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Proceedings of the UN-Water project on the

Safe Use of Wastewater in Agriculture

Coordinated by the UN-Water Decade Programme on Capacity Development (UNW-DPC)

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ACRONYMS AND ABBREVIATIONS

ANA	Autoridad Nacional del Agua
CNA	Capacity needs assessment
DALY	Disability adjusted life year
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
ha	Hectare
HACCP	Hazard Analysis and Critical Control Points
ICID	International Commission on Irrigation and Drainage
IEA	Institut International de l'Eau et de l'Assainissement
IWMI	International Water Management Institute
km^2	Square kilometre
m	Metre
m^3	Cubic metre
MENA	Middle East and North Africa
MCM	Million cubic metres
ml	Millilitres
MGAP	Ministry of Livestock, Agriculture and Fisheries (Uruguay)
NGO	Non-governmental organization
OECD	Organization for Economic Cooperation and Development
PCB	Polychlorinated biphenyls
POPs	Persistent organic pollutants
sec	Second(s)
SUWA	Safe Use of Wastewater in Agriculture
TND	Tunisian Dinar (the currency of Tunisia)
UN	United Nations
UN-Habitat	United Nations Human Settlements Programme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNSGAB	United Nations Secretary-General's Advisory Board on Water and Sanitation
UNW-AIS	UN-Water Activity Information System
UNW-DPC	UN-Water Decade Programme on Capacity Development
UNU-INWEH	United Nations University Institute for Water, Environment and Health
US$	United States Dollar
WHO	World Health Organization
WMA	Wastewater Management Authority (Mauritius)
WWAP	World Water Assessment Programme

FOREWORD

Wastewater use in agriculture is much more commonplace than many believe. At present, approximately 20 million hectares of arable land worldwide are reported to be irrigated with wastewater. The unreported use of wastewater in agriculture can be expected to be significantly higher. It is particularly common in urban and peri-urban areas of the developing world, where insufficient financial resources and institutional capacities constrain the instalment and operation of adequate facilities for proper wastewater collection and treatment. Wastewater use in agriculture has certain benefits, providing water and nutrients for the cultivation of crops, ensuring food supply to cities and reducing the pressure on available fresh water resources. However, wastewater is also a source of pollution, and can affect the health of users, consumers and the environment if safe practices are not applied. While populations and urban areas are growing at unprecedented rates and water scarcity is increasing, it is expected that, in the near future, the use of wastewater in agriculture will increase further in areas where fresh water is scarce.

To address and promote safe practices where wastewater is used in agriculture, seven UN-Water members, partners and programmes have come together in a multi-year, multi-sectoral project: the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), the United Nations Environment Programme (UNEP), the United Nations University Institute for Water, Environment and Health (UNU-INWEH), UNW-DPC, the International Commission on Irrigation and Drainage (ICID) and the International Water Management Institute (IWMI).

With this publication I am very pleased to present to you the results of the first phase of this joint project, which was launched with an International Kick-off Workshop at the UN Campus in Bonn, Germany in November 2011, reached nearly 160 participants from over 70 countries in a series of five regional workshops throughout Africa, Asia and Latin America, and then concluded with an international event to wrap up its first phase in June 2013 in Tehran, Iran. The objective during this phase was to raise awareness among participating Member States and identify the capacity needs in their respective countries, so that further work can be done at the national level in order to develop and implement guidelines for safe wastewater use in their countries. I wish you an interesting read.

Reza Ardakanian

Founding Director/Officer-in-Charge

The UN-Water Decade Programme on Capacity Development (UNW-DPC)

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The "Safe Use of Wastewater in Agriculture" project is a joint activity carried out under UN-Water and coordinated by the UN-Water Decade Programme on Capacity Development (UNW-DPC). It is a joint effort of the following UN-Water members and partners: the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), the United Nations Environment Programme (UNEP), the United Nations University Institute for Water, Environment and Health (UNU-INWEH), the UN-Water Decade Programme on Capacity Development (UNW-DPC), the International Water Management Institute (IWMI) and the International Commission on Irrigation and Drainage (ICID). Many of these project partners also took on the responsibility of organizing one or more of the workshops in the project series.

In particular, the following individuals who represented the agencies and organizations above were essential in facilitating this project: Javier Mateo-Sagasta, Jean Boroto, Satya Pria, Pilar Roman and Pasquale Steduto of FAO; Kate Medlicott, Robert Bos, Payden, Ana Treasure, Jonathan Drewry and Sharad Adhikary of WHO; Birguy Lamizana, Anjan Datta, Heidi Savelli, Joseph Ajayi, Vincent Sweeney and Thomas Chiramba of UNEP; Manzoor Qadir, Richard Thomas and Zafar Adeel of UNU-INWEH; Pay Drechsel, Bharat Sharma, Priyanie Amerasinghe and Liqa Rashid-Sally of IWMI; and Avinash Tyagi of ICID.

In addition to those regional and national offices of the project partners who took on the organization of regional workshops, we would also like to express our great appreciation to the following organizations: the Institut International de l'Eau et de l'Assainissement (IEA) for its support in the organization of the 1st Regional Workshop (Marrakech, Morocco); the WaterNet for its support in the organization of the 3rd Regional Workshop (Johannesburg, South Africa); the Autoridad Nacional del Agua (ANA) in Peru for its support in the organization of the 4th Regional Workshop (Lima, Peru); the Directorate General for Disease Control and Environmental Health, Ministry of Health, Indonesia for its support in the organization of the 5th Regional Workshop (Bali, Indonesia); and the Sharif University of Technology for the hosting and organizational support of the International Wrap-up Event (Tehran, Iran).

Finally, sharing knowledge and the exchange of experiences and good practice examples were at the heart of this project. We gratefully acknowledge the country representative participants for their preparation of national reports, contribution of valuable expertise and active involvement in the workshop series to make this a successful project.

Chapter 1

THE SAFE USE OF WASTEWATER IN AGRICULTURE PROJECT

1.1 Background and Scope

In many regions of the world, particularly in water-scarce urban and peri-urban areas and where competition for water is high, wastewater is being used for agricultural purposes. While some countries implement agricultural wastewater use practices and guidelines that follow national regulations or international guidelines and safety standards, in many other countries, especially in the developing world, use of wastewater is an unregulated but common practice. The lack of implementation of guidelines and safety standards can lead to an otherwise avoidable aggravation of health risks that could result in significant secondary impacts.

Although the international community recognizes that the *safe use of wastewater in agriculture* is an important water resources issue that needs to be addressed, efforts are still needed to advance it in national policies and to implement safe use guidelines and practices. The key word here is 'safe', and it is essential to understand that wastewater is a valuable resource.

From the technological perspective, the issue of wastewater collection and treatment has been solved. Many countries, however, do not have access to this technology or do not have the human capacity and financial means to operate such treatment plants efficiently in order to treat all effluents prior to discharge into the environment or reuse.

Although important, the safe use of wastewater in agriculture has often not been adequately addressed. In particular, it needs to be understood that, where water is scarce, the lack of implementation of regulations and guidelines will not prevent the use of wastewater, but will, rather, result in unsafe practices.

Tackling a complex topic such as wastewater requires concerted efforts which take into account various disciplines. In this project, UNW-DPC has brought together, under UN-Water, six UN-Water members and partners with extensive knowledge and experience in the field of wastewater use, all from different disciplinary backgrounds: the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), the United Nations Environment Programme (UNEP), the United Nations University Institute for Water, Environment and Health (UNU-INWEH), the International Commission on Irrigation and Drainage (ICID) and the International Water Management Institute (IWMI).

Together, these organizations have launched a global project with the aim to develop national capacities for the promotion of the safe use of wastewater in agriculture in developing countries and countries in transition. The project also aims towards enhancing the knowledge and skills on the safe use of wastewater among staff members in selected organizations. This will contribute to the improvement of the overall capacity and performance of the organizations as a whole. Another important aspect of the project is to increase the understanding of the link between wastewater and health, ecosystem functioning and the potential benefits of wastewater reuse in contributing to development and improved well-being. It also encourages the engagement of stakeholders in all sectors and the improvement of intersectoral collaboration through the development of professional skills and institutional capacities.

As a programme of UN-Water, one of the main tasks of UNW-DPC is to foster the collaboration of UN-Water members and partners in their capacity development activities. Doing so adds value and increases the coherence of UN-Water and contributes to the notion of the UN "Delivering as One."

The "Safe Use of Wastewater in Agriculture" (SUWA) project is an example of how UN-Water, in its role as the United Nations' inter-agency coordination mechanism for all freshwater-related issues, can make an important and meaningful impact.

1.2 The Wastewater Challenge

HRM King Willem-Alexander of the Netherlands, in his former role as Chairman of the UN Secretary-General's Advisory Board on Water and Sanitation addressing the 6th World Water Forum in Marseille, France on 12 March 2012 stressed the convergence of drinking water and sanitation issues in wastewater, calling it a

> *"…challenge for which we need multiple solutions from all sectors and at all levels. Right now more than 90% of the world's wastewater is discharged untreated into oceans, rivers or wherever else it can go. Given demographic trends, coupled with climate change impacts, this is a disaster in slow motion that will grow in proportion and impact. We need solutions for wastewater management, not only of human sewage, but also of industrial, agricultural and urban wastewater. Wastewater management can help meet multiple objectives and offers huge potential for a green economy" (*UNSGAB, 2013).

He went on to state:

> *"We know that in many parts of the world, wastewater is already used for agriculture. This practice should be encouraged, but it must be done safely, with the use of guidelines, such as the globally accepted World Health Organisation guidelines for wastewater reuse. Safe water reuse is a solution, since it promotes food security in the future" (*Ibid, 2013*).*

Wastewater, in its untreated form, is already widely used for agriculture, which has been the practice for centuries in countries all over the world. Where it is used in agriculture, and adequate treatment is not available, the challenge is therefore to identify practical and safe uses that do not threaten those communities which are dependent on wastewater, and take into account the importance that this resource plays in achieving food security in growing urban areas.

It is important to note in this context that wastewater presents not only a challenge but also an opportunity. On the one hand, its nutrients can be applied for agriculture and other productive uses; on the other hand, municipalities are struggling, especially in large metropolitan areas, with limited space for land-based treatment and disposal. Furthermore, its use can both deliver positive benefits to farmers, society and municipalities, as well as create potential health risks for farmers, their families and consumers while impacting the environment considerably. Although standards are set, these are not always strictly adhered to.

The following sections will provide further background information on the extent, categories, types and drivers of wastewater use. It is clear that wastewater, irrespective of its quality, type or category, is increasingly being used worldwide for irrigation – not only in urban and peri-urban agriculture, but also in rural areas downstream of large cities, in both developing and industrialized countries around the world.

1.3 Key Drivers of Wastewater Use in Agriculture

Wastewater is being increasingly used for irrigation in agriculture, both in developing as well as industrialized countries, and is driven by a range of multiple and complementary key drivers. Rapid population growth and high urbanization rates, particularly in cities of the developing world, increased water scarcity and stress and agricultural water demand for urban and peri-urban food production are, among others, key interacting factors whose interdependencies influence current and future magnitudes of wastewater production, treatment and use in several ways.

In high-income countries, as in other places, the main driver for reclaimed wastewater use is water scarcity. The main objective when using reclaimed water, as opposed to untreated water, is health and environmental protection. This is a common pattern in countries such as Israel, Australia or the United States of America (particularly in California and Florida), where highly effective sanitation and treatment technology can be found in planned reclamation facilities. This is a costly approach but reduces risk to a minimum.

Poverty is the key underlying factor that significantly influences the above-mentioned principle drivers of wastewater use. In dense and rapidly growing regions, where ever-increasing volumes of wastewater are being produced, insufficient financial and coping capacities constrain the establishment of comprehensive wastewater management systems for proper collection, treatment and use of wastewater in order to respond to the infrastructural needs of urbanization. However, the use of untreated wastewater is not limited to the countries and cities with the lowest gross domestic product (GDP), but is also a common practice in many middle-income countries as well (Raschid-Sally and Jayacody, 2008).

1.3.1 Increasing Water Scarcity and Stress

Global fresh water resources constitute about 2.5 per cent of the total volume of water on Earth, and a considerably small fraction of less than 1 per cent of this resource is the usable fresh water supply for ecosystems and human utilization (UNEP, 2008).

Available fresh water resources, however, are not evenly distributed, and are already scarce in many parts of the world, affecting almost every continent. Figure 1 illustrates that about one-third of the world's population lives in basins that face water scarcity, either physically or economically. Whereas physical water scarcity describes a physical lack of available water to satisfy the demand, economic water scarcity refers to a lack of institutional capacities to provide necessary water services and infrastructure development to control storage, distribution and access (Comprehensive Assessment of Water Management in Agriculture, 2007). By 2025, a total number of 1.8 billion people will be living in countries or regions with absolute water scarcity. Two-thirds of the world's population could be living under water-stressed conditions, and in Africa alone, it is estimated that 25 countries will be experiencing water stress (UNEP, 2008).

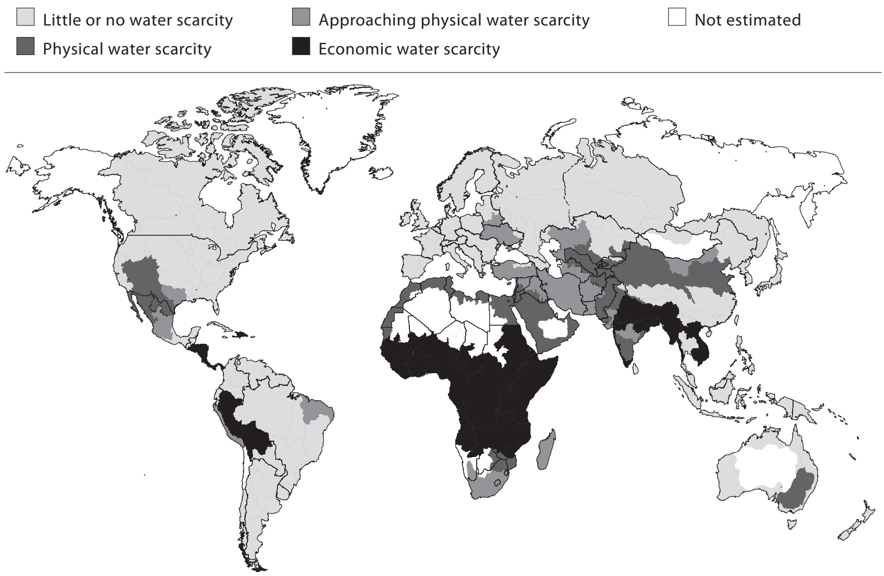

Figure 1: Areas of Physical and Economic Water Scarcity

Source: Comprehensive Assessment of Water Management in Agriculture, 2007.

