Water Policy Briefing

Issue 17 Putting research knowledge into action

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Vegetable production on open spaces in Kumasi, Ghana, using highly polluted stream water

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Irrigation with polluted water or wastewater is a widespread reality, especially in low-income countries where it is popularly used for vegetable cultivation. Yet many policymakers are unaware of the significance of the practice and the benefits it can bring. Nor do they know that practical recommendations are now available to make wastewater use safer and more sustainable without relying on non-affordable treatment technologies alone. These recommendations tackle the problem from many angles, over the short, medium and long term, and harmonize with new World Health Organization guidelines.

Recycling Realities:

Managing health risks to make wastewater an asset

In developing countries, fast-growing urban populations are demanding more fresh water and food, while generating greater volumes of domestic wastewater. Due to the lack of comprehensive wastewater management, a major portion of the wastewater pollutes natural water bodies.

These polluted sources are used in and around the cities for agriculture and other purposes. In drier climates, farmers often use the wastewater itself from drains and sewers because it is the only (reliable) source of water. Although municipalities increasingly recognize the importance of this sector in supplying cities, amongs other things with vitamin rich vegetables, they are also aware of the associated health risks through microbial crop contamination[1], especially when it concerns food consumed uncooked. Among wastewater-related infections, diarrhoeal diseases are the top cause of death among children in the developing world.

Fragmented attempts have been made to address this problem, by relying on technical solutions (wastewater treatment) or regulatory measures (such as banning wastewater irrigation or restricting the types of crops irrigated). Both approaches have failed in the context of low-income countries.

What's required is an integrated water resources management (IWRM) approach which looks at the whole urban water cycle and across the urban-rural continuum at environmental consequences downstream, as well as socio-economic benefits of resource recovery. This has to be combined with locally appropriate and sustainable risk reduction measures. It should also recognize that solutions require the active involvement of stakeholders from different sectors. This is a vital point in a sensitive and multi-sectoral issue like "peri-urban wastewater irrigation", which commonly concerns different ministries and municipal departments.

Wastewater use is a common reality with multiple benefits

Recent surveys across 50 cities in Asia, Africa and Latin America show that wastewater irrigation is a common reality in three-fourths of the cities. In Vietnam and Pakistan alone, between 10,000 and 30000 hectares are cultivated with undiluted wastewater. This does not reflect large areas using diluted wastewater or polluted water. In Ghana, in and around the city of Kumasi alone, farmers use polluted water sources on about 12,000 hectares—more than twice the area covered by the country's formal irrigation schemes. The Mezquital valley in Mexico, which is probably the largest irrigation area using raw wastewater, covers more than 90,000 hectares. Mexico accounts in total for about half of the 500,000 hectares irrigated with wastewater in Latin America. Global estimates of the total area under raw and diluted wastewater irrigation are still fragmentary, but might range from around 3 to 3.5 million hectares, with the largest share probably in China. This is twice the area under formal vegetable irrigation in the whole of Africa.

Many of these farms grow perishable vegetables, which are an important cash crop in urban and peri-urban areas. These vegetables have to be grown in proximity to markets due to the common lack of cold transport and storage facilities in developing countries. But close to cities, clean water sources are hard to find, and farmers often have no alternative to polluted water. Sometimes farmers choose raw wastewater for its nutrient value or, as in drier climates, for its water value

IWRM is a problem-solving approach to meet key water challenges in ways that are economically efficient, socially equitable, and environmentally sustainable. It is thus ideally suited to addressing the critical—and interconnected—water issues experienced by many developing countries in their efforts to achieve water supply and food security; health and sanitation.

[1]This policy brief focuses on the common situation of irrigation with raw or diluted wastewater, predominantly from domestic sources. The possible use of chemically contaminated water from industrial sources requires a different approach, which is not covered here.

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The possibility of post-harvest contamination requires attention

and as a reliable supply. In all these cases, cash crop production provides tremendous livelihood opportunities. In Pakistan, for example, wastewater farmers typically earn 30-40 percent more per year than farmers using conventional irrigation water, while in Ghana, dry-season irrigation with wastewater allows an average extra income of 40-50 percent. Around Kumasi more than 60,000 people depend on these sources for their living while in the Mezquital Valley in Mexico, the area irrigated with wastewater supports more than 450,000 people.

