WASPA – ASIA

Knowledge Sharing Workshop on Wastewater Reuse and Ecological Sanitation

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Dhaka

Edited by Sharfun Ara

NGO FORUM FOR DRINKING WATER SUPPLY & SANITATION

IWMI International Water Management Institute

COSI Community Self Improvement

SEI STOCKHOLM ENVIRONMENT INSTITUTE

IRC International Water and Sanitation Centre

ASIA PRO ECO II

EUROPEAID CO-OPERATION OFFICE

Contents

1 Introduction

World population growth is reaching the point where available freshwater is insufficient to meet the basic needs of mankind (e.g. for agricultural, industrial and urban use); this is becoming particularly acute in arid and semi-arid regions of the world. Hence, there is a growing need to utilize low quality water where freshwater is scarce. Urban wastewater, which is readily accessible, is a promising resource, but there are many concerns about the environmental and health impacts of using such waters. The use of wastewater in irrigation is vital for many farmers those who do not have direct access to clean irrigation water, but wastewater needs to be treated properly before using it in irrigation to reduce the associated health risks.

Considering these realities, NGO Forum for Drinking Water Supply & Sanitation (NGO Forum) has been implementing the project "Wastewater Agriculture and Sanitation for Poverty Alleviation (WASPA Asia) in Rajshahi, Bangladesh in collaboration with the International Water Management Institute (IWMI), Sri Lanka, the International Water and Sanitation Centre (IRC), Netherlands; the Stockholm Environment Institute (SEI), Sweden; and Community Self-Improvement Foundation (COSI), Sri Lanka. Recently WASPA Asia organized a national level knowledge sharing workshop in Dhaka to raise awareness about wastewater management and to provide options for improved management and treatment of wastewater, excreta and urine. The "WHO Guidelines for the Safe Use of Excreta, Grey water and Wastewater in Agriculture" formed an important part of the workshops and provided technical and non-technical options for risk reduction and barriers to disease transmission including various sanitation system solutions.

The participants at the workshop, which included representatives of various government agencies, development partners, academia and local and international NGOs, were welcomed by Mr. S. M. A. Rashid, Executive Director NGO Forum. He explained the importance of sharing knowledge, best practices and lessons around wastewater issues, and that this is a key responsibility of the project team and others working in the field. Only by sharing such knowledge and experience can the benefits of research be effectively realized. He therefore urged to the participants to look forward to finding out possible ways and means to minimize the knowledge and management gaps.

Mr. Rizwan Ahmed, Chief, National Resource Centre of NGO Forum and Team Leader of the WASPA Asia project in Bangladesh emphasized the significance of organizing this workshop and the need to share knowledge gained through project implementation and to receive their information to improve the planning and implementation component of the project.

Workshop Objectives

- To discuss issues around wastewater management including the WHO guidelines for safe use of excreta, greywater and wastewater in agriculture.
- To provide knowledge on barriers to reduce risks to health;
- To consider how these ideas can be brought into the Participatory Action Plans (PAPs) for Rajshahi, if relevant.

2 The WASPA Asia Project

WASPA Asia, an action research project funded by the European Commission under the EU Asia Pro Eco-II Programme had started in December 2005 and will continue to December 2008. The project is being implemented in two cities: Kurunegala of Sri Lanka and Rajshahi of Bangladesh, and there are five partners involved with the implementation of the project. The project has so far undertaken a number of activities that are briefly described here.

A number of rapid assessments have been completed to inform the PAP development process. These include stakeholder analysis, water quality, industry, sanitation and agriculture. The assessments were not comprehensive scientific studies but were intended to provide initial information to start the discussion and debate about action plan needs, including further assessment and implementation. It was considered necessary to limit the assessments to ensure that the planning process could be initiated soon after the start of the project to ensure that there was time to develop the plan and implement certain activities. Research projects often take a considerable length of time and community members get discouraged from participating because they see no obvious benefits.

To facilitate the process of developing PAPs, the project tried to establish Learning Alliances in Rajsahahi. These are networks of relevant stakeholders who share knowledge and ideas about the issues that they face in relation to wastewater management and use in agriculture and how they can be addressed.

An action plan has been developed for Rajshahi by the LA members. It covers three “visions”, relating to wastewater from the city; wastewater from industries and clinics; and agricultural use. The visions include some activities that can be undertaken immediately, some that require negotiation and further planning; and some that require more research. These activities have been prioritized by the stakeholders on the basis of importance and ease of accomplishment. The project team is now in the process of undertaking those activities. So far some training has been undertaken with regard to hygiene promotion for wastewater farmers, further agricultural training is planned and the WASPA team is hiring local university staff and consultants to review and suggest options for other components of the plans.

Linked to the learning process the project team has been documenting all the project activities and will use this to review the effectiveness of the process and make suggestions for improvement for other participatory planning activities.

The planned PAP activities include:

- Construction of garbage traps (with RCC and ward commissioner) to reduce the solid waste reaching fields.
- Reduction of solid waste reaching the canals, developed in consultation with Ward Commissioners and the JICA project in Dhaka.
- Investigation of cleaner production (CP) options in industrial area with BSCIC & NASCIB, and local experts from Rajshahi and Dhaka. This will be followed by workshops on regulations, CP and treatment, and implementation of appropriate options.
- Review of regulations and their implementation by Rajshahi University and BELA, and make suggestions for their improvement if applicable.
- Commission an investigation of appropriate wastewater treatment options for Bashuar Beel, that would improve the quality of water reaching the fields and that could potentially be implemented in other areas in Rajshahi or other cities.
- Training with DAE for farmers using wastewater. This would cover aspects of fertilizer application to maximize outputs, irrigation practices to reduce health risks, and pesticide use to reduce waste, costs and health risks.
- Community awareness around household sanitation and handling of wastewater crops.

