combination of:

Learning Alliances – SWITCH is linking up a wide range of stakeholders at city level to interact productively and to create win-win solutions along the water chain. Their activities consist ideally of a series of structured platforms at different institutional levels designed to break down barriers to both horizontal and vertical information sharing, thereby speeding up the process of identification, adaptation, and uptake of new innovations.

Action Research – SWITCH is carrying out more demand-led, action-orientated technological research in cities with a view to achieving greater integration and wider impact through the Learning Alliances.

Multiple-way learning – SWITCH is also promoting multiple-way learning, where cities learn from each other.

The "paradigm shift" in urban water management promoted by SWITCH is based on some key concepts of urban water management: resilient systems; integrated approach; and balanced supply and demand. Resilient systems refer to adaptability and flexibility, providing the best solutions in an uncertain world. Under SWITCH the participating institutions in the learning alliances are facilitated through a number of steps: visioning, scenario (and micro-scenario) building and the subsequent joint development of strategies. Participatory monitoring of progress is undertaken by using agreed sustainability indicators.

www.switchurbanwater.eu

itates action planning and policy development on urban agriculture with multiple stakeholders. Follow-up studies and demonstrations of promising innovations are being carried out under the SWITCH programme.

SWITCH (Sustainable Water Management Improves Tomorrow's Cities' Health; www.switchurbanwater.eu) is an EU-funded action research programme being implemented and co-funded by a cross-disciplinary team of 33 partner institutions from across the globe, including 17 from the EU and 12 from developing countries. SWITCH promotes innovation in integrated urban water management (IUWM) and has organised its training, research and demonstration activities in thematic work packages, which are embedded in the independent city 'learning alliances'. Some of its experiences are presented in the articles on pages 7-20.

The Sustainable Sanitation Alliance (SuSanA) is an open global competence network of more than 90 organisations active in the field of sustainable sanitation that are developing joint initiatives in support of the UN International Year of Sanitation, 2008. More on SuSanA and some experiences with the use of sustainable sanitation for urban agriculture are presented on pages 38-46.

City working groups on urban agriculture

One of the thematic work packages in SWITCH focuses on sustainable water for urban agriculture, which is also related to other themes such as scenario development (for example see page 19), training, joint learning, sustainable sanitation and social inclusion (as presented on page 17). The SWITCH activities on urban agriculture in Lima, Beijing and Accra are complementary to the activities of the RUAF partners under the Cities Farming for the Future Programme, and the institutional innovations already set in motion in the RUAF process (see UA-Magazine no.16). To link the urban agriculture multi-stakeholder platforms and the SWITCH city learning alliances, specific working groups have been set up in these three cities with the task of developing improvements in agricultural production, and other livelihood activities, using freshwater, rainwater and wastewater. Technical and institutional innovations being applied involve techniques like cooperative horticulture and agro-tourism using rainwater harvesting (Beijing), improvements in water storage, on-farm treatment of poor-quality water and its use for agriculture (Accra and Lima) and parks and gardens (Lima). The intention is also to increase awareness of health risks along the farm-to-fork pathway (as in Accra). Changes sought in the three cities include more integrated planning and development of policies (see Accra and Lima), organisational innovations (cooperatives in Beijing and urban producer organisations in Accra) and action to reduce risks to the environment and health of producers and consumers.

Coping with realities

Urban and periurban producers need water (year round or seasonally) to irrigate their crops and provide drinking water to their animals or fish. In the event of water shortages or decreasing quality of the available water sources, urban producers apply various strategies, including the enhancement of access to existing water sources or using these more efficiently, and using other water sources (e.g. rainwater collection, wastewater).

Farmers will take advantage of any water source, especially in the dry season, whether it is polluted or not. They use, for example, the water of streams and canals, shallow or deep wells, pipe-borne (potable) water, water collected during the wet season in tanks, drums or through another storage method, greywater, or recycled municipal wastewater (at different stages of treatment, as shown in the article on Beijing).

Sources of wastewater include surface runoff, city drainage canals, sewage, greywater or blackwater and drainage channels, as well as hospital and industrial wastewater, and combinations of all of these (with varying concentrations). Urban producers/farmers have a variety of motives for using untreated or partly treated wastewater. In semi-arid and arid areas it is often the only source of water available and it is available year-round. It is also an inexpensive source, not just of water but also of nutrients (Raschid-Sally and Jayakody 2008). Detailed case studies of water reuse for urban agriculture with its positive and negative impacts have been widely documented (see UA-Magazine no. 8, and no. 19 for instance). Irrigated urban agriculture produces very competitive profits, and flourishes and spreads without any external initiative or support. It takes advantage of market proximity, the demand for perishable cash crops, and the common lack of refrigerated transport as well as access to wastewater resources.

Producers' choices regarding water sources depend on the intended uses of the water, available and accessible water sources,

Technical and institutional innovations are being applied.
Photo: IWMI-Ghana

Stabilisation ponds reduce contamination risks
Photo: IPES

the price of the water from each source, the degree of contamination and related health risks, the nutrients the water contains, the costs related to transporting and storing the water and the distribution equipment needed, the reliability of the supply, farmers' knowledge (e.g. awareness of health risks), amongst other factors. This is illustrated well in the articles on Ghana and Burkina in this issue. As the contribution from Burkina on page 25 mentions, farmers could be assisted through (training in) safer and more efficient water use management. In addition a constructive dialogue among urban farmers' and their organisations with local authorities should be facilitated.

Recognition of the importance of using various sources of water for urban livelihoods has led to a number of initiatives to cope with this reality. IWMI has undertaken a number of research and development activities with FAO, WHO, and RUAF to ensure safe urban vegetable production. The revised WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater in Agriculture and Aquaculture were published in 2006. Some initiatives have started to use different management options to reduce risk where comprehensive wastewater treatment is too expensive and not feasible in the near future, following the proposed methods and procedures in different urban and periurban farming settings. A number of low-cost risk-reduction interventions have been developed with key stakeholders on the "farm-to-fork" continuum, which are based on the WHO multiple-barrier approach in which barriers (risk-reduction strategies) are implemented along the food chain for cumulative risk reduction. Some of this work is presented in this issue. See for example the articles on the WHO Guidelines on page 21, on reducing health risks on the farm-to-fork pathway as described on page 29, and on the search for alternative water sources like rainwater (illustrated by experiences from China, India and South Africa) and sustainable sanitation (pages 38-40). Werner (2004), cited in the article on SuSanA on page 38, shows that at present farmers worldwide use around 150 million tons of synthetically produced nutrients (N; P2O5; K2O) annually, while at the same time conventional sanitation systems dump more than 50 million tons of fertiliser equivalents with a market value of around $ 15 billion into water bodies. A paradigm shift in sanitation towards a recycling-oriented closed loop approach is needed. However, there are still a number of challenges related to awareness and knowledge, regulation, and the need for data on the existing gap between actual and potential reuse, and on organisational and infrastructural issues, which have been discussed in this International Year of Sanitation (2008).

Because awareness of potential health problems is typically low (and because consumers often have more pressing problems like malaria, poverty and/or HIV), there is little market demand and pressure for greater safety measures in urban agriculture, and hence joint research, joint learning and awareness raising activities are necessary.

The way forward

Urban agriculture faces common challenges as well as city-specific ones. The role and importance of water for urban agriculture and livelihoods varies across the cities, as presented in this issue, both currently and in terms of future perspective. However, there are similarities in terms of water management, water scarcity and the need for new and innovative systems that allow for the use of different sources of water (rainwater and wastewater). Access to water and irrigation is a crucial requirement for farmers to earn sufficient revenues to pull them up and over the poverty line. Sufficient profits with nich products may also allow them to innovate and adopt improved technologies that will improve the complementary role of urban agriculture in the city. While market proximity supports urban farming, urban expansion and environmental pollution constrain its sustainability. Based on proper analysis of farming under urban conditions, the actual role of farming in urban livelihoods, and current opportunities and constraints for its development, ongoing action research in these areas (as presented in this issue) is important to inform city planning and policy making. The process of developing joint action within a multi-stakeholder context requires time and has to be adapted to the particular institutional arrangements and research and planning cultures of the different countries.

Urban challenges related to the water-sanitation-agriculture nexus definitely call for a number of initiatives or interventions, advocacy, multi-stakeholder dialogue and joint action planning. New forms of governance, institutions and policies are needed which are constructed through the synergy created by initiatives, such as RUAF and SWITCH.

René van Veenhuizen, ETC
r.van.veenhuizen@etcnl.nl
Olufunke Cofie, IWMI
o.cofie@cgiar.org

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Using Treated Domestic Wastewater for Urban Agriculture and Green Areas; The case of Lima

Gunther Merzthal
Ernesto Bustamante

Scarcity of water is one of the main problems in Lima, and there is increasing competition for the use of water, for human consumption, agriculture, industry, and green areas. The use of alternative sources is urgently required.

The city of Lima (1) has a surface area of 2,794 km^2 and a population of 7,765,151, with a population growth rate of 2.1 percent annually, and a poverty rate of 46.8 percent (INEI, 2002, 2005 and 2006). Migration from the provinces to the capital of people looking for new livelihood opportunities is high. This growth generates increasing demand for water. However, Lima is a desert city with almost no annual precipitation (around 25 mm per year). The main sources of water for the city are surface water (the Rimac, Chillon and Lurin rivers, which contribute a total of 39.1 m^3/s) and underground water filtrations (from the Rimac, Lurin and Chillon Rivers, which contribute 8.3 m^3/s).

There is some wastewater treatment, but this is relatively limited: 1.6 m^3/s only, representing 9.2 percent of the total (SEDAPAL, 2006). As a result, most wastewater (90.8 percent) is discharged into surface water and eventually to the Pacific Ocean, without any treatment, causing contamination of the surface water and of agricultural products. It should be noted that of the wastewater that is treated 54.4 percent is dumped into the sea, which is a waste of a scarce resource. There is a legislative vacuum at the national level with respect to treatment and use of wastewater for productive and recreational purposes, which complicates sustainable management of wastewater. It is in this context that SWITCH Lima operates.

There is a need to search for alternative sources of water, such as the use of treated wastewater
Photo: IPES

SWITCH LIMA

The SWITCH Lima demonstration project is entitled "Treatment and use of wastewater for urban and periurban agriculture and green areas". SWITCH Lima is being implemented by IPES – Promotion of Sustainable Development (Peru) and by the Ministry of Housing, Construction and Sanitation. The main objective of the project is to formulate policy guidelines for the promotion of integrated treatment and reuse systems for urban and periurban agriculture and green areas. The SWITCH Lima Learning Alliance facilitates up-scaling of the research results achieved, and allows the participating stakeholders to discuss and validate these findings with the aim of formulating policy guidelines and building capacities at the same time. An important part of the demonstration is the pilot project "Optimising water management to combat urban poverty: Developing productive and recreational areas through the use of treated wastewater", which seeks to improve food security and community participation of the poor population in the district of Villa El Salvador and generate complementary household income. Once validated, the experience will be used as example for replication in other zones of the country in collaboration with the Ministry of Housing, Construction and Sanitation.

Cases of wastewater use

As part of the SWITCH project, 37 cases involving the use of household wastewater from various secondary sources were identified. They include productive activities like agriculture, aquaculture and the development and/or maintenance of green areas of the city. They also include activities for which untreated wastewater is used. Seventeen of these are located in the southern area of Lima, where the availability of water is low compared to other parts of the city. The cases are located in periurban (54 percent) as well as intra-urban areas (46 percent). The 37 cases identified cover a total surface area of 985 hectares, and use a flow volume of approximately 1,478 l/s of wastewater, of which 716 l/s is used without treatment and 762 l/s is treated. The majority of the wastewater (almost 80 percent) is used small and medium-sized areas (up to 20 hectares), 11 percent of which are smaller than 1 hectare.

Wastewater is used for a variety of purposes. 44 percent of the cases involve productive activities (agriculture and aquaculture). These activities represent 77 percent of the total area irrigated with treated wastewater, and are predominantly located in periurban areas. Another 56 percent of the cases involve the reuse of treated water for recreational activities like green areas, sports fields and public parks, which make up just 23 percent of the total irrigated area and are located primarily in the city. 34 of the cases involve the use of wastewater that has been treated in some way. The three cases of untreated use represent 40 percent of the total area irrigated with wastewater in Lima. The technologies used for treating wastewater have been grouped into five types: stabilisation ponds (29 percent), aerated lagoons (29 percent), activated sludge (24 percent), artificial wetlands (12 percent), and percolated filters (6 percent).

Action research

The SWITCH research team selected 19 of these 37 cases for a study of their institutional, social, technical, economic and environmental dimensions. Within this selected group, a significant variety of crops are produced, including fruits, vegetables, aromatic herbs, etc. Eight of these cases involve a total of 314 farmers who use wastewater to irrigate 653 hectares of farmland. The main crops are vegetables, which encompass 60 percent of the total productive land area. The largest area is in San Agustin, where 445 hectares of irrigated vegetables are grown using untreated wastewater. Among the most important crops are celery (Apium

Meeting with Ms Ricardina Cardenas, Director of the Office of the Environment of the Ministry of Housing, Construction and Sanitation

One of the responsibilities of the Ministry of Housing, Construction and Sanitation of Peru (MVCS) is the treatment of wastewater. The Ministry is implementing a National Urban Agriculture Programme which seeks to facilitate reuse of treated wastewater. As part of the SWITCH Lima Project, IPES and the MVCS are collaborating in action research towards the formulation of policy guidelines for the promotion of productive (urban and periurban agriculture) and recreational (irrigation of green areas) use of treated wastewater.

Ms Cardenas: The Ministry, through its Office of the Environment (OMA), promotes urban agriculture, in order to improve the quality of life of low-income residents, especially in peripheral urban areas, through training and support in income-generating activities. In addition, we are promoting the creation of sustainable green areas using treated wastewater. (...)

The Ministry collaborates with SWITCH. specifically in the formulation of policy and operational guidelines on wastewater treatment and reuse in urban and periurban agriculture and greening. OMA is dedicated to the preparation of these policy guidelines,which will formalise treatment, use and reuse and the construction of wastewater treatment plants that are more accessible to the poorer sectors of the population. (...)

Water is essential as a human right. So taking care of this resource is our civic duty. Wastewater is not just "waste" but it is a resource! And with proper treatment, enhanced awareness among citizens and industries, and a legal-regulatory framework, wastewater can be used. (...)

The OMA is working on necessary regulations already, such as a maximum level of emissions from wastewater treatment plants when discharging into receiving bodies, like the ocean, lakes, rivers, etc.; and for the reuse of wastewater in agriculture, green areas, aquaculture and reforestation. (..) Other projects OMA is working on include the level of discharge into the sewer network (a controversial issue we have been working on for almost two years with CONAM, (now with the newly formed Ministry of Environment); regulations for solid waste management; an environmental classification system for projects in this sector; and guidelines for the preparation of environmental impact studies and environmental adjustment programmes for water and sanitation activities. (...)

For more information, contact:
ambiente@vivienda.gob.pe

graveolens), onions (Allium cepa), wild leek (Allium ampeloprasum), radish (raphanus sativus), tomato (Lycopersicon sculentum) and squash (Cucurbita maxima Duch). Nine cases use wastewater for recreational purposes like green areas, sports fields and public parks. They manage 116 hectares of grass for gardens and another 54 hectares of forests with ornamental trees, like the eucalyptus (Eucalyptus spp.), poncianas (Caesalpinea pulcherrima) and the Peruvian peppertree (Schinus molle). Irrigation techniques vary and include the use of gravity by flooding or furrows, sprinklers, and drip irrigation.

The size of the treatment systems depends on the volume that is being treated, the final quality of the effluent and the technology used. Aerated lagoon plants require the largest amount of space, followed by activated sludge plants and stabilisation ponds.

The quality of the wastewater being treated is monitored in only nine of these cases, which means that currently there is no adequate system of control for reuse activities operating in Lima. The parameters that are monitored are faecal coliforms and the biochemical oxygen demand. Only two plants had effluents with less than 1,000 faecal coliforms per 100 ml, which is the quality required for irrigating parks and sports fields. The rest had higher levels, and, therefore the effluent would only be useful for some crops. In only two cases was the presence of human parasites reported, since this is a variable that is not yet monitored obligatorily. The investment, operational and maintenance costs of the facilities were not well documented, so no conclusions can be drawn from this.

> A legal and institutional framework has to be created at the national level

Using the information produced by the research, the SWITCH team in Lima drafted political guidelines to promote treatment and reuse of wastewater for use in urban and periurban agriculture and green spaces. These draft guidelines have a national scope, and will be validated through a series of meetings, workshops and a virtual platform, with different stakeholders like different local and national governmental institutions, universities, private sector and representatives from the civil society that participate in the Learning Alliance. It is expected that this process will be finished in 2008.

Conclusions

There is a need to search for alternative sources of water, such as the potential use of treated wastewater, water extracted from fog, etc., to cater for the high demand of water. Since 92 percent of wastewater currently ends up in the Pacific Ocean, there is a high potential for use (after proper treatment).

Because of the shortage of water, untreated wastewater is already being used for production in the city, and these farming systems have become important sources of food for the city. Treated wastewater is also used but this is still a minimal part of the potential that this resource has. Less than half of the total treated wastewater is used for agricultural or recreational activities. Utilising this potential would require assessment of the quality of the effluent from treatment plants and development of guidelines for its use for different activities.

The use of treated wastewater for agriculture will reduce the stress on the supply of water, since there will be a constant and larger flow of water available. This will result in higher yields, better products and improved access to food in the city, as well as extra income and jobs. Using treated wastewater for green areas and urban forestry will facilitate more public recreational spaces, improve the city's landscape, capture carbon dioxide and other polluting gases, as well as lead to other environmental benefits.

A legal and institutional framework has to be created at the national level that will encourage integrated wastewater treatment and use for productive and recreational purposes. Thus, rather than wasting a valuable resource, a policy should be developed that recognises this waste as a resource. The guidelines elaborated by the SWITCH Lima team will allow the achievement of this objective.

A variety of wastewater treatment technologies are available, which have different investment and operational costs and which are appropriate to the physical characteristics of the city. However, only for some of these technologies, regulatory frameworks are provided by the Peruvian state. These regulations relate to treatment and disposal of wastewater into a receiving body, but do not take into account the option of reuse of the effluent.

For this reason one of the strategic actions identified in the SWITCH studies is the need to update these regulatory frameworks and to seek to include the reuse of wastewater for productive-recreational purposes. In addition it is essential to develop a governmental system that links the different stakeholders and sectors involved, in order to define the different roles and facilitate the implementation and management of Integrated Wastewater Treatment and Reuse Systems.

Finally, the access to information and capacities of these stakeholders need to be improved, so that they are able to implement and manage integrated wastewater treatment and reuse systems. This activity is supported by SWITCH in Lima through the Learning Alliance.

Gunther Merzthal, SWITCH Lima Project Coordinator, IPES
Email: gunther@ipes.org.pe
Ernesto Bustamante, SWITCH Lima, IPES
Email: ernesto@ipes.org.pe

End notes

1) Throughout this article we refer to the "city of Lima", assuming, for simplification purposes, that it includes Metropolitan Lima, with 43 districts and the constitutional province of Callao, with 6 districts.

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The Use of Reservoirs to Improve the Quality of Urban Irrigation Water

Scarcity of water, pollution of rivers with untreated wastewater and the use of this water for production of food all generate serious health problems, especially for the poorest and most vulnerable sectors of the population. This is the case in Lima, the capital of Peru, where more than 8 million people live essentially in a desert. The Rimac River, which is the city's main source of surface water, is polluted by various activities carried out along its basin. Studies carried out by the International Potato Center (CIP) between 2005 and 2007 (Moscoso et al., 2007) confirmed that the irrigation water in the agricultural area of the Eastern Cone of Lima, where over 35 percent of the vegetables that are sold in Lima are produced, is heavily contaminated with parasites and faecal coliforms (the concentration of faecal coliforms is more than 5,000 times the level permitted for water meant to irrigate vegetables).

In this context, the CIP proposed the implementation of a (river) water treatment system based on the use of reservoirs in order to promote agricultural irrigation with good quality water and thereby guarantee the production of vegetables without any health risks to consumers. The earthen reservoirs are covered with a membrane, and are 11 by 15 meters wide, and have a capacity of 165 m3. The simple treatment process consists of keeping water in a reservoir for a period of seven to fourteen days. Under these conditions, the bacteria are not capable of living, and the parasites settle to the bottom and eventually die, leaving the water acceptable for irrigating produce. CIP research confirmed that storing river water for more than 10 days in the reservoirs can totally eliminate human parasites and reduce faecal coliforms to the levels stated in the national General Water Law for farmland irrigation. In addition, the treatment system is complemented with a technical irrigation system using "multi-floodgates", which enables a significant saving of water and easier irrigation.

In addition to improved quality of the irrigation water, the other advantages of these measures are:

- increased availability and more efficient use of water, which is enhanced by a technical irrigation system that reduces water usage by 50 percent compared to earlier methods;
- additional earnings from production of fish in the reservoirs;
- an increase in productivity and profitability of almost 50 percent in growing vegetables. This is due to the availability of nutrients in the reservoir water from the fish farming and a reduction in the growing period, which allows the farmers to get their crops to the market early.

This increased productivity easily compensates for the use of land for the reservoir and the investment made in installing it. This integrated production system provides a high-quality, low-cost protein source for the producers and for the very low-income families living in the neighbouring settlements.