Regardless of whether the availability of water is limited for physical or economic reasons, a variety of interrelated drivers cause water scarcity. Generally, water scarcity arises when the demand for water gets close to or exceeds its availability. Demographic pressures, urbanization and pollution are all putting unprecedented pressure on a renewable but finite resource and serving to increase water scarcity levels even further. Most population growth will occur in developing countries, mainly in regions that are already experiencing water stress and in areas with limited access to safe drinking water and adequate sanitation facilities. Agriculture is by far the largest user of fresh water resources. In order to satisfy growing food demands, related rises in agricultural water use are expected to increase the severity of water scarcity in some areas even further.

Intersectoral competition is most apparent in large urban centres and particularly in arid, semi-arid and densely populated regions. In particular, the competition for scarce freshwater supplies between urban areas and agriculture will grow. In such water-scarce regions, wastewater is an important resource for irrigation. Water scarcity and the reliability of the water supply are crucial factors influencing the use of wastewater as an alternative resource.

1.3.2 Population Growth and Urbanization

Over 80 per cent of wastewater worldwide is not collected or treated, and urban settlements are the main source of pollution (WWAP, 2012). Today, one in two people on the planet lives in cities. Most population growth is expected to occur in urban and peri-urban areas in the developing world. For example, all developing regions, including Africa and Asia, which are still mostly rural, will urbanize faster than other regions over the coming decades, and are expected to double their urban population between 2000 and 2030. It is estimated that 93 per cent of the urbanization will occur in poor or developing countries, and that nearly 40 per cent of the world's urban expansion will take place in slums (UN-Habitat, 2008). By 2030, 4.9 billion people, approximately 60 per cent of the world's population, will be urban dwellers (United Nations, 2006).

Growing urban populations are affecting the generation, treatment and use of wastewater in several ways. Urban areas are both consumers and producers of large amounts of wastewater. Higher population densities are leading to increased urban water demands and related volumes of wastewater generation, of which much is discharged untreated or only partially treated into the environment and its water bodies. This causes pollution of the traditional irrigation water sources and degradation of the fresh water resources available for urban and peri-urban agriculture (Raschid-Sally and Jayacody, 2008). In particular, in low-income countries where adequate collection and treatment facilities are often malfunctioning or lacking and no effective regulations for wastewater use are in place, up to 90 per cent of wastewater flows untreated into water bodies, threatening health, food security and access to safe drinking water (WWAP, 2012). Figure 2 demonstrates that, particularly in Southern and East Asia, West and Central Africa, the Caribbean and the Caspian Sea, large amounts of wastewater are discharged into water bodies without having undergone treatment. In addition, in urban populations, the per capita water consumption is generally higher than that of rural populations, resulting in an increased amount of wastewater produced (WHO, 2006). Consequently, in these regions, there is reason for concern that growing volumes of wastewater will be discharged into the environment and pollute the water sources utilized for irrigational practices. Polluted water that cannot be used for drinking, sanitation, industry or agriculture may effectively reduce the amount of water available for use in a given area.

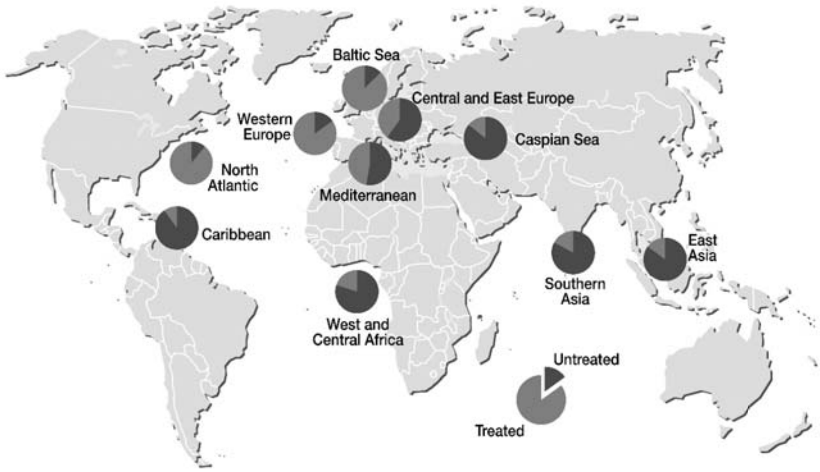

Figure 2: Ratio of Wastewater Treatment

Source: UNEP/GRID-Arendal (www.maps.gride.no/go/graphic/ratio-of-waterwater-treatment1), adapted from a map by H. Alhenius with sources UNEP-GPA 2004.

1.3.3 Agricultural Water Demands for Urban Food Production

Water for irrigation and food production constitutes one of the greatest pressures on fresh water resources. The daily drinking water requirement per person is 2-4 litres, but it takes 2,000 to 5,000 litres of water to produce one person's daily food. Agriculture is by far the largest consumer of fresh water resources, currently accounting for over 70 per cent of global withdrawals and 86 per cent of the world's total fresh water consumption (FAO, 2012). In Africa and Asia, an estimated 85–90 per cent of all fresh water resources are used for agriculture (UNEP, 2008). Figure 3 illustrates that, particularly in several countries in Africa and Asia, where water is an increasingly scarce resource, agricultural water withdrawals already exceed 90 per cent of total water withdrawals. Unprecedented population growth and shifts in dietary habits will increase food consumption in most regions of the world. By 2050, due to an estimated additional production of one billion tonnes of cereals and 200 million tonnes of meat needed to satisfy growing future food demand, global agricultural water consumption – both rainfed and irrigated agriculture – is expected to increase even further, by 19 per cent (WWAP, 2012).

Of all economic sectors, agriculture is particularly sensitive to water scarcity. Steadily increasing demand for agricultural products is the main driver of agricultural water use. In particular, in the cities of the developing world, where almost all world population growth will occur, food demands will increase accordingly. Urban and peri-urban agriculture play an important role in compensating rising food demands and supplying food products to the cities. Hence, agricultural activities need to be intensified to reach higher production levels, which require large amounts of additional water for irrigation. In areas with water-stressed conditions, where fresh water – due to population growth, urbanization and climate change – is becoming increasingly scarce and water supplies remain fixed, untreated or partially treated wastewater, of which larger volumes are produced, is increasingly being used for irrigation and will become the sole water source for many farmers (WHO, 2006). It is estimated that 10 per cent of the world's population relies on food grown with contaminated wastewater (Corcoran et al., 2010).

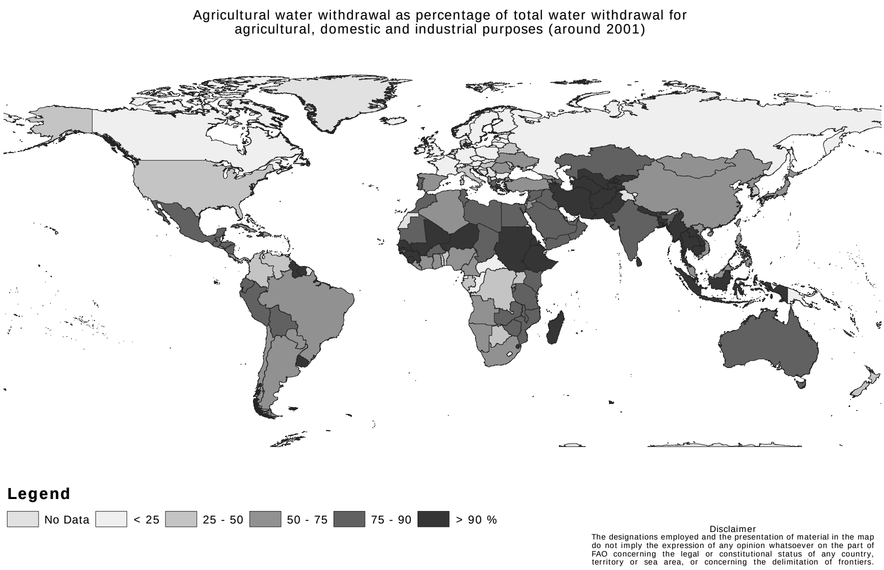

Figure 3: Proportion of Total Water Withdrawal for Agriculture

Source: FAO Aquastat, 2008.

1.4 Extent, Types and Categories of Wastewater Use

It is clear that wastewater is increasingly being used worldwide, both in developing and industrialized countries, particularly in rapidly growing urban areas with large wastewater production volumes. It is important to note, however, that there is a range of types, categories and uses of wastewater, depending on its composition, its treatment, and the planned or unplanned forms of its utilization (Raschid-Sally and Jayakody, 2008).

1.4.1 Extent of Wastewater Use Worldwide

When it comes to officially reported figures, information regarding the quantity of wastewater generated, treated and used at the national scale is often unavailable, limited, or outdated in numerous countries. Yet this kind of information is crucially important for policymakers, researchers and practitioners as well as public institutions, if they are to develop national action plans aimed at wastewater treatment and the productive use of wastewater in agriculture, aquaculture and agroforestry that include environmental conservation and health protection measures. While searching data and literature in published or electronic forms for 181 countries, Sato et al. (2013) found that only 55 countries have data available on all three aspects of wastewater – generation, treatment and use. The number of countries with one or two aspects of wastewater generation, treatment and use is 69, while there is no information available from 57 countries. Of the available information, only 37 per cent of the data could be categorized as recent (reported during 2008 to 2012).

Information on untreated wastewater is even more difficult to estimate, as it largely goes unreported. Reliable data quantifying its use are scarce, but it is estimated that, annually, areas of around 20 million ha (7% of the total irrigated land) are under irrigation with untreated or partially treated wastewater, particularly in arid and semi-arid regions and urban areas where unpolluted water is a scarce resource. The water and nutrient values of wastewater represent important, drought-resistant resources for farmers (Scott et al., 2004). Research results reported by Raschid-Sally and Jayacody (2008) indicate that, on a global level, around 200 million farmers use treated, partially treated and untreated wastewater to irrigate their crops, including in areas where irrigation water is heavily polluted.

Table 1: Percentage of Urban Populations Connected to Piped Sewer Systems in 2003-2006

REGION	NUMBER OF COUNTRIES WITH AVAILABLE DATA	CONNECTED URBAN POPULATION (%)
United States and Canada	2	94
European Union	18	90
Australia	1	87
Central Asia	5	83
Middle East and North Africa (MENA)	7	83
Namibia, South Africa, Zambia, Zimbabwe	4	68
Latin America and the Caribbean	21	64
China	1	56
South Asia	6	31
Sub-Saharan Africa	24	9
South-East Asia	5	3

Source: USEPA, USAID, 2012.

Table 1 presents the percentage of urban populations connected to piped sewer systems, divided by world region. According to recent estimates, it may be concluded that over 80 per cent of used water worldwide is not collected or treated at all (WWAP, 2012).

Mostly due to the prevalence of this informal practice, there are few reliable data on sewage volumes generated or assessments of the use of urban wastewater. This assessment in Table 1, however, serves to highlight that, with respect to the number of people with proper connection to sanitation and piped sewer systems, Africa, Asia and Latin America and the Caribbean are facing significant challenges. It is projected that after 2015, worldwide population growth will almost exclusively take place in cities of the developing world as a result of their growth at unprecedented rates. Together with the growing water supply and sanitation coverage, it is expected that untreated wastewater use in urban agriculture will increase at approximately the same rate as the population growth in the cities of developing countries (Scott et al., 2004).

1.4.2 Types of Wastewater

The wastewater used for agricultural irrigation has different sources and covers wastewater of different qualities, ranging from raw to diluted, generated by various urban activities (Raschid-Sally and Jayakody, 2008). The following are the most common types:

- **Urban wastewater** is usually a combination of one or more of the following:
  1. domestic effluent consisting of black water (excreta, urine and associated sludge) and greywater (kitchen and bathroom wastewater)
  2. effluent from commercial establishments and institutions, including hospitals;
  3. industrial effluent
  4. stormwater and other urban run-off.
- **Treated wastewater** is wastewater that has been processed through a wastewater treatment plant and subjected to one or more physical, chemical and biological processes to reduce its contamination by hazardous substances.
- **Reclaimed water or recycled water** is treated wastewater that can officially be used under controlled conditions for beneficial purposes, such as irrigation.
- **Greywater** is particularly suitable for reuse. It is generated from households not connected to a sewerage system and can be treated and used for irrigation of home gardens and trees, such as olive trees. Greywater is an important component of water conservation. It comprises 50-80 per cent of residential wastewater and offers great potential as an economic and resource conservation component of integrated water resource management in dry areas.

1.4.3 Categories of Wastewater Use

As with the different types of wastewater listed above, there are also different ways in which wastewater can be used:

- **Direct use of untreated wastewater** from a sewage outlet occurs when it is directly disposed of on land where it is used for cultivation.
- **Direct use of treated wastewater** occurs when wastewater has undergone treatment before it is used for agriculture or other irrigation or recycling purposes.
- **Indirect use of treated or untreated urban wastewater** occurs when water from a river receiving treated or untreated urban wastewater is abstracted by farmers downstream of the urban centre for agriculture. This occurs when cities lack a comprehensive sewage collection network and when drainage systems discharge collected wastewater into rivers.

- **Planned use of wastewater** refers to the conscious and controlled use of wastewater either raw (i.e. untreated) or diluted (i.e. treated). However, most indirect use occurs without planning.

The resulting schemes for wastewater use can be highly heterogeneous, but common patterns can still be detected among different countries.

1.5 Benefits and Risks of Wastewater Use

Depending on its composition, the treatment it has undergone, the extent to which it is irrigated and the regulations and principle guidelines under which it is being utilized, wastewater use in agriculture can be viewed as both a benefit, providing water and nutrients for the cultivation of crops and ensuring food supply to the cities, as well as a source of pollution, a threat affecting the health of users, consumers and the environment.

Hussain et al. (2001) developed an overview of the potential benefits and risks arising from the use of wastewater in agriculture. Selected potential impacts, which are addressed in further details further on in the coming sub-sections, are summarized as follows:

- **Public health:** Wastewater has the potential to cause diseases because it contains bacteria, viruses and parasites. Also, the inclusion of heavy metals in wastewater can be very dangerous for human health. Wastewater use in agriculture creates risks for the population living within and outside the wastewater irrigation zone.
- **Crops:** Wastewater is attractive and economically valuable for farmers because it contains important nutrients for crop growth. However, a high concentration of chemical pollutants in wastewater may be toxic to plants.
- **Soil resources:** Accumulation of nitrogen, phosphorus, dissolved solids and other constituents such as heavy metals in the soil affect its productivity and the sustainability of land use for agriculture. Salt accumulation in the root zone may have harmful impacts on crop yields.
- **Groundwater resources:** Leaching of nutrients and salts included in wastewater has the potential to affect the quality of groundwater. The degree of impact depends on several factors, including the quality of groundwater, the depth of the water table, soil drainage and the amount of wastewater applied for irrigation.

- **Property values:** Using wastewater for irrigation may influence the land property values positively or negatively. Low soil productivity due to the use of wastewater in irrigation may negatively affect the land prices and lease revenues. However, the value of wastewater as a source for irrigation may positively affect the value of land.
- **Ecological impacts:** Drainage of wastewater from irrigation schemes into water bodies may indirectly affect aquatic life and negatively influence overall biodiversity, e.g. the presence of water birds.
- **Social impacts:** The use of wastewater in agriculture has different social impacts on food safety, health and welfare, quality of life, property values and sustainability of land use.