2.1 Views and Comments

Mr. Shuvashish Karmakar, Associate Coordinator (Advocacy), VERC, emphasized the necessity of providing a wastewater treatment plant as a big solution in order to treat the wastewater which carries excreta and hospital waste with the drainage water towards agricultural lands. He was also concerned that attention should be given to explore the potential ways in which farmers can maintain hygiene and healthiness where wastewater is containing hospital waste, excreta, and organisms and finally being used in agricultural purposes.

Mr. J.K. Baral, Director of PROSHIKA and Managing Director of Canada Bangladesh Filters Ltd wanted more information about the research and achievements of the WASPA project in relation to agriculture. He was also interested in qualitative data on water quality, because this is essential to identify ways in which to reduce pollution and for the project to monitor any pollution reduction taking place as a result of the project. In this regard he also asked for clarification on what had been done so far on the project and the frequency of monitoring. The team members admitted that only one set of water quality analysis had taken place and agreed that this needed to be increased.

Mr. Md. Taufiqul Arif, National Professional Officer, WHO, suggested that analysis should take place on soil texture and the types of crops which would be the ideal crops to grow with wastewater.

Mr. Md. Arham Uddin Siddiqui, Rural Development Advisor, Delegation of the European Commission to Bangladesh, indicated the aim of WASPA project is to create instrument to help the least Asian developing countries in order to address some burning issues on environment and urban issues. As good environment is related with good health, knowledge sharing on these issues is significant in many regards. He also referred to the ECO – Asia Programme which addressed several waste management projects on ECOSAN, solid waste management and wastewater management in the context of Bangladesh. He emphasized on the significance of involvement of such project experience in the knowledge sharing workshop with a view to getting a comprehensive learning to be carried forward in terms of solid waste management, wastewater treatment and other waste management issues. He termed the workshop a good opportunity to let others to exchange the knowledge on necessary findings and learning from the project. Considering it a unique advantage of existing two Asian partners like Bangladesh and Sri Lanka in this project, he reiterated the necessity of exchanging knowledge to way forward on this particular field.

Mr. Ziaul Islam, Programme Officer of JICA, asked what the project was planning in relation to awareness raising among the community and efforts to make the campaign sustainable. He was also concerned about the potential sustainability of the project and what the team were doing to ensure its sustainability.

The project team members responded by explaining that an awareness raising campaign was currently being worked on. So far the project team has met with many stakeholders including community groups to inform them about the project, and their representatives have been invited to planning meetings, but there will be a specific campaign on hygiene awareness and issues around wastewater produce.

With regard to sustainability the design of the project, including the development of multi-stakeholder platforms is intended to enhance its sustainability. However the project team acknowledges that it will only be sustainable if the stakeholders are interested in the issues, feel that the activities that are implemented address their needs, and feel that they have ownership over the interventions. At present it is not clear if this will be the result but the project team will continue to work towards it and to document the process so that other projects and programmes can learn from the process.

3 WHO Guidelines

The WHO guidelines on the Safe Use of Excreta, Greywater and Wastewater in Agriculture, updated in 2006, have been very influential, and many countries have adopted or adapted them for their wastewater and excreta use practices. The Guidelines are presented in four volumes. Volume 1: Policy and regulatory aspects; Volume 2: Wastewater use in agriculture; Volume 3: Wastewater and excreta use in aquaculture; and Volume 4: Excreta and Grey water use in agriculture.

Volumes 2 and 4 of the Guidelines might be the basis for the development of international and national approaches (including standards and regulation) to tackle the health hazards associated with wastewater use in agriculture but it is important to note that the Guidelines themselves do not provide standards and are just a set of guiding principles or suggestions to protect health and agricultural output. As such they provide a framework for national and local decision making regarding wastewater use in agriculture. The information is applicable to the intentional use of wastewater in agriculture and is also relevant where faecal contaminated water is unintentionally used for irrigation. In terms of WASPA project these Guidelines could provide an integrated preventive management framework including risk management options, proper techniques for fertilizing, crop restrictions, systematic documentation and system over the project activities, human exposures control and also in wastewater treatment. A summary of the WHO guidelines is provided in Annex 1.

3.1 Questions and Views

Mr. A.K.M Rashidul Alam, Assistant Professor of the Department of Environmental Sciences, Jahangirnagar University, asked about the selection criteria of crops grown with wastewater in the context of Bangladesh. He suggested that the wastewater should be tested for physical, chemical, microbial and biological parameters and once these are known then the wastewater can be used on appropriate crops on a pilot scale. However, before initiating these kinds of steps a proper assessment must be done to understand the potential condition, accumulation of heavy metals in crops and so on. The results which will be obtained from these assessments need statistical justification and proper documentation.

In response to a query regarding the inclusion of waste and wastewater management in university education curricula, Mr. S.M.A Rashid, stated that NGO Forum is an adaptive learning organization that has taken the WASPA project as an action-research project to explore the possibilities and proper utilization of wastewater. He expressed his keen interest on behalf of NGO Forum to conduct further scientific research in this regard, where university students could be involved to provide them with an opportunity to gain experience of action research and improve knowledge on the issues for not only the research and academic community but also government departments and implementing agencies. The possibility of initiating a dialogue with different university authorities regarding the involvement of students in action research as well as to put this topic in the university education curriculum was raised.