The Bonifacio family's farm is located at the end of an irrigation channel. Before the new system was installed the family was ready to give up farming and sell the land because they didn't receive any water any more. With a reservoir in place the family now plants vegetables again, and is guaranteed safe water for up to 15 days at a time, including when the normal water supply is interrupted due to maintenance work (which affects all farmers two times per year). The Jaulis family sells its produce to suppliers of supermarket chains and gets a higher price because of the improved quality of the products. These crops use less chemical fertilisers and pesticides, and this could lead to a recognition of and market for organic production. The Serna family has a reservoir of 2,400 m³ in which it produces fish. The family is planning to install a recreational area with a restaurant, in order to take advantage of their new "lake".

These and other success stories about the use of reservoirs to improve the quality of agricultural irrigation water have led to an alliance between the Urban Harvest Program of the International Potato Center (CIP), the Board of Users of the Rimac River, the Municipality of Lurigancho-Chosica and local farmers to promote this initiative in the rest of the watershed and in other valleys of Peru.

Julio Moscoso, Tomás Alfaro and Henry Juarez
CIP
Email: julio@ipes.org.pe

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Adapting to Water Scarcity: Improving water sources and use in urban agriculture in Beijing

Ji Wenhua
Cai Jianming

SWITCH supports Huairou Cooperative in improving rainwater use
Photo: René van Veenhuizen

Beijing is facing a shortage of water. Because of a downward trend in rainfall, surface water is gradually drying up and the level of groundwater is declining. This decline in availability of water is affecting urban agriculture in the city. Innovations are being sought by both the government and farmers focusing on the use of new water sources, like reuse of wastewater and rainwater harvesting, and improved water management.

Although groundwater is still the main water source for urban agriculture in Beijing (90 percent in 2003), in some areas groundwater is not accessible anymore. In April 2007 the Beijing municipal government started to charge a fee for agricultural use exceeding a certain quota. Thus farmers are confronted with a rising cost of agricultural production. On the other hand, water use efficiency in agriculture is still comparatively very low.

The available surface water in Beijing decreased from 1.743 billion m^3 in 1980 to 0.447 billion m3 in 1995 and to 0.142 billion m^3 in 2003. The average water table of groundwater is more than 20 metres deep, and in some places more than 30, making it impossible for the farmers to use it.

The SWITCH programme supports the demonstration of multiple uses of rainwater, including an agro-tourism component, and by conducting research into water flows, water quality and the cost-benefit ratio of collecting rainwater (see UA-Magazine 19 for more details). This article puts the SWITCH activity in Beijing into a broader context.

Wastewater use

The use of wastewater has a long history in China. But not until 2000 did farmers around Beijing start to use treated water from the central wastewater treatment plants, which was initiated by the municipal government in an attempt to reduce depletion of groundwater. In 2004, only 70 million m3 of treated water was used for urban agriculture in Beijing. This amount increased to

In a SWITCH visioning workshop in Beijing in 2008, the Water Vision 2030 for Beijing was summarised by the SWITCH team as:

By 2030, the city of Beijing will have reached a higher level of sustainable urban water management. Balanced availability, supply and consumption of water will avoid depletion of groundwater levels, which will be restored to 1960s levels, and pollution will be minimised. Rivers and lakes will be protected or rehabilitated to meet Surface Water Quality Standards grade III and above, and rivers will flow all year round. Water quality at the tap will meet international drinking water standards.

There will be a high degree of equity and efficiency in water use, and different quality water will be used in different sectors as appropriate. Harmonised regional water use will be achieved through fair spatial allocation of water resources; conflicts between upstream and downstream areas will be avoided through negotiation and appropriate compensation. Good water governance, open public access to information, and participation of stakeholders in decision making will ensure a water-conscious society; and adequate planning will mitigate disaster damage.

230 million m3 in 2007 and accounted for about 20 percent of total water used for irrigation. The 11th five-year plan states that 400 million m3 treated water will be available for more than 0.66 million ha of croplands in Beijing in 2010, which is less than one quarter of agricultural land in Beijing municipality. Almost all kinds of crops and fruit trees are suitable for the use of treated wastewater. However, not all the farmers can access treated wastewater because they are located too far from the wastewater treatment plants.

Rainwater harvesting

In addition to the use of (treated) wastewater, the use of rainwater is an important (potential) source for the water needs of parks, gardens and agriculture in Beijing municipality. Rainwater harvesting systems are currently being promoted in residential areas in Beijing and in periurban agriculture.

Wastewater in Beijing usually receives up to the secondary level of treatment. The primary level removes the floating and suspended material, and the secondary level neutralises and disposes the wastes using biological matter. After the secondary treatment, the water can be used for agricultural purposes. Beijing discharges about 1.35 billion m³ of wastewater every year. One billion m3 of this is treated, of which 0.23 billion is used by agriculture, 0.1 billion by industry, and 0.05 by urban public utilities; whatever is not used is discharged. Clearly there is a big potential for using more treated wastewater for agricultural purposes. This is now promoted by all levels of government, and is reflected in the 11th five-year plan.

Capturing rainwater in residential areas of the city has been promoted since 2000. This includes techniques like porous pavement and roadside gutter collection of stormwater (rainwater from the roof and road) and storage in local deposit pools, after which this water is transferred to larger water-saving ponds for primary treatment (sedimentation). This water can be used for many purposes, such as irrigation of parks and gardens, aquifer recharge, maintaining water levels at small ponds and lakes in the city, and other uses like car washing (after some simple treatments). The number of projects introducing these uses has been increasing in Beijing, especially in the last two years. For example, in the Beijing National Stadium for the Olympics captured rainwater will be used for toilet cleaning, cooling towers, fire fighting, and irrigation of green areas (Scholes and Shutes, 2008). In 2006 more than 300 rainwater-collecting projects were implemented, and the capacity for collecting water In Beijing has consequently increased to 40 million cubic metres.

A wider diversity of crops can be grown in the greenhouse
Photo: René van Veenhuizen

Rainwater harvesting using roofs of houses in rural China has been practiced for thousands of years. Using the roofs of greenhouses to capture rainwater for irrigation of crops has been promoted since June 2005. Experiences with this were reported in UA-Magazine no. 19. These projects became popular because they are relatively simple to use and maintain, and because they are subsidised by the government. So far, twenty of these rainwater harvesting systems have been installed. On average, 200-300 m3 of rainwater can be collected per greenhouse (with a roof of 667 m2) each year, which can irrigate 2-3 times the same area with efficient irrigation (drip irrigation). The demonstration project of SWITCH in Beijing supports this work by analysing water flows, adding the use of wastewater, by conducting cost/benefit analyses of typical farming systems, and by linking other productive activities, like mushroom production and agro-tourism.

Challenges remain in terms of financial sustainability

So the potential of this technique is high, and given that there were some 20,000 ha of agriculture land under glasshouses in 2005 in Beijing, the current proportion of irrigation using rainwater harvesting is very low, accounting for less than 1 percent.

Improving water management

The Beijing Municipal Water Authority was founded in 2004, illustrating the beginning of reforms in the water management system of urban and periurban Beijing. Integrated urban-rural water management is being developed at four levels: municipality, districts and counties, water stations and at user (farmer) level. At the latter level, the Beijing Water Authority has village water managers and stimulates the organisation of farmers' water use associations or cooperatives. These village level associations manage issues such as access to water (and developing alternatives, like using wastewater and building rainwater harvesting structures), water pricing, irrigation practices, and quota management. By the end of 2006, Beijing had established more than 3,339 of these farmers' water use associations. Every villager (except the village leaders in order to prevent power from becoming too concentrated in the hands of few people) has the right to apply for the position of water manager, and selected villagers will receive capacity building training from the Water Authority. In December 2006, 10,800 farmers were appointed as water managers of their villages in Beijing (the total number of periurban villages in Beijing is 3,954).

Future perspective

Integrated reuse of wastewater, rainwater harvesting, and more

In December 2006, 10,800 farmers were appointed as water managers of their villages in Beijing
Photo: IGSNRR

efficient water use (e.g. by village water managers and farmers' water use cooperatives) are important technological and institutional innovations in Beijing. Challenges remain, especially in terms of financial sustainability. Farmers in Beijing municipality are used to having free access to all kinds of water for agricultural purposes. If a fee is charged, higher returns will also need to be established. But this also opens new opportunities to improve current farming systems. The SWITCH programme in Beijing, together with the RUAF-CFF programme, seeks to demonstrate a model of urban agriculture which incorporates multiple sources and efficient use of water and delivers higher returns by diversifying production and services. These higher returns not only compensate for water fees, but also enable farmers to pay for the relatively high investment in rainwater harvesting facilities.

Ji Wenhua and Cai Jianming
IGSNRR
Email: jiwh.07b@igsnrr.ac.cn

An example is the Caijiandian farmers' water use association, located in Xincheng Town of Miyun County. The association has 233 households. Its director, vice director and secretary were elected by members. Each household has an account number for its drinking water quota, which is published regularly. Farmers who want to use this water need to apply to the association 3 days in advance. The cost of drinking water is 1.48 RMB Yuan per ton, but farmers only pay 1 Yuan if their consumption quantity is within the quota. The Caijiadian farmers produce apples. By using more efficient methods and rational water distribution as promoted by the association, the farmers have substantially improved their quality and quantity of apples without consuming extra water. In addition, each household earned 1,800 Yuan (180 USD), which was higher than the previous year's average (Jinhuai Yang and Cailin Cui, 2005).

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The SWITCH programme collaborates with the Huairou Fruit and Vegetable Cooperative. The cooperative is located in An ge zhuang village, Beifang town, in Huairou district of Beijing, and was initiated in March 2004. The cooperative specialises in the production of vegetables, grapes and Chinese dates. At present, there are 1108 households in the cooperative who participate voluntarily. In an interview, the cooperative's chairperson, Ms Zan, discussed the importance of rainwater harvesting:
(..) The farmers of the cooperative used to use groundwater for irrigation, but in recent years, the water table has been drying up very quickly, and some wells cannot be used anymore. Digging deeper and pumping up water increases cost. (..)
Rainwater harvesting is therefore very important to the cooperative. A problem is the funding for the building of the rain harvesting systems. Despite the subsidies, not all farmers have access to it. SWITCH helps us improve the rain harvesting system. (..)

We are now using the underground space to plant mushrooms. The environment of the basement by the side of the water storage pool is quite good for growing mushrooms in terms of temperature and humidity conditions. Using the ground space can save us lots of money by making it easier to control growth conditions and it allow us to gain more benefits. (..) Agro-tourism is another opportunity to raise the value of our products. (..)
In addition, opportunities and constraints experienced by our cooperative as a result of rapid urbanisation need to be tackled by involving several institutions and stakeholders in the development of our cooperative and our search for sustainable use of the water. We are collaborating with RUAF on this. (..)

Technology and Institutional Innovation on Irrigated Urban Agriculture in Accra, Ghana

Olufunke Cofie
Esi Awuah

Accra has an annual rainfall of 730 mm and the population in its administrative boundaries is 1.6 million (GHS, 2002). About 80 percent of the population in Accra has access to water and 88 percent has access to some form of toilet facilities. However, waste and wastewater disposal and treatment are still ineffective. SWITCH works in Accra on the use of urban water for agriculture and other livelihood opportunities.

Wastewater (including greywater, stormwater runoff and polluted surface water) from the city remains the major source of water and nutrients for urban vegetable production, which takes place on seven major sites and many smaller ones in the city. It is estimated that about 80,000 m^3 per day of wastewater is generated by 1.66 million inhabitants based on an average per capita daily consumption of 60 litres, and a wastewater return flow of 80 percent. A portion of this reaches the stream and drainage network of the city, which serves as the main source of water for irrigated agriculture. Other identified sources of water for agriculture are streams, drains, pipe-borne water, shallow groundwater and rainfall. The water resources of Accra are distributed from five key water basins consisting of rivers/ streams, lagoons, ponds, and storm water: Kpeshie basin, Odaw basin (also known as the Odaw-Korle catchment), Osu Klottey basin, Chemu West basin and parts of the Lafa basin.

Irrigated urban vegetable production in Accra provides up to 90 percent of the city's need for the most perishable vegetables, especially lettuce, which benefits around 250,000 people daily. Moreover it yields an average monthly net income of US$ 40-57 per farm (Drechsel et al. 2006). Nevertheless, it is associated with health and environmental risks from the use of polluted water and attendant contamination of vegetables with pathogens. Local and international initiatives have responded to some of these constraints. Notably are research projects on safer vegetable production as supported by the IWMI Challenge Programme on Water, WHO, IDRC and FAO, as well as the capacity building and multi-stakeholder processes of RUAF-CFF, as highlighted by several articles in the UA Magazine. SWITCH is benefiting from the results of these programmes and building on them by demonstrating new technology and institutional innovations designed to minimise risks associated especially with urban wastewater reuse for agriculture within the context of integrated urban water management.

Irrigated urban vegetable production in Accra provides up to 90 percent of the most perishable vegetable needs of the city
Photo: IWMI Ghana

Multi-stakeholder learning

In Accra the SWITCH programme seeks to engage stakeholders in a Learning Alliance. In an initial scoping exercise the alliance identified as the major challenges in urban water management: improper land use planning and control in urban water management; poor access to safe water and sanitation especially in poor areas; pollution of water bodies affecting downstream users and

SWITCH Accra Learning Alliance

In Accra, the SWITCH Learning Alliance seeks to develop a sustainable and healthy urban water system which will result in improved access to water, sanitation and livelihood opportunities, improved water quality, reduced risk posed by water- and sanitation-related diseases, and reduced effects of flooding and droughts. The members of the Learning Alliance in Accra are supported by scientific and technological research in: (a) the use of urban water (fresh and wastewater) for urban agriculture and other livelihood opportunities; (b) maximizing the use of natural systems in all aspects of the municipal water cycle; (c) governance for integrated urban water management and d) social inclusion. The research will be enhanced through the testing and adaptation of locally relevant innovations such as: on-farm wastewater treatment systems, community-managed water facility, rainwater harvesting and sustainable sanitation.

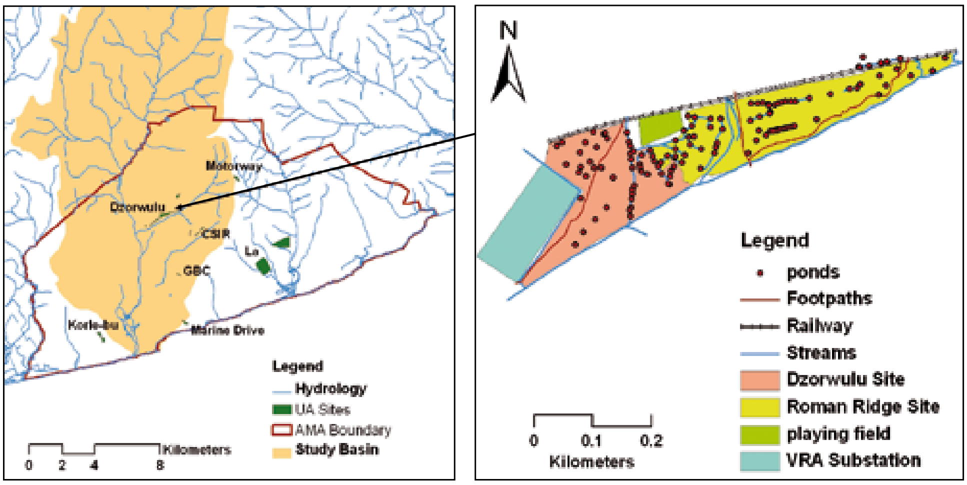

Figure.
The Odaw-Korle catchment in Accra showing rivers and major urban agriculture sites, including Dzorwulu-Roman Ridge farm lay-out.

the environment; and flooding due to poor drainage systems and blocked channels.

Under the SWITCH work package on urban agriculture, a working group was first formed to guide this component, undertake research, and link with the Learning Alliance members. This working group identified the need for research and demonstration on water use in urban agriculture and for development of guidelines on how to minimise health risks and provide institutional support based on the role of urban agriculture in livelihoods. Issues emerging from the deliberations of the working group included the need to treat wastewater for agriculture, consider groundwater as an alternative water source where possible, and also to harness rainwater for domestic and other livelihood activities. Institutional networking and collaboration were stressed as paramount in order to avoid re-inventing the wheel as well as create awareness and educate the public on how to minimise water pollution. To concentrate the study and its findings, a sub-basin within the Accra Metropolitan Area – the Odaw-Korle catchment – was chosen as the study site.

Research at two levels

The research of work package 5.2 operates at both catchment and plot levels and demonstrations take place at plot level. The main goal of research and other activities at the catchment level is to understand the interrelationship between livelihood activities, stakeholder interventions and institutional responses. The programme investigates the impacts these have on urban water quality, and analyses options for improvement. This will provide feedback for the Learning Alliance members and the urban water planning process in the city.

The Odaw-Korle catchment (see figure), sometimes called Korle-Chemu, covers an area of 250 km^2 . It is the major urbanised area in Accra and drains about 60 percent of the city (Boadi and Kuitunen, 2002). The main stream that drains the catchment is the Odaw River and its tributaries. Many of the drainage channels are not well developed and maintained, which results in erosion, siltation and flooding during heavy rains and causes loss of property and sometimes lives. The stream water is of very low quality (Boadi and Kuitunen, 2002). The faecal coliform levels are high, ranging between 103 and 108/100ml (Amoah et al. 2005, 2006). A public health risk assessment of the water system in this catchment compared potential water-borne disease exposure routes including recreational swimming in the ocean, flooding of the Odaw drain, open drainage channels, food contamination due to use of polluted water for irrigation, a faecal sludge disposal site, contaminated water distribution system and errors in the water treatment processes (Ibrahim 2007).

Demonstration

The action research and demonstration at plot level take place with farmers at the Dzorwulu-Roman Ridge site. Working group members conducted field visits and considered a number of sites, using pertinent questions as criteria for site selection. Together with research on social inclusion (see the next article), action research aims to test and adapt locally relevant innovations on farm-level wastewater treatment systems and on sustainable sanitation.

Covering an area of 8.3 ha, the Dzorwulu-Roman Ridge site is one of the largest urban agricultural sites in Accra. The area is cultivated by about 50 farmers (half of whom are members of an association). The site is bounded by an electricity sub-station and railway line to the north, by a stream to the south and by a sewage drain to the east, all draining into the Odaw river (see figure). The landscape is divided into two sections: Dzorwulu and Roman Ridge, with two separate farmers' groups. The farmers have access to two sources of water for irrigation: the drain and stream, polluted by domestic wastewater (greywater contaminated with excreta) and pipe-borne water. The polluted stream and greywater are classified together here as wastewater. Shallow ponds are extensively used to store wastewater and pipe-borne water for irrigation. They are filled from the tap by hose or from the drain in part with pumps to reduce the walking distance when using watering cans for irrigation (see the article on page 27). These ponds are farmer innovations for intermediate water storage and improving accessibility, and are therefore located very close to farm plots. The farmers also use the ponds to 'clean' the water for crops through the introduction of duckweed. There are 128 small ponds at the site, 21 of which are used for storing pipe-borne water while the remaining ones are used for wastewater. Average surface area of each pond is 7.5 m^2 with a capacity of 4 m^3. In some cases, farmers use sand bags to block wastewater flow and then collect water from the pond.

During the baseline study conducted at this site, farmers commented that the stream was clean in the past, but is now polluted as a result of human settlement and activities along the stream. Most of the farmers are willing to accept any suitable on-farm water treatment intervention. While some (at Dzorwulu) prefer trenches and ponds with aquatic plants to purify the water, others (at Roman Ridge) are more inclined toward acquiring alternative water sources, especially treated pipe-borne water. These farmers complained of the difficulty of carrying water with watering cans from the stream to the field and their suggested improvement is to dig more ponds and sewage trenches for storing water closer to farm plots. In addition, the farmers would love to learn more about proper maintenance of soil fertility and simpler irrigation methods.

Against this background, the SWITCH working group on urban agriculture has initiated participatory action research and demonstration on on-farm water treatment integrated into farmers' institutional setting and supported by appropriate capacity building and awareness.

IWMI has generated substantial knowledge in the past few years on simple irrigation methods Photo: Olaleye Olutayo

On-farm water treatment options

Action research focuses on further improvement of farmer innovations, using dugout ponds. Based on the principle of sedimentation and the use of multiple ponds and macrophytes, improvement in treatment is developed in a farmer field school setting. Research with farmers focuses on improvement of irrigation water quality and volume, as well as on appropriate crop management and social-economic implications. Treatment options are evaluated for microbial pollution reduction and nutrient recovery. The goal is to ensure that contamination of vegetables is reduced, farmers' and extension workers' awareness of water quality issues is increased and their technical skills in water and crop management are improved.

Capacity building and awareness of safe vegetable handling

In addition, farmers' and market traders' perceptions and practices in relation to water sources, water use and contamination have been analysed to demonstrate and discuss improved strategies and procedures for vegetable handling at the farm and market levels, and thereby guarantee greater safety for the consumers. IWMI has generated substantial knowledge in the past few years on simple irrigation methods (Keraita 2008) and post-harvest handling of vegetables (Amoah 2008) for safe vegetable production in urban farming (see articles in UA-Magazine 8 and 19). These are cost-effective methods for reducing pollution at the farm site and beyond (see the article on page 29). The RUAF working group AGWUPA collaborates with IWMI in awareness raising and this knowledge base, amongst others, is further used at the catchment and demonstration site through the field school. By increasing the farmers' and market traders' awareness and use of safe vegetable handing, water pollution and crop contamination levels and associated health risks will be reduced.