Wastewater irrigation also provides jobs and incomes for the traders who market the produce, input suppliers, and other service providers. In Sub-Saharan Africa, women particularly benefit, as in many countries more than 95 percent of vegetable vendors are women.

Wastewater irrigation provides a quarter of all vegetables produced in Pakistan, and, in most parts of Sub-Saharan Africa, irrigated urban and peri-urban farming with highly polluted water sources contributes 60-100 percent of the perishable vegetables needed in most cities. Domestic wastewater is often used for producing rice and fish. In India, as well as in many other countries, it is also used to grow fodder for livestock, and thus contributes to thriving small-scale enterprises based on providing milk to city dwellers.

The challenge: maintaining benefits while minimizing risks

Using wastewater or polluted water sources without adequate safeguards raises obvious potential health risks for farmers and consumers while the actual risks depend on many factors like the living conditions of the exposed population. Most studies show clear links between wastewater irrigation and the health of exposed farming households. There is also considerable evidence showing the impact on soil and groundwater through high nutrient levels, salts, or heavy metals. But not all environmental impacts have to be negative. Where large-scale wastewater irrigation takes place, like in Mexico the groundwater table has risen by more than 50 meters. This shows that resource recovery is possible through water recycling, and treatment costs are also lower. What's necessary then is a holistic and integrated assessment following IWRM principles. What's necessary then is that wastewater is used in ways that recover the resource while reducing the risk.

The complex mix of possible benefits and risks associated with wastewater use in agriculture calls for a balanced approach as outlined by researchers and water professionals in the 'Hyderabad Declaration on Wastewater use in Agriculture' (http://www.iwmi.cgiar.org/home/wastewater.htm). This approach has been recognized in the new WHO guidelines.

> The Stockholm Framework also refers to the concept of "**relative risk**", which requires that one considers all possible sources of risk and exposure when setting guidelines. These would include risks related to poor water supply, hygiene and sanitation, and other sources of (e.g. post-harvest) food contamination. For example, if contaminated drinking water or lack of toilets is causing high background levels of illness in the population, then a costly treatment of wastewater for crop application is not likely to improve public health, and should not be the priority investment in countries where funds are limited. Wastewater use guidelines can be made more stringent when the relative risk factors change, i.e. when water supply and sanitation improve, for example. Decision-makers are thus encouraged to look at the larger nexus of water-sanitation and health and their interconnections: an example of IWRM in practice.

Developing and applying safety guidelines based on the combination of intermediate options appropriate to the local context

The WHO's previous wastewater-treatment guidelines set stringent water quality standards for irrigation application, which most developing countries could not apply because they do not have the resources or capacity to meet them. Subsequently, the WHO produced new guidelines, which are more flexible and consider wastewater treatment as only one component of an **integrated risk management strategy**. To reduce risk from pathogens, the components focus on health-based targets, and offer various combinations of risk management options for meeting them (Box 1). The guidelines are based on the Stockholm Framework, which suggests that countries should adapt guidelines to their own social, technical,

economic, and environmental circumstances, as done, for example, in Mexico.

Prioritizing risk management strategies for the short, medium and long terms

The **long-term** goal of integrated wastewater management will always be to move from the unregulated use of untreated wastewater to the regulated use of treated wastewater. Depending on local possibilities, the level of treatment, however, can vary if a complementary health risk reduction strategy is in place as explained in the new WHO guidelines. This flexibility will be necessary in low-income countries so long as the provision of sanitation infrastructure lags behind urbanisation rates.

But even where no wastewater treatment is available, health risks can still be reduced. A simplified decision making process that can be used for identifying locally appropriate health protection measures and entry points for action along the "farm to fork" pathway is shown in Figure 1. The different options have different timeframes for implementation (Box 2). The highest priority in the **short-term** should be to minimize the daily risk to consumers and the potential of epidemics, which is possible also with modest investments, like through awareness creation for appropriate vegetable washing and hygiene. In the case of Accra's lettuce supply, for example, less than 1000 urban farmers produce salad consumed each day by 200,000 urban dwellers. In other words, over a period of two to three days, at least one of four urban citizens benefits from urban and peri-urban irrigation, but at the same time, they are at direct risk from crop contamination with pathogens.

To ensure that the challenge is tackled efficiently, in the medium term a combination of different intermediate options is recommended. Examples are provided in the WHO guidelines and will largely depend on local opportunities.