1.5.1 Benefits: Wastewater as a Resource

Despite its apparent high level of usage, the value of wastewater as a potential resource is often underestimated. If managed properly and guidelines for utilization are adhered to, instead of being a source of problems, well-managed wastewater can provide beneficial effects for society, the economy and the environment, ensuring social equity and enhancing food security.

First of all, components found in wastewater can contain useful and valuable nutrients that are required by plants. These nutrients and fertilizers can reduce the input of artificial fertilizers, which not only results in a reduction of the environmental impacts associated with the use and production of artificial fertilizers, but also has positive impacts on farmers' incomes (WHO, 2006). Farmers therefore benefit through increased productivity and yields and faster growing cycles, while decreasing their needs for artificial fertilizers and additional water sources (Corcoran et al., 2010).

Another benefit of wastewater lies in its availability. In urban areas where alternative water supplies are lacking, wastewater is an advantageous resource because it is available all year round and is a low-cost option for farmers.

There are also potentially significant positive health effects from improved food supply and nutrition in arid and food-insecure areas. To date, a systematic global assessment of the positive health benefits of the use of wastewater in agriculture has not been conducted and positive health benefits versus health risks will vary widely depending on the setting. For example, subsistence-level farmers who can benefit most in terms of improved food security and nutrition are also at the highest risk of negative health impacts, especially where untreated wastewater is used for irrigation. Conversely, in settings where alternative water sources are limited, treatment quality is high, and farming practices and food processing are advanced, potential benefits are likely to significantly outweigh risks. In any context, efforts should be made to quantify positive health impacts on nutrition and food security and weigh them against the potential negative health impacts discussed in the next section.

There are, of course, still many instances where farmers either have no other option but to use marginal-quality water resources (such as in regions where reliable water supplies are lacking and discharge of municipal wastewater into the environment pollutes water bodies), or where farmers are unaware that they are directly using wastewater (such as when farmers are located downstream of large cities where wastewater is being dumped into open water).

Planned wastewater use for irrigation, however, is an increasingly important resource in recognition of its potential benefits, especially in urban and peri-urban agriculture. This is driving wastewater use in both developing and industrialized countries – especially in water-scarce areas where alternative supplies are lacking.

1.5.2 Risks of Wastewater Use

In addition to its potential benefits, wastewater use also poses high health and environmental risks if no additional measures are applied. Untreated wastewater generated from cities and industries potentially contains a wide range of different constituents, such as pathogens, organic compounds, synthetic chemicals, nutrients, organic matter and heavy metals. The suspended or unsuspended components carried along in the water from different sources affect the water quality.

1.5.2.1 Health Risks

Health risks from wastewater use may manifest directly as outbreaks of food-, water- and vector-borne diseases, or less visible yet persistent diseases (e.g. intestinal helminth infections or diarrhoeal diseases) and non-communicable diseases resulting from exposure to heavy metals from industry or household detergents contained in the wastewater. Indirect health effects are also possible through contamination of drinking water sources, recreational water with nitrates or the production of toxic cyanobacteria. In addition, there have been emerging concerns related to micropollutants such as pharmaceutical residues.

The 2006 WHO Guidelines for Safe Use of Wastewater, Excreta and Greywater (WHO, 2006) summarize the array of pathogens and pollutants that can be found in wastewater, as well as summarizing the results of studies on human health risks posed by wastewater irrigation, especially from pathogen contamination. An excerpt from these results, on the information available from epidemiological studies of infectious disease transmission related to wastewater use in agriculture, is summarized in Table 2.

Health risks of concern are often context-specific. In low-income countries, risks from microbiological contaminants receive most attention since populations are most affected by diarrhoeal diseases and helminth infections related to poor sanitation. In higher-income settings where microbiological risks are largely under control, chemical pollution and emerging pollutants are a larger public concern.

The greatest health risks are associated with crops that are cultivated in close proximity to the soil and eaten raw, such as salad crops, onions or radishes. Intestinal helminths are the most likely infection in places where wastewater is used without adequate treatment due to the long survival time of their eggs - up to several years in water and soil. Studied viruses, bacteria and protozoa have shorter survival times in water, of usually less than 10 to 70 days. Factors that affect the survival of pathogens in the environment include humidity, temperature, soil content, pH level, ultraviolet radiation levels, plant and foliage type and competition with other native flora and fauna.

Polluted canals and streams expose farmers, children and other inhabitants to pathogens, pollutants and bacteria. Intestinal worm infestations have been shown to pose the greatest risk for occupational exposure (Drechsel et al., 2010). Serious diseases such as diarrhoea, ascariasis and schistosomiasis, which cause a significant burden of diseases and potentially lead to death, are among the major wastewater-related diseases. To a large extent, the impacts on public health depend on the location of farm fields and the quality of water applied. The closer the farmers and consumers are to the source of pollution, the more vulnerable they are. Hence, consumers and marginalized communities living around agricultural regions where untreated wastewater is used are particularly exposed to risks. Further downstream, the concentrations of pathogens decline and become less harmful. Health implications linked to the use of untreated and contaminated wastewater can also result in substantial secondary impacts. High costs for health care and lost labour productivity restrict and decelerate economic development and increase poverty. In effect, polluted water causes child mortality. Thus, unmanaged wastewater can be regarded as a vector of disease (Corcoran et al., 2010).

Table 2: 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 104 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 104 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 (106–108 total coliforms/100 ml) and high aerosol exposure associated with increased rates of infection; use of partially treated water (104–105 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

Source: WHO, 2006.

1.5.2.2 Environmental Risks

The generation and discharge of wastewater into water bodies can cause significant impacts on the environment. Where irrigation with untreated, inadequately treated and/or diluted wastewater cannot be avoided or is common, negative impacts on irrigated crops, soils and groundwater are likely, which can affect not only human but also environmental health.

Wastewater contains different types and levels of undesirable constituents, depending on the source from which it is generated and the level of its treatment. In addition to organic chemicals, debris and solutes, the non-pathogenic components of wastewater can comprise a range of elements at beneficial levels, such as essential plant nutrients (as listed above in the section on benefits), but also undesirable salts or metals and metalloids in toxic concentrations, depending on their concentration and solubility.

Eutrophication is one of the major prevalent global problems affecting the health and functioning of marine and freshwater ecosystems. Studies indicate that, through current agricultural practices and related run-off, approximately 80 million tonnes of nitrogen and 10 million tonnes of phosphorous discharge into inland waterways and coastal zones each year, which far exceeds all natural inputs. Together, such processes can exacerbate potentially toxic algal blooms and affect profound changes in biodiversity, such as devastating hypoxic events and an enhancement of dead zones, which in turn can lead to massive economic losses across many sectors (Rockström et al., 2009). It is estimated that up to 90 per cent of the wastewater produced flows into coastal zones and contributes to a rise in marine dead zones, already covering an area of approximately 245,000 km^2, equivalent to the global area of coral reefs (Corcoran et al., 2010).

Irrigation system in Accra, Ghana

Diverse toxic pollutants from land-based sources – ranging from agricultural and industrial chemicals such as organic compounds and heavy metals to personal-care products and pharmaceuticals – make their way into both fresh and marine waters, which have far-reaching impacts. From 1999 to 2002, for instance, the run-off of agricultural herbicides resulted in the deterioration of 30 km^2 of mangrove in north-east Australia (Duke et al., 2005). Twenty-one of the world's 33 megacities are on the coast, and their economies largely depend on the marine ecosystem services for their two main economic activities which contribute to food security – tourism and fishery. A deterioration of the ecosystems and loss of the valuable services that they provide, however, could have significant secondary impacts, resulting in a contamination of fish stocks, algae blooms, the rise of marine dead zones and subsequent loss of livelihoods and food security.

In general, the high concentrations of chemical constituents that need to be addressed in wastewater-irrigated environments can be divided into the following:

- metals and metalloids, such as cadmium, chromium, nickel, zinc, lead, arsenic, selenium, mercury, copper and manganese, among others;
- nutrients such as nitrogen, phosphorus, potassium, calcium and magnesium, which in high concentrations might suppress other nutrients and/or otherwise negatively affect plant growth;
- salts and specific ionic species such as sodium, boron and chloride;
- persistent organic pollutants (POPs), such as pesticides as well as 'emerging contaminants', such as residual pharmaceuticals, endocrine disruptor compounds and active residues of personal care products, among others.

Metals and metalloids: All of the potentially toxic metals and metalloids are naturally present in the environment in trace amounts and are ingested with food, water and air. Human bodies have the ability to deal with these basic levels. Several of these metals and metalloids are of particular concern due to their adverse effects on agricultural productivity as well as environmental health, however. Metals such as cadmium, mercury and lead do not have any essential function, but are detrimental, even in small quantities, to plants, animals and humans, and accumulate due to their long biological half-life. Other metals and metalloids, such as manganese, zinc, boron and copper in small concentrations, are essential micro-nutrients, but harmful to crops when they reach higher concentrations. Although wastewater treatment is the best choice in managing wastewater irrigation, some farm-based measures and low-cost treatment options can reduce their risk for environmental and human health (WHO, 2006; Qadir and Scott, 2010).

Nutrient elements: Wastewater usually contains valuable plant nutrients, such as nitrogen, phosphorus and potassium. Developing countries use wastewater for irrigation because of its available nutrients; however, maintaining appropriate levels of nutrients is a challenging task. The nutrient concentrations vary significantly in wastewater due to source and treatment, and may reach levels that are in excess of crop needs. Since wastewater seldom contains nutrients in optimal ratios, guidelines are needed to optimize wastewater for irrigation.

Salts and specific ionic species: Wastewater contains more soluble salts than fresh water because salts are added to it from different sources. There are no economically viable means to remove the salts once they enter wastewater because techniques such as cation exchange resins or reverse osmosis membranes are prohibitively expensive and are thus only used to produce high-quality recycled water.

Organic contaminants: In developing countries, the exposure of farmers and crops to organic contaminants is probably higher through pesticide application than organic contaminants in the irrigation water. Pesticide contamination is more likely to reach significant levels through direct on-site application.

1.6 Management of Health and Environmental Risks

1.6.1 Rationale and Context of the 2006 WHO Guidelines

1.6.1.1 Background

Prior to the publication of the 2006 WHO Guidelines for Safe Use of Wastewater, Excreta and Greywater (WHO, 2006), conventional wastewater treatment was regarded as almost the exclusive option for mitigating the risks of wastewater use.

However, it became increasingly clear that the levels of treatment were too expensive in many settings, and the previous guidelines (WHO, 1989) needed more input on other forms of health protection in the increasingly frequent incidence of either direct or indirect use of raw or partially treated wastewater in agriculture.

The 2006 WHO Guidelines provide a risk assessment and management framework to assess and manage the health risks and maximize the health benefits of wastewater use in agriculture.

1.6.1.2 Health Protection Measures – the "Multiple-barrier Approach"

The 2006 WHO Guidelines propose combining a number of measures, including treatment and non-treatment options, in order to achieve the target level of health protection (expressed in disability-adjusted life years, or DALYs) from the point of waste production through to the point of exposure for consumers, farm workers and their families and nearby communities. This approach is commonly referred to as the "Multiple-barrier Approach" and is a departure from focusing primarily on wastewater treatment quality targets: Examples of options for the reduction of pathogens by different combinations of health protection measures that would achieve the health-based target of $\leq 10^{-6}$ DALYs per person per year are shown in Figure 4.

In contrast to the use of water quality standards, conventional wastewater treatment is regarded as one of the barriers, but not the only one. Hence, treatment, where possible, is combined with other health protection measures at farmer and consumer levels. The most cost-effective and feasible health protection measures can be combined according to local socio-economic conditions. Health protection measures should be tailored to ensure they provide protection to the various exposed groups – consumers, farm workers and their families and nearby communities – some of which are listed here:

- wastewater treatment
- crop restriction
- wastewater application techniques that minimize crop contamination (e.g. drip irrigation)
- withholding periods to allow pathogen die-off after the last wastewater application
- hygienic practices at food markets and during food preparation
- health and hygiene promotion
- produce washing, disinfection and cooking
- medication (e.g anti-helminthic drugs) and immunization
- use of personal protective equipment
- access to safe drinking-water and sanitation facilities at farms and in local communities
- disease vector and intermediate host control
- reduced vector contact
- restricted access to irrigated fields and hydraulic structures.

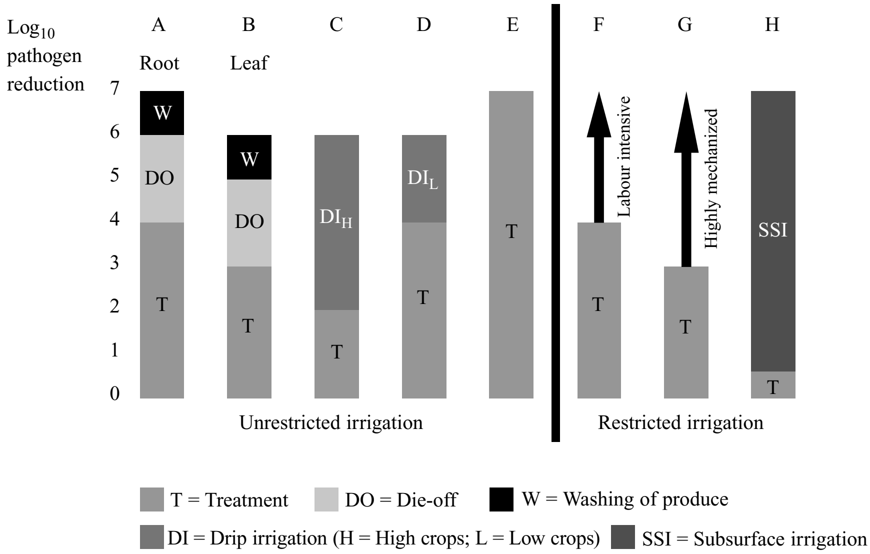

Figure 4: Examples of Options for the Reduction of Pathogens by Using the "Multiple-barrier Approach"

Source: WHO, 2006.

1.6.1.3 System Assessment, System Management and Monitoring

The 2006 WHO Guidelines put forward a risk assessment and management approach derived from the Stockholm Framework to control water-related diseases. WHO is currently working on the development of a Sanitation Safety Planning Manual to provide step-by-step support to the implementation of the 2006 WHO Guidelines.

The approach is closely related to the Hazard Analysis and Critical Control Points (HACCP) concept as commonly applied in food safety programmes. It includes three core components:

- system assessment
- system management
- operational and verification monitoring

The approach calls for incremental improvement through periodic assessment and review of the reuse system.

1.6.2 Management of Environmental Risks

There are several management options for smallholder farmers in developing countries to avoid potential negative impacts on the environment from irrigation with untreated or inadequately treated wastewater and to address the challenges and risks of exposure to elevated levels of metals, metalloids, salts, specific ionic species and added nutrients. These measures include soil and water-based interventions as well as changes in crops and crop varieties, among others. For potential organic contaminants, appropriate pest and pesticide management practices have crucial importance.