Inclusion and access

Although the emphasis of the work is on water and safe handling of produce, attention is also paid to strengthening urban producer groups. Support is also provided to improve the farmers' capacity to manage the water treatment interventions. Information gathered during the baseline study shows that the Roman Ridge farmers are not in any organised group while the Dzorwulu farmers benefit from their existing farmers' association. Information is thus also being gathered about the accessibility of urban producers' groups, these groups' access and entitlement to land and water and their degree of security/vulnerability (see the next article). The relationships of the producers' groups with city authorities are also being investigated, including tenure arrangements and processes of representation and communication. Farmer representatives are already participating in the working group. This work will also be linked to the RUAF From Seed to Table programme, which will start in January 2009.

Sustainable sanitation

This will involve mainly the collection, treatment and use of urine for farming at the demo site. Preliminary investigation shows this to be a readily available resource for use in urban agriculture. However, the cost of transportation is usually too high, hence farmers are encouraged to store urine on farm site (Tettey-Lowor, 2008) in mini disposal units, which will be tested.

Olufunke Cofie
IWMI-Ghana
Email: o.cofie@cgiar.org

Esi Awuah
KNUST
esiawuahrt@yahoo.com

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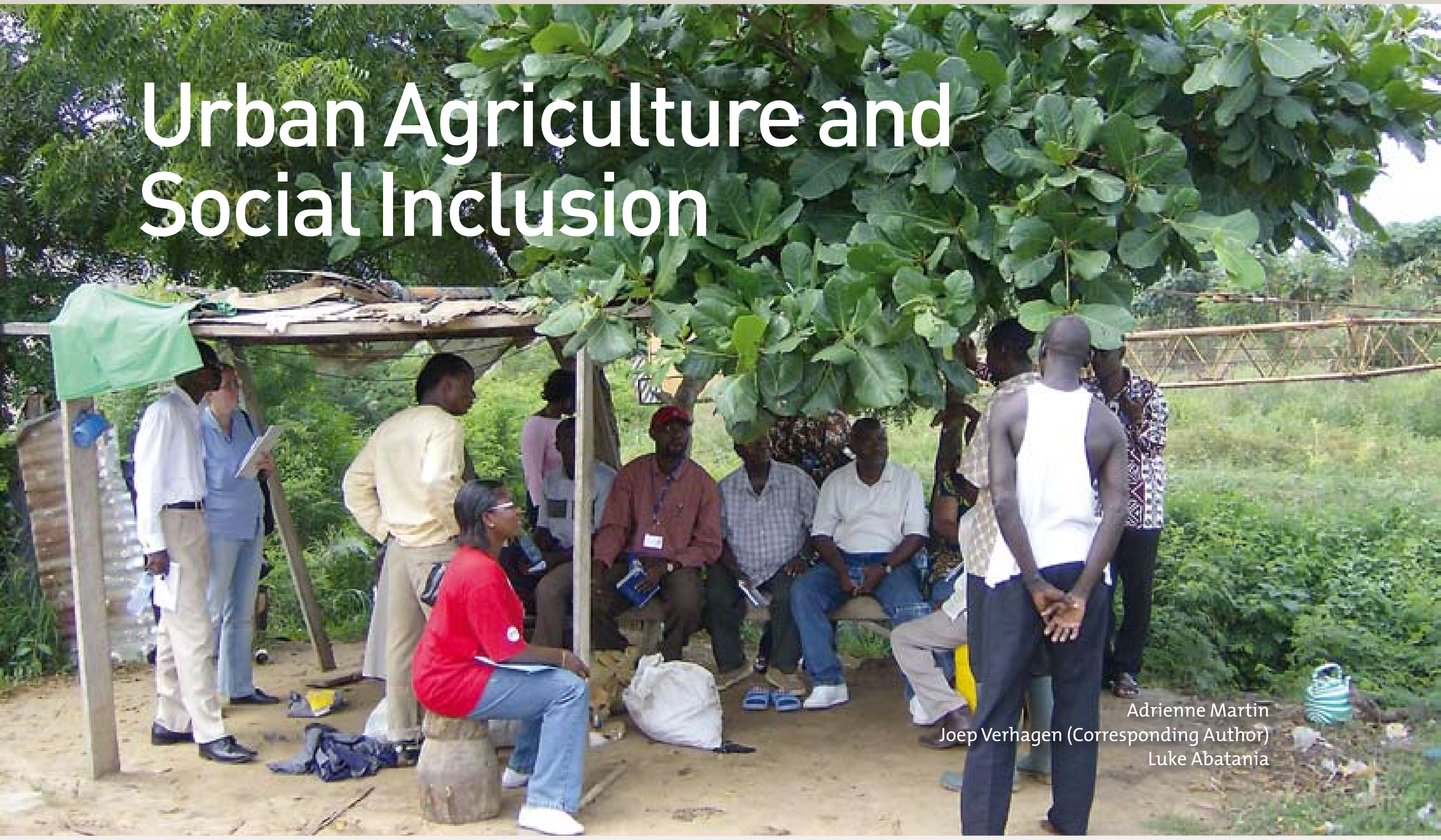
Urban Agriculture and Social Inclusion

Adrienne Martin
Joep Verhagen (Corresponding Author)
Luke Abatania



Understanding social exclusion requires an in-depth investigation
Photo: IWMI Ghana

The SWITCH programme promotes a participatory, multi-stakeholder approach via its city learning alliances. As these stakeholder participation processes do not necessarily give a voice to socially excluded groups, SWITCH is initiating specific activities to address issues around social inclusion[1]. The ultimate objective of these activities is to ensure more equal and sustainable management of, use of, and access to urban water.

Social inclusion describes the state of being included in a community and society as a whole; a condition in which individuals and groups can access the range of available opportunities, services and resources and contribute to planning and decision making. This notion of social inclusion has come to the fore because of the growing recognition that well-being involves more than reasonable income levels and access to material goods. Its converse is social exclusion, which refers to a "process by which certain groups are systematically disadvantaged because they are discriminated against on the basis of their ethnicity, race, religion, sexual orientation, caste, descent, gender, age, disability, HIV status, migrant status or where they live. (DFID, 2005). Hence, social exclusion and poverty are not necessarily the same, but poverty is often an important contributing factor to social marginalisation. Social inclusion also refers to the policies and actions intended to influence institutions and change the perceptions that create and sustain exclusion (Beall, 2002). To identify such actions, it is necessary to understand the existing context and processes of social exclusion.

Dimensions of social exclusion

Understanding social exclusion and identifying the types of actions needed to promote social inclusion, requires an in-depth investigation of the following three dimensions of social exclusion:

- what people have or do not have, in terms of access to natural, monetary, and other resources;
- where they live; spatial deprivation occurs when stigma or the bad reputation of a specific neighbourhood acts as a barrier to creating social contacts or accessing markets;
- who they are; discrimination flowing from specific group identities as perceived by others; for instance, discrimination based on gender, ethnicity or occupation.

These different dimensions of social exclusion may overlap, simultaneously excluding people from employment, livelihood opportunities, property, housing, education, citizenship, personal contacts and respect (Silver, 1994). For example, poorer urban areas inhabited by excluded social groups tend to have limited access to water and sanitation.

Social exclusion and urban agriculture

This article presents lessons learned related to social inclusion in the work of the SWITCH working group on urban agriculture in Accra. Action research, with urban agricultural producer groups as described in the previous article, pays close attention to the dimensions of inclusion and access. A baseline study was undertaken at the Dzorwulu-Roman Ridge site, one of the largest sites in Accra. The social component included discussion at the level of the producer association, farmers' group and individual producers and market traders. It explored the diversity of households involved in urban agriculture (gender, age and ethnicity) and its contribution to livelihoods. It looked at the inclusiveness of producer organisations and the capacity of urban producers to have a voice in city planning and other relevant platforms.

Identity and social exclusion

There is a vegetable producers' association at the site, as well as an informal group. Many of the association members were originally migrants from Northern Ghana and Burkina Faso and members of northern origin remain the majority. The association has twenty-six members, three of whom are women. There are no written membership criteria for membership of the group. In general any person farming at the site qualifies to join the group. There was no indication of exclusion or discrimination either within or from outside the group on the basis of ethnic origin or religion. Vegetable production at the site is a male-dominated venture. The women generally have smaller plots than their male counterparts, which the women said reflects their limited capacity to manage a larger area. Female household members are not involved in vegetable production, but harvesting the crops is mainly done by women market traders.

The land is fully occupied so there is limited potential to expand farming at this location. Following the acquisition of plots by the original occupants, subsequent transmission of plots has been through inheritance or allocation from relatives, friends or employers. Existing farmers or new entrants can only obtain additional or new plots through fragmentation of existing plots or when an occupant leaves his/her plot for good. Allocation thus depends on social relationships, although once the plot is allocated, it is a permanent arrangement. The group has investigated the possibility of acquiring additional farm land at another site, but so far without success. The main form of social-exclusionary attitudes relates to the negative public image of urban agriculture (exclusion based on occupation and location) and the group's associated low social status.

Economic basis of social exclusion

The baseline study indicated that urban agriculture is an occupation that has provided sustainable livelihoods for farmers and their families, in some cases, for decades. Vegetable farming is the most important economic activity among the survey households – for six households out of twenty-five interviewed, it was their sole source of income. For the others, vegetable farming was the first among the three most important economic activities of the household, providing up to 82 percent of household income. While the producers are not well off, vegetable production provides a reasonable living in comparison to occupations of people with similar levels of education. Seven of the twenty-five farmers interviewed were illiterate, nine had Koran or primary schooling, eight had junior secondary or middle schooling and one had secondary schooling. Farmers report profits in the range of US$ 600 – 1,500 per farmer per year with a mean profit of about US$ 1,000 per farmer per year. Apart from cash benefits, the group mentioned urban agriculture as a source of employment and better nutrition. An estimated 95 percent of vegetables consumed by the households is grown on their own plots. Thirteen households reported that they have savings and no debts while a further five indicated they have both savings and debts.

Harvesting the crops and marketing is mainly done by women market traders Photo: IWMI Ghana

The farmers commented that urban agriculture "is a source of employment and more remunerative than any other job they could get given their backgrounds". They said that others may be financially better off, but they are healthier because of better nutrition from the consumption of vegetables. The group was convinced that urban agriculture can be a pathway out of poverty, but added that larger areas of land would be required. Land is a limiting factor for poverty reduction through urban agriculture.

Group organisation and empowerment

The perception of urban agriculture and the impression of poverty associated with it contributes to the lack of 'voice' experienced by the farmers. Strengthening their organisation is one strategy to build internal cohesion and support and a structure through which their needs can be articulated.

Social relationships among the farmers were generally described as cordial or good and most thought there was trust and willingness to share information. There are shared arrangements for using piped water for irrigation. The vegetable growers' association (founded in 2001) was initially motivated by the need for social as well as financial mutual support. Membership is voluntary, but applicants are expected to pay a registration fee (about $2) as well as monthly subscriptions ($1). Levels of mutual social support are good, but payment of subscriptions is sometimes delayed or missed, which limits the group's ability to finance farm inputs or to provide loans for members.

The farmers do not hold title to the land they cultivate. Although there is an informal arrangement, there is no written agreement between the farmers and any recognised individual or organisation. Though there have been attempts to evict the farmers, they still feel that the land will be secure for many years to come. The association members reported that they sometimes meet with city authorities and other organisations to discuss their vegetable production activities. They send representatives to meetings at the Accra Metropolitan Assembly when invited (and participate in RUAF and SWITCH working groups. Despite this, the group feels it lacks the social recognition to make its views or situation known to the relevant organisations. However, the group has the cohesion to do everything possible to counter any threat to its activities. The informal group does not have linkages with other farmers' organisations. However, the group interacts with research organisations and government institutions. Information on agriculture practices and policies is made known to them by Ministry of Agriculture and IWMI. Input dealers also provide information on the proper use of agricultural inputs.

Conclusion

The baseline study findings illustrate the importance of urban agriculture as a strategy for poverty alleviation, community building and social integration of disadvantaged groups. Despite the instability of the market and other constraints, the performance of vegetable production in Accra over the past five years has been good, and is providing sustainable employment and food security to the farmers and their households.

It is important to combine approaches that seek to secure sustainable and profitable use of water in urban agriculture with those focused on socially inclusion and poverty reduction., In particular, programmes need to support capacity strengthening for group development, networking, marketing, financial management and other skills. Ultimately this would widen access to urban agriculture opportunities including access to water and improved water treatment and for facilitating contact between farmers groups and decision making bodies. These issues will be fully taken into account in the follow up activities in the frame of the SWITCH and RUAF projects.

Adrienne Martin
Natural Resources Institute, University of Greenwich, UK.
Email: a.m.martin@gre.ac.uk

Joep Verhagen (Corresponding Author)
IRC International Water and Sanitation Centre, The Netherlands
Email: verhagen@irc.nl
Luke Abatania
University of Ghana, Accra. Email: abat142002@yahoo.co.uk

End notes

1) This article is adapted from Nelson, V., Martin A., Sutherland, A., Casella, D., Verhagen J. (2007), Social inclusion and integrated urban water management, a concept paper, NRI/University of Greenwich & IRC, SWITCH programme. The information on Urban Agriculture and Social Inclusion is from the report of baseline study field work in Accra by Luke Abatania and Seth Agbottah.

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Improving Decision-making on Interventions in the Urban Water System of Accra

Suleiman Ibrahim[1]
Henk J. Lubberding
P. Drechsel
Peter van der Steen

Management of water in an urban context has an important effect on the general health status of the city's population. Whereas a good water supply and sanitation improve people's health, the absence of these may cause serious health problems for thousands of citizens. Most sub-Saharan African cities are suffering from poorly managed urban water systems (water supply, sanitation, surface waters, groundwater). Wastewater, septage and solid waste are often not properly treated and disposed of, so that they become instrumental in the transfer of diseases from one person to another. Providing full collection and treatment is usually too expensive. Reuse of (treated) wastewater in urban agriculture may create some revenues to pay for the partial treatment of the wastewater, before it is used for irrigation. Simultaneously, use of this water in agriculture prevents it from polluting receiving waters. There is, however, also the danger of contamination of crops with pathogens.

Accra is one of these cities where the urban water system is far from optimal, and therefore a number of projects are underway to improve the situation. In the current situation, only a part of the expanding city has reliable access to drinking water. Moreover, many citizens do not have access to well-functioning sanitation. Most people rely on septic tanks or some type of soakaways. The effluents from these tanks or from overflowing soakaways are discharged in open roadside drains. These drains may be an important disease transfer pathway. The small drains combine into larger ones, which ultimately end up in one of the lagoons that subsequently discharge into the ocean. Urban farmers use water from these drains to irrigate their crops, which include vegetables consumed uncooked.

For planners and decision makers it would make sense to invest the available budgets in upgrading the urban water system in such a way that the health effects are maximised. To determine which intervention is most effective, one could use a method called Quantitative Microbial Risk Assessment (QMRA). This method starts with an inventory of all possible transmission routes of infectious diseases that are somehow related to the urban water system, including wastewater reuse. It then predicts the number of disease cases for each transmission route. In the figure a schematic overview is presented of the different transmission routes that can lead to 'consumption' of pathogens (bacteria, viruses, protozoa or worm eggs). Once the contribution of each pathway is known, interventions can be designed that block transmission through that particular pathway. If a certain budget is available for investments, one can calculate for each pathway the positive health effect that would be achieved per dollar invested.

This information can be used by decision makers and planners to target the investments. It is crucial that the planners take a broad perspective on the urban water system. Usually water sector institutions are responsible for only one element of the urban water system (such as the drinking water supply or the wastewater treatment). The approach described above looks at the entire system. For example, the QMRA analysis may show that more would be gained by educating the public on how to properly wash vegetables produced in urban agriculture, rather than by investing in further improvement of the water quality of the drinking water system. The organisations responsible for these elements of the system (in this case the Ministry of Health and Ghana Water Company Limited) should therefore coordinate their actions. It may even be necessary to transfer funds from institution A to institution B, if the interventions by institution B would have a greater impact on public health.

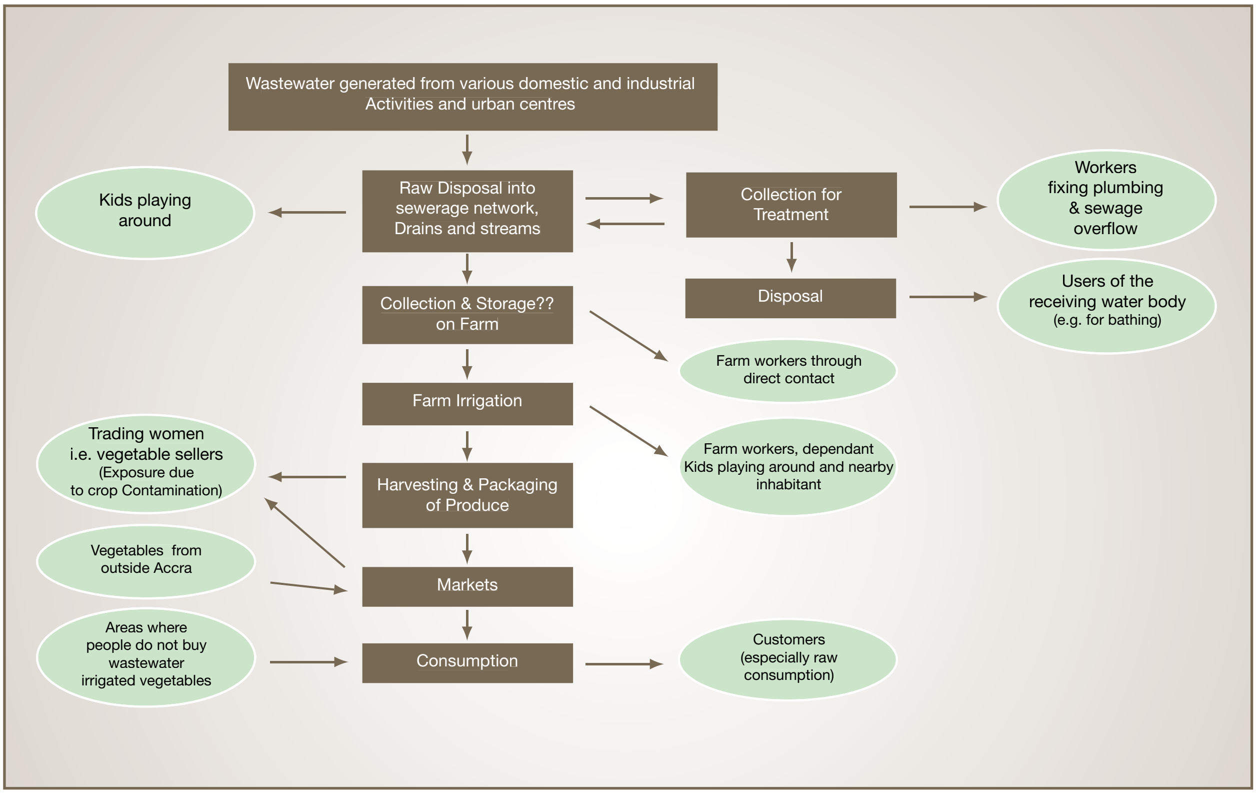
Obviously there may be a lot of resistance to this integrated approach, since it cuts through the mandates of and barriers between institutions. To overcome these barriers the SWITCH research process includes Learning Alliances, which is is a multi-stakeholder platform of organisations active in the water sector, including government offices, NGOs and the private sector. The Learning Alliance in Accra, embarked on a process to create new strategies for urban water management, and, as part of that process, developed a vision of how the urban water system of Accra should look in 20-30 years. Subsequently, it identified possible future scenarios, in terms of climate change, population growth, etc., and then developed strategies that would both address the various scenarios and still reach the vision.

Part of the strategy in Accra is the application of an integrated approach as described above. A QMRA can feed the participants of a Learning Alliance with information about which interventions are most effective, for discussion on which interventions are realistic, affordable and supported by all stakeholders. In this way planning and decision making are based on a rational and scientific analysis of the problem and its potential solutions. In addition, they are based on informed and joint decision making by all stakeholders. This is an example of transparency in planning and decision making.

The SWITCH partners in Accra are currently engaged in the strategy development process and are simultaneously carrying out research on QMRA, details of which will be reported elsewhere.

Suleiman Ibrahim UNESCO-IHE Institute for Water Education, Delft, The Netherlands. Email: ibro0072000@yahoo.com
Henk J. Lubberding UNESCO-IHE
P. Drechsel International Water Management Institute, Accra, Ghana
Peter van der Steen UNESCO-IHE

End notes
(1) Present address: African Environmental Research and Consulting Limited, Accra, Ghana



Testing the new 2006 WHO guidelines in real-life situations

In the wake of publication of the third edition of the WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater in Agriculture and Aquaculture (2006), three international agencies and around 10 local partners have embarked on a set of projects in Ghana, Jordan and Senegal to test out the methods and procedures proposed in these guidelines in different urban and periurban farming settings, to reduce risk where comprehensive wastewater treatment is too expensive and not feasible in the near term.

The guidelines look at how to develop health-based targets that may differ under certain contexts. Furthermore, they outline how to do a comparative assessment of risks and effective management at the various steps in the chain of events from the production of wastewater and excreta, their use in agricultural production through to the sale and consumption of produce. The guidelines also present an enhanced monitoring methodology that builds on lessons learned since the last set of guidelines was published in 1989. At the core of this framework is the acknowledgement that a multi-disciplinary approach is required that includes experience, skills and capacities that go beyond those required for simple measurements of water quality. The 2006 guidelines represent a significant shift from the 1989 guidelines in that instead of emphasising water quality standards, emphasis is now placed on health-based targets and support for a myriad of management options to meet them. What is not known is how feasible many of the proposed management options are in particular contexts.