Mr. Md. Taufiqul Arif, National Professional Officer, WHO, suggested increasing the coordination of the local hospitals with the city corporations and the municipalities with respect to hospital waste management. He cited an example of **Sylhet City Corporation which has been providing each household with two buckets in order to separate and collect organic and inorganic wastes** respectively, in order to reduce the risk of spreading diseases. He suggested that the local government authorities should be made aware of such initiatives and the concerns of the city residents should be brought to the authorities.

It was requested by Mr. Felix B. Rozario that the WASPA project team should document all their work, undertake full analysis and publish the findings properly in both English and Bangla so that people all over the country could benefit from the information. He was concerned that too many projects undertake research work in the country that is then not shared with the people of the country.

4 Issues identified in Rajshahi, Bangladesh

Several rapid assessments were conducted in Rajshahi. These have highlighted gaps in knowledge and where further, more detailed assessments need to take place, but they have also provided some preliminary insights that were useful in initiating discussions between stakeholders regarding problems associated with wastewater, particularly related to its use in agriculture. These discussions enabled the stakeholders to propose initial plans to address the problems, some of which need further research before concrete actions can be proposed.

Water quality testing has not been conducted on a regular basis in Rajshahi but a baseline data set has been collected that was also used as a "presence or absence" test. This will be followed by further data collection and it is hoped that local university students may become involved in these activities. The results indicate that nutrients are present in high concentrations in the wastewater, which could have implications for the quantity of chemical fertilizers that farmers should apply. The wastewater samples taken did not show high levels of metals but some metals were detected above drinking water quality standards in the two tube wells sampled. The microbial quality of the wastewater was very poor and parasites were also found in certain samples.

This work was supplemented by an industrial survey which identified a number of industries that may be contributing to the pollution loads in the drainage canals. The project team undertook a limited study of the types of pollutants that may be present and will try to commission a more detailed study from a cleaner production expert. However, the initial findings are that there are no large industries present in the area nor are there any industries categorized as red or orange A industries under the Environment Act. Consequently the industries do not require wastewater treatment plants and the threat to the environment is limited, but since the wastewater is being used on food crops more detailed information would be beneficial to planners.

The sanitation study provided information about basic hygiene awareness and hygienic practices in one village near the wastewater irrigated area. The study covered ownership and use of latrines, handling of children's faeces, hand washing and use of water sources. The team also asked about the major health problems in the area but a health study was not conducted since this would require a detailed and lengthy study and would not necessarily contribute to the objectives of the project. It was felt that it was sufficient to assume that the community would benefit from improved water sources and hygiene practices.

The agriculture survey provided information about crop type and yields, and chemical inputs. Several paddy varieties are grown in both clean water areas and wastewater areas. The results show that average yields in wastewater areas are significantly lower than in clean water areas; 3.9 tons/ha in the wastewater area and 4.7 tons/ha in the clean water area. This difference in yield could be attributed to a number of factors such as: plot size, rice varieties, soil type, salinity, nutrient availability, and farming practices; however, the exact cause could not be established.

It was also found that many farmers under-apply urea, but by contrast application of Muriate of Potash (MOP, which contains potassium) and Triple Super Phosphate (TSP) was well above the recommended level in all areas by the majority of farmers. The use of pesticides in one waste water area was particularly high as compared to the other two areas, with insecticide and fungicide applications by 46% and 55% of farmers respectively. The implications for the project and for wastewater use in general in Rajshahi are that:

- Fertilizer application is highly variable and does not reflect either government recommendations or nutrient levels in wastewater.
- Extension services need to be improved to optimize fertilizer use to improve yield and reduce costs, as fertilizer is often over applied.
- Further analysis of nutrients in wastewater and soil are needed.
- Oil, grease and solid waste are clearly problems and need to be addressed through interventions upstream.

4.1 Questions and Views

Mr. Felix B. Rozario was concerned that periodical data collection had not taken place, and suggested that this was necessary in order to satisfactorily relate the data, including water quality, agricultural practices and livelihoods. It is most important that vegetables that are grown with wastewater are analyzed to determine the contamination that has taken place, and whether the consumption of the crops could be harmful for humans. **There was considerable emphasis from him and other workshop participants on the need to reduce knowledge gaps regarding wastewater agriculture.**

Mr. A.K.M Rashidul Alam, Assistant Professor of the Department of Environmental Sciences, Jahangirnagar University suggested to focus more specifically on the presented information on the average yield rate of paddy cultivation within clean water and wastewater area. The results show that there is a significant difference ($P<0.05$) between clean water and wastewater yield with an average yield of 3.9 tons/ha in the wastewater area and 4.7 tons/ha in the clean water area. Mr. Alam stated that in Bangladesh there is a lot of varieties of paddies and the average yield rate of the different types of paddies in Rajshahi could have been mentioned specifically. **This once again highlights the limited data collection and the need for more systematic and specific studies.**

The project team acknowledged the significant gaps in the data collection but also explained the need for a rapid assessment in order to move towards a phase of planning and implementation. Since wastewater agriculture is already taking place and this is part of the reality of the livelihoods of many households both in Rajshahi and other areas, the project is not intending to undertake activities that will limit its use and therefore negatively impact on their livelihoods. Neither is the project planning to encourage wastewater agriculture with unmanaged and untreated wastewater, where it is not already used. Therefore a limited amount of information was sufficient for the stakeholders to develop initial plans to improve the quality of water, to reduce the contaminants entering the water and to propose household practices to reduce health risks, such as regular hand washing, not washing household items in the drains (as currently happens) and washing and peeling vegetables.