The following are the key steps in risk management of **metals and metalloids**:

- Identify geographical areas with elevated risks from specific metal sources.
- Perform quality assured testing of soil and plant samples to verify the level of the risk from specific metal(s).
- Identify alternative crop varieties of the same desired crop that take up the least metal or convert the toxin to less toxic forms when grown in high-risk areas.
- Develop irrigation, fertilization and residue management strategies that help to minimize metal uptake by plants.
- Recommend crop restrictions, i.e. using other crops that have lower risks of contamination with metals and metalloids and/or pose a lesser risk to human health due to levels of dietary intake.
- Zone the affected area(s) for non-agricultural land use or land rehabilitation (Simmons et al., 2010).

The available techniques that have been successfully applied to remediate metal/metalloid contaminated soils include *in situ* and *ex situ* engineering options, irrigation management options, *in situ* soil-based immobilization, phytoremediation, chelate-enhanced phytoextraction and the use of transgenic crops.

When it comes to the management of **nutrients**, farmers can avoid excessive or unbalanced additions of particular nutrients to wastewater-irrigated soils and crops by selecting crops that are less sensitive to high nutrient levels or that can take advantage of high amounts of major nutrients such as nitrogen and phosphorus. Higher levels of nitrogen, for example, can be accommodated in farms where leafy vegetables are grown. In addition, certain grasses are well-suited to wastewater irrigation and act as scavengers for nutrients added through wastewater. Moreover, soil-based options can be used that depend not only on the type of crop, but also on local soil and site conditions. For example, medium- to fine-textured soils may hold more nutrients than sandy soils, thereby releasing fewer amounts in the water percolating through the soil and adding to the groundwater. However, there is a need for groundwater quality monitoring when groundwater is shallow and used for drinking. In areas where farmers do not have the options to grow crops that benefit from high nutrient levels, the irrigation water might first pass through other systems to transform a part of its nutrient load into biomass. Another option may be the dilution of wastewater with fresh water to decrease the nutrient concentration and increase the benefits through increased volumes of irrigation water. This option might have a strong seasonal dimension and is only possible where wastewater streams are separated from other surface water bodies. In case of non-availability of fresh water, the quantity of wastewater applied per unit area can be decreased. The same applies to wastewater having high levels of organic matter. In this case, wastewater should not be applied continuously to allow soil to biodegrade organic matter.

In terms of managing **organic contaminants**, since pesticide contamination is more likely to reach significant levels through direct on-site application, farm-based measures such as the use of alternative pesticides or integrated pest management remain the key to risk reduction. To avoid pesticides from entering streams used for irrigation or other purposes, buffer zones, run-off reduction and use of wetlands for remediation could be considered (Simmons et al., 2010). Containment of contaminated water in dams or wetlands may allow for pesticide removal by sediments or through degradation. Farming practices that reduce runoff, such as the provision of vegetation cover or vegetation buffer strips, can significantly reduce the probability of environmental impacts. The key removal mechanisms for most organic substances are adsorption and biodegradation (WHO, 2006). Removal efficiencies are greater in soils rich in silt, clay and organic matter.

Chemical stability and slow natural attenuation of certain persistent organic pollutants (POPs) such as polychlorinated biphenyls make their remediation a particularly intractable environmental challenge, which is a more common challenge in countries in transition than in developing countries. The approach usually taken is to isolate affected sites, and either remove the contaminated soil or rely on phytoremediation. In general, however, it remains crucial to ensure that these and other hazardous chemicals are replaced in the production processes; industrial wastewater is treated at source and/or separated from other wastewater streams used for irrigation.

Finally, in terms of dealing with the **salts and specific ionic species** in wastewater, long-term irrigation with saline wastewater needs specific preventive measures and management strategies, which may include the following:

- Appropriate selection of crops or crop varieties capable of producing profitable yield with saline wastewater.
- Selection of saline wastewater irrigation methods reducing crop exposure to salts.
- Application of saline wastewater in excess of the crop water requirements (evapotranspiration) to leach excess salts from the root zone.
- Saline wastewater irrigation in conjunction with fresh water, if available, through cyclic applications or blending interventions.
- Use of agronomic interventions such as: sowing on relatively less saline parts of ridges; raising seedlings with fresh water and their subsequent transplanting and irrigation with saline wastewater; mulching of furrows to minimize salinity build-up and to maintain soil moisture for longer periods and increasing plant density to compensate for possible decrease in growth.
- Application of calcium-supplying amendments, such as gypsum, to the soils for irrigation with highly sodic or saline-sodic wastewater to mitigate the negative effects of sodium on soils and crops.

The conventional wastewater treatment options, which can control the release of salts, metals and metalloids, nutrients and emerging contaminants into the environment, remain the key to protecting water quality for beneficial uses including agriculture. For metals, metalloids, nutrients and emerging contaminants, an important step is pre-treatment and/or segregation of industrial wastewater from the domestic and municipal wastewater stream. The sources of salts in wastewater can be reduced by applying technologies in the industrial sector that cut the salt consumption and thus its discharge into the sewage system. In addition, restrictions can be imposed on the use of certain products for domestic use that are major sources of salts in wastewater.

In assessing environmental risk management in developing countries, the required analytical capacity to analyse specific heavy metals and, in particular, organic contaminants is seldom adequate. Therefore, there is a need for capacity development in developing countries for environmental risk assessment and management. In addition to separating industrial wastewater from domestic wastewater, increasing awareness of environmental risks and implementation of farm-based interventions by the wastewater irrigating farmers can help create the conditions that would favour the safe and productive use of wastewater in agriculture.

1.7 Supportive Policy and Institutional Settings

The diverse impacts that wastewater use has on the environment, public health, local economies and food security, combined with substantial secondary impacts, highlight the complexity and cross-cutting nature of wastewater management. Proper wastewater management requires collaboration and dialogue between partners and stakeholders involved in wastewater issues, for example, farmers, public health officials, municipal and waste managers, planners and developers.

The management of wastewater use in agriculture typically involves many of the following actors, which need to cooperate and coordinate their actions and regulations:

- Ministries of Agriculture, Water Resources, Health, the Environment, Energy and Development
- research institutions and universities
- non-governmental institutions and organizations
- farmers' groups
- consumers
- municipalities and local water management institutions
- water operators.

To facilitate the safe management of wastewater in agriculture in this complex context, appropriate policies, legislation, institutional frameworks and regulations at international, national and local levels need to be in place which bring these actors together.

While some countries have already established platforms for these actors to exchange knowledge at a national level, there is little structure and opportunity for a cross-sectoral approach to the issues of safe use of wastewater in agriculture. Important aspects to address this gap should be analysed, such as the following:

- **institutional roles and responsibilities**, i.e. the responsibilities and jurisdictions among public institutions and the coordination mechanisms among them;
- **laws and regulations**, i.e. legal instruments to facilitate and govern the safe use of wastewater in agriculture (e.g. creating rights of access to wastewater, establishing land tenure, developing public health and agricultural legislation);

- **economic instruments**, i.e. the financial tools that the public authorities can use to promote safe practices when using wastewater in agriculture and to share the costs of wastewater treatment and reuse projects (e.g. subsidies, taxes, water pricing, payment for environmental services); and
- **education and social awareness**, i.e. the education and training tools used to increase knowledge and skills on the safe use of wastewater in agriculture, as well as advocacy and communication campaigns used to impact public perception and awareness.

In complex issues such as the safe use of wastewater in agriculture, capacity development needs to address different levels and requires a multidisciplinary approach to be effective.

1.8 Capacity Development in the Context of the Project

Cost-effective and appropriate wastewater treatment suited for the end use of wastewater is a fundamental action. However, for most developing countries, wastewater treatment is not economically feasible in the short term, and interim solutions may be needed to protect farmers and public health. In these countries, the focus should be on prioritizing affordable and easily adoptable risk management strategies. Adopting the "Multiple-barrier Approach" (WHO, 2006) described in section 1.6 can reduce human and crop exposure to toxic compounds and pathogens.

In addition, however, farmers must be provided with specific guidelines to support their production and to be able to access markets. Moreover, proper dissemination and education campaigns must be designed to facilitate the adoption of such guidelines by farmers.

An integrated risk assessment with maximum protection for human health and the environment as well as the maximum use of resources (water and nutrients) to support the livelihoods of poor farmers needs to be considered when using wastewater. Applications need to be monitored to ensure that wastewater is being used in a manner consistent with the intended applications and practice. Tested technologies and strategies for the safe use of wastewater in agriculture are available worldwide, but the capacities to implement them are still lacking in many countries.

Capacity development is thus an essential component in the context of the SUWA project. Since the term is at the core of many initiatives throughout the United Nations system and other international organizations, it is useful to clarify it before elaborating further on its implications for the project.

The United Nations Development Programme (UNDP) defines capacity development as

> *"…the process by which individuals, organizations, institutions and societies develop abilities (individually and collectively) to perform functions, solve problems and set and achieve objectives"* (UNDP, 1997).

From the previous definition, there are two elements worth noting: first, that capacity development is understood as a process, and second, that it involves agents and stakeholders from different parts of society, from individuals to institutions. It is therefore evident that capacity development is a broadly defined concept and not only engages in supporting individuals in acquiring new skills, but also in facilitating the formation of an enabling environment where these skills of individuals can be used.

UNDP distinguishes three main dimensions or levels of capacity (UNDP, 2009), which are illustrated in Figure 5. The first is the individual level, which involves the knowledge and skills that allow an individual to successfully perform a task. The individual not only obtains these competences formally, through education or training, but also informally through practice and observation. The second is the organizational level, and refers to the internal structure, policies and procedures that enable organizations to act effectively towards a specific objective – here is where institutional capacity operates. The third level is the enabling environment, which refers to all the rules, laws, power relations and social norms that regulate social interactions. It is also understood as a broad social system within which individuals and institutions perform their roles.

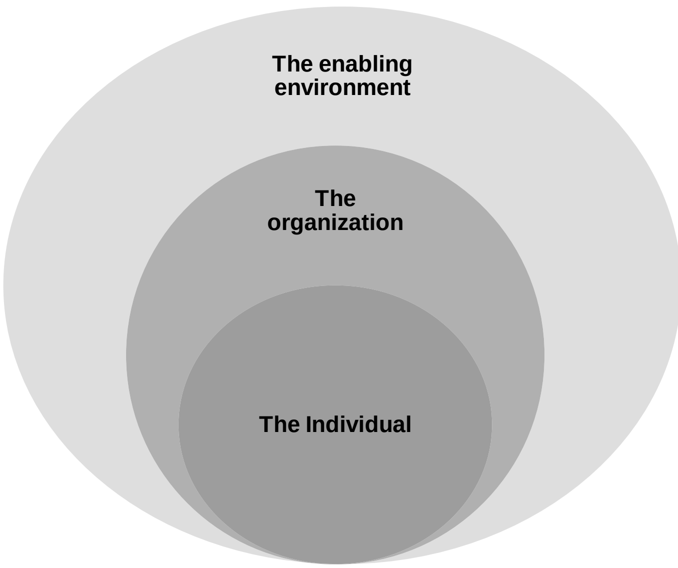

Figure 5: Holistic View of Institutional Capacity Development

Source: USEPA, USAID, 2012.

Regardless of the issue, there is commonly a diverse group of stakeholders involved, and the implementation of new policies can greatly benefit from this diversity. The inclusion of input from a variety of perspectives can enrich the discussion and help define better policies. Cooperation is also a crucial element because isolated initiatives, notwithstanding their value and good intention, often achieve very little, since country or regional action requires the participation of many organizations, particularly among ministries and agencies at the same institutional level. Cooperation is therefore essential among organizations at different levels, from local and national governments to international entities and the private sector.

Following from this definition, capacity development for safe wastewater use in agriculture can be defined as the process through which relevant stakeholders, especially from the sanitation, agriculture, environment and consumer sectors, can improve their abilities to perform their core roles and responsibilities, solve problems, define and achieve objectives, understand and address needs, and effectively work together in order to ensure the safe and productive use of wastewater in agriculture.

In complex issues such as the safe use of wastewater in agriculture, capacity development needs to address different levels; in particular, institutional capacity development requires a multidisciplinary approach to be effective. This capacity development approach targets organizations in a vertical direction (individuals, institutions, system) as well as in a horizontal direction (health, water and agriculture sectors). An essential aim of the regional workshops in the SUWA project was also to facilitate first steps for national platform building and the international exchange of experiences. Overall, different capacity development techniques have been followed in this project, such as international knowledge-sharing, the development of web-based learning systems (the UN-Water Activity Information System, or UNW-AIS) and the use of relevant materials developed by UN-Water members and partners.

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Chapter 2

IMPLEMENTATION PHASE

2.1 International Kick-off Workshop

To launch the two-year UN-Water capacity development project on the “Safe Use of Wastewater in Agriculture” (SUWA), a two-day International Kick-off Workshop was held at the UN Campus in Bonn, Germany from 14–15 November 2011. This workshop brought together participants from 17 countries from Africa, Asia and Latin America, largely representing ministries responsible for water, health, the environment and agriculture, as well as research institutions and universities.

The main objective of the workshop was to discuss the relevance of capacity development for the safe use of wastewater in agriculture, based on national reports and the capacity needs presented by the country representatives. Furthermore, the workshop produced a roadmap for the upcoming regional workshops and identified potential hosting countries, institutions and training contents, while refining the target group of the initiative. The international workshop also served to raise awareness on the topic within the international community, present current trends, challenges and activities, exchange experiences and knowledge and build a community of practice among participants.

The participants presented preliminary results from their national capacity needs assessments. In regional breakout groups for Africa, Asia and Latin America, the countries’ specific capacity development needs were further defined to safely address the use of wastewater in agriculture. These needs were discussed and addressed with the resources and potential contributions from the participating United Nations institutions.

National Reports and Capacity Needs Assessments

Prior to each workshop, the representatives from each participating country were requested to prepare draft national reports for submission. The participants were asked to address the following points, to the best of their ability:

- the current status and trends on wastewater production, treatment and use in agriculture at the national level;
- a policy framework, strategy and objectives on safe wastewater use in agriculture in their country;
- a description of key organizations working on the safe use of wastewater in agriculture in their country;
- an assessment of the knowledge, skills and competences on the safe use of wastewater in agriculture required by individuals working in these key organizations (e.g. capacities of the extension services of different ministries to promote health protection measures).

To support the development of these national reports, a questionnaire was provided to country focal points for collecting the required information from key institutions and organizations. Examples of the national reports are available in the Regional Workshop section of the project's online platform within the UNW-AIS at **www.ais.unwater.org/wastewater**.

In addition to the national reports, all workshop participants, mainly representatives at various levels nominated from ministries, carried out a separate capacity needs assessment (CNA). Following the structure of the 2006 WHO Guidelines (WHO, 2006), the survey asked the participants to rank their perceived capacity needs in their respective country in the following fields:

- health risk assessment
- health protection measures
- monitoring and system assessment
- crop production aspects
- environmental aspects
- socio-cultural aspects
- economic and financial considerations
- policy and institutional aspects
- resource efficiency (water/nutrients).