The **medium-term** strategy should be to apply the most effective intermediate solutions while making gradual progression towards the long-term goal of wastewater treatment before use. Helping farmers to reduce crop contamination or improve water quality before application through on-site treatment is a possible medium term goal. In addition, simple interventions like enforcing existing pollution control legislation to control contaminants at source, and to prevent the mixing of industrial and domestic wastewaters can be very effective in reducing health risks. Countries such as

Table 1. The effectiveness of various health-protection measures that can be used to remove pathogens from wastewater (WHO, modified).

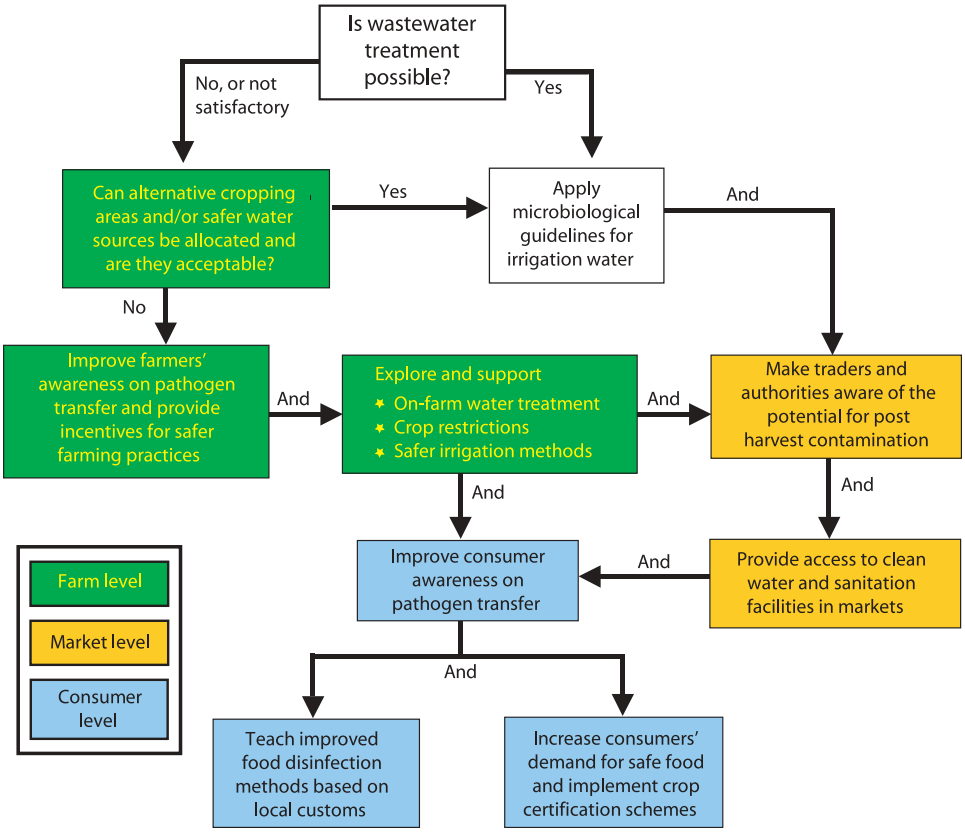
Protection measure (examples)	Pathogen reduction (log units)
Wastewater treatment (to different degrees)	1-6
Localized (drip) irrigation (with 'low-growing' crops, e.g. lettuce)	2
Localized (drip) irrigation (with 'high-growing' crops, e.g. tomatoes)	4
Pathogen die-off on the surface of crops after the last irrigation	0.5-2 per day
Washing of produce with clean water	1
Disinfection of produce (using a weak disinfectant solution)	2
Disinfection of produce (using one part vinegar on two parts water)	5
Peeling of produce (fruits, root crops)	2
Cooking of produce	6-7

Box 1. New risk-reducing guidelines on wastewater irrigation from the World Health Organization (WHO)

The revised WHO guidelines for wastewater quality now include health-based targets, which correspond to the 'tolerable' burden of disease that would result from wastewater use in agriculture. Models were used to calculate the levels of pathogen reduction that would be needed to meet the targets in different types of agriculture and with different degrees of wastewater treatment.

The guidelines now give decision-makers greater flexibility, allowing them to better plan how to achieve the required levels of pathogen reduction. They do this by allowing planners to choose a number of different options depending on what is feasible locally. **These options should be used in combination,** as their impact, for example on pathogen die-off varies (Table 1). Current research by the *CGIAR Challenge Program on Water and Food* aims at extending and fine-tuning the options for reducing bacteria and helminth eggs.

