Agricultural Water Management 130 (2013) 1–13

Contents lists available at ScienceDirect

Agricultural Water Management

journal homepage: www.elsevier.com/locate/agwat

Review

Global, regional, and country level need for data on wastewater generation, treatment, and use

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ARTICLE INFO

Article history:
Received 6 July 2012
Received in revised form 5 August 2013
Accepted 7 August 2013
Available online 1 September 2013

Keywords:
Water quality
Urban agriculture
Water scarcity
Water recycling
Water reuse

ABSTRACT

Irrigation with wastewater supports agricultural production and the livelihoods of millions of smallholder farmers in many parts of the world. Considering the importance of better wastewater management at the local and national levels, there is a need for updated national data on wastewater generation, treatment, and use, which would also assist in regional and global wastewater assessments. While searching data and literature in published or electronic forms for 181 countries, we find 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% of the data could be categorized as recent (reported during 2008–2012). The available data suggest that high-income countries on average treat 70% of the generated wastewater, followed by upper-middle-income countries (38%), lower-middle-income countries (28%), and low-income countries, where only 8% of the wastewater generated is treated. The availability of current information on wastewater generation, treatment, and use is crucially important for policy makers, researchers, and practitioners, as well as public institutions, to develop national and local action plans aiming at safe and productive use of wastewater in agriculture, aquaculture, and agroforestry systems. The country level information aggregated at the regional and global levels would help in identifying the gaps in pertinent data availability and assessing the potential of wastewater in food, feed, and fish production at different scales.

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http://dx.doi.org/10.1016/j.agwat.2013.08.007

1. Introduction

Freshwater resources and population densities are unevenly distributed worldwide. As a result, water demands already exceed supplies in regions with more than 40% of the world's population (Bennett, 2000). Limited access to freshwater already impacts the lifestyle and development opportunities in water scarce areas (Qadir et al., 2007a). By the year 2025, as much as 60% of the global population may suffer physical water scarcity (Pimentel et al., 1999; Rijsberman, 2006).

With about 70% of the world's freshwater currently used for irrigation, agriculture remains the largest user of water. In some countries, irrigation accounts for more than 95% of the developed water supply (FAO-AQUASTAT, 2012). The competition for freshwater allocation already exists among municipal, industrial, and agricultural sectors, particularly in water scarce areas. As a result, agriculture has been yielding its share gradually to non-agricultural uses (Rosegrant and Ringler, 2000; Qadir and Oster, 2004; Qadir et al., 2010a). As the use of freshwater for non-agricultural activities generates wastewater, the volume of wastewater has been increasing, commensurate with rapidly growing population, urbanization, improved living conditions, and economic development (Lazarova and Bahri, 2005; Asano et al., 2007).

The combination of less freshwater allocation to agriculture, more freshwater allocation to non-agricultural sectors, and increasing volumes of urban wastewater, is expected to continue and intensify, particularly in water scarce countries. Therefore, agriculture in these countries will increasingly rely on alternative water resources, such as wastewater generated by non-agricultural activities in urban and peri-urban areas. Most small-scale farmers in urban and peri-urban areas of water scarce countries already depend on wastewater to irrigate a range of crops, often as they have no alternative sources of reliable irrigation water (Raschid-Sally and Jayakody, 2008; Drechsel et al., 2010).

Despite the importance of wastewater irrigation in supporting the livelihoods of millions of smallholder farmers, as described in several studies highlighting the significance of wastewater use in agriculture (Qadir et al., 2007b; Jiménez and Asano, 2008a,b; Drechsel et al., 2010), information regarding the quantity of wastewater generated, treated, and used at national scale is unavailable, limited, or outdated in numerous cases. Yet information describing current levels of wastewater generation, treatment, and use is crucially important for policy makers, researchers, and practitioners, as well as public institutions, to develop national action plans aiming at wastewater treatment and productive use of wastewater in agriculture, aquaculture, and agroforestry systems for environment conservation and health protection. Country level information aggregated at the regional and global levels also is needed to identify the gaps in pertinent data availability and assess the potential of wastewater in food, feed, and fish production at the regional and global scales.