Md. Arham Uddin Siddique, the Rural Development Advisor for the Delegation of the European Commission, which is funding the WASPA project, expressed his **disappointment about the lack of national level networking and knowledge sharing** that had so far taken place on the project. He felt that there were a number of either projects that this project could have benefited from, either through information sharing or partnerships.

The project team members acknowledged that they had been slow to undertake this networking and that it should have come much earlier in the project. Networking had been attempted to a limited extent and with certain organizations but it was insufficient. The project team therefore agreed that they needed a significant effort in this regard in the coming months.

4.2 International WASH Practitioners' Marketplace and Fair

The 2nd International WASH Practitioners' Marketplace and Fair on November 11 to 13, 2008 at Cox's Bazaar in Bangladesh was announced. It is being organized by STREAMS together with its member, the NGO Forum for Drinking Water Supply and Sanitation. The themes of the fair will be:

- Theme 1: Addressing environmental vulnerability through Integrated Water Resources Management
- Theme 2: Policy, Practice and Advocacy for Sustainable Sanitation
- Theme 3: Wastewater Management for Productive Use
- Theme 4: Community Participation in Sanitation Solutions
- Theme 5: Business Unusual: Sanitation Entrepreneurship
- Theme 6: Safety Nets for Ensuring Water Quality

More information can be found at http://www.streams.net/.

5 Group Discussion: Suggestions for the project team

What next in the context of Rajshahi

1. Re-enforcing the LA working in this field
2. Study should be more scientific
3. Monitoring should be done at food consumption level
4. Low cost wastewater treatment plant needs to be explored.
5. Health awareness regarding food consumption needs to be raised
6. Effective and meaningful involvement of policy making body should be ensured for wastewater management

Areas to concentrate on

1. Inadequate data regarding Water Quality, Microbial characterizations of Pathogens, Pests and Phyto accumulator
2. Urban community awareness and acceptability

3. Involve government organizations in awareness building activities
4. Determine eco toxicological effects of crops produced by wastewater
5. More coordination amongst stakeholders and similar interventions
6. Increase research activities for primary data collection
7. Comparative study on the amount of production using clean water and wastewater
8. Reduce stagnant water spots by improving the drainage system

Assessment

1. Periodical data collection is needed (water, soil and crops)
2. Cohort study should be undertaken

Implementation

1. Process is not clear according to the presentation

Monitoring

1. Lack of monitoring system

Suggestions/recommendations

1. Information dissemination (developing a Local Information Centre)
2. Farmer led approach
3. Demo farm (Multiple Crops)
4. More emphasize on livelihood issues along with technical aspects
5. Establish participatory monitoring system
6. Involve all practitioners (BIRI, BADC, BUET, RU etc.) in knowledge sharing

6 Concluding Remarks

The introduction and implementation of sound wastewater management policies and practices are thus of vital importance to the countries in the developing world, like Bangladesh. Wastewater management clearly needs to be incorporated into the overall comprehensive management of water resources, with the objectives of providing adequate and sustainable water supplies to meet present and future demands in an environmentally sound and economically efficient manner. The distinguished participant discussed and formulated recommendations for action on improving wastewater management and also provided some guidelines for WASPA – Asia project in the workshop. The concern bodies of the WASPA – Asia project think that the project would certainly be able to meet the success addressing the health hazards, environmental pollution and also the economic benefits effectively.