The summarized response (Figure 6) suggests that there are capacity gaps in all fields covered by the questionnaire, especially in "health risk assessment" and "monitoring and system assessment", followed by "crop production aspects", "economic and financial considerations", "health protection measures" and "socio-cultural aspects". "Environmental aspects" and "policy aspects" ranked lowest. In sum, it was evident that there are still great disparities between countries and that each region has its own set of priorities to tackle in terms of capacity development.

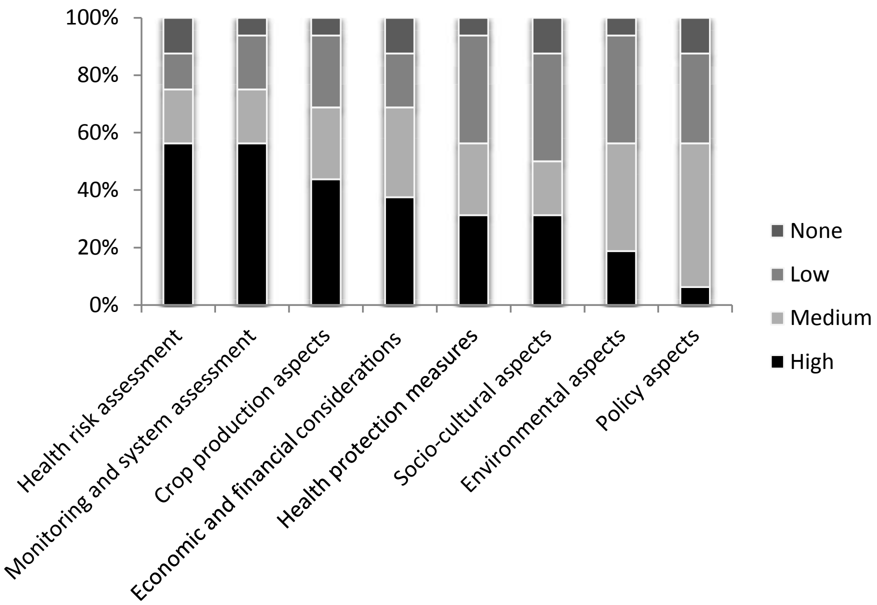


Figure 6: Capacity Development Needs Identified at the International Kick-off Workshop

The capacity development needs assessment carried out during the International Kick-off Workshop showed lower perceived capacity development needs than what emerged from the assessments carried out within the regional workshops.

2.2 Regional Workshops

Following up on the impetus and the priorities identified at the International Kick-off Workshop, the project continued with a series of regional workshops in five different regions:

- 1st Regional Workshop for Francophone and Northern Africa in Marrakech, Morocco
- 2nd Regional Workshop for South, West and Central Asia in New Delhi, India
- 3rd Regional Workshop for Anglophone Africa in Johannesburg, South Africa
- 4th Regional Workshop for Latin America and the Caribbean in Lima, Peru
- 5th Regional Workshop for Southeast and Eastern Asia in Bali, Indonesia

The series targeted developing countries and countries in transition. Each regional workshop focused on individuals in key organizations and institutions with competences in safe wastewater use in agriculture. Represented institutions and organizations included ministries responsible for agriculture, water, the environment, health, food, irrigation and rural affairs; research centres; water control laboratories; and other institutions linked with wastewater treatment and reuse for agricultural irrigation.

140 participants from over 70 countries participated in the regional workshops. As indicated in Figure 7, most of the participants were government representatives (ca. 71%), followed by researchers (ca. 16%), non-governmental organization (NGO) representatives (ca. 7%) and other bodies (ca. 6%). The Ministries of Agriculture and of Health were those with the greatest representation, as illustrated in Figure 8.

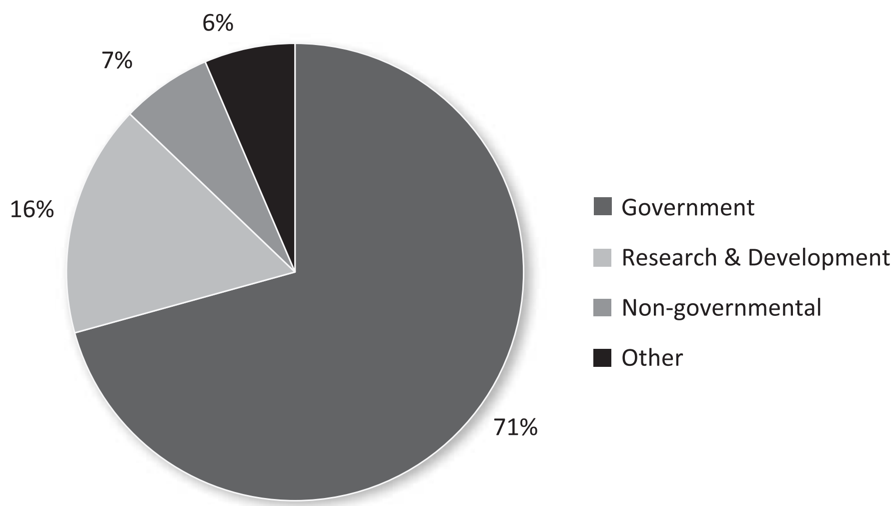


Figure 7: Background of Participants at the Regional Workshops

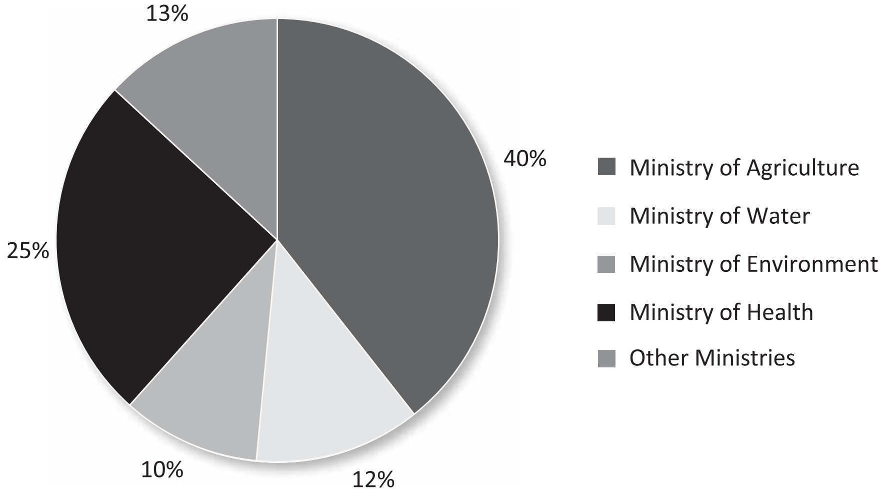


Figure 8: Percentage of Ministries Represented at the Regional Workshops

The regional workshop series aimed to assist a larger number of United Nations Member States in addressing safe agricultural wastewater use in their countries, resulting in their greater knowledge and skills to promote safe practices.

The main objectives of the regional workshops were to

- raise and increase awareness among the participating Member States on the increasing importance of wastewater use in urban and peri-urban agriculture, the principal drivers behind the increased use, as well as the multidisciplinary nature of the topic of wastewater use in agriculture with related risks and potential benefits for public health, the environment, society and the economy;
- identify the capacity needs in the respective countries and regions and discuss how safe practices can be promoted where wastewater is used in agriculture;
- facilitate the cooperation of the involved ministries at the national level;
- provide a platform to exchange experiences, establish networks and create a community of practice for continuing exchange on recent implementation strategies between the involved countries and regions; and
- facilitate the dissemination of available materials and guidelines to the relevant organizations and stakeholders.

As in the International Kick-off Workshop, the participating countries were requested to submit a national report prior to each regional workshop, elaborating on the situation of wastewater treatment and use in their country. Additionally, each participating country was requested to complete a capacity needs assessment survey (see box on p. 40).

The overall analysis of the five regional workshops, illustrated in Figure 9, reveals that there are high capacity needs in every thematic field, regardless of the region, country or institution/organization represented by the participants. Among the different thematic fields related to safe wastewater use in agriculture, "health risk assessment", "resource efficiency (water/nutrients)" and "health protection measures"/"monitoring and system assessment" were ranked the highest. Furthermore, an additional post-workshop survey that was submitted by the participants following the regional workshops in South Africa, Peru and Indonesia, showed even higher overall capacity needs after the conclusion of the workshops and a slight shift in the top three capacity needs. After the workshop, the importance of "policy aspects" was ranked much higher. A detailed overview of the top three capacity needs identified in the regional workshops, before and after, is given in Table 3.

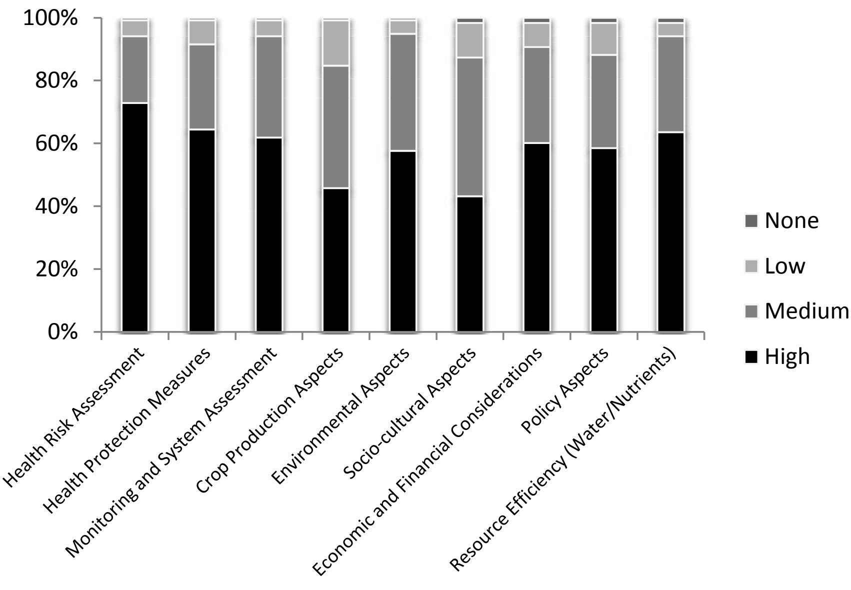


Figure 9: Summary of the Capacity Development Needs that Emerged from the Five Regional Workshops

Table 3: Top Three Capacity Needs, Before and After the Regional Workshops

WORKSHOP	TOP THREE CAPACITY DEVELOPMENT NEEDS – BEFORE THE WORKSHOP	TOP THREE CAPACITY DEVELOPMENT NEEDS – AFTER THE WORKSHOP
1st Regional Workshop –Francophone and Northern Africa	Health Risk Assessment	-
	Health Protection Measures	-
	Resource Efficiency	-
2nd Regional Workshop – South, West and Central Asia	Monitoring & System Assessment	-
	Economic & Financial Considerations	-
	Health Risk Assessment/Health Protection Measures	-
3rd Regional Workshop –Anglophone Africa	Economic & Financial Considerations	Economic & Financial Considerations
	Health Risk Assessment	**Policy Aspects**
	Monitoring & System Assessment	Monitoring & System Assessment
4th Regional Workshop – Latin America & the Caribbean	Economic & Financial Considerations	Health Risk Assessment
	Environmental Aspects	**Policy Aspects**
	Health Risk Assessment	**Socio-cultural Aspects**
5th Regional Workshop – Southeast and Eastern Asia	Health Risk Assessment	Health Risk Assessment
	Policy Aspects	**Monitoring & System Assessment**
	Health Protection Measures	**Economic & Financial Considerations**

Note: Bold entries highlight changes in the top three capacity needs identified after the workshops.

Participants at the International Wrap-up Event in Tehran, Iran

2.3 International Wrap-up Event

The International Wrap-up Event for the SUWA project was attended by 33 participants from 18 countries, which were selected from the participants of the previous five regional workshops. The participating countries were Algeria, Bolivia, China, Egypt, Ghana, India, Indonesia, Iran, Mauritius, Mexico, Morocco, Nepal, Pakistan, Peru, Philippines, Senegal, South Africa and Tunisia.

The purpose of the wrap-up was to jointly develop ideas and proposals for a potential second phase of the SUWA project, focusing on the national, regional and global capacity needs. With the developed proposals, funding for a second phase may be acquired.

First, the participating countries presented revised capacity development needs and selected good practices on "Economics, Resource Recovery and Reuse" (Egypt, Morocco and the Philippines), "Supportive Policy and Institutional Settings" (Mexico, Peru and Algeria), "Risk Management and Use of WHO Guidelines" (Senegal, Tunisia and Peru) and "Diagnostic Analysis of Wastewater Management" (Mauritius, Mexico, China and Iran).

The core of the International Wrap-up Event was, however, the development of proposals. At the national level, each country prepared a proposal regarding an area of need they had identified, based on a predefined template which had been circulated beforehand to streamline the process. The proposals were then discussed and further refined with the support of the project organizers. The national proposals are largely intended for the countries' individual follow-up.

At the regional level, the participants were grouped to discuss regional issues which they would suggest for a potential second phase of the SUWA project, according to four regional groupings:

- Middle East and North Africa (MENA)
- Sub-Saharan Africa
- Asia
- Latin America and the Caribbean

Similarly, the regional proposals were presented and discussed in the meeting. Particular focus was given to ideas on how regional networks and exchanges could share good practices, and identify needs and activities that could be followed up in a potential second phase of the project. The regional proposals were refined by the participants after the wrap-up event.

Also, potential interventions at the global scale were discussed, focusing on scale-independent activities that can reach a larger audience than the group of participants of workshops and potential regional activities. Different elements of knowledge exchange were discussed in the group, such as e-learning to supplement face-to-face events, particularly on the use and implementation of the 2006 WHO Guidelines, but also issues of awareness raising and strategies to gain higher acceptance among consumers.

Overview of participating countries during the workshop series:

Throughout the International Kick-off Workshop, the Regional Workshop Series and the International Wrap-up Event, the "Safe Use of Wastewater in Agriculture" (SUWA) project has addressed 157 representatives from 73 countries around the world. An overview of the participating countries is given below.