The initiative for this activity came from the International Development Research Centre (IDRC), which recognised that the process-oriented approach proposed by the new edition of the guidelines would need testing in real-life situations in order to identify capacity gaps and opportunities for capacity strengthening. This is particularly true for countries faced with large groups of farmers using wastewater, but also for those faced with resource constraints.
WHO and IDRC defined the objectives of the project as follows:

- To identify economically, technically and socially appropriate non-treatment options for health protection. These can include crop restriction, wastewater, excreta and greywater application techniques that reduce levels of exposure to hazards, as well as exposure control measures, such as the use of personal protective equipment, hygiene education, food safety measures, etc., as promoted by the WHO Guidelines.
- To study the feasibility and potential effectiveness of the non-treatment health protection measures in reducing the disease burden associated with the use of wastewater, excreta and greywater.
- To increase awareness of the guidelines in the international development community and among national governments.
- To synthesise research findings into a joint document that will help low-income countries adapt the WHO guidelines for effective application in their own unique circumstances.

The final output of the research will be a guidance document that can help practitioners apply the methods suggested in the 2006 Guidelines.

IDRC, WHO and FAO (which agreed at the project outset to participate in supporting a fourth case study) accepted the following projects:

- Ghana (Kumasi): Evaluation of non-treatment options for maximising the public health benefits of WHO guidelines governing the use of wastewater in urban vegetable production.
- Ghana (Tamale): Minimising health risks from using excreta and greywater by poor urban and periurban farmers in the Tamale municipality.
- Jordan: Safe use of greywater for agriculture in Jerash Refugee Camp: focus on technical, institutional and managerial aspects of non-treatment options.
- Senegal (Dakar): Integration and application of the guidelines on wastewater and excreta reuse in agriculture.

The projects started their operations in April 2007 and in this year all four pilots will complete their research. In addition, the project will be presenting preliminary results and an information guide at World Water Week in Stockholm. In March, 2009, the final project workshop will take place in Amman and final results will be shared amongst all of the teams.

The agencies involved are the International Development Research Centre (IDRC), based in Ottawa, Canada, the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) of the United Nations. Contacts:

WHO: Robert Bos bosr@who.int
FAO: Ines Beernaerts Ines.Beernaerts@fao.org
IDRC: Mark Redwood mredwood@idrc.ca

The WHO Guidelines can be ordered from WHO Geneva, or downloaded from www.who.int/water_sanitation_health.

Surface Water Quality and Periurban Food Production in Kano, Nigeria

Roy Maconachie

Kano, the largest city in northern Nigeria, has long served as an important market for resources produced in its periurban zone. In particular, urban farming is widespread in Kano and is tolerated as an important response to the economic and social conditions faced by many poor individuals. Previous studies in the region have concluded that urban farms make very significant contributions to city nutrition, household food security, employment and the environment (1).

However, recent research also suggests that there is much cause for concern as industrial and domestic toxins are reaching dangerously high levels in periurban areas. This article examines some of the environmental and health consequences associated with urban farming in Kano, as irrigation sources become increasingly polluted.

Water availability and quality

Kano is growing quickly. Statistics from the most recent census undertaken in 2007, which are yet to be released, suggest that Kano currently boasts a population of just under four million. The region also faces low and unreliable rainfall, with most rain falling predominantly in the five-month 'wet season' between May and September. Each year, there is a serious water deficiency in the Kano vicinity, which can last for up to seven months. Dry season production is only possible in low-lying depressions where the water table is close to the surface (referred to as fadamas in Hausa). There is intense competition for periurban plots where such irrigated cultivation is possible.

Levels of pollution in water sources vary both temporally and spatially Photo: Roy Maconachie

The combination of Kano's low and unreliable rainfall, its growing population, and industrial pollution from nearby factories seriously threatens the quantity and quality of local water resources. The tannery and textile industries, using the largest quantities of water and producing the greatest amounts of wastewater, constitute the main sources of pollution. The waste by-products from these tanneries have high concentrations of the heavy metals chromium and cadmium. Further compounding the problem is the city's inadequate sewerage provision, leading to the discharge of effluents into rivers and drains. This contamination of water sources poses a major risk to human health.

> Due to recent water scarcity, domestic water use and residential runoff had been reduced

Water quality measurement

During field research carried out in 2002 at three agricultural sites in urban and peri urban Kano, water samples were taken at various points from the Getsi Stream and Jakara River. An attempt was made to examine water quality both temporally and spatially. The Kofar Ruwa site and Jakara site off Airport Road were chosen because they are situated close to the city centre in areas of high population density, while the Kwarin-Dankukuru site is located at the urban periphery. At Kwarin-Dankukuru, water was sampled from both an irrigation channel and a washbore (6-8 metres deep), so that comparisons could be made between the two sources. Water samples were also taken from the Getsi Stream in the nearby Bompai Industrial Estate, since this was the main source of industrial pollution at Kwarin-Dankukuru. Both of the waterways sampled were major sources of irrigation water for periurban farmers. For each sample, standard procedures were followed for the analysis of the selected elements cobalt, copper, iron, manganese, nickel, lead, chromium, mercury, cadmium, magnesium, and calcium - some of the trace elements which are typically associated with discharges from tanneries and textile mills, two of the major polluters in the Kano industrial estates. The investigation did not examine levels of pathogens associated with faecal contamination (for information on this see Tanko, 1997). The majority of sampling was carried out during the month of April, at the end of the long dry season, since this was the critical period when farmers were irrigating on a daily basis and there were no natural water flows to dilute toxins in the channels. However, a set of samples was also taken during August, the wettest month, in order to compare water quality in the wet and dry seasons. Water specimens were taken both in the early morning and in the afternoon, as it was noted that local factories release pollutants into water courses at different times during the day, causing daily temporal variations in water quality. The results of the analysis are presented and discussed in detail in Maconachie (2007). In addition to the quantitative data collected, interviews were conducted with producers at each site, and their concerns for water quality further suggest that there is an urgent need to ameliorate the considerable health and environmental hazards associated with agriculture in urban and periurban Kano.

The Kwarin-Dankukuru site

At the Kwarin-Dankukuru site, where the Jankara River and Getsi Stream meet, high levels of toxins were revealed in the analysis. Farmers commented that in previous years, large volumes of water from residential areas would dilute industrial pollution, even in the dry season, but due to recent water scarcity, domestic water use and hence residential runoff had been reduced. It was also noted that wastewater from the Bompai industrial estate is released, without any form of treatment, into the Getsi Stream. All the farmers interviewed at Kwarin-Dankukuru expressed great concern about the current environmental state of the site, and the implications that this may have on their health. Farmers could distinguish water toxicity levels by colour and provided detailed descriptions of the temporal variations in water quality.

> There are three bad colours [of water] that come at different times. The oily red one and the green one will kill the crops, and when we see these colours in the channel, we turn off our pumps immediately. The bluish water is corrosive and causes a red rash when it comes in contact with the skin. We always wash our hands after we come in contact with the blue water (personal communication, April 2002).

Farmers' observations suggest that there is a clear need for the regulation of industrial contamination by authorities. Whilst some contaminants were found to be present in water sampled from the washbore at Kwarin-Dankukuru, the water was free of heavy metals. Although previous research has revealed traces of these metals in shallow hand-dug wells around the Bompai settlement (Tanko, 1997), no evidence of such contamination was found in the current study, suggesting that deep ground water sources may be a good alternative for farmers in urban and periurban Kano, for the irrigation of their crops. However, longitudinal studies are urgently needed to clarify the health risks for farmers and consumers.

Jakara site

Unlike the water in the Getsi Stream, the Jakara River showed no evidence of pollution by heavy metals. In fact, the Jakara joins the Getsi, and thus helps to dilute toxins originating from the tanneries and textile mills in the downstream portion of the Getsi system. However, chemical analysis of water samples from the Jakara revealed that other pollutants, including cobalt, manganese, and iron, were present in high concentrations. Substantial vegetable production takes place with water from the Jakara channel, and farmers report observing colour differences in effluents at different times during the day. The analysis of water samples also reflected these temporal variations in water quality.

Farmers report colour differences in effluents at different times during the day

Urban agriculture around a factory
Photo: Roy Maconachie

Kofar Ruwa site

The Kofar Ruwa production site is situated in the floodplain of a small tributary of the Jakara River, which serves as a drain for urban wastewater from the built-up area. The construction of a sewage treatment scheme in the area has long been abandoned, and the sources that supply irrigation water for vegetable production are heavily polluted and have been flagged as a major environmental and health concern. Interviews with farmers at Kofar Ruwa suggest that concern for the quality of available water was also a significant issue for many farmers. According to one cultivator, both the odour and colour of water sources change periodically at Kofar Ruwa, especially during the dry season, and sometimes the poor quality of irrigation water will "burn" the lettuce and cause it to "dry up". Although no traces of heavy metals were detected in the samples taken at the Kofar Ruwa site, toxicities of some of the domestic contaminants, especially manganese, were detected. In addition, a number of respondents at Kofar Ruwa mentioned that there was a general lack of water in the dry season, and that farmers were frequently forced to use poor-quality water on their plots.

Conclusion

There is currently much cause for concern for periurban farmers in Kano, as industrial and domestic toxins are reaching dangerously high levels and the environmental resources required for farming are becoming increasingly polluted. Water treatment and water supply facilities are virtually non-existent, and the scarcity and prohibitive cost of irrigation water and chemical fertilisers are such that those who engage in urban agriculture are left with no choice but to use contaminated water sources. Local surface water is of vital importance and the shallow ground water supplies found in fadama depressions, where much agricultural production takes place, are highly polluted with urban and industrial contaminants.

However, evidence suggests that levels of pollution in urban and periurban water sources vary both temporally and spatially and there may be safer times and locations where agriculture can be encouraged by authorities. There is an urgent need, therefore, for urban agriculture to be carefully monitored, and for improvements in management to be sought. If local authorities were able to harness the beneficial characteristics of domestic wastewater, surface water pollution problems would not only be mitigated, but valuable water resources would be conserved and dependence on commercial fertilisers might be lessened (see Pescod, 1992). However, since the health implications of long-term exposure to toxins are unclear, coordinated longitudinal research involving urban planners, agricultural scientists and health specialists is urgently needed.

Although zoning by-laws in the industrial areas supposedly do exist, they are poorly enforced, penalties for violating industrial standards are very lax, and in some cases they are non-existent. Industrial pollution management capabilities are severely constrained at institutional levels, both financially and technically, and there is a lack of effective implementation of environmental management laws. Market-based incentives to reduce pollution, such as the "polluter pays" principle, or grants, subsidies and tax credits for environmentally friendly behaviour, either do not exist or are ineffective. Responsibility for pollution control enforcement is not clearly defined, and both state and federal governments seem to disagree on who should be liable.

Farmers report colour differences in effluents at different times during the day

Interventions include improved irrigation practices
Photo: IWMI-Ghana

There is an urgent need to monitor urban agriculture and improvements in management.

Substantial investment and community action are needed in urban and periurban waste management.

In short, coordination among environmental agencies is weak and a new concerted programme of action is urgently needed to stimulate effective strategies for the management of the urban and periurban environment. It thus remains crucial that government and institutional actors effectively monitor and enforce both environmental and zoning by-laws, if the health and environmental constraints of urban agriculture are to be overcome, and the future sustainability of production is to be assured.

Roy Maconachie

Institute for Development Policy and Management (IDPM)
University of Manchester
Email: roy.maconachie@manchester.ac.uk

Notes

1) See Binns and Fereday, 1996; Binns and Lynch, 1998; Olofin et al, 1997

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Modeste L. Kinané
Arlette Tougma
Denis Ouédraogo
Moise Sonou

Urban Farmers' Irrigation Practices in Burkina Faso

Farmer using watering cans for irrigation
Photo: Sangare Drissa

Many studies have pointed out the health risks associated with inappropriate use of untreated wastewater or polluted water for both consumers and farmers in urban vegetable production in Burkina Faso. But this is a reality in daily life, and at this point understanding farmers' strategies is critical for implementing measures to make irrigation practices safer.

Together, Ouagadougou and Bobo-Dioulasso comprise about one quarter of the total urban population of the country. Since the 1960s the number of sites on which exotic vegetables are grown has increased in the city of Ouagadougou alone from just a few to more than 50, representing about 2500 ha, to meet the growing demand of urban consumers. Quite a number of studies have been carried out on various health and environmental risks associated with the inappropriate use of untreated wastewater or polluted water in these cities. However, implementation of various recommendations for safer irrigation practices has been extremely slow or almost nonexistent. To learn more from urban farmers and their irrigation systems, information was collected from 570 vegetable farmers on 13 sites in Ouagadougou and Bobo-Doulasso during the dry season in 2006 and 2007.

Who are the water users?

Almost all vegetable farmers are men with an average age of 37 years. Most of them are not educated and they have been using water for vegetable production for an average of 13 years. For most of the farmers, vegetable production is their main or secondary source of income, which helps them take care of an average of 7 people (in their households or families). They grow vegetables (mainly lettuce, carrot, cabbage and onion) on small plots of 0.12 ha to 0.35 ha that have been informally inherited, borrowed or donated.

> The urban environment is very unstable

Origin and use of water

The farmers usually get their main irrigation water from shallow wells, dugouts or rivers located less than 50 m from their farms. In Bobo-Dioulasso, more than one third of the farmers use the Houet River as their main source of irrigation water all year round, while in Ouagadougou farmers mostly use water from shallow wells and dugouts. Especially during the dry season, when the study took place, farmers use several different sources for water.

Houet River
The name of the Houet province, in which Bobo-Dioulasso is the biggest city, comes from the river that crosses this city. Upstream, water from this river is used for washing clothes (especially by women), for gardening, etc. Downstream the water is used mainly for vegetable production. The Houet River also carries liquid and solid wastes from riverside households and the abattoir. Apart from microbiological contaminations, the water from this river sometimes contains high concentrations of hazardous chemicals. (Tarnagda et al., 2001; Toe et al., 2004).

Four irrigation systems were identified (see table).

Main irrigation systems

	Sources of water (*)	Fetching and transportation	Application	percentage
System 1	Shallow wells or dugouts	Watering can	Watering can	63
System 2	Shallow well or river	Motor pump and storage in a reservoir	Watering can	13
System 3	Drain or river	Motor pump	Water hose or furrow	2
System 4	Drain or river	Watering can	Watering can	14

*) Farmers use one or more sources of water. For this study we considered the main source during the dry season. Source: Author

Some of the farmers (around 25 percent) perceive that poor quality of irrigation water could pose health risks to both themselves and consumers. However, water quality was not mentioned as a cause of disease amongst farmers. Health-related issues from the use of untreated wastewater are complex in urban areas especially among poor people. What does irrigation water quality mean in a context where some of the farmers do not have potable drinking water for themselves? Moreover, some farmers complain that generalisations are being made about the quality of their irrigation water:

During an informal discussion, the oldest farmer at the "boulmiougou" site in Ouagadougou (who has been producing vegetables on the site for almost 35 years) mentioned: "If this water was not good we would have died first, before the vegetable consumers. Many civil servants and expatriates are my clients. I never ask them to come back, they do it voluntarily".

In Ouagadougou, farmers prefer systems 1 and 2, while systems 3 and 4 are used more often in Bobo-Dioulasso. These cities face different land and water constraints. Pressure on land resources is greater in Ouagadougou than in Bobo-Dioulasso, and water is more available year round in Bobo-Dioulasso. The use of a particular irrigation system is also based on the type of crop grown and availability of labour. For instance, when a farmer increases the area allocated in his farming system to cabbage and lettuce, using system 2 becomes a constraint. System 2 is mostly used by older farmers (generally autochthons), while system 1 is mostly used by young migrants or newcomers into the sector. Farmers also prefer system 1 when they have a positive perception of the availability of water, and when they are involved (or not?) in a farmers' organisation. When a farmer has a larger number of people from his household involved in marketing and production, systems 2 and 3 are dominant (the motor pump, because of funds available?). Interestingly, land tenure security does not affect the adoption of these systems. These irrigation systems seem to be already adapted to the uncertain urban environment in which vegetable farmers operate.

The urban environment

Most of the farmers agree that the urban environment is very unstable especially in terms of prices (for both inputs and outputs) and land tenure. In Ouagadougou, land tenure insecurity ranks among the most important sources of uncertainty for 53 percent of the farmers while in Bobo-Dioulasso the main source of uncertainty is market prices. Climate and sanitary risks are cited as major sources of uncertainty by fewer than 10 percent of the farmers in both cities. Farmers have developed few strategies to cope with these sources of uncertainty, like mixing crops in different cycles in the farming system, and to maintain a continuous flow of income so that unexpected social events and celebrations can be tackled. An important strategy is to maintain good relationships with the traditional chief of the area, the oldest on the site and with people living around the site. They also try to keep the site clean from solid wastes, generally in their plots and on a radius of 5 metres around the plot.

Supporting these farmers

The urban vegetable farmers are among the poorest socioeconomic groups in Bobo-Dioulasso and Ouagadougou. Irrigation practices in these cities depend on both socioeconomic and environmental factors, and are already adapted to land tenure insecurity in these cities. These farmers could be assisted by:

- Training in safer and more efficient water use management, without changing the existing irrigation systems too much (otherwise land tenure will become an important constraint);
- Strengthening the operational capacity of local authorities in integrated urban (waste)water and sanitation management, for instance by limiting and reducing as much as possible sources of chemical pollution;
- Facilitating a constructive dialogue of urban farmers' organisations with local authorities.

Modeste L. Kinané, FAO RAF, Accra, Ghana
Email: Modeste.Kinane@fao.org
Arlette Tougma, IDR, Bobo-Dioulasso, Burkina Faso
Denis Ouédraogo, IDR, Bobo-Dioulasso, Burkina Faso
Moise Sonou, FAO RAF, Accra, Ghana

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Farmers' Perceptions of Benefits and Risks from Wastewater Irrigation in Accra, Ghana

Kafui Adjaye-Gbewonyo

As safe water sources become scarcer and more polluted, the use of wastewater in urban agriculture may produce many benefits but may also lead to crop and soil contamination and endanger farmers and consumers. To effectively manage wastewater use in agriculture, it is important to understand how stakeholders feel impacted by the practice. .

Urban farmers are of special importance as they are the ones converting wastewater into a resource, creating benefits and risks not only for themselves but for consumers, their communities, and the environment. In 2006, twenty drain-water users and twenty-two pipe-water users were surveyed at six farming sites in Accra. To evaluate farmers' perceptions of risks from wastewater irrigation, farmers in Accra, Ghana, who use pipe-borne water for irrigation were compared with those using drain water and waste-polluted streams. Farmers were asked about their farming practices, inputs, production, demographic information, perceptions, and general health during the past year. The responses from the group of drain-water users and the group of pipe-water users were compared statistically.

Results

Malaria was the most commonly reported illness among the farmers (63.4 percent of the respondents reported having had it within the past year), followed by body pains (14.6 percent), fatigue (14.6 percent), and headache (7.3 percent). Only one farmer reported gastrointestinal illness, and this farmer used pipe water for irrigation. Only the reporting of malaria showed significant differences between the two groups of farmers; 77.3 percent of the pipe-water users reported having had malaria over the past year, as compared to 47.4 percent of drain-water users. Otherwise, no significant differences were seen in the proportions of drain- and pipe-water irrigators reporting other illnesses.

Differences were observed between pipe- and drain-water users' perceptions about their irrigation water. A significantly larger proportion of drain-water users (63 percent) considered their irrigation water supply to be reliable, whereas just 19 percent of pipe-water users deemed their water supply reliable since it is often shut off by the water providers. As a result, many pipe-water irrigators store water in open reservoirs or shallow pools dug in the ground and draw their irrigation water from these pools with watering cans.

Farmer using watering cans for irrigation
Photo: Sangare Drissa

Higher proportions of pipe-water users than drain-water users, in some cases significantly so, felt their irrigation water affects their crops or soil, farming revenue, and health in a different manner than do other water sources. When pipe-water users were asked whether they believed their crops and soil were affected differently by pipe-borne water than by other water supplies such as drain water, 80 percent of the respondents said yes. When asked this question with respect to their farming revenue, 56 percent said yes, and with respect to their health, 40 percent said yes while one respondent was unsure. Most of the pipe-water users perceived these effects to be positive in comparison to using drain water or other sources. Some of the explanations given were that pipe water prevents disease and that crops cultivated with pipe water are fresher, more hygienic, of better quality, or preferred by customers. A few pipe-water irrigators did claim, however, that drain water is better for crops because it has more nutrients.

In contrast to the pipe-water users, most of the drain-water users did not believe that their irrigation water affects their crops, farming revenue, or health in a different manner than pipe-borne water or other water sources do. Only 41 percent of respondents perceived an effect on their crops and soil (two respondents were unsure), 14 percent on their farming revenue, and 16 percent on their health. However, of the drain-water users who did perceive an impact on their crops and soil, most believed this impact was positive, such as through nutrients, improved crop growth, or the absence of chlorine; but a couple of drain irrigators mentioned negative impacts on either their crops or sales. Healthwise, while two drain-water farmers said they had experienced skin irritation from their irrigation water, others stated that taking common precautions such as washing after work prevents illness. Two other drain-water users stated that although the media or "learned" people talk of health risks from using drain water for irrigation, they had not experienced any such problems.