7 List of Participants

1. Mr. A.K.M. Rashidul Alam, Assistant Professor, Department of Environmental Sciences, Jahangirnagar University.
2. Dr. A. Mannan Bangali, National Professional Officer, World Health Organization, Dhaka, Bangladesh.
3. Mr. Felix B. Rozario, Programme Coordinator- Development Project, CARITAS, Bangladesh.
4. Mr. S.M.A. Rashid, Executive Director, NGO Forum for DWSS, Dhaka.
5. Mr. Md. Khaled Murshed, Regional Manager, NGO Forum for DWSS, Rajshahi.
6. Mr. Md. Jakariya, Coordinator Programme Research, NGO Forum for DWSS, Dhaka.
7. Mr. Mahbub-Ur-Rahman, Research Officer, NGO Forum for DWSS, Dhaka.
8. Mr. Benozir Ahmed, Training Officer, Training Cell, NGO Forum for DWSS, Dhaka.
9. Mr. Proshanto Kumar Bose, Sub-Assistant Engineer, Department of Public Health Engineering, Dhaka.
10. Ms. Lubna Yasmeen, Sr. Information Officer, NGO Forum for DWSS, Dhaka.
11. Mr. Md. Ziaul Haq, Chief, Field Operation, NGO Forum for DWSS, Dhaka.
12. Mr. Saha Dipak Kumar, Sr. Advocacy Officer, NGO Forum for DWSS, Dhaka.
13. Mr. Monjur Ahmed, Communication Officer, NGO Forum for DWSS, Dhaka.
14. Mr. Md. Wafi-Ur-Rahim, Communication Officer, Bangladesh Water Partnership.
15. Mr. Mostak Ahmed, Market Monitoring Officer, Canada Bangladesh Filters Ltd.
16. Mr. Md. Mushtaque Ahmed Shah, Programme Coordinator, ARBAN.
17. Mr. Joseph Halder, Chief, Advocacy & Information Cell, NGO Forum for DWSS, Dhaka.
18. Mr. Suvashish Karmakar, Associate Coordinator (Advocacy), VERC.
19. Mr. Md. Arham Uddin Siddiqui, Rural Development Advisor, Delegation of the European Commission to Bangladesh.
20. Mr. Sayed A.H. Sunny, Programme Officer, Asia Arsenic Network.
21. Mr. Md. Shameem-E-Zaman, Liaison Officer, NGO Forum for DWSS, Dhaka.
22. Dr. Nazmul Hassan, Project Manager, NGO Forum for DWSS, Dhaka.
23. Mr. Md. Iqbal Rabbani, HR Officer, NGO Forum for DWSS, Dhaka.
24. Mr. Md.Taufiqul Arif, National Professional Officer, WHO.
25. Mr. Ziaul Islam, Program Officer, JICA.
26. Dr. M. Mahbubur Rahman, Director, HYSAWA.
27. Ms. Shirin Biswas, Programme Officer, Delegation of Intercooperation-Bangaldesh.
28. Mr. Shahin Obayed, Lecturer, The People's University of Bangladesh.
29. Mr. Abul Kalam Raja, Chief, Development Communication, NGO Forum for DWSS, Dhaka.
30. Mr. Md. Mahfujur Rahman, Project Coordinator, NGO Forum for DWSS, Dhaka.
31. Mr. Rafiqul Alam Khan, Programme Coordinator, PSTC.
32. Mr.Sushil Kumar Das, Project Manager, NGO Forum for DWSS, Dhaka.
33. Mr. J.K. Baral, Director, PROSHIKA & Managing Director, Canada Bangladesh Filters Ltd.
34. Mr. Rizwan Ahmed, Chief, National Resource Centre & Team leader, WASPA-Asia

Project, NGO Forum for DWSS, Dhaka.

35. Mr. Md. Arifur Rahman, Asst. Programme Officer, NRC, NGO Forum for DWSS, Dhaka.
36. Mr. S.M. Mohsin, System Manager, IT, NRC, NGO Forum for DWSS, Dhaka.
37. Mr. Md. Maksudul Amin, Technical Specialist WASPA-Asia Project, NGO Forum for DWSS, Dhaka.
38. Ms. Sharfun Ara, Research & Documentation Officer, WASPA-Asia Project, NGO Forum for DWSS, Dhaka.
39. Mr. Md. Mashiur Rahman, Communication Officer, WASPA-Asia Project, NGO Forum for DWSS, Rajshahi.
40. Mr. Md. Shafiqul Islam, Agronomist, WASPA-Asia Project, NGO Forum for DWSS, Rajshahi.
41. Ms. Alexandra Clemett, Researcher-Livelihoods, Water Quality and Wastewater, International Water Management Institute, Sri-Lanka.
42. Mr. Thor Axel Stenstrom, Senior Research Fellow, SEI, Sweden.
43. Ms. Rosario Aurora L. Villaluna, Executive Secretary, STREAMS of Knowledge, Philippines.
44. Ms. Shamsun Naima Rahman, Assistant Research Officer, NGO Forum for DWSS, Dhaka.

Annex 1: Summary of WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater, 2006

The United Nations General Assembly (2000) adopted the Millennium Development Goals (MDGs) on 8 September 2000. The MDGs that are most directly related to the safe use of wastewater, excreta and greywater in agriculture and aquaculture are “Goal 1: Eliminate extreme poverty and hunger” and “Goal 7: Ensure environmental sustainability.” The use of wastewater, excreta and greywater in agriculture and aquaculture can help communities to grow more food and make use of precious water and nutrient resources. However, it should be done safely to maximize public health gains and environmental benefits.

In 1973, the World Health Organization (WHO) produced the publication *Reuse of effluents: Methods of wastewater treatment and public health safeguards*. This document provided guidance on how to protect public health and how to facilitate the rational use of wastewater and excreta in agriculture and aquaculture. Technically oriented, the publication did not address policy issues *per se*.

A thorough review of epidemiological studies and other new information led to the publication of a second edition of this normative document in 1989: *Health guidelines for the use of wastewater in agriculture and aquaculture*. The guidelines have been very influential with respect to technical standard setting and also at the policy level, and many countries have adopted or adapted them for their wastewater and excreta use practices.

The present third edition of the Guidelines has been updated based on new health evidence, expanded to better reach key target audiences and reoriented to reflect contemporary thinking on risk management.

Box 1: What are the Guidelines?

The WHO Guidelines are an integrated preventive management framework for maximizing the public health benefits of wastewater, excreta and greywater use in agriculture and aquaculture. The Guidelines are built around a health component and an implementation component. Health protection is dependent on both elements.

Health component:

• establishes a risk level associated with each identified health hazard;
• defines a level of health protection that is expressed as a health-based target for each risk;
• identifies health protection measures that, used collectively, can achieve the specified health-based target.

Implementation component:

• establishes monitoring and system assessment procedures;
• defines institutional and oversight responsibilities;
• requires system documentation;
• requires confirmation by independent surveillance.