Figure 1. An example of a decision-making process that can be used to identify locally appropriate entry points to protect consumers' health, where municipal wastewater treatment is not a realistic option in the short or medium term, and polluted water is used to irrigate crops in and around cities (Adapted from Drechsel et al., 2002).



Box 2. An integrated approach to health risk reduction for less developed countries: components and associated implementation timeframes

Recommendation	Timeframe
1. Treat produced wastewater and control volumes and contaminants at source and monitor water quality	Long term
2. Develop local strategies and guidelines based on a combination of appropriate alternative risk management options, such as:	
• Increase public awareness	Short to medium term
• Promote hygiene and safer vegetable washing in kitchen	Short term
• Allocate new land with access to safer water sources to urban/peri-urban farmers	Short to medium term
• Provide incentives for on-farm risk reduction	Short term
• Use safer irrigation methods	Short to medium term
• Restrict the types of crops grown	Short term
• Reduce risk of post-harvest contamination	Short to medium term
• Minimize farmers' exposure	Short to medium term
• Prevent and treat infections (e.g. anti-worm campaigns)	Short to medium term
• Improve institutional coordination	Medium to long term
• Increase donor and state funding to support sanitation and introduce applied cost-sharing models	Short, medium and long term
3. Conduct accompanying research on local food safety and the relative and absolute risks of wastewater use, on related stakeholder perceptions, and identify opportunities and constraints for the adoption of locally applied recommendations.	Short to medium term

Source: *Scott et al., 2004; modified*

Tunisia, Jordan and Mexico offer valuable lessons of advanced strategies. In Tunisia and Jordan, for example, inter-agency coordination, public awareness campaigns, and emergency responses to disease outbreaks have been crucial in mitigating risk. To reduce farmers' exposure is another objective. Surveys in Asia and Africa show that farmers often face many other health risks as well from other sources besides exposure to wastewater. Protective clothing or other means to reduce exposure seldom finds users," thus more attention must be paid to perception studies to understand farmer needs and design interventions for awareness creation accordingly.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Intermediate water storage supports pathogen die-off

Intermediate options for risk management

The philosophy behind the intermediate options:

- In cases where comprehensive wastewater treatment is not a feasible option in the near future, intermediate, less-expensive options aimed at reducing risks can save lives and money.
- Related costs are likely to be low in comparison with the construction and operation of conventional wastewater treatment plants, not to mention the costs of mitigating or recovering from any wastewater related epidemic.
- Water and food related health risks require, in any case, a comprehensive approach, as wastewater is not the only source of food contamination.

Providing safer water sources for irrigation

Authorities could reduce farmers' and consumers' health risks easily if they provide the concerned farmers in urban and peri-urban areas with safer water sources. In Cotonou, Benin, for example, the authorities recognized the contribution of urban agriculture for the city and allocated new land to urban farmers outside the city with unpolluted shallow groundwater, while in Accra, Ghana, the Ministry of Food and Agriculture is exploring options for groundwater use in urban agriculture areas currently irrigated with water from city drains.

Promote incentives for adoption of on farm risk reduction measures

Secure land tenure encourages farmers to invest in mitigation measures at the farm level. A majority of urban and peri-urban farmers in many countries occupy/squat on public lands or are tenants on land owned by others and have no tenure security. Where policy reforms can provide greater (formal or informal) tenure security, farmers are more likely to invest labour and capital in irrigation infrastructure, such as drip or furrow irrigation, which reduce crop contact with wastewater. Improved tenure contracts would allow for such investments, while credit systems could facilitate them. A certification program for "safer crops" and awards for innovative farmers, are other possible incentives.

More tenure security would also allow simple water storage reservoirs to be built on farmers' land. Storage reservoirs provide basic treatment by supporting pathogen die-off and help to balance irrigation water supply with demand.

Promote safer irrigation methods

In many parts of the world, and Sub-Saharan Africa in particular, most farmers use watering cans, which require only little investment. However, this method increases crop contamination especially of leafy vegetables through spraying of droplets on the leaves. Irrigation techniques that apply water to the root zone (such as wastewater adapted drip irrigation) are much safer and use less water. Reducing crop contamination by ceasing irrigation a few days before harvest to allow for pathogen die-off is a recommendation that can be applied only in the case of vegetables which are less sensitive to water loss.