Discussion

This study found most types of illnesses reported by both drain-water users and pipe-water users to be similar, suggesting that other sources of illness may overshadow those presented by farmers' contact with irrigation water. Interestingly, in Ouagadougou where the health perceptions of urban farmers were compared with those of their non-farming neighbours, significant differences could not be found either (Gerstl, 2001). However, the results from the present study do not mean that differences do not exist. A survey by Amoah (2003), found a higher incidence of diarrhoea, fever, and headaches among Accra farmers using polluted irrigation water versus those using non-polluted water. It is also possible that some farmers regard certain health problems (e.g. gastrointestinal problems) as not serious enough to report. Additionally, farmers' answers might have been biased to justify the use of their water sources. Because this was only a pilot study, more farmers will need to be interviewed and more detailed data collected before sound conclusions can be made. Nonetheless, it was evident that even those farmers who were aware of potential health risks of using untreated water for irrigation did not value these risks high, i.e. they seemed willing to accept these risks because of the benefits gained from drain water and the unavailability of other water sources.

The difference observed in the reporting of malaria between the two groups of farmers raised questions. It could indicate that the locations in which many of Accra's pipe-water irrigators farm or live are more prone to malaria-transmitting mosquitoes. It could also suggest that the small storage ponds (about 0.5 m3) used by pipe-water irrigators provide a more suitable breeding ground for mosquitoes, while wastewater pools are known as unsuitable breeding grounds. However, other studies have shown that natural predators and other known competitors (tadpoles) effectively controlled mosquitoes' larval development in such freshwater pools on farming sites in Accra (Miah 2004). The possible link between irrigated urban agriculture and malaria has been studied by the International Water Management Institute (IWMI) in Kumasi and Accra (Afrane et al. 2004; Klinkenberg et al., 2005), but as yet no explicit link between malaria and local farming activities has been established.

Challenge ahead

While more detailed research is needed to better understand the issues discussed here, we observe that farmers are increasingly becoming tired of participating in surveys and long interviews that provide no benefits for them. There is also always the fear of too much official attention being paid to the as yet illegal practice of drain water irrigation.

Polluted stream/drain used for irrigation
Photo: Kafui Adjaye-Gbewonyo

Nevertheless, increased government involvement in the ongoing studies on consumer health risk mitigation could lead to more supportive policies and, for example, increased land tenure security. Also, more collaboration among researchers is necessary to avoid duplication in research. Data from previous and ongoing studies could be compiled and stored in a database and made available to researchers, as is being initiated by IWMI for the RUAF and SWITCH projects in Accra.

Acknowledgments
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Kafui Adjaye-Gbewonyo, Harvard University,
Email: KafuiG@post.harvard.edu

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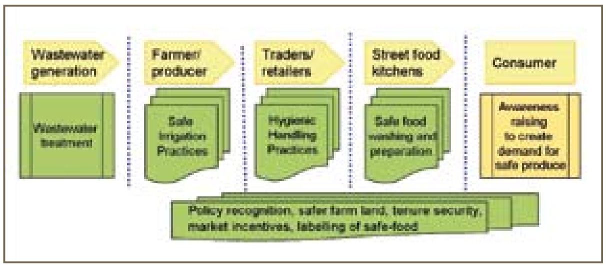
Use of Irrigation Water to Wash Vegetables Grown on Urban Farms in Kumasi, Ghana

Lesley Hope

Owing to the importance of irrigated urban vegetable farming in Ghana, a number of research and development activities have been recently initiated to improve the safety of vegetables. The positive and negative impacts of these initiatives have already been widely documented (UA Magazine no 8, and the article in no. 19 on this issue). This paper describes a number of low-cost risk-reduction interventions developed together with key stakeholders in the "farm to fork" continuum. These initiatives were based on the WHO multiple-barrier approach that calls for the implementation of risk-reduction strategies at various points along the food chain in order to achieve a cumulative risk reduction (see the figure and the article on page 21).



The Multiple-barrier concept (Adapted from WHO, 2006)

These interventions include farm-based measures such as sedimentation ponds, simple filtration techniques and improved irrigation practices as well as post-harvest measures such as improved vegetable washing methods (Keraita, 2008; Amoah, 2008). A number of best practices have been developed from these interventions, and implementation is ongoing, particularly of farm-based practices with which the Urban Agriculture Directorates of the Ministry of Food and Agriculture (MoFA) are actively involved. Follow-up studies are also being carried out, such as by the SWITCH programme, which is implementing improved pond systems at the Dzorwulu in Accra (see article on page 14), and the boreholes implemented by MoFA in some vegetable farming sites in Accra. Although these interventions have the potential of reducing health risks, other practices of vegetable traders (market women) like the washing of vegetables in irrigation water jeopardize efforts to ensure the safety of vegetables.

Quality of irrigation water and vegetables

Farm-based intervention measures tested so far have been able to reduce levels of helminth eggs to less than 1 egg, and faecal coliforms by 1-3 log units, per 100g of lettuce. The presence of these contaminants on lettuce not washed in irrigation water has thus been reduced to acceptable levels of about less than 4 log units per 100g. Washing of lettuce in contaminated irrigation

Women harvesting vegetables in Kumasi
Photo: IWMI-Ghana

water deposits microorganisms on the vegetable's surfaces, thereby increasing contamination levels, especially bacterial by 1-2 log units, and thus significantly reversing the contamination reduction gained from intervention measures (data are available with the corresponding author).

Why wash vegetables in irrigation water?

A number of different kinds of vegetables are grown on urban farms. The most commonly grown are lettuce, cabbage, spring onions, green pepper, cauliflower, carrots and cucumber. In Ghana, harvesting of vegetables is done by traders who are often women. Observations revealed that lettuce is the only crop commonly washed in irrigation water. It is uprooted from plots, heaped on vegetable beds (bare soil) and carried to nearby irrigation water sources, usually ponds and dugouts, where it is washed. Washing is a delicate task and care is taken that lettuce retains its physical quality and attractiveness.

Vegetable sellers (market women) and farmers explained in interviews that washing lettuce in irrigation water is an old practice which has existed as long as lettuce has been grown at the farming sites. The main reasons given by vegetable sellers for washing vegetables in irrigation water was to remove soil particles and earthworms that are attached to leaves and roots. This makes the lettuce more attractive and reduces its weight, which is important when the lettuce has to be carried to markets. Washing also helps keep vegetables fresh, especially when kept overnight before selling. Lettuce to be transported out of Kumasi city is not washed because washing makes it "soft" (flaccid) and rot faster during the long hours of transportation in intense heat, as it is not refrigerated.

It is recommended that market women be better informed
Photo: IWMI-Ghana

Farmers often walk into the water sources when collecting irrigation water and wash their boots, feet and hands in the same sources in which market women wash vegetables. In most cases, these water sources are visibly dirty. The main reasons given by market women for using this water are convenience and unavailability of water in the markets and at home. Salamatu, one of the market women interviewed noted.: "There is no water in the market. I do not even have enough space to display my vegetables in the market. I always have to pick up my vegetables whenever a truck is approaching to prevent vegetables from being run over. How do you expect me to even have space to wash them? You understand the market problems now!" Memuna, also a market woman, who once tried washing vegetables at home, said "my children were fetching water at distant places for me to wash vegetables at home but it was too tiresome for them so I decided to wash on the farm to finish up all the activities associated with marketing of vegetables, especially lettuce, before I go home".

Perceptions on health risks

The market women interviewed knew that irrigation water has some harmful organisms that could cause diseases. Efua, one of the market women, noted that "once the water has no cover, there will definitely be certain germs in the water". This was perhaps based on experience from households where drinking water in storage containers is covered to minimise contamination. They also said that vegetables were "dirty" (with mud and germs), hence needed to be washed. However, only one of them could associate health risks (diarrhoea and stomach ache) with washing vegetables in irrigation water. Others saw no increased risk with this practice. Armah said, "this is the same water that the farmers use for watering these crops, so what is wrong with using it to wash vegetables? It is just like watering uprooted lettuce!"

Main reasons for washing vegetables is to remove soil particles and earthworms. Photo: IWMI-Ghana

Even if the lettuce was contaminated, market women strongly believed that the pathogens will die before the lettuce reaches the consumer. They noted that everyone who buys lettuce washes it with salt or vinegar before use, so the consumer is never at risk". Even without washing, they said that the heat alone that builds in lettuce between harvesting and selling, i.e. during storage and transportation, will kill all the pathogens. Microbiological studies disprove this idea as they show that pathogen levels do not decrease from farms to markets and washing of lettuce with vinegar and salt can only reduce pathogen levels but not eliminate them totally as initial levels are usually very high (Amoah et al., 2007).

The market women themselves may be at higher risk of exposure, as they spend long periods washing vegetables in irrigation water without any protection. But very few market women recognised this occupational risk. Ataa indicated "if anyone is at risk it is the traders and farmers who have direct contact with irrigation water." Skin rashes on hands and palms were the main health effects reported by the market women. In response (to these effects, some women now wear gloves during harvesting and washing of vegetables while others have totally stopped washing vegetables in irrigation water and now sell them unwashed.

Conclusion

Washing of lettuce poses a health risk, and therefore it is recommended that market women be better informed, with the aim of stopping the practice. There is a clear knowledge gap among market women on pathogen transfer and health implications, which needs to be addressed. If the practice is to be considered as one of the multiple uses of irrigation water, then efforts should be directed at improving the water quality.

Lesley Hope, Bernard Keraita* and Maxwell SK Akple
IWMI West Africa, Kumasi Office, Ghana.
Email: Contact: b.keraita@cgiar.org

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Water Supply and Urban Agriculture in Bulawayo

Takawira Mubvami
Percy Toriro

Irrigation with municipal wastewater is practised in many urban and periurban areas of developing countries. In Zimbabwe this has largely been restricted to pasture irrigation (Chimbari et al., 2003). Wastewater is increasingly being used for irrigation in urban and periurban agriculture, thereby supporting the livelihoods of (particularly poor) farmers. There is a need to identify practical, affordable health safeguards that do not threaten the livelihoods of those dependent on wastewater.

Bulawayo water

Bulawayo is the second largest city in Zimbabwe. The city has a population of approximately one million inhabitants. Situated in a dry part of the country, Bulawayo receives less than 800 mm of rainfall every year in the summer season, (from November to March). Maintaining a sufficient water supply has always been a challenge. The city's supply dams rarely fill up, and water levels go down during the dry season, making them insufficient to meet demand. Therefore, municipal authorities usually put water rationing measures in place to limit the residents' water usage. The city's average water demand per day is 150,000 cubic metres, while the dams are currently only able to supply 130,000 cubic metres. Domestic plots, for example, receive 450 litres of water per day from the local authority. In 2007 rotational water cuts were also put into place, whereby a suburb's water supply could be cut off for a period of time.

Boreholes around Bulawayo
Photo: MDPESA

Maintaining a sufficient water supply has always been a challenge Bulawayo
Photo: MDPESA

The city provides wastewater for irrigation

Urban agriculture

The city has resorted to using various sources of water for urban agricultural purposes. These include boreholes and treated wastewater. The city has a policy that guides use of clean water, stating that the primary use of water in the city is for domestic use. This applies especially to borehole water. Where a borehole is made available, the first priority is for domestic uses such as cooking, bathing, and drinking. Other uses such as watering of plants and animals are secondary. The boreholes are locally managed by the communities in which they are situated.

The city council has been able to provide treated wastewater to a number of farmers in various locations. At a pilot project site at the Gum Plantation, RUAF has provided funding for improving the water supply through lining of the main irrigation canal to avoid water losses through seepage.

Nine garden allotments, which are managed by the social services office in the Department of Housing and Community Services, use treated wastewater. The beneficiaries are mostly the elderly and the destitute, who grow vegetables mainly for domestic

Beneficiaries harvest enough for household consumption
Photo: MDPESA

consumption and sometimes for sale to generate income. The city also manages the Gum Plantation Allotment, a massive community garden project on an estimated four and a half square kilometres. This allotment receives the bulk of the treated wastewater. Beneficiaries are drawn from several high-density suburbs in the city, and each beneficiary household is allocated six long-beds. The city provides wastewater for irrigation. The beneficiaries' allotments have been divided into blocks. Each block is given one day during the week when it irrigates its crop. The council employs two extension officers who help the residents with sound advice on farming practices and measures that they can take to protect the environment. With the availability of water, beneficiaries are able to practice year-round agriculture.They grow vegetables, sugar beans and maize.

Farmers who use treated wastewater need training in handling the water

Council officials estimated that beneficiaries harvest enough for household consumption and earn an average of US$ 70 a month from selling the surplus from their allotments. It is also estimated that 60 percent of the vegetables from the Gum Plantation Allotment are sold in the city, while the balance is exported to Francistown in neighbouring Botswana. While at the site, the author of this paper witnessed scores of vegetable buyers driving trucks with trailers from Botswana loading vegetables for resale in their country.

Apart from the community projects the council manages, it has its own urban agriculture projects in and around the city. For example, at the Gum Plantation Allotment, the council keeps horses that are used for mounted patrols and for the Mazwi Nature Park, which is an eco-tourism project. Situated to the north of the city, Aisleby farm is another council urban agriculture project, with 2000-2500 head of cattle. In winter the council also grows wheat. Both the wheat and the pastures for the animals are irrigated using wastewater.

Awareness on using wastewater

The farmers who use the treated wastewater have not been trained in handling the water. A baseline survey conducted in 2005 amongst urban farmers in the city revealed that most of the farmers (62 percent) had been using wastewater for more than six years. The majority (89 percent) were comfortable using wastewater and it was their only source of water for irrigating. Those who preferred using wastewater (62 percent), chose it because they recognised that the water is fertile and there would be no need to buy fertilisers; while those who were not comfortable with wastewater (11 percent) preferred to have another source of water which they can also use to drink and grow a wide range of other crops that are not restricted. In terms of the health risks associated with using wastewater, 70 percent were aware of the risks but could not enumerate the type of infections they might get. Knowledge on what types of crops could be grown using wastewater appeared to be high (74 percent).

Sixty-two percent of the farmers felt there was sufficient support from the local authority in the form of the land and water, which they were getting for free; whilst the rest felt local authorities were not doing enough to support them. The local authority, on the other hand, questioned the feasibility of sustaining the service of supplying and pumping the wastewater because it was becoming too costly. In addition, although support was seen as necessary, it should be guided by policies and by-laws. To ensure sustainability of the service, the farmers were willing to pay (91 percent) for the services of supplying wastewater and maintenance of the system.

The local authorities are key stakeholders in urban agriculture and their engagement and participation are crucial. They can help farmers in ensuring that water for urban agriculture is available, be it treated wastewater or other forms like borehole water. They can also play an important role in addressing the negative effects of wastewater use thorough extension services to and training of farmers.

Takawira Mubvami and
Percy Toriro
Municipal Development Partnership Eastern and Southern Africa
Email: tmubvami@mdpafrica.org.zw

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Efficient Usage of Water in South African Township Gardens

Founded in 1999, Ubuntu Education Fund is an NGO dedicated to providing vulnerable children and their families in the townships of Port Elizabeth, South Africa, with an empowering environment and access to services and opportunities. Ubuntu Education Fund began developing urban community gardens at schools, health clinics and community backyards in 2005. The purpose of these gardens is to provide food and income to orphaned and vulnerable children and people living with HIV (see article in UA-Magazine no. 18).

> In future all of the gardens will be using rooftop collection and drip irrigation

Availability of water

Port Elizabeth is not a drought-ridden area, however the substantial amount of rainfall received is often periodic and torrential in nature. All of the Ubuntu gardens have access to tap water provided by the local municipality, and the schools and clinics where these gardens are located are public institutions that do not have to pay for their water, which is always clean and of a reasonable quality. There are, however, limitations on the quantity of water each institution may use for irrigation, and during times of drought severe restrictions are implemented on water use for gardening.

With these factors in mind, Ubuntu seeks to develop systems of gardening which are efficient and conservationist in there utilisation of water, prioritising low-cost simple technologies that are appropriate to an urban setting. Using these techniques in the urban gardens has contributed to high productivity and year-round yields of crops such as swiss chard, carrots, beet roots, green peppers, broccoli and cauliflower, and prevented the periodic lack of water from becoming a serious issue. In future all of the gardens will be using rooftop collection and drip irrigation, with tap water being almost completely phased out.

Water-saving practices

In developing a garden site, the topography is first examined to see if there is significant flooding, and run off from pavement and rooftops. If this is a major issue, a trench of approximately 1 metre wide is dug, transecting the garden, and following the contours of the landscape. This swale serves the purpose of allowing water that would otherwise have caused flooding, run off into drains, or otherwise been wasted or destructive, to absorb directly into the garden's water table (Mollison, 1991). Plants, planted on the swale help to prevent it from eroding, and fruit trees or windbreak hedges planted along the swale will benefit from the large volumes of groundwater.

Ubuntu has had considerable success with using swales to absorb greywater from the school kitchens. Only liquid dish soap is used in these kitchens, so there is no risk of toxicity from the water. Either a pipe is run from the sink drains, or a concrete furrow is used to channel the water into the swale. Concrete furrows can also be built to channel water to the gardens from the fountains used by children at the school for drinking and washing their hands. Greywater has also successfully been channelled into mulch pits used for growing bananas, which would otherwise be difficult to grow in our climate. Mulching prevents the top soil from drying out, which would reduce microbiological activity. In the gardens, water-conserving micro-climates are created by planting windbreak hedges, utilising fast-growing, hardy species that require little attention, like Vetiver grass. Compost, besides assisting in overall plant health, allows the soil to absorb more water and hold it for longer. Compost is added at each planting in a layer of 4-6 inches covering the bed.

Since 2006, Ubuntu has been installing plastic gutters, pipes and large PVC tanks to collect water from school and clinic rooftops. The water is used for irrigation either by filling watering cans with a normal garden hose and watering attachment, or ideally by means of a gravity-fed micro-drip irrigation system. A main line is run along the length of the garden and blocks of micro-drip line are then attached to this main line. Gardeners turn on each block by opening a valve. The micro-drip irrigation ensures that more water penetrates deeper into the soil. Less water is wasted or lost to evaporation and the gardeners have more time to devote to other tasks such as weeding or planting. Watering cans and hoses are still used for watering newly planted seedbeds and seedlings.

Some of the garden sites face a challenge of severe soil salinity due to an underground aquifer of brackish water. The salt tends to get worse after intense rainfalls. Drip irrigation at these sites is prioritised, since overhead watering will bring salt up in the way that rain does. In addition, raised beds allow the salt to drain out of the beds more rapidly after rainfalls, and adding large amounts of compost helps to neutralise the salinity.

Matthew Lief, Ubuntu
Email: matthewlief@gmail.com

Rainwater Harvesting Potential for Urban Agriculture in Hyderabad

Priyanie Amerasinghe
Charles Devenish
KB Suleman[1]

Agriculture in and around Indian cities is under pressure due to rapid urbanisation and associated land use change, and coupled with pressure on already scarce water resources. The major beneficiaries of UA in the larger cities are low-income communities that make use of the available resources – vacant land, river banks and wastewater – to supplement their meagre incomes. Rainwater is a valuable potential resource, and government attention to rainwater harvesting is growing, but its potential for UA is still poorly understood and documented.

Serilingampally

Hyderabad is a mega city, with a growing population of 7 million. In April 2007 the city limits were expanded (from 165 to 675 sq. km), absorbing 10 surrounding municipalities. Serilingampally is one such municipality that came under the Greater Hyderabad Municipal Corporation's (GHMC) jurisdiction. Between 2003 and 2006 Serilingampally lost 61 percent of its arable land to real estate development (IWMI, 2007: 19). Despite a booming IT sector and unprecedented economic growth, food security declined during this period for many of its inhabitants. Those who were once able to manage with the help of produce from their plots, have become dependent on food brought from afar with prices that are, in many cases, beyond their means. With nearly 30 percent of the population below the poverty line in 2003, Serilingampally has witnessed a shift in livelihood patterns among the low-income groups. Thus, the potential and need for localised household vegetable production for increased food

Rainwater harvesting unit, with compost bin
Photo: IWMI

In future all of the gardens will be using rooftop collection and drip irrigation

Purnima's story:

Purnima lives with her family of seven in Surabhi Colony. Their household income is 8000 INRs (US$ 200) per month and their monthly expenditure on food (excluding meat and dairy products) prior to taking part in the kitchen garden project was 2500 INRs (US$ 62). Purnima spends up to four hours each day gardening and although she had no previous knowledge about growing vegetables before the RUAF-CFF kitchen garden project began, she has been an active and enthusiastic participant and a team leader for five other families within the colony. With training and support provided by IWMI staff (the local NGO running the RUAF-CFF programme), Purnima estimates that her kitchen garden has saved the family an average of 200 INR a month during the winter months, representing 12.5 percent of her family's monthly food expenditure. There have been difficulties along the way, such as seeds not germinating and poor soil quality; however, it is the gradual decline of water supply that is the main problem. In the hot summer months only a few taps are functional, and Purnima collects her water from the next street where the water tap works allowing her to collect a 25 L bucket in a ten-minute round trip. It takes her two hours every morning to collect enough water for the family's daily use. Approximately 60 L of the 200 L of water collected is used for watering her vegetable garden.

This information is based on two interviews conducted with Purnima by IWMI staff on 24/4/08 and 26/4/08.

security is clear. In areas like Serilingampally, those with a home garden can be encouraged to develop it to improve their household food security.