VOLUME I: POLICY AND REGULATORY ASPECTS

Policy Aspects

This chapter covers policy aspects as a basis of governance and the international policy framework. It includes policy aspects related to: implementation of WHO Guidelines to protect public health; wastewater, excreta and greywater use and its benefits and health risks; international policy implications and trade; cost-effective strategies for controlling negative health impacts; policy formulation and adjustment, based on objective defining, situation analysis, policy appraisal, needs assessment, political endorsement, dialogue and research. Institutional arrangements and inter-sectoral collaboration are also an important part of the chapter.

In developing a national policy framework to facilitate the safe use of wastewater, excreta and greywater in agriculture and aquaculture, it is important to define the objectives of the policies, assess the current policy environment, formulate new policies or adjust existing ones, and develop a national strategy. Environmental protection is a policy goal in most countries, from the viewpoints of both conservation of natural resources and ecosystem services and public health protection. Yet such a view overlooks the value of the source of water or nutrients for plant production and fish cultivation.

The main policy issues to investigate are:

• *Public health*: To what extent is waste management addressed in national public health policies? What are the specific health hazards and risks associated with the use of wastewater, excreta or greywater in agriculture and aquaculture? Is there a national health impact assessment policy? Is there a policy basis for non-treatment interventions in line with the concepts and procedures contained in the Stockholm Framework?

• *Environmental protection*: To what extent and how is the management of wastewater, excreta and greywater addressed in the existing environmental protection policy framework? What are the current status, trends and expected outlook with respect to the production of wastewater, excreta and greywater?

What is the capacity to management wastewater, excreta and greywater? What are the current and potential environmental impacts? What are the options for reuse in agriculture or aquaculture?

• *Food security*: What are the objectives and criteria laid down in the national policies for food security? Is water a limiting factor in ensuring national food security in the short/medium/long term? Are there real opportunities for the use of wastewater, excreta and greywater in agriculture and aquaculture to (partially) address this problem? Is reuse currently practiced in the agricultural production system? Has an analysis of the benefits and risks of such waste use been carried out?

The steps to develop a policy are:

- establishment of a mechanism for ongoing policy dialogue;
- defining objectives;
- situation analysis, policy appraisal and needs assessment;
- political endorsement, dialogue engagement and product legitimization;
- research

Regulation

This chapter provides an overview of the technical issues that regulators should consider when developing new or modifying existing regulations for the safe use of wastewater, excreta and greywater in agriculture and aquaculture. Essential functions in regulation include:

- identification of hazards;
- generating evidence for health risks and the effectiveness of possible health
- protection measures to manage them;
- establishing health-based targets to manage health risks;
- implementing health protection measures to achieve the health-based targets; and
- system assessment and monitoring.

It also covers pathogen reduction options such as excreta storage, greywater treatment, disinfection and so on, as summarized in Table 1.

Table 1: Pathogen reductions achievable by various health protection measures

Control measure	Pathogen reduction (log units)	Notes
Excreta storage without fresh additions	6	The required pathogen reduction to be achieved by excreta treatment refers to stated storage times without addition of fresh untreated excreta. Pathogen reductions for different treatment options are presented in chapter 5 of Volume 4.
Greywater treatment	1–>4	Values relate to the relevant treatment options. Generally, the highest exposure reduction is related to subsurface irrigation.
Localized (drip) irrigation with urine (high-growing crops)	2–4	Crops where the harvested parts have not been in contact with the soil
Materials directly worked into the soil	1	Should be done at the time when faeces or urine is applied as a fertilizer
Pathogen die-off (withholding time one month)	4–>6	A die-off of 0.5–2 log units per day is cited for wastewater irrigation. Reduction values cited are conservative to account for a slower die-off of a fraction of the remaining organisms.
Produce washing with water	1	Washing salad crops, vegetables and fruit with clean water
Produce disinfection	2	Washing salad crops, vegetables and fruit with a weak disinfectant solution and rinsing with clean water
Produce peeling	2	Fruits, root crops
Produce cooking	6–7	Immersion in boiling or close-to-boiling water until the food is cooked ensures pathogen destruction

Sources: Beuchat (1998); Petterson & Ashbolt (2003); NRMMC & EPHCA (2005).

The guidelines also provide recommendations for microbial monitoring, using *E.coli* as the parameter, and Helminth eggs, as shown in Table 2.

Table 2: Recommended minimum verification monitoring of microbial performance targets for wastewater and excreta use in agriculture and aquaculture

Activity/exposure	Water quality monitoring[a] parameters	
Agriculture	*E. coli* per 100 ml[b] (arithmetic mean)	Helminth eggs per litre[b] (arithmetic mean)
Unrestricted irrigation		
Root crops	$\leq 10^3$	≤ 1
Leaf crops	$\leq 10^4$	
Drip irrigation, high-growing crops	$\leq 10^5$	
Restricted irrigation		
Labour-intensive, high-contact agriculture	$\leq 10^4$	≤ 1
Highly mechanized agriculture	$\leq 10^5$	
Septic tank	$\leq 10^6$	
Aquaculture	*E. coli* per 100 ml[b] (arithmetic mean)	Viable trematode eggs per litre[b]
Produce consumers		
Pond	$\leq 10^4$	Not detected
Wastewater	$\leq 10^5$	Not detected
Excreta	$\leq 10^6$	Not detected
Workers, local communities		
Pond	$\leq 10^3$	No viable trematode eggs
Wastewater	$\leq 10^4$	No viable trematode eggs
Excreta	$\leq 10^5$	No viable trematode eggs

[a] Monitoring should be conducted at the point of use or the point of effluent discharge. Frequency of monitoring is as follows:

- Urban areas: one sample every two weeks for *E. coli* and one sample per month for helminth eggs.
- Rural areas: one sample every month for *E. coli* and one sample every 1–2 months for helminth eggs.