Considering this lack of information, we compile the available data on these aspects of wastewater. Our goals include: (1) identifying potential sources of data for wastewater[1] production, treatment and use; (2) reporting the volumes of wastewater generation, treatment[2] and use based on country-specific data, where available; (3) summarizing country-specific information and describing wastewater production, treatment and use at regional and global scales; and (4) identifying gaps in pertinent data availability.

2. Sources of wastewater data and data reporting

We use the following published and web-based online sources to compile data describing the volumes of wastewater generation, treatment, and use at the country level: Food and Agriculture Organization of the United Nations (FAO, 2011; http://www.fao.org/nr/water/infores_databases_wastewater.html; FAO-AQUASTAT, 2012; http://www.fao.org/nr/water/aquastat/main/index.stm); European Commission supported Eurostat (http://epp.eurostat.ec.europa.eu/portal/page/portal/environment/data/database); United Nations (UN, 2000); United States Environmental Protection Agency (USEPA, 2004, 2012); country level database (NIWP, 2010; CSBL, 2011; CROSTAT, 2012; CSO, 2012; FIE, 2012; NBSRM, 2012; National Statistics Institute, Spain, 2012; SCSU, 2012; Statistics Netherlands, 2012; TURKSTAT, 2012); and published material (Solley et al., 1998; PEDCAR, 2001; Shrivastava and Swarup, 2001; UNECE, 2001, 2009; Basandorj, 2002; UNMIK, 2003; UNDESA-DSD, 2004; AQUAREC, 2006; Nyachhyon, 2006; Jiménez and Asano, 2008a; Kamal et al., 2008; MNRERF, 2009; PMDFEU, 2009; ABS, 2010; Environment Canada, 2010; MONSTAT, 2010; Van Rooijen et al., 2010; NSCRB, 2011; RMSSO, 2011; Aziz and Aws, 2012; Deras, 2012; FOSFBH, 2012; Gomez et al., 2012; Gyampo, 2012; Joysury et al., 2012; Kaur et al., 2012; Kayiizzi et al., 2012; Lekhooana, 2012; Marka, 2012; MENZ, 2012; MEPPRC, 2012; Moyo, 2012; Murtaza, 2012; Navarrete and Viches, 2012; NSSRA, 2012; Pérez and Montás, 2012; Saloua, 2012; SORS, 2012; SORSi, 2012; Souare et al., 2012; Tajrishy, 2012; Ulimat, 2012; World Bank, 2012; WRDLWB, 2012).

We use the FAO database as a starting point to arrange the country-specific data on wastewater generation, treatment, and use. We use data from other sources, as available, to fill gaps in the FAO database. We have updated some values in the FAO database, using more recent or more accurate data from reports produced by national institutions and ministries, and statistics offices. For example, in the case of Japan, FAO-AQUASTAT (2012) refers to wastewater treatment data (11.37 km^3/year) from the year 1993, while World Bank, 2012; WRDLWB (2012) provides more recent information on wastewater treatment in Japan (14.65 km^3/year), based on data from 2009.

In some cases, publications refer to 'current estimation' for specific data on wastewater. In such cases, we consider the reporting year for the data to be the year when the publication was produced. For example, Nyachhyon (2006) mentions 0.351 km^3/year as the current estimated volume of wastewater generation in Nepal, and UNMIK (2003) reports 167,000 m^3/year as a recent estimate of raw sewage production in Kosovo. In these cases, we consider 2006 and 2003 to be the reporting years for wastewater generation in Nepal and Kosovo, respectively.

[1] Wastewater definition varies from country to country and there are different versions of the definition in scientific literature. We consider 'domestic, commercial, and industrial effluents, storm water, and other urban run-off' as wastewater.

[2] Wastewater treatment has various levels, i.e. primary, secondary, and tertiary. Several developing countries are unable to achieve the satisfactory levels of treatment found in most developed countries. We consider treated wastewater to be 'wastewater receiving any physical or chemical treatment process'.