Surabhi Colony

Surabhi Colony used to fall within Serilingampally municipality, but it is now within the GHMC of Hyderabad. It is situated on the western fringe of Hyderabad and is registered as a low-income community, allowing it access to the programmes of the Urban Poverty Alleviation and Livelihood Cell of the GHMC (www.ghmc.gov.in). Supported by strong community leaders and self-help groups, the members of the community are well positioned to represent themselves in seeking government support. Mixed livelihood activities are common despite the community's non-farming heritage. Nevertheless, one of the new challenges facing the community is household food security. Thus the RUAF-CFF programme sought to assist 38 households in the Surabhi Colony (December 2007) to realise the potential of urban kitchen gardens, with a view to improving household food security. By the end of the first growing season (February), however, water proved to be a considerable barrier to the full realisation of urban agriculture's potential. As in most semiarid regions, the rains come all at once, during the monsoon months June to September; and in the summer (March – May), the temperature rises to 40 degrees Celsius and water shortages become even more acute.
The main agricultural systems in Hyderabad are fodder and vegetable cultivation, where the much-needed water for growing is extracted from the Musi River that runs through the city (see UA-Magazine no. 8). However, no such water course is available to the Surabhi Colony, where groundwater is the main source for domestic use and other purposes. This too is erratic and inadequate. From interviews with members of Surabhi Colony (April 2008) it appeared that perceptions of water availability and daily usage vary depending on the resident's proximity and access to the single bore well that supplies water to the entire colony.

In April 2008, the number of households in Surabhi Colony rose to 240. Fifty-one taps distribute water for domestic use throughout the colony and this all comes from a single motorised bore well. While such a supply can be considered a blessing, this water is hard and undrinkable and the supply is restricted to four hours a day. Taps closer to the pump benefit from high water pressure, while those further away suffer from inadequate pressure and insufficient supply. This situation is exacerbated in the summer as groundwater levels go down. In addition to the piped water from the colony bore well, there are five hand pumps (four public and one private) distributed throughout the colony. However, the residents are less inclined to use these given the effort involved in extracting this water. More recently, their persistent representation at meetings with the local authorities resulted in the supply of potable water from the Krishna water project (Personal communication with IWMI project officer Radha). Supply was to be one 5000 L tanker every other day, an achievable target in the rainy season. However, in the recent summer months, supply has been reduced to two or three deliveries per week, as the demand for fresh cleaner drinking water throughout the city has increased. With a population of approximately 600, the average supply in summer works out to be between 2.38 L and 3.47 L of drinking water per person per day. For all other domestic purposes the bore well supply is the only source, but availability throughout the year is unreliable. So the kitchen gardens require an alternative source as a sustainable solution. While reusing greywater from kitchens is a potential option, the existing house plans are not conducive to this. All the washing (clothes and cooking utensils) is done outside where the water is stored in barrels or a concrete storage tank. A cemented area for washing where the effluent can be channelled to vegetable plots needs adequate planning, and investment of time and money.

It is in this setting that the imperative need for alternative sources of water, such as that provided by rainwater harvesting, to supplement the groundwater used for sustainable kitchen gardens becomes clear.

Rainwater for urban agriculture

Harvesting rainwater provides a free source of water, and utilising rainwater before it enters existing water systems within the urban area may provide a source of water that is less polluted than other sources of water within the city. If the water collected on rooftops is stored in private tanks it can be used by the residents, or, if directed to recharge the groundwater supply, it can help replenish local reserves. Thus, it can help reduce residents' dependence on local municipal supply and, depending on the storage capacity, has the potential to see them through times of seasonal water scarcity.

In addition, proper rainwater harvesting systems can help reduce pressure on the local infrastructure in times of heavy rainfall by storing or redirecting rainwater runoff from stressed stormwater drainage systems. In regions that experience monsoonal rainfall, a particular issue can be the overloading of these systems. Flooding and the potential for sewer overflows have obvious health risks which rainwater harvesting may – at least in a limited capacity – help minimise (Hewa et al., 2006: 445.)

Rainwater harvesting includes three components: a watershed area to produce runoff, a storage facility (soil profile, surface reservoirs, or groundwater aquifers), and a target area for beneficial use of the water (agriculture, domestic, or industry) (Molden, 2007: 332). The rainwater harvesting potential of a building is calculated by multiplying the rainfall amount by the catchment area by the runoff co-efficient (see for instance www.rainwater-harvesting.org for more information).

In an urban setting, harvesting rainwater from one's rooftop is perhaps the most obvious example, but is not the only method available. Rainwater harvesting can be as simple as capturing water on a plastic sheet with its four corners tied to poles (Hewa et al., 2006: 445). Once captured, the rainwater can either be stored in a tank or container above ground and drawn from as necessary, or directed to an underground tank or pit where it is used to recharge the groundwater. The size of the storage container will be constrained by the space each housing plot has in its garden, and therefore a rainwater harvesting system that enables both limited storage and recharge of the local groundwater reserves would be preferable. Unless adequate water quality testing is carried out, the captured water should not be used for human consumption. The initial cost of construction of the catchment and storage system does not have to be high: a storage container of 500 L with the required pipes and labour can cost around INR 2000/-.

For urban agriculture, the following list offers some issues to consider:

- *Local climate: is the rainfall steady throughout the year or concentrated within a short period?*
- *Soil structure: will the soil absorb the water once directed for the purpose of recharging groundwater?*
- *Storage capacity and effects of storage on water quality.*
- *Scale of urban agriculture practice and the specific crop requirements.*

Given the water shortages identified in Surabhi Colony, utilising the rainwater harvesting potential of each house could make a considerable difference to the residents' daily life. Given the rainfall patterns of Hyderabad, rainwater will most likely be harvested and stored during the monsoon – the period when irrigation will be least necessary. The issue therefore is the dry summer months, which come some five months after the end of the monsoon. The groundwater recharge could extend the supply over a two month period, but a mere 500 L storage water tank would most likely not be adequate to see the household through the remainder of the period. This predicament therefore illustrates the need for a diversified rainwater harvesting system, which includes recharging local groundwater supplies, and which will enhance the water supply throughout the year for crops and other domestic uses.

Rainwater harvesting on the government agenda

If Hyderabad city is to achieve the Hyderabad Metropolitan Water Supply & Sewerage Board's (HMWS & SB) vision to: "provide water of the highest quality, round the clock, at an affordable cost" (http://www.hyderabadwater.gov.in/) and if Hyderabad Urban Development Authority's (HUDA) plan to deliver 150 litres of water per capita per day (HUDA, 2006: 67) is to be met, then the harvesting of rainwater for both storage and groundwater recharge are vital steps that must be taken immediately.
The HMWS &SB has already envisaged the potential for rainwater harvesting in the city: in its attempt to promote rainwater harvesting it has drafted plans for rainwater harvesting units and offered a 10 percent subsidy to help cover construction costs (See: http://www.hyderabadwater.gov.in/rwhu.htm).
The need for such planning and action is imperative, since rapid building construction, coupled with plans to lay roadways throughout Surabhi Colony mean that the potential for the natural recharge of groundwater is in jeopardy. Awareness of the importance of rainwater harvesting has been increased through the RUAF's programme. The colony's leaders must be motivated to establish a diversified rainwater harvesting system for the colony; if not the scarcity of water will only intensify.

Priyanie Amerasinghe and KB Suleman
IWMI India
Email: P.Amerasinghe@cgiar.org
Charles Devenish
Victoria University of Wellington, New Zealand

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Some useful websites

www.rainwaterharvesting.org
www.wateraid.org
www.rainwaterclub.org
www.iwmi.cgiar.org

Greywater Recycling for Food Production in Montreal, Canada

Urban food production is quickly gaining popularity in Canadian cities, where community gardens are thriving and backyard or balcony cultivation is widespread. However, the desire to produce local food must be compensated by responsible water use if the practice is to be sustainable. Garden watering can account for more than 40 percent of household water use during the summer months, and wasteful irrigation practices are often the norm in Canadian cities[2].

In order to promote responsible resource use in Canadian households, pilot 'green' construction projects have cropped up in different parts of the country. In Montreal, one such housing project has gained international attention for its small ecological footprint and innovative water-use planning.

The Project

The house, designed with sustainability in mind, has successfully integrated water conservation, urban food production, waste recycling, and city greening, all in one small space. Situated in the heart of one of Canada's densest urban neighbourhoods, the building's entire 65 square meter roof is a flourishing food garden that produces a large summer harvest of fresh produce for the family that lives inside. And all this is achieved without any input of either tap water or fertiliser!

Domestic greywater from the family's two showers, one bathtub, and one clothes-washing machine is captured and redistributed for non-potable reuse. Since it is important to treat greywater that cannot be reused right away, the basement of the building includes a greywater treatment room where collected water passes through a simple treatment process before being stored in an underground tank for later use. In order to simplify treatment and prevent damage to the plants, only environmentally non-toxic and biodegradable soaps are used. The treated water is then pumped up on demand for use in toilet flushing and rooftop garden irrigation. The system was constructed by the homeowner with recycled materials, on a minimal budget of approximately CAN$ 2000 (1250 Euro). The energy requirement is also very reasonable, since the treatment process is gravity-fed and only a small amount of electric power is required to pump water from the basement to the upper stories of the house.

Up on the roof, recycled greywater circulates through a subsurface porous-pipe irrigation system, which delivers water directly to plant roots, thereby minimising wastage. In addition to reusing greywater, this intensive roof garden retains rainwater in a layer of loose stones beneath the garden soil, storing it for later irrigation needs. This water capture system also allows for evaporation to

In Montreal, one housing project has gained international attention for its small ecological footprint and innovative water-use planning
Photo: Sara Finley/www.ecohabitation.com

passively cool the building in summer and almost completely eliminates rainwater runoff into the street below. These innovative water-reuse practices result in over 60% less tapwater use than in a typical home, and reduce the amount of waste sent to the municipal sewer by up to 90%. In total, the house reuses over 80,000 litres of greywater each year, and this is only a fraction of the supply available. If more uses were found for the greywater or the garden was expanded, water savings could be even higher. Over the 5-month Montreal growing season, the roof garden produces daily greens for the family's meals, and enough tomatoes, peppers and basil for the canning of winter preserves. The plants are fertilised with composted household organic waste, assuring that even non-edible portions are not wasted.

Reuse for edible plants

Some caution need be exercised in irrigating edible plants with recycled greywater. Even after treatment, the water can contain dangerous bacteria. The risk is most strongly associated with direct contact of greywater with edible portions of the plant, and thus can be minimized with a properly designed drip or subsurface irrigation system. The pilot rooftop garden is lined with a system of soaker hoses which deliver greywater 1-3 inches below the surface of the soil, alongside the rows of crops. These hoses are relatively inexpensive and no clogging problems have been encountered. A series of laboratory experiments conducted in 2007 to monitor the bacterial contamination of the food surfaces revealed no significant contamination of crops by this irrigation method[3].

In Canada, no policy framework yet exists to promote or regulate greywater reuse in homes. This leaves innovation in the hands of individuals until city and local officials recognise the importance of water-saving measures. More projects like this one are therefore necessary in order to encourage a new way of thinking about water.

Sara Finley
Email: sara.finley@gmail.com

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Productive Sanitation: Increasing food security by reusing treated excreta and greywater in agriculture

Robert Gensch

Currently some estimated 854 million people worldwide are chronically hungry due to extreme poverty; and about 2 billion people lack food security intermittently due to varying degrees of poverty (FAO 2006). Despite the great efforts and promising attempts being made to decrease the number of people suffering from food insecurity, this number still remains high worldwide and will most likely intensify in the coming decades, due to the growing world population. A great deal of this population growth will take place in cities, causing a substantial increase in the volume of urban waste products, the over-exploitation of rural resources and a significant increase in urban food demand. Developing countries are particularly affected by the rampant urbanisation tendencies and face great difficulties in coping with this development.

In terms of the natural resources needed, food production requires mainly water and arable land that steadily supplies nutrients and the organic substrate for plant growth. These vital resources are often distributed unevenly around the world and many soils have been depleted or damaged by inappropriate agricultural practices. Around 70 percent of the globally used water resources are used for agricultural irrigation purposes (Brown, 2006). In addition, agriculture has to compete increasingly for water resources with domestic demand, industry, tourism, commerce and infrastructural institutions. Already today, large parts of Asia, Africa and the Middle East face either physical or economic water scarcity. Within the next 50 years it is estimated that more than 50 percent of the world population will live in such countries (WHO, 2006). Considering this fact and the direct relation between ongoing population growth and its additional water demand, a new approach to water is needed that recognises the human wastewater load as an important resource for agricultural irrigation.

Sustainable sanitation on maize explained to schoolchildren in Malawi
Photo: SuSanA

Agriculture and sanitation

Domestic wastewater and human excreta (urine and faeces) are essentially the same as animal manure and can serve as important sources for soil amelioration, as they deliver all relevant nutrients, organic matter and water needed for plant growth. Indeed, growing food and achieving food security are historically strongly linked with the idea of reusing liquid and solid waste from households in agriculture. The idea that human residues including excreta are wastes with no useful purpose can be seen as a modern misconception, and this system has been copied blindly in developing countries. At present farmers worldwide use around 150 million tons of synthetically produced nutrients (N; P2O5; K20) annually (IFA 2004), while at the same time conventional sanitation systems dump more than 50 million tons of fertiliser equivalents with a market value of around $ 15 billion (Werner 2004) into water bodies. This value will even increase in the years to come due to rising fertiliser prices and the continuously growing global population.

Productive sanitation

A paradigm shift in sanitation towards a recycling-oriented closed loop approach is imperatively needed to bring gravely limited nutrient resources back to the fields. This requires a new alliance between the agricultural and sanitation sectors, fostering resource recovery as a key requirement for sustainable sanitation concepts. Sustainable sanitation is a general term for all approaches that aim at improving the overall sustainability of sanitation systems, including a paradigm shift from purely disposal-oriented to reuse-oriented sanitation. In order to be sustainable, a sanitation system has to not only be economically viable, socially acceptable and technically and institutionally appropriate, but it should also protect the environment and recognise household excreta and wastewater as resources that should be productively reused. Sustainable sanitation systems should therefore allow for the almost complete recovery of nutrients in household wastewater, minimise the consumption and pollution of water resources and support the conservation of soil structure as well as agricultural productivity. Sustainable sanitation applies the basic natural principle of closing the loop by using safe sanitation and reuse technologies (Werner 2004). Sustainable sanitation systems used so far comprise decentralised and locally adapted as well as large-scale centralised solutions that favour no specific technology and range from low-cost basic sanitation (e.g. urine separation dehydration toilets, arboloos, ponds, constructed wetlands, etc.) to high-end solutions (vacuum systems, biogas plants, membrane technology, etc.). The sanitary resources can be divided into different resource streams (urine, faeces, greywater, rainwater, organic solid waste) and should, due to their different characteristics, be collected separately with adapted treatment facilities and application methods.

Urban agriculture

From the sanitation point of view, urban agriculture as well as wastewater aquaculture offer opportunities for win-win situations by turning urban waste products into productive resources (Drechsel and Kunze, 2001). Cities serve as both giant markets and a reliable and constant source of nutrients through the huge amount of urban wastewater. Today many cities are unable to ensure appropriate wastewater treatment, and they thus pollute the surrounding water bodies. Due to water scarcity and the lack of economical alternatives, many developing countries use untreated or partially treated wastewater as a source of nutrients and irrigation water, causing potential and often acute health risks. The sustainable sanitation approach can be seen as a promising integrated attempt to assure urban food security through the safe reuse of water and nutrient resources in urban wastewater.

Urban agriculture and urban aquaculture complement rural food supplies with often perishable and high-value food products, create jobs and safeguard the livelihoods of many urban dwellers. They also improve many people's macro- and micronutrient intake, particularly in vulnerable households and they can make important contributions to urban food security. One of the most apparent benefits of sustainable sanitation with respect to food security is the highly perceptible increase in agricultural yields, especially if directly compared with unfertilised crops.

Excreta and wastewater are low-cost fertiliser alternatives that can decrease farmers' dependence on commercial fertilisers. This is, especially relevant given the rise in the cost of fertiliser in recent years. The value of the nutrients that could be used in agriculture produced by each human being can be seen as a considerable quantity within the national economy. Recent estimations vary between 4 (KfW 2008) and 7 (Stravato & Dagerskog 2008) per person per year. Furthermore, efficient reuse would minimise the negative impact on surface and groundwater, resulting in less environmental follow-up costs. Recycling would also result in reduced water consumption on household level for non-drinking purposes, and thus enhance the availability of drinking water. In combination with the reuse in irrigation, it could lead to a more reasonable use of valuable potable water, which is especially important in arid regions. In terms of soil fertility, the nutrient loss through harvesting can be almost completely compensated with excreta products.

The Sustainable Sanitation Alliance

Motivated by the UN's decision to declare 2008 as the International Year of Sanitation (IYS 2008) a number of organisations promoting sustainable sanitation systems took the initiative to form a task force to support the IYS 2008 and to contribute within and beyond the IYS 2008 to the promotion and up-scaling of sustainable sanitation.

In January 2007, a first meeting in Eschborn/ Germany resulted in a large number of commitments by the participants from various organisations, and in drawing up a first draft of a "joint road map for the promotion of sustainable sanitation in IYS 2008". Several working groups were established that are focusing on different sustainable sanitation related issues like "cost and economics of sustainable sanitation", "food security and productive sanitation", "sustainable sanitation in emergency and reconstruction situations" or "treatment options, hygiene and health". The intention of these working groups is to elaborate various deliverables and bring together relevant organisations with global competence in the respective areas and that are not yet fully involved in the sanitation discussions, in order to stimulate the joint work and help to convey the sustainable sanitation approach to new groups. In order to have a joint label for the planned activities, and to be able to align with other potential initiatives, the group formed the "Sustainable Sanitation Alliance (SuSanA)". During the years 2007/2008 regular quarterly meetings were, and will continue to be, held in different parts of the world in order to facilitate local actors' involvement. These meetings are often closely linked to other relevant water and sanitation related conferences or events. The meetings are intended to monitor progress of the various working groups and other activities of the SuSanA, and update and coordinate the commitments of the partners. The number of participating organisations grew steadily over the last meetings and resulted in the commitment of more than 80 multi- and bilateral organisations, NGOs, businesses, governmental and research institutions to be recognised as official partners of the SuSanA.

The overall goal of the SuSanA is to contribute to the achievement of the MDGs by promoting sanitation systems that take into consideration all aspects of sustainability. The MDGs and the UN's "International Year of Sanitation 2008" are highly appreciated by the SuSanA as they help push sanitation high up in the political agenda. The main focus of the work of the SuSanA is it to promote the implementation of sustainable sanitation systems in large-scale water and sanitation programmes. The objectives of the SuSanA relate to awareness raising, and sharing of experiences involving linkages, MDGs, project planning and specific technologies. SuSanA collects and compiles information to assist decision makers; gathers good practices; facilitates demonstrations of sanitation systems; identifies and describes mechanisms for up-scaling and appropriate financing for pro-poor sanitation; and develops global and regional visions of how sustainable approaches can contribute to reach the sanitation MDG and how to promote them in the IYS 2008 and beyond.

sustainable sanitation alliance

Challenges

Attention for urban agriculture has increased considerably in the past years and an increasing number of city governments have or are now formulating policies and programmes on urban agriculture. This heightened awareness offers opportunities for integrated and decentralised efforts including sustainable sanitation.

Despite all the known and convincing benefits of reuse-oriented sustainable sanitation systems, there are still a number of challenges and problems to be overcome. These relate to a lack of awareness and knowledge on sustainable sanitation, and the still existing gap between actual and potential re-use. In most parts of the world the new closed loop sanitation paradigm has not yet reached the legal frameworks.

In addition there are a number of more practical considerations as well as organisational and infrastructural issues to be addressed, e.g. economic viability of sustainable sanitation and reuse systems, the use of market incentives for transport from source to farmers' fields over longer distances, and cost-efficient storage of urine in regions where there are short periods of cultivation. These challenges (and hence entry points for research) differ largely between regions, and between developed and developing countries.

The SuSanA invites others to join in

SuSanA is an informal network of organisations working towards a common goal. Participation is open to thotse who want to join and be active in the promotion of sustainable sanitation systems. The Sustainable Sanitation Alliance invites other international, regional and local organisations to join the network, contribute ideas, and become active partners in the thematic working groups. Feedback for the advancement of the joint road map is certainly appreciated, as it is a work in progress that will be continuously updated, and will include all joint activities leading towards increased implementation of sustainable sanitation systems.

The SuSanA plans to publish selected case studies of sustainable sanitation projects that demonstrate the wide range of possible fields of application for sustainable sanitation systems. The aim is to distribute this information to decision makers, planners, engineers and the interested public. For the collection of good practice case studies we are depending on your support and would therefore kindly invite sustainable sanitation experts, project managers and other informed persons to contribute to this collection by suggesting case studies and making use a case study template that can be found under the following link: http://www.sustainable-sanitation-alliance.org/documents/case-studies/en-susana-case-study-template-2008-04-11.doc.

homepage: www.susana.org
contact: info@sustainable-sanitation-alliance.org
further info: The SuSanA road map:
http://www.sustainable-sanitation-alliance.org/pdf/en-susana-roadmap-version-1-2-feb-2008-01-24.pdf
The SuSanA statement:
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ECOSAN Fertilisers with Potential to Increase Yields in West Africa

Linus Dagerskog, Simeon Kenfack
and Håkan Jönsson

Ambroise Dipama selling his vegetables
Foto: Linus Dagerskog / CREPA

In 2002 CREPA initiated a regional research and demonstration programme on ecological sanitation in seven West African countries. ECOSAN is focused on simultaneously improving sanitation and food production. This is done by making urine and faeces more hygienic and then using them as safe fertilisers. Demonstrations showed that crops fertilised with ECOSAN products often gave a higher yield during a longer harvest period.