International Kick-Off Workshop in Bonn, Germany (November 14-15, 2011):

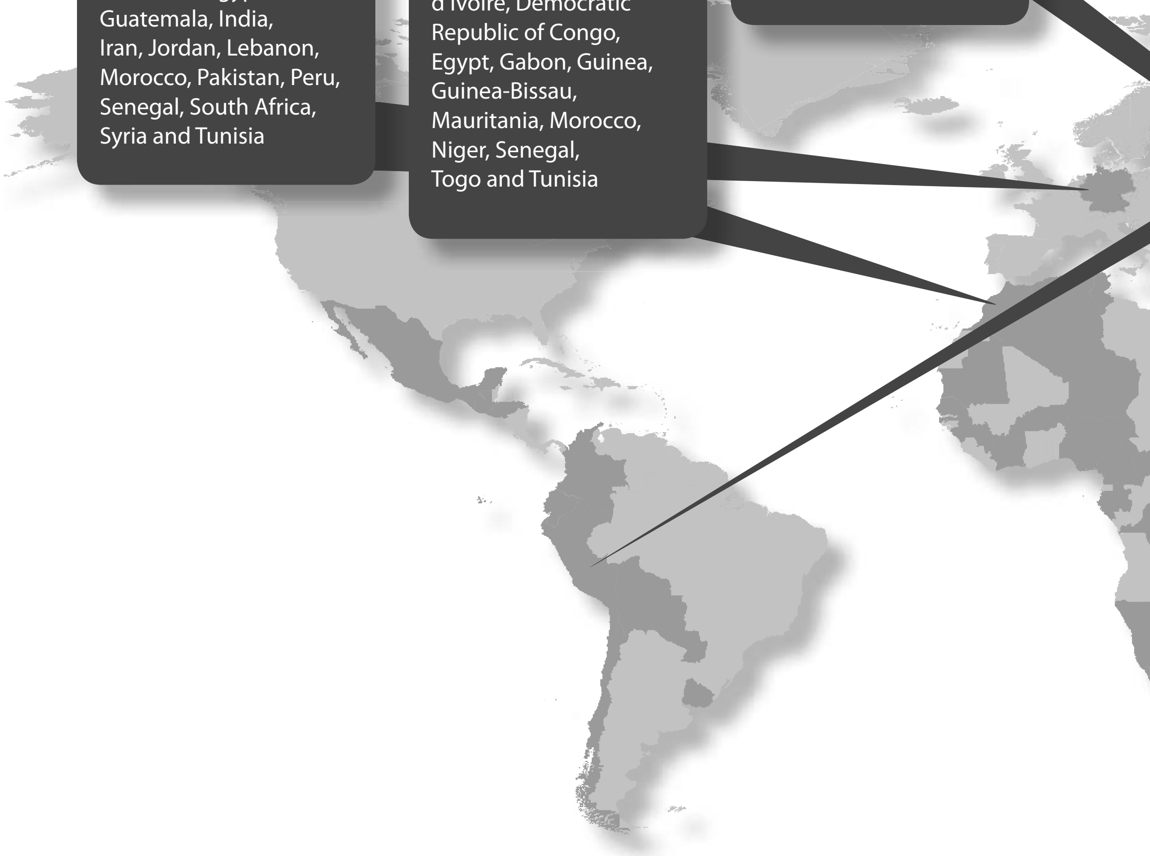
Algeria, Bolivia, Colombia, Egypt, Ghana, Guatemala, India, Iran, Jordan, Lebanon, Morocco, Pakistan, Peru, Senegal, South Africa, Syria and Tunisia

1st Regional Workshop for Francophone and Northern Africa in Marrakech, Morocco (February 18-19, 2012):

Algeria, Benin, Burkina Faso, Cameroon, Central African Republic, Côte d'Ivoire, Democratic Republic of Congo, Egypt, Gabon, Guinea, Guinea-Bissau, Mauritania, Morocco, Niger, Senegal, Togo and Tunisia

2nd Regional Workshop for South, West and Central Asia in New Delhi, India (May 16-18, 2012):

Bangladesh, India, Iraq, Jordan, Myanmar, Nepal, Pakistan, Sri Lanka, Syria and Turkey




5th Regional Workshop for Southeast and Eastern Asia in Bali, Indonesia
(March 5-7, 2013):
Cambodia, China, Indonesia, Lao PDR, Malaysia, Mongolia, Philippines, Thailand, Timor-Leste and Vietnam
4th Regional Workshop for Latin America and the Caribbean in Lima, Peru
(December 11-13, 2012):
Bolivia, Chile, Colombia, Dominican Republic, Ecuador, El Salvador, Haiti, Honduras, Mexico, Paraguay, Peru, St. Kitts and Nevis and Uruguay
3rd Regional Workshop for Anglophone Africa in Johannesburg, South Africa
(September 26-28, 2012):
Botswana, Burundi, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mauritius, Mozambique, Namibia, Seychelles, Somalia, South Africa, Swaziland, Tanzania, Uganda, Zambia, Zanzibar and Zimbabwe
International Wrap-up Event in Tehran, Iran
(June 26-28, 2013):
Algeria, Bolivia, China, Egypt, Ghana, India, Indonesia, Iran, Mauritius, Mexico, Morocco, Nepal, Pakistan, Peru, Philippines, Senegal, South Africa and Tunisia

2.4. UNW-AIS: the Project's Online Platform

2.4.1 The UN-Water Activity Information System (UNW-AIS)

The UN-Water Activity Information System (UNW-AIS) is UN-Water's online platform to present and share information on water-related projects and learning initiatives from UN-Water and its members and partners. Information is available on water-related field projects and programmes, joint activities and learning initiatives categorized by thematic clusters and regional scope, ranging from global to local level. The portal also presents a gateway to other water platforms and learning portals of partner agencies. It combines the functionalities of an information website and a learning platform.

In the framework of the SUWA project, UNW-AIS is used as a platform to support the participants and other water professionals to gain access to relevant information, and to facilitate their dissemination. The web pages of the SUWA project can be accessed at **www.ais.unwater.org/wastewater**, where all the relevant information of the project is compiled. It provides access to the materials and reference documents from the partners of the project (FAO, WHO, UNEP, UNU-INWEH, UNW-DPC, ICID and IWMI), including the 2006 WHO Guidelines, a wealth of different publications on various aspects related to wastewater use in agriculture, "discovering water re-use" and good practice videos. It also hosts the information and outputs of each individual regional workshop, such as country reports, e-lectures, and case studies, etc., allowing participants to access the material and share it in their local contexts, and consequently reach a much larger audience. UNW-AIS facilitates 'blended learning', an effective method of capacity development that supplements face-to-face training with online learning materials.

2.4.2 Reference Materials

UNW-AIS plays an important and effective role in support of the UN-Water mandate. UNW-AIS brings together the available resources from UN-Water members, partners and support programmes, which would otherwise be widely spread over dozens of web pages of different organizations. This renders the joint effort coherent and most importantly, makes the resources easily accessible to the SUWA workshop participants and Member States. The SUWA section of the UNW-AIS is therefore not only a documentation for UN-Water addressing an important issue, but it is also an integral resource for participants from a variety of organizations and countries.

The reference materials include the following:

- 2006 WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater;
- various FAO publications, such as “The Wealth of Waste”, research papers and fact-sheets;
- topical reports and publications from UNU-INWEH, UNEP and UNW-DPC;
- a wide range of publications from IWMI, including a book on “Wastewater Irrigation and Health”, research reports, working papers and scientific papers; and
- videos, such as ones from IWMI on good farming practices, improving food safety and recycling realities in Africa, and FAO’s “Discovering Water Reuse“ in English, French and Spanish.

Easy access to these resources not only facilitates the participants’ preparation of the regional workshops through blended learning, but it also provides them with a reference to a wide range of materials that can be used when advocating the safe practices of wastewater use at the national level and supports the dissemination of key materials.

2.4.3 Region-specific Information

In support of the five regional workshops of the SUWA project, individual regional web pages were developed for "Francophone and Northern Africa", "South, West and Central Asia", "Anglophone Africa", "Latin America and the Caribbean" and "Southeast and Eastern Asia".

Access to regional information and the sharing of experiences and lessons learned are essential as a source of valuable resources and opportunities to draw from successful approaches taken in countries with similar bioclimatic and socio-economic conditions. Policies and practices on the safe use of wastewater vary across regions. Access to region-specific information and experiences greatly enhances effective learning and can shape policy development and other actions at the national level elsewhere in the region.

The national reports are of particular relevance and are an important vehicle for realizing the project's objective of enhancing collaboration among diverse ministerial and institutional players who are responsible for formulation and implementation of national wastewater policy.

The web pages in support of the individual workshops provide additional information, such as the submitted national reports on the situation of wastewater use in the participating countries and video recordings of the presentations given at the workshops, prepared as e-lectures with synchronized presentation slides.

The "Presentations" section serves as a post-event repository of presentations that might be relevant to the region, and the e-lectures may serve as a post-workshop resource for workshop participants and other visitors who could not attend any of the workshops.

Additional valuable resources are available on the web page of SUWA's International Wrap-up Event (www.ais.unwater.org/wastewater/wrap-up), including "Good Practice Examples" cutting across all regions in the following thematic fields:

- economics, resource recovery and reuse;
- supportive policy and institutional settings;
- risk management and the use of the WHO Guidelines;
- diagnostic analysis of wastewater management.

The former Chair of UN-Water, Zafar Adeel of UNU-INWEH, at the launch of the UN-Water Activity Information System in November 2011 during the International Kick-off Workshop in Bonn, Germany

Chapter 3

LESSONS LEARNED FROM THE PROJECT'S WORKSHOP SERIES

3.1 Economics of Resource Recovery and Reuse

3.1.1 Considering Wastewater as a Resource

Water, energy and nutrients are the main resources that can be recovered from wastewater. While awareness of the potential for water recovery was already expressed in almost all the national reports, wastewater was considered a valuable resource mostly in water-scarce areas or in countries facing recurrent periods of drought. There was less knowledge of the concept of recovering nutrients or energy from wastewater or faecal sludge in a planned manner. In addition, only a few participants reported on technologies and practices that were particularly designed to recover the phosphorus and nitrogen present in human excreta and urine. Biogas recovery from wastewater or faecal sludge after anaerobic digestion was also not commonly reported by the authors of the national reports and participants of the working groups. The participants emphasized that the full potential of wastewater as an economic asset is still clearly untapped.

3.1.2 Economic Challenges of Reuse

Many of the participants reported that, in their countries, wastewater treatment plants usually fail due to poor operation and maintenance. This appears to be related to constraints in local institutional capacity and low levels of cost recovery, leading to strong dependence on subsidies, which are often limited. This was reported to be a major issue in low-income countries, particularly in Sub-Saharan Africa and Southeast Asia. Many of the reported reuse projects, which typically rely on treatment plants, do not go beyond the pilot phase and are heavily subsidized, thus consequently not replicated and upscaled. The economics of water reuse was ranked as one of the main areas where the participants would like to see reinforced capacities in their respective countries. It was frequently noted in the different workshops throughout the project that in order to carry out a feasible and replicable reuse project, an economic justification and a clear cost recovery strategy are needed.

3.1.3 Economic Appraisal of Water Reuse Projects

In very rare cases, the participants reported on complete economic appraisals undertaken in their countries prior to going ahead with a wastewater treatment and reuse project. The lack of a complete economic appraisal was noted as a major reason for project failure. During the workshops, the key steps in an economic appraisal of a reuse project were discussed (FAO, 2010; Heinz et al., 2011; Hussain et al., 2001), as presented below.

Economic justification

Identification of boundaries and parties: The economic appraisal and justification of a reuse project should be made from a river basin viewpoint, comparing the economic costs and benefits of the project at this scale and considering all the key stakeholders involved – cities and their citizens (as municipal wastewater generators), farmers (as the users of these waters) and the environment, which can be positively or negatively impacted by the project.

Cost-benefit analysis

Once the boundaries and parties have been identified, the key question is whether the total benefits of a reuse project are higher than the total cost. Water reuse may have substantial benefits for farmers, cities and the environment. But reuse also has costs, since any risk mitigation strategy (e.g. the "Multiple-barrier Approach") has associated expenditures. Additionally, other capital, operation and maintenance costs in terms of infrastructure (e.g. pipes and canals to convey wastewater or pumps to transport it) can be substantial. These costs and benefits need to be systematically quantified before deciding whether to invest in a reuse project.

Cost-effectiveness analysis

Another crucial issue that needs to be considered is whether there are other feasible alternatives to achieve the objective aimed at with the reuse project and whether reuse is the most cost-effective alternative. For example, if the objective is to cope with water scarcity by augmenting available water resources, there are several potential alternatives: water harvesting, water transfers from other basins, or, if in a coastal area, sea water desalination. The costs of the alternatives need to be examined with care before going ahead with a reuse project. If there are equally beneficial, but cheaper, alternatives, then the reuse project would not be justifiable.

Financial feasibility and cost recovery analysis

Once the basic economic justification of the project is established, the next step is to examine its financial feasibility. The equitable distribution of the costs of the project between different stakeholders is crucial to its feasibility. When benefits are shared by different stakeholders, not just farmers, the costs can also be shared. The contribution from various stakeholders – national government, regional water authority, farmers, municipal utility (public or private) and/or other major players – should be assessed. Financial gainers and payers should be identified to gauge the incentives, or conversely the penalties or fees, to be applied and the type of funding that would be appropriate. The economic and financial analysis will allow for the designing of the cost recovery strategy of a reuse project. The costs that may need to be recovered are primarily the financial costs (i.e. operating and maintenance costs, and ideally also capital costs). But a cost recovery strategy could also aim to recover other costs, such as support costs (e.g. institution building, awareness raising, human resources development, information systems, monitoring and assessment, regulation, planning and strategy development) and other economic costs (e.g. the lost value of water for other uses, environmental costs, health costs, etc).

3.1.4 Strategies to Achieve High Cost Recovery

During the workshops different strategies to increase the cost recovery, and therefore the economic sustainability, of reuse projects were discussed and are listed below.

Investment strategies

An investment strategy includes the choice of technology and the location of the project, and has the basic aim of minimizing investment and future recurrent costs and increasing access to end users. To keep costs at a minimum, it is important to plan early for reuse and locate the resource recovery plant (rather than wastewater treatment plant) close to the end user (e.g. farmers) in order to reduce unnecessary transport costs. Particular attention needs to be paid to energy. Energy consumption can account for up to 50 per cent of the total operation costs (Lazarova et al., 2012) and should be kept low. If possible, the use of gravity flow instead of pumping is recommended. Aerobic wastewater treatment needs aeration and has typically high energy demands; therefore this choice should be examined with caution. Energy can also be recovered from wastewater or sludge in the form of biogas or electricity for its subsequent reuse, reducing the need for extra energy.

Consequently, from the energy perspective, pond systems or anaerobic treatments are preferred. Waste stream separation could also save money in the subsequent treatment process; for example, if nitrogen is to be recovered as a fertilizer, it may be more cost-effective to opt for a urine-diverted toilet and treat this urine independently than aim to recover this nitrogen from a conventional collection and wastewater treatment system. Finally, investing in multiple barriers for health risk reduction has been shown to be more cost-effective than relying exclusively on conventional treatment (Drechsel and Seidu, 2011).

Charges for wastewater services

The "polluter pays principle" states that whoever is responsible for damage to the environment should bear the costs associated with it. According to this principle, water users (and thus wastewater dischargers) should be charged for the environmental and social costs that would result from disposing, or better yet treating, their wastewater. The most frequent instruments used to bring this principle into practice are fees for wastewater services attached to the water bill and indirect local taxes. This has been implemented with success in Organisation for Economic Co-operation and Development (OECD) countries as an effective tool to recover the cost of wastewater services. Few people can disagree with the proposition that those who cause damage or harm to others should 'pay' for those damages; it appeals directly to our sense of justice. Nevertheless, during the workshops it was frequently stated that this principle needs to be applied progressively in low-income countries, always considering the capacity and willingness of poor urban dwellers to pay. Charges for wastewater services could contribute to recovering the capital and operation and maintenance costs of wastewater collection and treatment.