Ongoing research shows that with simple changes in shallow well construction and in water collection and application methods (even when watering cans are used), the amount of suspended material and number of worm eggs in irrigation water can be reduced significantly. Similar possibilities exist to reduce crop contamination from other sources, like fresh poultry manure or already contaminated soil. Studying farmer perceptions of such innovations and related changes in labour allocation is thus critical for understanding which 'best practices' and corresponding risk reduction rates have the highest adoption potential in a given context. This requires functional research-extension linkages supported, for example, by Farmer Field Schools.

Influence the choice of crops grown

When irrigation projects are centrally managed, and when laws are strongly enforced, it is possible to introduce restrictions to ensure that wastewater is not used to irrigate high-risk crops, such as leafy vegetables that are eaten raw. Research in Mexico, Chile and Peru has shown that this is most likely to be successful when the crops allowed under the restrictions are of similar profitability and in high demand. If restrictions cannot be enforced, then public-awareness campaigns might reduce consumer demand for crops that pose a health risk, and thus indirectly influence farmers' choice of crops.

Avoid post-harvest contamination

Health risk reduction measures should not only focus on improving irrigation water quality. Post harvest contamination might occur during transport or at markets. This is due to poor sanitation facilities and lack of water supply for personal hygiene as well as washing and "refreshing" of vegetables. Displaying vegetables on the ground instead of on tables is an additional source of contamination. It is important that authorities do not overlook well-established, but often officially ignored, informal vegetable markets in their efforts to improve cleanliness in markets.

Increase public awareness for vegetable washing at the point of consumption

An important option for complementary risk reduction is vegetable washing and disinfecting at home and at food outlets, which is common practice in developed and developing countries. Well-designed awareness programs can have a significant impact on safeguarding public health where treatment technologies cannot be put in place. It does not require large financial outlays at the consumer level and has a high potential for large-scale risk reduction where pathogen contamination is likely, be it from wastewater irrigation or post-harvest handling. However, washing methods vary between households and countries, and can be very ineffective if not carried out properly. Awareness programs, like the WASH (water, sanitation and Hygiene for All)[2] campaigns of the water and sanitation sector, should be based on a good understanding of local customs and perceptions of risk and risk mitigation. Programs might involve mass media, but also target school curricula.

PHOTO CREDIT: IWMI

Simple modifications have the highest chance of adoption

[2]www.wsscc.org/wash

Improve institutional coordination and develop integrated policies

Case studies from around the world show that sanitation, agricultural, environmental and health guidelines are usually the responsibility of different agencies and, because of this, they often overlap or conflict. Furthermore urban and peri-urban agriculture has no official recognition in many countries. Multi-stakeholder platforms are vital to find mutually satisfactory guidelines with a high potential for institutionalization.

Action research to sustain risk-reduction methods and approaches

For sustainable risk mitigation it will be necessary to encourage research to improve our understanding of the opportunities and constraints involved in adopting locally applied safety measures, with special reference to their feasibility and sustainability. This includes the perceptions of risks and risk mitigation of the concerned stakeholders, and the relative and absolute risk of wastewater use in the local context of developing countries from both farmers' and consumers' perspectives.

From the treatment perspective emphasis should be placed on options to treat chemically polluted wastewater before it enters the domestic wastewater stream that is used for irrigation. Low-cost and farm-based systems, which conserve nutrients of value for agriculture while removing pathogens should get more attention.

One uncharted area of research is a comprehensive assessment of the positive and negative economic impact of (raw or diluted) wastewater use on agriculture, health and the environment. The results of such and other analysis could potentially impact the way in which wastewater agriculture is viewed.

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About the Global Water Partnership (GWP) Advisory Center at IWMI

The GWP Advisory Center at IWMI provides research-based knowledge to support implementation of Integrated Water Resources Management (IWRM)—drawing on IWMI's expertise in water and land management.

This issue of Water Policy Briefing is a cooperative effort between the Advisory Center and the GWP's Technical Committee (TEC). It is intended to compliment the series of publications recently launched by the GWP TEC to tackle key issues and potential stumbling blocks for countries developing and implementing IWRM and water efficiency plans and strategies. The series includes the *Catalyzing Change* handbook and a series of associated policy and technical briefs.

For more information about the Advisory Center see www.iwmi.org/gwp. To download the *Catalyzing Change* handbook and briefs, see www.gwpforum.org.

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