The research and demonstration programme of CREPA (Centre Régional pour l'Eau Potable et l'Assainissement à faible coût), started in Benin, Burkina Faso, Côte d'Ivoire, Guinea, Mali, Senegal and Togo. During the research period from 2003 to 2005, ECOSAN (Ecological Sanitation) fertilisers were successfully tested on eleven different crops. The table shows the field results from applying urine as a source of nitrogen compared to reference plots (no fertiliser) and plots with NPK and urea.

The agronomic research by CREPA in Burkina Faso was led by Dr Bonzi, head of soil fertility at INERA (the National Institute for Environmental and Agronomic Research). He mentioned that the research showed that hygienised urine can replace urea as a fast-acting nitrogen fertiliser; while hygienised faeces can be used as

Table 1 **Urine compared to NPK and urea as a source of nitrogen**

Plant		Auber-gine	Gombo	Tomato	Lettuce	Chou	Sorghum	Maize	Manioc	Ground nuts	Cotton	Igname
Country		Burkina	Burkina	Burkina	Togo	Togo	Burkina	Benin	Côte d'Ivoire	Benin	Mali	Cote d'Ivoire
Reference plot	Harvest: Ton/ha	2,8	1,7	2,1	6,8	19,1	2,3	2,4	45	0,44	0,18	4,0
NPK + Urea	Harvest: Ton/ha	17,1	2,6	5,8	13,3	31,0	4,1	3,5	60	0,78	0,38	6,0
PK + Urine	Harvest: Ton/ha	16,0	2,3	5,2	15,7	32,0	3,8	3,6	60	0,56	0,35	8,0

a base fertiliser instead of mineral NPK (14:23:14), which is the most common fertiliser in Burkina Faso. Combining faeces and urine gave very good results. In maize trials the yield was about 30 percent higher with faeces and urine compared to when NPK and urea was used. The total dose of the macro nutrients N, P and K were the same in both cases, but the urine and faeces also provided organic material, micronutrients and a slight increase in the soil pH. Hygienised faeces is therefore recommended as a base fertiliser, if it is available. The recommendation for maize is about 1 tonne of faeces per hectare, or 25 grams per plant. In Burkina Faso the soils are extremely poor in organic matter (less than 1 percent), so the use of hygienised faeces, manure or compost is strongly recommended to improve the soil structure.

ECOSAN fertiliser improves not only production, but also appearance. The ECOSAN-fertilised vegetables looked very nice and their harvest period was significantly extended. These are all important factors for the vegetable farmer who sells his produce on the market.

The use of ECOSAN fertilisers is introduced in the community through participative experimentation with the farmers. The farmers choose the crops to be tested and are assisted in the application of the fertilisers. The ECOSAN-fertilised plots are compared with the conventionally fertilised plots, and this appeared to be a learning process for everyone.

The ECOSAN fertilisers have been renamed in Burkina Faso into "birg-koom" and "birg-koenga", which mean liquid and solid fertiliser. These name change makes it easier for people to get past the mental barrier. Some are also worried about the urine odour. It is explained that the odour is the nitrogen that is evaporating, and that a strong odour indicates a good-quality fertiliser.

The odour is normal – if there is no odour you should be worried!

ECOSAN-fertilised vegetables in Saaba

One of the ECOSAN pilot sites in Burkina Faso is in Saaba, a peri-urban municipality with 35,000 inhabitants, located 10 km from the capital Ouagadougou. In Saaba, 70 UD toilets were built between 2003 and 2005 and about 40 urban farmers were trained on the use of ECOSAN fertilisers. Ambroise Dipama, who grows vegetables on 1.5 hectares close to the Saaba dam, participated in the training programme in 2005. Below are excerpts from an interview with Ambroise.

I first started using ECOSAN fertilisers in 2005, after the training by Dr Bonzi. We were told to store the urine for 45 days and the faecal material for at least six months. Wood ash is always added to the faeces right after defecation to help kill off the pathogens. I grow mostly onion, which gives the best benefit for me, but I don't apply the urine or faeces to crops that grow directly in the ground, like onion. Instead I use the ECOSAN fertilisers on crops such as aubergine, tomato and zucchini.

If I have access to hygienised faeces I apply it before sowing, about a handful per plant. Urine is then applied during the growth of the plant. If I only have urine and no faeces, I apply a small amount of NPK as base fertiliser first. I apply the first dose of urine about three weeks after sowing or transplanting and then after three weeks again for a second dose. I first make a furrow some distance from the plants and then apply the urine. Water is applied afterwards to dilute the urine and make it infiltrate into the soil. I apply about one litre of urine per square metre during each application.

I have noted several advantages with ECOSAN fertiliser compared to chemical fertiliser. It is clear that the plants give fruit for a longer period. With zucchini for example, the chemical fertiliser gives a lot of fruit but all in a short time, around 30 days, while the fruiting continues up to 60 days with the ECOSAN fertilisers. To me this is very important. The quality also seems to be better. The ECOSAN fertiliser gives fewer fruits, but they are bigger and more beautiful compared to when I use chemical fertiliser. When it comes to taste, I have not noticed any difference. The ladies who come to buy my crops and bring them to the market do not mind my way of fertilising. Almost everyone in Burkina has grown up in a village, and everyone knows that the field closest to the house is the one with the best production.

70 UD toilets were built between 2003 and 2005.
Foto: Linus Dagerskog / CREPA

Dr. Bonzi of CREPA and farmers: a learning process for everyone
Foto: Linus Dagerskog / CREPA

As people became aware of the results, they started to bring their urine to their own fields

I would be prepared to pay for the fertilisers, but not more than I would pay for chemical fertiliser. At the moment though, the toilet owners don't want to sell urine to me, since they know the value it gives to their own land. ECOSAN has been a blessing for me. We now have a toilet that is easy to empty, and that produces safe fertiliser. I buy around 20 bags of NPK (50 kg) per year for the three crop cycles on my land. Where I apply urine I reduce the quantity of chemical NPK by half, but I only have enough urine for about 300 m2 per crop cycle. We are 15 people in my family, but many of us work or go to school during the days, so we don't manage to collect as much urine and faeces as I would like. We fill up a 20-litre jerry can with urine in about ten days, which I then take to my field located 1.5 km away. In the beginning I could also col¬lect urine from other households that have UD toilets. However, over time, as people became aware of the results, they started to bring the urine to their own fields to enrich the soil for the next rainy season, instead of giving it away.

Production of ECOSAN fertiliser

The quantity of fertiliser in the urine and faeces from a person is equal to the quantity in the food and drinks consumed. There is an equilibrium in the human body – what goes in also comes out. The human production of nitrogen and phosphorous can be estimated from data on protein consumption (Jönsson et al., 2004). In West Africa the average diet, and hence excreta, contains about 2.8 kg of nitrogen, 0.45 kg of phosphorous and about 1.3 kg of potassium per person per year. This is worth around $8 in Burkina Faso if compared to the cost for the corresponding quantity of chemical fertiliser (data from January 2008). The population of Burkina Faso (13 million people) has the potential to produce ECOSAN fertilisers worth about $100 million per year. At the moment Burkina Faso imports chemical fertiliser for roughly the same amount.

60 kg of N per hectare is a recommended fertilisation for cereals in Burkina Faso. This would require the urine and faeces from around 20 people. Basically what is taken away from the field needs to be brought back to maintain the soil fertility. ECOSAN fertiliser is one step in the direction of more sustainable agriculture, but it needs to be complemented with recycling of organic kitchen waste, crop residues from the harvest and animal manure. Conservation agriculture techniques are also important to reduce soil and nutrient losses by rain run-off and winds.

ECOSAN dissemination and challenges

After the research phase, CREPA started an ECOSAN dissemination programme in ten West African countries (the seven research countries + Congo, Guinea Bissau and Niger), with financing from Sida. In the rural projects, the possibility to gain safe fertiliser was shown to be an important motivating factor for the households when adopting ECOSAN. The challenge in the rural areas, is the prevailing poverty and thus the farmers' lack of money to invest in UD toilets. Low-cost models made mostly of local materials need to be developed if replication is going to pick up. To benefit from a larger scale, reuse-oriented toilets also need to be integrated in national sanitation programmes. In the more urbanised areas, the big challenge concerns storage and transport. Many citizens do not see any use for ECOSAN products (since they do not cultivate), but there is a very high potential production of ECOSAN fertilisers in the city, which could be of great benefit for the urban and periurban farmers.

The first large urban ECOSAN project in West Africa is now being implemented in four periurban sectors in the capital of Burkina Faso, Ouagadougou. CREPA, GTZ (German cooperation) and ONEA (National Water and Sanitation Office) are collaborating in this EU-funded project. 1000 UD toilets are about to be built and the private sector is involved in the construction of toilets as well as in the collection, transport, treatment and delivery of the ECOSAN fertilisers. However, in the preliminary stage, the willingness of the household to pay to get their urine and faeces collected and of the urban farmers to buy the ECOSAN fertilisers does not cover the cost of transportation and the treatment/conditioning at the eco-station. This means that the municipality or the state has to put in money to make the system economically viable. Capacity building and lobbying is now needed so that the authorities understand that investing in ecological sanitation systems benefits several public interests, such as protecting health and the environment and improving agricultural production. NETSSAF (Network for the development of Sustainable approaches for large scale implementation of Sanitation in Africa) is presently preparing the groundwork for wider implementation of sustainable sanitation projects.

Linus Dagerskog, CREPA /EcoSanRes, Stockholm Environment Institute. Email: linusdagerskog@yahoo.fr
Simeon Kenfack, CREPA
Håkan Jönsson, EcoSanRes, Stockholm Environment Institute / Swedish University of Agricultural Sciences

More information:
CREPA www.reseaucrepa.org
NETSSAF www.netssaf.net

Robert J. Holmer
Gina S. Itchon

Reuse of Ecological Sanitation Products in Urban Agriculture: Experiences from the Philippines

Local government official check the quality of the segregated and stored urine and faeces at the UDD toilet in Manresa Farm
Photo: PUVeP

Shortly after the first community-based allotment gardens were established for urban poor families of Cagayan de Oro, Philippines (Holmer & Drescher, 2005), one of the constraints observed was the lack of sanitary toilet facilities inside the gardens. A sustainable solution to address this sanitation problem had to be found, especially since these gardens are considered as showcases for integrated solid waste management, including the composting of segregated biodegradable wastes from the garden and neighbouring households (Urbina et al., 2005).

Several stakeholder meetings with community members and local government officials took place. The model of a urine-diversion dehydration (UDD) toilet, similar to those used in Danish allotment gardens (Bregnhoj, 2003), was introduced and discussed as one of the possible alternatives to a simple, ventilation- improved pit (VIP) latrine with a septic tank. This idea was introduced to Cagayan de Oro after one of the PUVeP technicians attended a training course on ecological sanitation at the Stockholm Environment Institute (SEI) in 2004. Research as part of this course showed that the application of urine increased the marketable yield of sweet corn by an average of 13.7 percent (Guanzon et al., 2005, Sol & Holmer, 2007).

Aside from improving the hygienic situation of the gardeners, UDD toilets would also help close the nutrient cycle by providing the possibility of reusing treated urine and faeces in urban agriculture.

Similar experiments were also carried out for non-food crops in cooperation with commercial growers in different areas of Cagayan de Oro. The urine application resulted in earlier and increased flowering of different ornamental plants with subsequent better marketability, as confirmed by the growers. Greener

UDDT toilets do not pollute nor produce wastewater, since human excreta are diverted, sanitised and recycled in a safe way. They collect and treat faeces and urine separately and do not need a central water supply or sewage system. Urine is stored in a plastic container and applied as fertiliser after one month of storage to ensure pathogen die-off. The faeces are collected in a vault, which consists of a single chamber with a mobile container or of two chambers. The 2-chamber model has the advantage that the second chamber can be used while the faeces in the first chamber are left for storage. The design of the toilet makes it easily adaptable to different types of communities.

"Urine is good for fruit-bearing vegetables, but should be mixed with water prior to application. I will encourage other farmers to use urine. However, (pesticide) spraying is still necessary, especially during heavy pest infestation. Based on my experience, a clean and well-maintained allotment garden encourages customers to buy vegetables, even those grown with the application of urine. The smell of urine is okay for me, but it takes some time to get used to it."
(Mr. Mansueto Cadete, president, Macasandig Allotment Garden, Cagayan de Oro).

leaves and healthier crop stand in general were reported for certain palms and mango seedlings, which are traits appreciated by both growers and customers (Guanzon et al., 2007).

Socioeconomic studies were also conducted to investigate urban growers' and customers' acceptance of crops fertilised with treated urine and faeces. Initial studies showed that acceptance among allotment gardeners was high, with an approval rate of more than 90 percent, since for them treated urine and faeces were not much different from the animal manures commonly used. However, only about 60 percent of the potential customers said that they were willing to buy vegetables fertilised with human urine and faeces, indicating the need for a strong information and education campaign to increase acceptance of vegetables produced in such a way (Urbina et al., 2005).

Most of the buyers' concerns were related to the safety of the crop produced. Although the guidelines of the World Health Organization (WHO, 2006) suggest a safe reuse of urine and faeces after a storage period of one month for urine and six to twelve months for faeces, it was decided to carry out several studies in the local context as regards the effect of storage time and secondary treatment on the presence of pathogens and helminth ova in human faeces.

The microorganisms found in fresh human faeces collected from 10 UDD toilets of different allotment gardens of Cagayan de Oro were *E. coli, Proteus vulgaris, Proteus mirabilis, Citrobacter spp. and Enterobacter spp.* These organisms are part of the normal human flora and all have a potential to cause disease in humans. These microorganisms decreased considerably during the first six months of storage in the collection chamber of the UDD toilets and do not pose a public health threat if the human excreta are reused in agriculture. However, helminth eggs were still found and, hence, six months of storage are considered not adequate to dehydrate human faeces and render them safe for agricultural use in a tropical country like the Philippines, where ambient humidity is high most months of the year. Secondary treatment of human faeces, such as subjection to aerobic composting or vermicomposting, is therefore suggested (ITCHON et al., 2008). One of the experiments conducted (Nuesca et al., 2007) showed that 60 days of vermicomposting of dried human faeces collected from UDD toilets decreased highly significantly the number of hookworm ova, while the number of Ascaris ova decreased significantly to 0.2 ova / 2 grams substrate in boxes with earthworms, compared to 2.6 ova / 2 grams substrate in boxes without earthworms. This data confirms results obtained by a similar study conducted by Eastman et al. (2001) in the United States, which recommends vermicomposting as a non-thermal treatment to sanitise bio-solids.

"If there is a supply of urine, I will really apply it. I have observed a 30 percent increase in the growth and stand of my plants applied with urine. Neighbours wondered about the strong smell in my area, but later on they got used to it. Based on my experience, the smell of urine will last for 15 minutes. I am 100 percent satisfied with my plants. It is important to not apply urine directly to plants but to dilute it with water first."
(Mrs. Rachel Osabel, grower of ornamentals plants, Westbound Bus Terminal, Barangay Bulua, Cagayan de Oro).

Acceptance among allotment gardeners was high

In the meantime, until further research studies are available, we recommend the reuse of urine in the allotment gardens according to the following guidelines (PUVeP, 2008):

- Store urine undiluted and in a closed container for one month to eliminate all pathogens. Storage in a sealed container prevents contact with humans or animals and hinders evaporation of ammonia. To provide a harsher environment for micro-organisms, the urine should not be diluted during storage.
- Prior to application to crops dilute at a rate of 1 part urine to 4-5 parts of water.
- Urine can be considered as a liquid fertiliser since nutrients in urine are mostly water soluble, and thus directly available for plant uptake.
- Urine should not be sprayed on plants but incorporated into the soil 10 cm away from the plant. This will reduce odour, foliar burns and the loss of nitrogen. Urine may also be applied through drip irrigation systems. However, clogging of emitters by salt precipitation may occur.
- Observe a waiting period of one month from last urine application to harvest of crops.
- Urine should not be applied to crops that are consumed raw (cucumber, lettuce, etc.) to ensure acceptance by costumers.

For the safe reuse of faeces, treatment is a must to prevent spreading of pathogens: faeces should be kept in the storage chamber of the UDD toilet for 6-12 months after the last defecation. Thereafter it should be subjected to a secondary treatment of 60 days of either vermicomposting or aerobic composting, whereby a temperature of more than 50°C is obtained during at least one week in the compost heap.

Reuse of diluted urine on sweet corn
Photo: Martin Wafler, SEECON GMBH

After secondary treatment has occurred, it can be used like any other organic fertiliser: nutrients are slowly released as the faeces is degraded in the soil by soil organisms. To ensure acceptance of vegetable produce by customers and to minimise health risks, it is recommended to use treated faeces not for vegetables but for fruit trees (banana, papaya, etc) or other tree species, whose harvested plant part is at a certain distance from the soil.

One question that is often asked regards the risk of heavy metals and micro-pollutants contained in human excreta. The Ecosan Services Foundation (http://www.ecosanservices.org) states that the presence of heavy metals is generally low or very low in excreta and depends on amounts present in consumed products. Hormones are excreted with urine and have long been excreted in terrestrial environments by mammals. Vegetation and soil microbes are adapted to and can degrade these hormones. Based on available data, they are considered a very low risk when applied on soil. Pharmaceutical substances are degraded in natural environments with diverse microbial activity and the risks associated with them are small.

The potential of ecological sanitation to contribute to sustainable development has already reached the lawmakers of the Philippine House of Representatives. The Committee on Ecology is presently discussing House Bill No. 3279 "An Act Mandating the Adoption and Implementation of Ecological Sanitation as a Method of Sustainable Urban Development Program and Institutionalizing the Integrated Support and Facilities towards Sustainable Urban Environment Development, Appropriating Funds therefore and for other Purposes" (or in short "Ecosan Act of 2007"), as an addendum to the existing Clean Water Act of 2004, which already mentions ecological sanitation as a viable tool to achieve the Millennium Development Goals.

Robert J. Holmer and Gina S. Itchon
Director, Periurban Vegetable Project, Xavier University, Cagayan de Oro City, Philippines
Email: rholmer@xu.edu.ph
Research Director, Jose P. Rizal School of Medicine, Xavier University, Cagayan de Oro, City Philippines
Email: gsjuly18@yahoo.com

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Nuesca, M. Z., Lee, S.O., Trappe, L., Holmer, R.J., 2007. Effect of vermicomposting on the presence of helminth ova (Necator americanus, Ttrichuris trichiura, Ascaris lumbricoides) in human faeces. In: Proceedings of the International Conference on Sustainable Sanitation: Eco-Cities and Villages, August 26-31, 2007, Dongsheng, China.

Itchon, G. S., Tan, M. L. B., Holmer, R. J., 2008. An observational study to determine the length of time necessary to eradicate parasitic ova and pathogenic bacteria in human excreta kept in the storage vaults of urine-diverting dehydration toilets in Cagayan de Oro City: A Preliminary Report. Faculty Working Series No. 11, March 2008, Kinaadman Research Center, Xavier University, Cagayan de Oro City Philippines, 6p.

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Urbina, C. O., Miso A.U., Holmer, R.J., 2005. The socioeconomic impact of the allotment garden project in Cagayan de Oro City. Paper presented at the 6th International PUDSEA Conference "Strategies for Community Development in Urban and Periurban Areas of South-East Asia", July 11-15, 2005, Cagayan de Oro City, Philippines.

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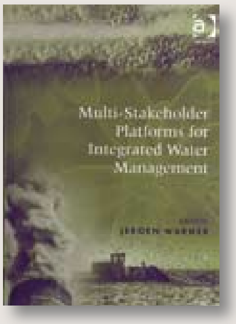
Books
further readings

Multi-stakeholder platforms for integrated water management

Warner, J. (editor). 2007. Ashgate

Multi-stakeholder platforms are important in involving various stakeholders in research, decision-making, policy development and action planning. RUAF partners have worked with this in the past four years (see UA Magazine no.16) and the SWITCH partners work in their cities through the so-called Learning Alliances. Like SWITCH, this book focuses on water management. Taking a positive but critical look at experiences with multi-stakeholder platforms in both the developed as well as developing worlds, the book argues that care should be taken not to promise too much or expect that political barriers will automatically be broken down and equal participation will be achieved. Suggestions for improving success and sustainability are made.



Smart Water Solutions,

examples of innovative, low-cost technologies for wells, pumps, storage, irrigation and water treatment.

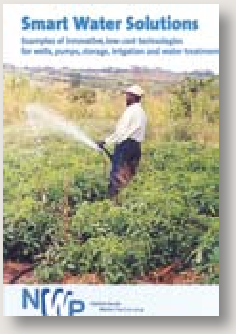
Smart Sanitation Solutions,

examples of innovative, low-cost technologies for toilets, collection, transportation, treatment and use of sanitation products.

Smart water harvesting solutions,

examples of innovative low-cost technologies for rain, fog, runoff water and groundwater.