Five-litre composite samples are required for helminth eggs prepared from grab samples taken six times per day. Monitoring for trematode eggs is difficult due to a lack of standardized procedures. The inactivation of trematode eggs should be evaluated as part of the validation of the system.

[b] For excreta, weights may be used instead of volumes, depending on the type of excreta: 100 ml of wastewater is equivalent to 1–4 g of total solids; 1 litre = 10–40 g of total solids. The required *E. coli* or helminth numbers would be the same per unit of weight.

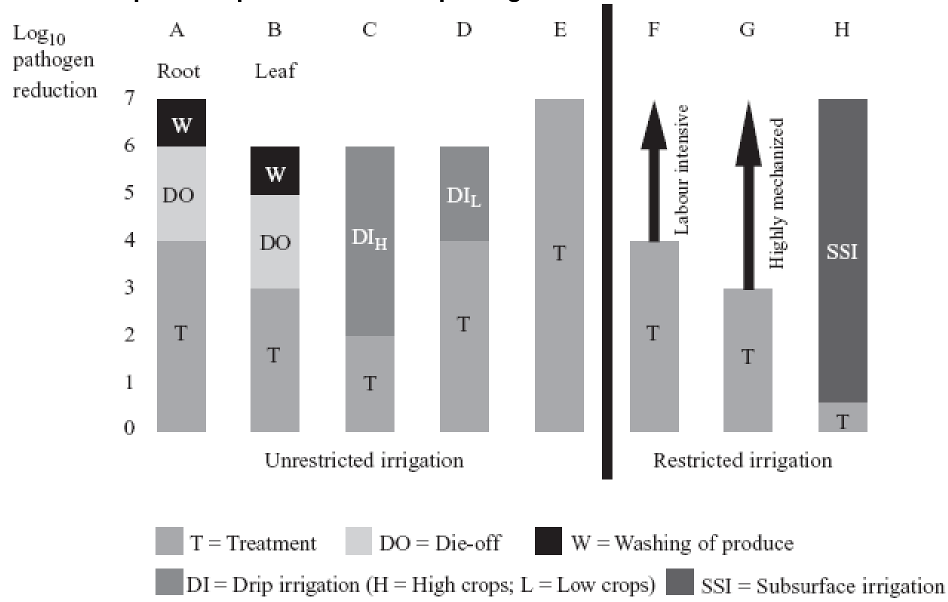
Volume 2: Wastewater Use in Agriculture

Volume 2 builds on Volume 1, providing more details. It describes the present state of knowledge regarding the impact of wastewater use in agriculture on the health of product consumers, workers and their families and local communities (Table 3). Health hazards are identified for each vulnerable group, and appropriate health protection measures to mitigate the risks are discussed. The purpose of this volume of the Guidelines is to ensure that the use of wastewater in agriculture is made as safe as possible, so that the nutritional and household food security benefits can be shared widely within communities whose livelihood depends on wastewater-irrigated agriculture. The Guidelines provide an integrated preventive management framework for safety applied from the point of wastewater generation to the consumption of products grown with the wastewater and excreta. There are many ways in which crops can be treated or managed to reduce viral, bacterial and protozoan pathogens, including irrigation method, die-off, washing practices and treatment, as shown in Table 4.

Table 3: Summary of health risks associated with the use of wastewater for irrigation

Group exposed	Health threats		
	Nematode infection	**Bacteria/viruses**	**Protozoa**
Consumers	Significant risk of *Ascaris* infection for both adults and children with untreated wastewater	Cholera, typhoid and shigellosis outbreaks reported from use of untreated wastewater; seropositive responses for *Helicobacter pylori* (untreated); increase in non-specific diarrhoea when water quality exceeds 10^4 thermotolerant coliforms/100 ml	Evidence of parasitic protozoa found on wastewater-irrigated vegetable surfaces, but no direct evidence of disease transmission
Farm workers and their families	Significant risk of *Ascaris* infection for both adults and children in contact with untreated wastewater; risk remains, especially for children, when wastewater treated to <1 nematode egg per litre; increased risk of hookworm infection in workers	Increased risk of diarrhoeal disease in young children with wastewater contact if water quality exceeds 10^4 thermotolerant coliforms/100 ml; elevated risk of *Salmonella* infection in children exposed to untreated wastewater; elevated seroresponse to norovirus in adults exposed to partially treated wastewater	Risk of *Giardia intestinalis* infection was insignificant for contact with both untreated and treated wastewater; increased risk of amoebiasis observed with contact with untreated wastewater
Nearby communities	*Ascaris* transmission not studied for sprinkler irrigation, but same as above for flood or furrow irrigation with heavy contact	Sprinkler irrigation with poor water quality (10^6–10^8 total coliforms/100 ml) and high aerosol exposure associated with increased rates of infection; use of partially treated water (10^4–10^5 thermotolerant coliforms/100 ml or less) in sprinkler irrigation is not associated with increased viral infection rates	No data on transmission of protozoan infections during sprinkler irrigation with wastewater

Table 4: Examples of options to reduce pathogens



Volume 3: Wastewater and Excreta use in Aquaculture

Volume 3 undertakes the same task for aquaculture as Volume 2 did for agriculture. It therefore gives health-based targets for waste-fed aquaculture.