Revenue strategies

Shifting from conventional sanitation (treating for disposal) to productive sanitation (treating for reuse) creates opportunities to increase revenue generation. This will require a sound market analysis. The revenues can come from any of the following sources: water fees; sales of biosolids as soil conditioner and fertilizer; sales of biogas from sludge digestion, production of duckweed and fish; and other resource recovery and reuse options. These revenues can cover the additional cost of reuse (e.g. water canals) and may be high enough to recover part of the cost of the treatment system. There are examples of up to 100 per cent general operation and maintenance cost recovery (through the recovery of water, nutrients and energy) in Jordan and India. There are also examples of cost recovery on capital after only six years where low-cost pond systems in Bangladesh and Peru are used for aquaculture to increase the revenue stream. Finally, as discussed during the workshops and as shown previously in the report, water reuse provides environmental and social benefits for society as a whole that will justify subsidies as additional revenue.

3.1.5 Recommendations for Resource Recovery and Reuse

Millions of tonnes of valuable resources (e.g. water, nutrients and energy) are wasted every year in the form of wastewater. Recovering these resources for productive activities makes good economic sense and can increase cost recovery in ("productive") sanitation systems, therefore increasing the project's sustainability. An early economic appraisal of reuse projects that includes an economic justification as well as a financial and cost recovery analysis will help to decide on the best strategy in the local context.

3.2 Institutional and Policy Aspects of Wastewater Use in Agriculture

If supported by pertinent policy-level interventions, relevant institutional settings and skilled human resources, the implementation of research-based technical options for wastewater treatment and use in agriculture offers great promise for environment and health protection as well as livelihood resilience. This has greater importance in developing countries where untreated, inadequately treated, or diluted wastewater is used for irrigation and wastewater irrigation is expected to increase in the foreseeable future.

Feedback on Institutional Arrangements and Collaboration

Feedback was collected from a total of 51 developing countries from Asia (18 countries), Africa (23 countries) and Latin America and the Caribbean (10 countries), in the form of responses to questionnaires as well as discussions during the workshops. This feedback from the country representatives was given in their personal capacity and views, and provided the basis for an assessment of the institutional and policy aspects of wastewater management. The Asian countries that participated in the assessment of the institutional and policy aspects included Cambodia, China, India, Iran, Iraq, Jordan, Lao PDR, Malaysia, Mongolia, Nepal, Pakistan, Philippines, Sri Lanka, Syria, Thailand, Timor-Leste, Turkey and Vietnam.

The countries from Africa were Benin, Botswana, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mauritius, Mozambique, Namibia, Nigeria, Senegal, Seychelles, Somalia, South Africa, Swaziland, Tanzania, Tunisia, Uganda, Zambia and Zimbabwe. Finally, the countries from Latin America and the Caribbean were Chile, Colombia, Dominican Republic, El Salvador, Guyana, Honduras, Mexico, Paraguay, St. Kitts and Nevis and Uruguay.

In regard to the ministries with overall responsibility for wastewater management at the national level, there is great diversity among the countries. In Asia, wastewater management at the national level is for example the responsibility of the Ministry of the Environment and Forests in India; the Ministry of Energy in Iran; the Ministry of Agriculture in China and Iraq; and the Ministry of Water and Irrigation in Jordan. But the situation can also be more complicated, such as in Thailand, where four ministries are responsible for wastewater management – the Ministry of Industry for industrial wastewater, the Ministry of Interior for community wastewater, the Ministry of Natural Resources and Environment for water quality control of natural water resources and the Ministry of Public Health for human excreta collection, transportation and treatment.

In the other regions, the situation is not much different and a variety of ministries can be in charge of wastewater management, from one ministry to several. The obvious challenge is that irrigation, independently of the water quality, often falls under a different ministry than the one in charge of sanitation.

Similar diversity in wastewater management is reflected at the municipal level, where a range of institutions is responsible for wastewater collection, treatment, use and/or disposal in the three regions. None of the countries reported excellent interministerial and inter-institutional collaboration in wastewater management. Only 10 countries reported adequate collaboration (20%); 20 countries reported inadequate collaboration (39%) and 18 countries reported average collaboration (35%). Three countries reported that there was no interministerial collaboration in managing wastewater (Figure 10).

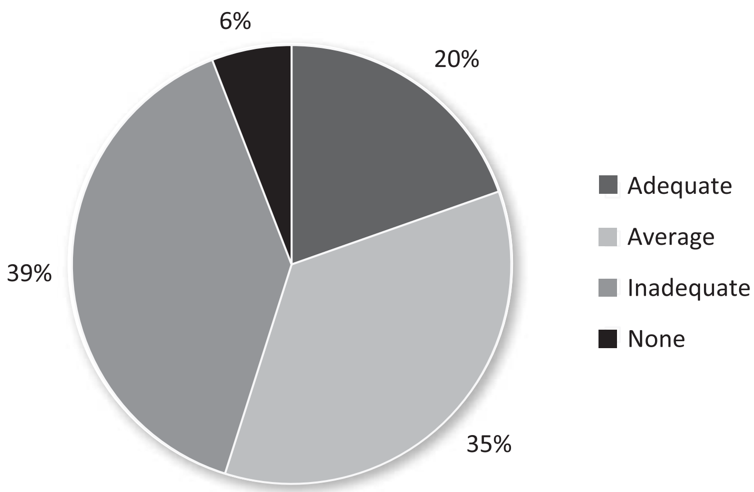


Figure 10: Level of Interministerial Collaboration in Wastewater Management in 51 Developing Countries from Asia, Africa and Latin America and the Caribbean

There is lack of coordination between national agencies and local institutions for wastewater management. Therefore, the division of roles and responsibilities among relevant federal ministries and local institutions has several challenges. The institutional arrangements are not sufficiently clear and there are overlapping responsibilities between some institutions. As a result, there are bureaucratic hurdles in wastewater management at different scales. In terms of rating governments' commitment and budget allocation to wastewater management, a trend similar to interministerial collaboration was reported. Only 7 countries reported adequate commitment and budget allocation for wastewater management (14%); 22 countries reported an inadequate level (43%) and 18 countries reported an average level (35%). Four countries reported that there is almost no or very little budget allocation for wastewater management (Figure 11). Especially where wastewater treatment is not the main objective of the authority, bottlenecks from funding to institutional capacity are common. In Ghana, for example, the Ministry of Defence manages its own treatment plants, the Ministry of Health manages those in hospitals and the Ministry of Education manages plants in universities.

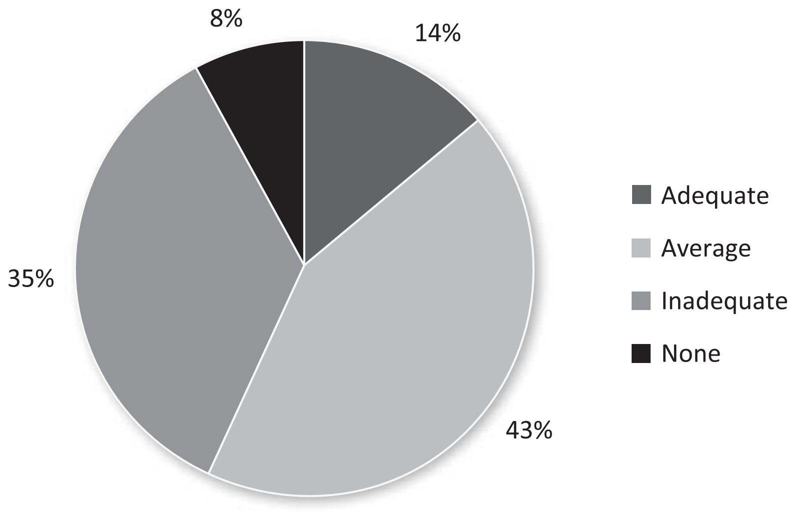


Figure 11: Level of Governments' Commitment and Budget Allocation to Wastewater Management in 51 Developing Countries from Asia, Africa and Latin America and the Caribbean

With regard to paying to use wastewater for irrigation, only seven countries reported that the farmers in peri-urban areas pay the local institution/organization for the wastewater they use for irrigation. In Tunisia, farmers pay for irrigation water on the basis of the volume of water required and the area to be irrigated, and the number of hours corresponding to the contract, at a rate of TND 0.020–0.030 per m^3 (1 TND = US$ 0.61 as of August

2013). In some areas in South Africa, such as in eThekwini Metropolitan Municipality, the cost of wastewater is much lower than that of potable water. Since in addition drinking water is often subsidized, it is obviously difficult to achieve any substantial cost recovery for water reuse where wastewater is sold at a very low price.

In some areas in India, treatment is not available or sought for a significant portion of the collected wastewater and is sold to the nearby farmers by the respective Water and Sewerage Board. In areas such as Vadodara, Gujarat, which lack alternative sources of water, one of the most lucrative income-generating activities for the lower social classes is the sale of wastewater and renting pumps for the lifting of wastewater.

In addition, in Jordan, farmers sign contracts for wastewater with the Water Authority of Jordan, usually at 20 fils per m^3 (1,000 fils = 1 Jordanian dinar = US$1.4 as at 2013). In Pakistan, wastewater is auctioned, and the highest bidder in turn sells to small farmers on an hourly basis. In Mexico, wastewater irrigators in the Mezquital Valley pay a rate of US$0.80 per ha.

There are only nine countries where farmers' associations or water users' associations collaborate with local institutions for wastewater delivery. For example, in the Irrigation District 03, Tula, Mezquital Valley, in Mexico, there are several farmers' associations that have been in operation since the 1990s. These associations are responsible for developing irrigation plans, ensuring water distribution and carrying out assessments of farms on fertilizer and pesticide use in order to improve crop yields. In South Africa, there is a private network of local communities for wastewater use in the eThekwini Metropolitan Municipality area. In addition, there are farmers' groups in Mauritius that collaborate with the Wastewater Management Authority with respect to the quantity and quality of wastewater delivered. In general, however, there is a divide between the agricultural and sanitation sectors and a lack of collaboration between farmers' associations or water users' associations and institutions responsible for wastewater management at the local scale.

The subject of wastewater management including reuse as part of school curricula is still in its infancy. Most countries have yet to introduce the importance of water quality and wastewater management in schools. However, in recent years, the topics of wastewater management and reuse have received attention at the higher education level in universities; the curricula of several universities in various countries address wastewater management in some form. An analysis of the use of the WHO Guidelines (WHO, 2006) for wastewater use is presented below in section 3.3: Risk Management and Use of the WHO Guidelines.

Feedback on some special health programmes from government or local institutions targeting farmers working in wastewater-irrigated areas revealed that there are only four countries where such programmes are in place to some extent. Some programmes are being implemented in Tunisia, for example immunization and awareness raising for occupational protective measures such as wearing boots, but they remain insufficient and, in the case of protective gear, also uncomfortable in hot climates. The Ministry of Health in Mozambique occasionally organizes programmes addressing sanitation problems. In some areas of South Africa, health and hygiene education is provided with a focus on the safe use of wastewater. In Uruguay, there is a specific project supported by the Ministry of Livestock, Agriculture and Fisheries (MGAP), the Sustainable Management of Natural Resources and Climate Change Project, that focuses on effluent management specifically in confined dairy farms and livestock. In addition to property taxes to support initiatives of effluent management in the context of water management, training and dissemination activities for technicians and producers are in place.

The annual budgets in most countries of the region are insufficient to collect, treat, use and/or dispose of wastewater in an environmentally acceptable manner. While regulations are in force which prohibit the agricultural use of untreated or partly treated wastewater, their implementation remains a challenge. Indeed, many wastewater treatment plants are plagued by poor operation and maintenance, and are operated well beyond their design capacity. These conditions eventually call into question the reliability of wastewater treatment and the quality of treated wastewater and its safe use in agriculture.

In most countries of Asia, Africa and Latin America and the Caribbean regions, there is a need for supportive policy and institutional arrangements to facilitate wastewater collection, treatment, use and/or disposal. These institutional arrangements must be sound at different levels and may include some of the following components: relevant policies facilitating water recycling and reuse at the local/national scale; strategic campaigns on water quality protection and wastewater treatment and productive reuse; and/or institutional collaboration such as private sector participation. With flexible policy frameworks addressing rapid demographic changes and health and environmental protection combined with collaboration across relevant institutions, water recycling and reuse have great potential through integrating water reuse with water resource planning, environmental management and financing arrangements.

3.3 Risk Management and Use of the 2006 WHO Guidelines

In terms of using the 2006 WHO Guidelines, almost all of the countries in the Latin America and the Caribbean region use their own national guidelines, which mainly stem from or refer to an older version of the WHO Guidelines (WHO, 1989). While there is apparently limited understanding of the recent WHO Guidelines, the countries consider the 1989 WHO Guidelines to be better focused on environmental aspects, such as restrictions on wastewater use based on specific criteria, while they consider the 2006 WHO Guidelines to mainly focus on health-based targets. However, when the different features of the more recent WHO Guidelines were explained to the participants during the regional workshops, most participants appreciated the additional flexibility and shared responsibility among institutional stakeholders in implementing specific elements of the Guidelines, such as the "Multiple-barrier Approach". In summary, the participants of nine of the 51 countries stated that their national institutions probably follow some edition of WHO Guidelines, 21 definitely follow national guidelines (mostly based on 1989 WHO Guidelines), 11 reported following both WHO and national guidelines, while ten countries have apparently no guidelines for wastewater use in agriculture (Figure 12).