These series of publications by the Netherlands Water Partnership, 2006, are collaborative efforts with several leading Dutch partners. They describe practicel techniques, designed as sources of inspiration, and providing alternatives to the large, centralised, conventional water and sanitation systems. You can download these booklets, in various languages at www.nwp.nl/publicaties



Technical bulletin on greywater treatment and reuse in MENA

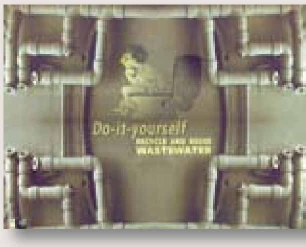
Arafa, D., M. Redwood, L. Thompson (eds). 2007. Regional Water Demand Initiative (WaDImena), IDRC.

This technical bulletin introduces greywater as a water demand management tool that could alleviate water scarcity in the Middle East and North Africa (MENA). The bulletin captures local knowledge on greywater treatment and reuse gained as a result of research projects in MENA funded and coordinated by IDRC. It is intended to highlight the future courses of action required to balance the increasing challenges of water scarcity, food security, and sustainable development.

Do-it-yourself: Recycle and reuse wastewater

Srinivasan, R.K., S.V. Suresh Babu. 2008. Centre for Science and Environment.

This is the second edition of the manual. It answers the question: how does one recycle wastewater? With its simple presentation, it guides the reader through the basics of this activity. It was written for architects, engineers and other professionals interested in implementing wastewater recycling systems, as well as for individual households. After explaining various methods and techniques of wastewater recycling, the manual presents real-life experiences of wastewater treatment methods adopted in various parts of India.



Philippine allotment garden manual with an introduction to ecological sanitation

PUVeP 2008. Cagayan de Oro City: Periurban Vegetable Project (PUVeP), Xavier University College of Agriculture, pp. 104

Manual with information on the background of allotment gardens, the social preparations, physical preparations and information on good agricultural practices necessary to start a successful allotment garden. Special focus on ecological sanitation. Publication can be ordered from PUVeP.

Impacts of urban agriculture: Highlights of Urban Harvest research and development, 2003-2006

Barker, C., G. Prain, M. Warnaars, X. Warnaars, L. Wing, F. Wolf. 2007. Peru: International Potato Center. 62pp. ISBN: 978-92-9060-329-0

This publication is "a review of some of the ongoing work of Urban Harvest, the CGIAR system-wide initiative on urban and periurban agriculture, focusing on how initiatives under the themes of urban livelihoods and markets, urban ecosystems health and stakeholder and policy dialogue are helping to support urban poor in Africa, Latin America and Asia." Downloadable at: http://www.cityfarmer.info/impacts-of-urban-agriculture-highlights-of-urban-harvest-research-and-development-2003-2006/

Agriculture and urban development in Sub Saharan Africa

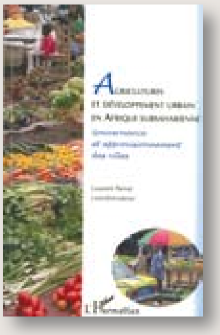
Parrot, L., A. Njoya, L. Temple, F. Assogba-Komlan, R. Kahane, M. Ba Diao, M. Havard (eds). 2008. Paris: L'Harmattan.

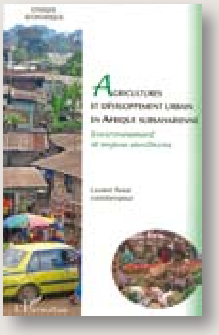
(Original title: Agricultures et développement urbain en Afrique subsaharienne. Gouvernance et approvisionnement des villes & Agricultures et développement urbain en Afrique subsaharienne).

These two books contain papers presented at a conference on agriculture and urban development in West and Central Africa, held in Yaoundé, Cameroon, from 30 October to 3 November 2005.

Books
further readings

One copy “Gouvernance et approvisionnement des villes” is a compilation of papers covering governance and impact measurement methods, and supplies to towns. The second book, “Environnement et enjeux sanitaires”, is a compilation of papers on the interactions between urban and periurban agriculture and the environment on the one hand, as regards waste management and water resource use, and the health risks linked to the growing use of chemicals and to waste recycling on the other.





WaterLines. International Journal of Water, Sanitation and Waste

Published by Practical Action since 1982, Waterlines is a journal providing a forum for those involved in extending water supply, sanitation, hygiene and waste management to all in developing countries. Each issue concentrates on a key theme within the water and sanitation sector. Early 2008 it has been relaunched as an 80-page refereed journal with full peer reviewed articles, short articles from the field, and several other features. You may visit http://practicalaction.org/?id=waterlines for more information and a subscription.

Rural-urban food, nutrient and virtual water flows in selected West African cities

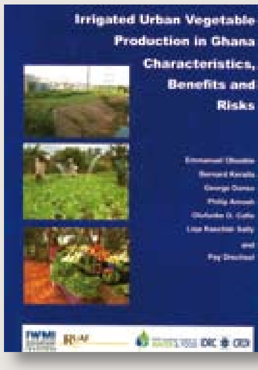
Drechsel, P., S. Graefe, M. Fink. 2007. Colombo, Sri Lanka: International Water Management Institute. 35p (IWMI Research Report 115). www.iwmi.org/publications

Impacts of increasing population pressure on food demand and land and water resources have sparked interest in nutrient and water balances and flows at a range of scales. This report tries for the first time to quantify rural-urban food flows for selected cities in Ghana and Burkina Faso in order to analyse their dependency on food supplied from rural, periurban and urban farming. Options to reduce the environmental burden by closing the rural-urban water and nutrient cycles are discussed.

Irrigated urban vegetable production in Ghana: Characteristics, benefits and risks

Obuobie, E., B. Keraita, G. Danso, P. Amoah, O. Cofie, L. Rachid-Sally, P. Drechsel. 2006. IWMI- RUAF-CPWF. Accra: IWMI. 150pp. ISBN: 92-9090-628-6

This book summarises results from a large number of students’ theses and research reports. It gives a comprehensive overview of urban and periurban vegetable farming in Ghana’s major cities, and highlights economic impacts as well as consequences and perceptions related to the use of wastewater. The book ends with recommendations on how in a low-income country like Ghana health risk for consumers could be effectively reduced, while simultaneously supporting the important contribution of open-space urban and periurban agriculture”. Available online at: http://www.cityfarmer.org/GhanaIrrigateVegis.html



Greywater management in low and middle income countries: Review of different treatment systems for households or neighbourhoods

Morel, A., S. Diener (eds). 2006. Swiss Federal Institute of Aquatic Science and Technology (Eawag). Dübendorf, Switzerland. 107pp

This report compiles international experience in greywater management on household and neighbourhood level in low and middle-income countries.

Downloadable at: www.eawag.ch/.../sandec/publikationen/publications_ewm/downloads_ewm/Morel_Diener_Greywater_2006_lowres.pdf

Comprehensive Assessment Research Report Series
Drivers and characteristics of wastewater agriculture in developing countries – results from a global assessment

Liqa Raschid-Sally and Priyantha Jayakody

This paper presents a cross country analysis of 53 cities in the developing world, representing a range of settings in arid and wet areas, in rich and poor countries, and coastal as well as inland cities. It provides an understanding of the factors that drive wastewater use and shows that the main drivers of wastewater use in irrigated agriculture are in most cases a combination of three factors: increasing urban water demand; urban food demand; and a lack of alternative (cheaper or safer) water sources. Use of untreated wastewater is not limited to the countries and cities with the lowest GDP, and is prevalent in many mid-income countries as well. Across the 53 cities, just for these cities alone, approximately 0.4 million ha are cultivated with wastewater by a farmer population of 1.1 million with 4.5 million family dependants. A number of key policy recommendations are made, among which that urban and periurban agriculture can enhance food supplies to cities and is an effective source of nutrition which can be improved at very little marginal cost. You can find the document at: http://www.iwmi.cgiar.org/SWW2008/PDF/CA_53_city_Final_August_2008_V5.pdf

More publications at www.ruaf.org

Weblinks

www.switchurbanwater.eu
SWITCH aims to bring about a change in urban water management. At its website you find more information on the work in the cities, learning alliances, the SWITCH partners and published research reports.

www.susana.org
The improved website of the Sustainable Sanitation Alliance now available with new sections on capacity development, course material, and videos.

www.ruaf.org/node/47
This is the themes section on the RUAF website on reuse of waste and wastewater, with linkages to RUAF publications and earlier articles on this theme.

www.rainwaterharvesting.org/Urban/Urban.htm
The Center for Science and Environment in India is very active on rainwater harvesting in urban areas. This section offers information on practical urban technologies and research tools.

www.idrc.ca/en/ev-57064-201-1-DO_TOPIC.html
The Regional Water Demand Initiative for the Middle East and North Africa (WaDImena) promotes water demand management approaches and policies in the region

www.waste.nl
WASTE advisers on urban environment and development facilitates the dissemination of knowledge and supports activities on urban waste management and sanitation of southern partners.

www.ecosanres.org
The Ecosanres group is an active discussion group on all aspects of sustainable sanitation. At this site, you can find information and links to other organisations or you may join the discussion group.

www.gtz.de/en/themen/umwelt-infrastruktur/wasser/8524.htm
The GTZ website has numerous publications on ecological sanitation and a database of projects on ecosan around the world. Furthermore it sends out an email bulletin every three months in English, German, Spanish, French and Chinese.

www.akvo.org
AKVO is Esperanto for water. The website is still under construction, but already worthwhile to have a look at. The website is wikibased, which means that knowledge is updated regularly an projects can be followed closely. Part of the website also offers a platform to promote projects or find partners and funding.

www.eawag.ch/organisation/abteilungen/sandec/publikationen/index_EN
Sandec is the Department of Water and Sanitation in Developing Countries at the Swiss Federal Institute of Aquatic Science and Technology (Eawag). It offers many publications on waste reuse in agriculture and wastewater management in urban areas..

www.irc.nl/content/search/?SearchText=harvesting
IRC International Water and Sanitation Centre offers resources on low-cost water supply, sanitation and hygiene in developing countries. This specific link offers access to a rainwater harvesting toolkit, various publications and projects on the topic.

www.iwmi.cgiar.org/health/wastew/index.htm
Here you can learn more about IWMI's Water, Health and Environment research –including objectives, projects, outputs and impacts on the issue of wastewater reuse for agriculture.

www.fao.org/ag/Agl/aglw/WaterTour/index-r_en.htm
Water at a Glance by FAO is a ten-minute guided tour intended primarily for people who are not familiar with the relationship between water, agriculture, food security and poverty.

www.indiawaterportal.org/tt/rwh/case/rainwater_rooftop.html
"The India Water Portal is an open, inclusive, web-based platform for sharing water management knowledge amongst practitioners and the general public.

On DvD

Improving Food Safety in Africa; where vegetables are irrigated with polluted water (contributions by RUAF a.o.)

Health risk reduction in a wastewater irrigation system in urban Accra, Ghana

Good farming practices to reduce vegetable contamination ; options tested in wastewater-irrigated farms in Ghana
Three DvDs by the International Water Management Institute, Accra, Ghana: Contact address: iwmi-ghana@cgiar.org

From waste to water: Greywater reuse in the Middle East - IDRC
A video by IDRC you can watch at youtube, which shows the problems, different stakeholder views and possible solutions to deal with a lack of water in agriculture.
http://www.youtube.com/watch?v=FPjLooYDuJ4 (part 1)
http://www.youtube.com/watch?v=7fAuYt882do&feature=related (part 2)

Events

International Conference on the Global Food Crisis: Promises and Prospects of Urban and Periurban Agriculture

(Nairobi, Kenya)

2009

A group of organisations that are involved research and promotion of urban and periurban agriculture at the national, regional and global levels has proposed that an international conference. They have formed a convenors' group, with representatives of Mazingira Institute (Kenya), Urban Harvest and University of Nairobi, linking to RUAF NAUPA (North America), and NRI (UK). More information on themes and exact dates will follow on the RUAF website.

ICLEI World Congress 2009, Connecting Leaders - Advancing Local Action for Sustainability

(Edmonton, Canada)

14 - 18 June 2009

The World Congress is key gathering of ICLEI members, strategic partners, and experts. The event will facilitate exchange and capacity-building among local governments and other stakeholders who play leading roles in the path towards sustainability. Registration will open soon, but you may visit: world.congress@iclei.org

2nd International Conference on Landscape and Urban Horticulture 2009

(Bologna, Italy)

9–13 June 2009

The conference will explore the advances being made in a wide range of topics, among which plant management in urban environment, garden design and urban agriculture.

The conference will be the hosted by the International Society for Horticultural Science (ISHS), and include food and flower production, urban horticulture meets architecture and social and psychological role of horticulture in the urban environment. For further information, please visit: http://www.luh2009.org

5th World Water Forum

(Istanbul, Turkey)

15–22 March 2009

"The World Water Forum is the main water-related event in the world, aimed at putting water firmly on the international agenda. A stepping stone towards global collaboration on water problems, the Forum offers the water community and policy-and-decision- makers from all over the world the unique opportunity to come together to create links, debate and attempt to find solutions to achieve water security."

http://www.worldwaterforum5.org/

Sanitation for the Urban Poor, Partnerships and Governance

(Delft, the Netherlands)

19-21 November, 2008

Organised by the IRC, International Water and Sanitation Centre, this symposium will be the closing event for the International Year of Sanitation for the Dutch water sector and a celebration of IRC's 40th anniversary.

More information: www.irc.nl/symposium2008

Transboundary Water Management for the MENA Region: Advanced international training programme

(Jordan, Sweden)

Jordan 2–13 November 2008 and Sweden 16-20 February 2009

The overall objective of this training programme is for the participants to identify the advantages of collaborative transboundary water management strategies and improve their ability to apply these strategies in their respective organisations. The training programme comprises a wide range of management and institutional aspects of Transnational Water Management." Please visit: http://www.sida.se

Market access for sustainable development

(Wageningen, The Netherlands)

3 -21 November 2008

This international course, organised by Wageningen University is an introduction in using markets in a sustainable manner to alleviate poverty. The course, a.o. discusses market analysis, identification of pro-poor development opportunities, and practical tools and instruments to develop appropriate market-driven policies. For more information go to http://www.cdic.wur.nl/UK/newsagenda

Expert Think-Tank "Wastewater risk assessment and mitigation"

(Accra, Ghana)

6-9 October 2008

As a follow-up to the 2002 Hyderabad meeting which resulted in the 'Hyderabad Declaration' on wastewater use in agriculture, IWMI, IDRC and WHO are organizing a workshop on "Wastewater irrigation: Consumer health risk assessment, on-farm and off-farm options for health risk mitigation, and wastewater governance in low-income countries". The meeting is for invited participants only. More information can be obtained with Dr. P. Drechsel:

12th annual Community Food Security Coalition conference "Restoring Our Urban and Rural Communities with Healthy Food"

(Philadelphia, USA)

4-8 October, 2008

This year's event focuses on access to healthy by local communities, health and economic impacts, and policy and grassroots-based solutions. The meeting will also include sessions on climate change and the global food crisis, as well as over 50 workshops, 12 field trips and 5 short courses. Prior to the conference on Saturday 4, the North American Urban and Periurban Agriculture Alliance (NAUPAA) and the Penn Planning Institute for Urban Research will organise an afternoon event "Metropolitan Agriculture in North America: From Planning to Development".

Urban Agriculture, Environment and Society

(Coimbra, Portugal)

23 September 2008

The Municipality of Coimbra and other partners (ACTUAR, ACTIONAID International), the Grupo de Apoio ao Desenvolvimento Sustentável da Agricultura Urbana (GRAU) at the Escola Superior Agrária de Coimbra Becantawe organise this seminar, which aims to capitalise and to share experiences on urban agriculture, both in Portugal and internationally. More information: www.webgrau.blogspot.com

IWA World Water Congress and Exhibition

(Vienna, Austria)

7–12 September 2008

Through a combination of scientific and technical sessions, practice-oriented workshops and an industry forum, the IWA World Water Congress will provide water professionals with opportunities to interact with the world's leaders in water research and practice. Please visit http://www.iwa2008vienna.org/i8/

Landscape Ecology and Forest Management: Challenges and Solutions

(Chengdu, China)

16–18 September 2008

The conference includes a symposium titled 'Urban forest landscapes in the context of developing countries and rapid urbanization'. More details at: http://research.eeescience.utoledo.edu/lees/IUFRO/2008MTG/

Sanitation Challenge, international conference on new sanitation concepts and models of Governance

(Wageningen, the Netherlands)

19-21 May 2008

More information at www.sanitation-challenge.wur.nl/UK

World Water Week

(Stockholm, Sweden)

17–23 August 2008

For the enormous amount of presentations, seminars, events, and other interactions, please visit http://www.worldwaterweek.org. Both SWITCH and SuSanA organised events at this meeting. Another interesting event was: the Middle East Northern Africa Seminar, organised by SIWI, Sida, BGR, BMZ and UNESCO, focused on innovations in all aspects of groundwater in the MENA region.

International Master 'Urban Forestry and Urban Greening'

(Alnarp, Sweden, and Copenhagen, Denmark)

25 August 2008

The programme Urban Forestry and Urban Greening is focused on the training of communicative approaches and the combination of landscape architecture and forestry. Moreover it looks at the urban green resource as a whole; this involves working closely with research and practice, using interdisciplinary tools and methods in order to create a sustainable and more vivid society. Visit: http://www.nova-university.org/ufug/

Water and Sanitation in international Development and Disaster Relief

(Edinburgh, UK)

28-30 May 2008

More information at
www.lifelong.ed.ac.uk/water_and _sanitation_2008

Sanitation Challenge, international conference on new sanitation concepts and models of Governance

(Wageningen, the Netherlands)

19-21 May 2008

More information at www.sanitation-challenge.wur.nl/UK

Photo: IWMI-India

We would like to receive your contributions or suggestions for the next issue of the UA-Magazine

NO. 21: LINKING RELIEF, REHABILITATION AND DEVELOPMENT - A ROLE FOR URBAN AGRICULTURE? DECEMBER 2008

Please send us your contribution before: 1 October 2008

Natural disasters, political conflicts, wars and economic crises make it difficult for people to maintain their livelihoods and often result in people being forced to leave their homes. Many international refugees or internally displaced people have to remain for an extended period in refugee camps, or reside (often illegally) in and around cities. Under such conditions displaced people may improve their food security by establishing some form of agriculture, be it small-scale gardening on open spaces inside or outside camps or settlements, or by using non-soil bound forms of agriculture. Insecurity in the areas of origin may continue over many years. Refugee camps tend to gradually convert into "shanty towns" or become permanent settlements. And for diverse other reasons, part of the displaced persons does not return to their original "home" areas, and often seek new livelihood opportunities in and around cities.

In this issue of the UA-Magazine we will look into the role that urban agriculture can play in mitigating the effects of crisis situations and in rehabilitation and development following the crisis situations. The issue will also discuss how urban agriculture may contribute to building resilient cities.

Similarities exist between agriculture in refugee camp settings and urban and peri-urban agriculture in "normal" cities. Urban agriculture, with its emphasis on space confined technologies, use of composted organic wastes, rainwater harvesting and recycling of grey wastewater, may offer good options for provisioning fresh vegetables, eggs, dairy products and other perishables and generate some income. Moreover, gardening and animal husbandry activities may contribute to enhance the knowledge and skills of the refugees (which also may be of value when returning to their home area), and may play a role in building the new community and improving the living environment.
We are interested to receive your articles and well-documented experiences regarding agricultural activities after crisis situations in and around cities or in protracted refugee situations, for example:

- Case studies on initiatives of refugees to develop agriculture in refugee camps;
- Experiences gained by support organizations seeking to assist displaced persons to make the transition from relief and food aid to local development initiatives, including a food production component;
- Innovative technologies that have been developed or propagated in refugee camps, that optimally use the scarce local resources;
- Experiences gained with the social and organizational side of such programmes;
- Issues of planning; legal and regulatory issues.;
- The role of urban agriculture in building resilient cities and disaster/crisis prevention and mitigation.

Please clearly mention in your article where these experiences were gained, who the main actors were and the conditions under which the activities were developed.

Issues of the UA-Magazine in 2009

The following issues will be produced in 2009 and your ideas and contributions of articles are already most welcome:
No. 22: Linking Urban Producers to Markets; Chain development for urban agricultural products
No. 23: Designing the Resilient City - What role will urban agriculture play?

Articles on urban agriculture should consist of maximum 2000 words (three pages), 1300 words (two pages), or 600 words (one page), preferably accompanied by an abstract, a maximum of 5 references, figures and digital images or photographs of good quality (more than 300 dpi or in jpg format more than 400 kb preferably). The articles should be written in a manner that is readily understood by a wide variety of stakeholders all over the world.

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- *East and Southern Africa:* MDP Municipal Development Partnership (MDP); email: tmubvami@mdpafrica.org.zw ; website: www.mdpafrica.org.zw/urban_agriculture.html
- *South and South East Asia:* International Water Management Institute, IWMI-India; email: r.simmons@cgiar.org Website: www.iwmi.cgiar.org/southasia/index.aspnc=9106&msid=119
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Editors, No. 20
This issue was compiled by René van Veenhuizen (Responsible Editor), together with Olufunke Cofie of IWMI Ghana.

Web Editing, Events, and Books
Femke Hoekstra and René van Veenhuizen

Administration Ellen Radstake

Language Editor Catharina de Kat-Reynen

Design, Layout and Printing Koninklijke BDU

Subscriptions The editor: ruaf@etcnl.nl

Address
Urban Agriculture Magazine
P.O. Box 64, 3830 AB Leusden, The Netherlands
Visitors' address: Kastanjelaan 5, Leusden.
Tel: +31.33.4326000 Fax: +31.33.4940791
e-mail: ruaf@etcnl.nl website: www.ruaf.org

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