Table 5: Health-based targets for waste-fed aquaculture

Exposed group	Hazard	Health-based target[a]	Health protection measure
Consumers, workers and local communities	Excreta-related diseases	10^{-6} DALY	Wastewater treatment
			Excreta treatment
			Health and hygiene promotion
			Chemotherapy and immunization
Consumers	Excreta-related diseases	10^{-6} DALY	Produce restriction
			Waste application/timing
	Foodborne trematodes	Absence of trematode infections	Depuration
	Chemicals	Tolerable daily intakes as specified by the Codex Alimentarius Commission	Food handling and preparation
			Produce washing/disinfection
			Cooking foods
Workers and local communities	Excreta-related pathogens	10^{-6} DALY	Access control
			Use of personal protective equipment
	Skin irritants	Absence of skin disease	Disease vector control
	Schistosomes	Absence of schistosomiasis	Intermediate host control
	Vector-borne pathogens	Absence of vector-borne disease	Access to safe drinking-water and sanitation at aquacultural facilities and in local communities
			Reduced vector contact (insecticide-treated nets, repellents)

[a] Absence of disease associated with waste-fed aquaculture-related exposures.

Volume 4: Excreta and Greywater use in Agriculture

Traditional waterborne sewerage will continue to dominate sanitation for the foreseeable future. Since only a fraction of existing wastewater treatment plants in the world are optimally reducing levels of pathogenic microorganisms and since a majority of people living in both rural and urban areas will not be connected to centralized wastewater treatment systems, alternative sanitation approaches need to be developed in parallel.

Volume 4 provides health-based targets for excreta and greywater use that may be achieved through different treatment barriers or health protection measures. The barriers relate to verification monitoring, mainly in large-scale systems, as illustrated in Table 6. The health-based targets may also relate to operational monitoring, such as storage as an on-site treatment measure or further treatment off site after collection. This is exemplified for faeces from small-scale systems in Table 7.

Table 6: Guideline values for verification monitoring of large-scale treatment systems of greywater, excreta and faecal sludge used in agriculture

	Helminth eggs (number per gram total solids or per litre)	*E. coli* (number per 100 ml)
Treated faeces and faecal sludge	<1/g total solids	<1000/g total solids
Greywater for use in:		
• Restricted irrigation	<1/litre	$<10^{5}$ [a] Relaxed to $<10^{6}$ when exposure is limited or regrowth is likely
• Unrestricted irrigation of crops eaten raw	<1/litre	$<10^{3}$ Relaxed to $<10^{4}$ for high-growing leaf crops or drip irrigation

[a] These values are acceptable due to the regrowth potential of *E. coli* and other faecal coliforms in greywater.

Table 7: Recommendations for storage treatment of dry excreta and faecal sludge before use at the household and municipal levels

Treatment	Criteria	Comment
Storage; ambient temperature 2–20 °C	1.5–2 years	Will eliminate bacterial pathogens; regrowth of *E. coli* and *Salmonella* may need to be considered if rewetted; will reduce viruses and parasitic protozoa below risk levels. Some soil-borne ova may persist in low numbers.
Storage; ambient temperature >20–35 °C	>1 year	Substantial to total inactivation of viruses, bacteria and protozoa; inactivation of schistosome eggs (<1 month); inactivation of nematode (roundworm) eggs, e.g. hookworm (*Ancylostoma/ Necator*) and whipworm (*Trichuris*); survival of a certain percentage (10–30%) of *Ascaris* eggs (≥4 months), whereas a more or less complete inactivation of *Ascaris* eggs will occur within 1 year.
Alkaline treatment	pH >9 during >6 months	If temperature >35 °C and moisture <25%, lower pH and/or wetter material will prolong the time for absolute elimination.

[a] No addition of new material.

Table 8: Recommended storage times for urine mixture based on estimated pathogen content and recommended crops for larger systems

Storage temperature (°C)	Storage time (months)	Possible pathogens in the urine mixture after storage	Recommended crops
4	≥1	Viruses, protozoa	Food and fodder crops that are to be processed
4	≥6	Viruses	Food crops that are to be processed, fodder crops[d]
20	≥1	Viruses	Food crops that are to be processed, fodder crops[d]
20	≥6	Probably none	All crops[e]

[a] Urine or urine and water. When diluted, it is assumed that the urine mixture has a pH of at least 8.8 and a nitrogen concentration of at least 1 g/l.

[b] Gram-positive bacteria and spore-forming bacteria are not included in the underlying risk assessments, but are not normally recognized as a cause of any infections of concern.

[c] A larger system in this case is a system where the urine mixture is used to fertilize crops that will be consumed by individuals other than members of the household from whom the urine was collected.

[d] Not grasslands for production of fodder.

[e] For food crops that are consumed raw, it is recommended that the urine be applied at least one month before harvesting and that it be incorporated into the ground if the edible parts grow above the soil surface.

Conclusion

These four volumes therefore provide important guidance on management of wastewater, greywater and excreta for productive end-use, which covers technical, policy and health issues. It is recommended that anyone working in these sectors should refer to these Guidelines, especially where unregulated use is currently taking place. It should also be noted that this use may be direct or indirect, where wastewater, greywater or excreta have contaminated sources of water that are being used for irrigation, as is likely to be the case in Sri Lanka and will increase as the population increases unless steps are taken now.