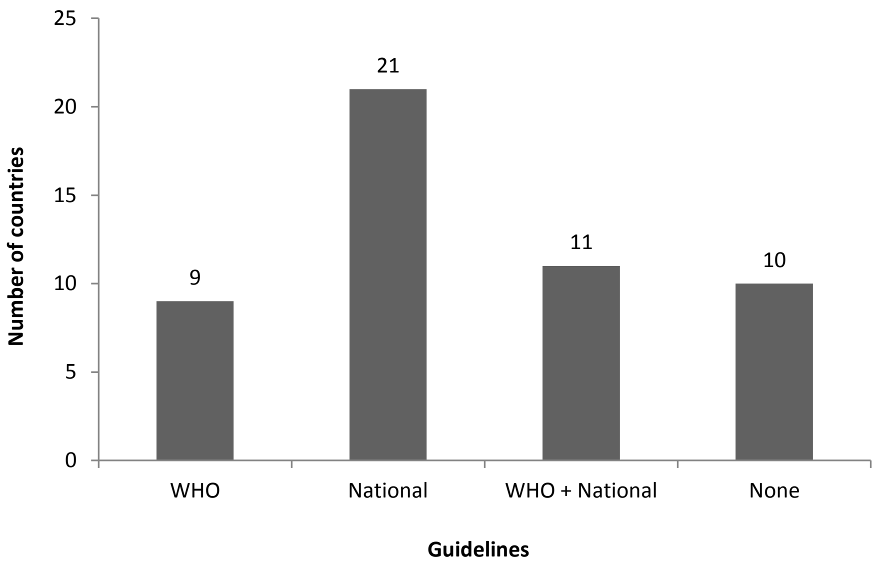


Figure 12: Guidelines on Wastewater Use in Agriculture in 51 Developing Countries from Asia, Africa, and Latin America and the Caribbean

Key findings and lessons learned drawn from the workshop series are summarized as follows:

- The 1989 version of the WHO Guidelines was largely known and are reflected in many national guidelines.
- Heath risk assessment, health protection and monitoring were consistently rated highly in the self-identified capacity needs of the participants. However, uptake of the 2006 WHO Guidelines has been low, primarily due to lack of awareness of national authorities or the institutional and technical complexity of implementing them.
- Even when countries' representatives were aware of the 2006 edition and changes of the WHO Guidelines, a number of them still felt more comfortable with the simpler 1989 WHO Guidelines, which provide more explicit wastewater quality targets. However, after more in-depth explanation, participants appreciated the additional flexibility and shared responsibility among institutional stakeholders afforded by the "Multiple-barrier Approach", which will not, however, reduce the complexity challenge.
- Intersectoral coordination and clearly defined responsibilities are important preconditions for implementing the 2006 WHO Guidelines. For example, clarity is needed on which organization should take responsibility for implementing and monitoring health protection measures along the sanitation chain – from waste production to produce consumption. Almost no country had well-defined responsibilities for the use of wastewater in agriculture, although many had some form of interministerial coordination platform that could serve as a starting point. There were few examples of clear coordination and management arrangements for assessing and managing health risks associated with wastewater use.
- In order to implement the 2006 WHO Guidelines other than at trial sites, most countries will need to consider updating national policies and/or standards to accommodate the treatment and non-treatment options, and explore incentive systems to support behaviour change for the adoption of non-treatment options from farm to fork.
- Increased and specific capacity-building is needed within Member States on health risk assessment and selection of appropriate control measures relevant for local socio-economic and health conditions. This could be met by scaling up the currently explored sanitation safety planning approach to wastewater use.
- The primary actors in wastewater use normally operate outside the health sector. Greater emphasis is needed to engage the health sector, both government agencies and academia, on the development of sanitation safety plans, with particular emphasis on health risk assessment and verification monitoring.
- Although microbial risks pose the greatest health risk in most cases, there are increasing concerns from system managers and the public with respect to chemical risks. These concerns need to be more clearly addressed in the next revision of the WHO Guidelines.

3.4 Diagnostic Analysis of Reuse-oriented Wastewater Management

The Diagnostic Analysis of Reuse-oriented Wastewater Management was one of the four topical areas that emerged as a priority need for capacity development across the countries that participated in the regional workshops. A diagnostic analysis contributes to a clearer understanding of a situation, which then assists in informed decision-making for resource recovery and the safe use of wastewater and other waste products. A diagnostic analysis can comprise both quantitative and qualitative elements. In wastewater management for safe and sustainable use in agriculture, it can cover a wide variety of analyses, starting from a simple quantification of the different types (industrial, domestic, etc.) and amounts and qualities of wastewater being generated, collected and treated. It may continue with a quantification of the different agricultural and other uses for this wastewater including excreta, be it from on- or off-site sanitation facilities and their potential in terms of nutrients and water to be recovered for supporting crop yields. In addition, value could be added through energy generation. Such analyses can also be extended to cover perceptions and socioeconomic factors that influence wastewater management and use. In addition, the potential health and environmental impacts can be quantified through soil, crop and water analyses. The economics of reuse may also be a part of this diagnostic analysis. A good diagnostic is the basis of all future wastewater management and reuse decisions: recognition of the capacity needs (human resources and technical expertise) for carrying out such an analysis is a critical element of success.

In this series of regional workshops, efforts were made to identify and showcase "good practices" of successful diagnostic analyses and identify lessons learned for others attempting similar exercises. A total of 12 case studies from 11 countries were suggested under this topical area. A template designed to internally evaluate whether the particular study could be held as a recommendable practice was used. The degree of detail necessary for selecting interesting examples for presentation, was, however sometimes not available. Based on available submissions, the four case studies suggested for presentation were from China, Iran, Mauritius and Mexico (Table 4).

For each of the identified examples, a summary of the lessons learned on how diagnostic analyses may be used for informed decisions is presented in the next section.

Table 4: Selected Good Practice Examples of Diagnostic Analysis

CASE STUDY TITLE	COUNTRY	LEAD PRESENTING INSTITUTION	DESCRIPTION
Collection, treatment and reuse of wastewater in Beijing, China	China	Beijing City Government partnering with the China Institute of Water Resources and Hydropower Research	This is a good example of a city authority responding to water scarcity by reclaiming and recycling wastewater, both domestic and industrial, in a rapidly expanding city.
Wastewater reuse in Mashhad plain	Iran	Tarbiat Modares University, IRAN-IRPID	Groundwater extraction for municipal, industrial and agricultural purposes led to drawdown and salinization of groundwater. The large volumes of city wastewater were seen as an opportunity to replace agricultural water with treated wastewater, and proactively increase the recharge.
Diagnostic analysis of wastewater management in Mauritius	Mauritius	Wastewater Management Authority (WMA) of the Ministry of Energy and Public Utilities	The situation in Mauritius is typical of other small island nations in the region suffering from water pollution impacts of indiscriminate discharge of wastewater. This exemplifies a case where the need for pollution management and cost recovery was the driver of wastewater treatment and reuse for agriculture and energy recovery.
Effects of the reuse of untreated municipal wastewater for agriculture in the Mezquital Valley	Mexico	Universidad Nacional Autónoma de México, Comisión Nacional del Agua (water distribution)	This is a highly unusual diagnostic analysis, spanning a period of 20 years, on the comprehensive long-term impacts of essentially untreated wastewater application (over a period of 50 years) in the Mezquital Valley.

3.5 Lessons Learned from the Case Studies

The following lessons learned were drawn from each of the four selected case studies, as shown below.

3.5.1 City of Beijing, China

1. The recognition of reclaiming and recycling city wastewater requires different types of analysis for informed decisions. Historical water use and wastewater generation data supplemented by demographic, planning and development data can be used for projecting future scenarios of wastewater generation and treatment and potential alternative uses.
2. Using an external driver such as the Olympic games in Beijing can drive decisions on recycling wastewater. This is similar to the approach of using climate change as the driver for improving water resource management through recycling.
3. Beijing is a very large city, with a population of 19 million in 2010 and an area of 17,000 km^2 including the rural counties. To make good use of its wastewater, an extensive collection network and associated treatment systems must be in place.
4. Segregating domestic from industrial wastewater treatment was a key factor in managing the wastewater for reuse.
5. In spite of limited water resources, city development was possible due to the political will exemplified by the Municipality's decision to develop wastewater as a secondary water source. As a result, by 2012, the amount of reclaimed water use exceeded the use from surface water sources and now makes up 21 per cent of total water supply.
6. Agriculture in Beijing consumed 43 per cent of the reclaimed water. In addition to this more traditional wastewater use sector, it emerges from this analysis that, properly planned, reclaimed water can largely contribute to city water use, such as industrial cooling, landscaping and other municipal uses requiring lower water quality. In addition, it may be a supplementary source for environmental water requirements, maintaining minimum levels in lakes and rivers.
7. Relevant supporting policies are a major driver for promoting reuse. The Beijing City Government made a major policy decision to upgrade treatment plants and build new ones.
8. Beijing has costed reclaimed water at 1 yuan/m^3, an approach that could be used in costing for other cities. Beijing can serve as a model for other large Chinese cities that show similar characteristics.

3.5.2 Mashhad plain, Iran

1. The densely populated Mashhad plain, which is experiencing a water crisis, saw competition between domestic rural and agricultural water users, which led to overexploitation (a deficit of 88 MCM/year) and drawdown (1 m/year) of groundwater levels, as well as salinization.
2. The Master Plan developed to respond to this problem recognized that agriculture was the major user, and that allocation of treated wastewater for agriculture could alleviate the problem.
3. The diagnostic analyses focused on the quality of wastewater, the quality of crops and effects on soils, groundwater recharge with wastewater and its impacts on groundwater quality through modelling.
4. The results confirmed the safety of treated wastewater use, both from a chemical and bacterial standpoint, for crops destined for human and livestock consumption. In addition, yields were higher when treated wastewater was used.
5. Diagnostic analyses, when performed in support of an existing policy decision, can confirm the validity of the direction adopted and encourage farmers to use the resource confidently. They can also fine-tune recommendations, such as shifting from undiluted to diluted treated wastewater or using wastewater and fresh water in alternation.
6. While high-grown crops were safe for cultivation with treated wastewater, crops that are consumed raw, such as lettuce, showed inacceptable contamination levels. Such analyses indicate either that the treatment type is badly chosen, or that the system needs better monitoring and correction to maintain regular levels.

3.5.3 Small Island Nation Case Study: Mauritius

1. Mauritius typifies a small island nation of 1.3 million people in an area of 1,864 km^2. Up to 2010, the treated wastewater represented less than 30 per cent of the wastewater generated and discharged leading to water pollution.
2. Environmental audits have shown an overall improvement in the quality of the environment, particularly water quality, since the implementation of the National Sewerage Programme.
3. Involving the private sector in treatment and reuse, particularly in the tourism industry, has paid off, with water being recycled for landscape irrigation, lawns and golf courses.
4. Biogas production from the anaerobic sludge treatment plants can generate up to 25 per cent of their energy consumption, showing potential for resource recovery.
5. Institutional conflicts resulted in limited use of treated wastewater for productive use in agriculture, but subsequent water scarcity was a driving force in agricultural reuse.
6. Agriculture uses 48 per cent of the fresh water resources in Mauritius. Under water

stress conditions, as is the case here, diagnostic analyses on fresh water availability and potential for substituting with alternative sources such as wastewater are critical. The need is emerging for re-allocation of irrigation water for beneficial purposes.

7. These diagnostic analyses must go beyond Mauritius and address the needs of the other neighbouring small island developing states in the region. Analyses must extend beyond the national to the regional level.
8. Farmers' interest is an incentive for developing treatment systems for reuse, which is influenced by the price of treated wastewater. Pricing policy has to account for the price of fresh water to farmers.
9. The Public Sector Investment Programme does not take into consideration the benefits of collection and treatment systems for Mauritius. Financing such activities, which involve a significant investment, must therefore rely on external funding sources.
10. Economic analyses of cost recovery for such systems will have to be conducted to identify cost-effective options.

3.5.4 Mezquital Valley, Mexico

1. The Mezquital Valley irrigation area, covering 90,000 km^2, uses 40 m^3/sec of wastewater supplemented by 12 m^3/sec of surface runoff. Irrigation with wastewater has taken place since 1912.
2. The case study is a unique example, describing the long-term research on the impacts of untreated wastewater application for agricultural irrigation. A baseline had been established using samples preserved from 1990, and the same sites were re-analysed in 2009 in a chronosequencing experimental framework.
3. Such an analysis allows for a better understanding of the nitrogen balances and the build-up and processes of accumulation of nutrients and heavy metals, as well as their uptake by crops. As a result, myths can be dissipated and facts can be verified about the long-term impacts of excessive concentrations in soils. The degree of aquifer recharge and microbial resistance determinants that affect the quality of ground water were also analysed.
4. This will also provide a baseline for understanding how eventually treated wastewater application will change the equilibrium within the system.
5. Application of diagnostic tools and findings from this case study would contribute to a wider understanding of similar untreated wastewater application situations, which are extremely common across Mexico. They will also form the baseline for comparative studies with other land use and wastewater application systems in Mexico.

In conclusion, it is clear from the cases described that diagnostic analyses cover a wide range of topics and are the foundation for good decisions.

Selected photos from submitted good practice examples for the International Wrap-up Event of the project. Above: Effects of the reuse of untreated municipal wastewater for agriculture over a century at the Mezquital Valley, Mexico. Below: Reusing farmland with multi-treated wastewater from a large-scale swine farm in China.

Chapter 4

THE WAY FORWARD: OUTLOOK AND EXPECTATIONS

In the framework of the regional SUWA workshops, many invited representatives of participating Member States requested further institutional support on safe wastewater use in agriculture. In particular, the participants appreciated the joint initiative of the group of organizers, providing participants with a comprehensive insight into the range of aspects that need to be considered in the development and implementation of wastewater reuse policies and practices. Likewise, the UN-Water organizers partnering in this project expressed their interest to jointly develop a proposal for a potential second phase.

Lessons learned from the project

- High capacity is needed in all fields.
- Overall self-assessment of the needs was higher at the end of than before the workshops.
- “Health risk assessment“, “economic and financial considerations“ and “monitoring and system assessment“ constantly rank among the top three categories; “policy aspects“ raised in importance at the end of the workshops.
- Countries have difficulties implementing the 2006 WHO Guidelines.
- There is a lack of good examples/models.
- Exchanges of practical experiences are valuable.

In order to achieve a good balance of wide outreach and in-depth support, capacity development on safe use of wastewater in agriculture can be addressed at national, regional and global levels. To ensure the greatest possible match between country needs and proposed actions for a second phase, the International Wrap-up Event of the SUWA project was dedicated to the identification of the most important capacity needs at a national level, examples of good practices from which other countries may learn and general needs of training, support and outreach.

As described in chapter 2, the national representatives developed national proposals on key issues they had identified in their respective countries. Following the workshop, the authors are in the process of revising the proposals and seeking endorsement from the national partners that are considered therein. Although not all national proposals may be a direct part of a potential second phase of the SUWA project, with the involvement of the entire group of project partners, the national representatives may approach individual partner organizations of the SUWA consortium, and are also encouraged to find other support.

At the regional level, the participating countries produced proposals which highlight the needs perceived in the four regions of Africa, MENA, Asia and Latin America and the Caribbean, as well as ideas and suggestions of how support can be extended in the framework of a potential second phase of SUWA on a regional scale. Similarly to the development of the national proposals, the regional proposals are undergoing a revision and refinement process, coordinated by a volunteer focal point of each of the regional groups.

The development of a proposal of scale-independent activities and activities at the global level was discussed with the participants of the International Wrap-up Event and will be developed by the SUWA project partners. The global and scale-independent activities not only focus on awareness raising, but largely seek to provide support on general needs and to reach a wider audience than can be reached by workshops alone. Based on the input and information gathered from the participating Member States and their stated needs and suggestions, the SUWA project partners started to engage in the development of a joint proposal, which largely focuses on the regional and global levels. The regional workshops and capacity needs assessments have shown the great needs for further support and that lending such support can stimulate actions and lead to improvements at the national level. The participatory approach of the conception of a potential second project phase ensures the identification of activities with the greatest possible impact. Given the greater scale of the activities discussed, this joint proposal is foreseen to be used to seek additional funding from interested donor agencies in the coming months.

Workshop participants at wastewater treatment plant in Bali, Indonesia

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