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Challenges to treated wastewater reuse in arid and semi-arid areas

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ABSTRACT

This paper evaluates technical, legal, social and economic challenges facing treated wastewater in the West Bank as an example of arid and semi-arid areas. Although treated wastewater reuse is recognized as a strategic option in augmenting agricultural water supplies in arid and semi-arid areas, there are many challenges that face the utilization. Legal challenges include adopting relevant and appropriate standards for reuse, which could be implemented at the farm level. Social and economic considerations should be considered in developing reuse options and strategies. In the West Bank, treated wastewater reuse standards and guidelines have been adopted. Field surveys and interviews with farmers showed that farmers are willing to irrigate many crops utilizing treated wastewater. However, this study shows that there are discrepancies between what farmers are willing to implement and what planners and policy makers would recommend. Farmers indicated a good understanding of the technical solutions on how to make treated reuse safe and technically sound. However, emphases on social and economic implications are highly essential for the success of reuse. Surveys of farmers showed that they need to understand and know the economic costs, returns and benefits of the different qualities of treated wastewater (TWW) to select appropriate reuse alternatives. Therefore, public awareness campaigns are highly needed to address the legal, social, economic and institutional consideration for TWW reuse. Participation of farmers in developing guidelines, standards, policies and plans for agricultural reuse is very important for the sustainability of treated wastewater reuse.

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1. Introduction

Middle Eastern and North African (MENA) countries are located within arid and semi-arid areas characterized with low availability of fresh water resources (World Bank, 2012). Table 1 shows that annual withdrawals of fresh water sources exceed the amount of renewable internal fresh water resources in most countries of the MENA region. It also shows that the amount of renewable internal fresh water resources available is below 500 m³/capita/year in most MENA countries. This availability of fresh water supply is low especially when

compared to countries on the northern shores of the Mediterranean Sea such as Italy and Spain where internal renewable water resources exceed 2400 m³/capita. Considering population growth rates in the MENA countries, the amount of fresh water availability is expected to reduce with time which will negatively affect socio-economic development of these countries.

The situation of water availability in the MENA region is common to countries located in arid and semi-arid areas. In these areas, water is becoming more scarce forcing planners to consider developing non-conventional water resources including treated wastewater (TWW) reuse (Pescod, 1992). The

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Table 1 – Renewable freshwater withdrawal and availability at selected countries in the Middle East and North Africa (World Bank, 2012).

Country	Population (millions)	Population growth rate (%)	Renewable internal freshwater resources (billion m ³)	Annual freshwater withdrawal (billion m ³)	Annual renewable internal fresh water resources (m ³ /capita)	% of agricultural annual freshwater withdrawal	Agricultural % of GDP	% of agricultural employment
Jordan	6	2.2	1	0.9	100	65	3	2
West Bank and Gaza	4.2	2.7	1	0.4	201	45	5.3	13.4
Syria	20.4	2	7	16.8	356	88	23	14.9
Egypt	81.1	1.7	2	68.3	23	86	14	31.6
Saudi Arabia	27.4	2.4	2	23.7	90	88	3	4.1
Yemen	24.1	3.1	2	3.6	90	91	8	54.1
Libya	6.4	1.5	1	4.3	96	83	2	19.7
Tunisia	10.5	1	4	2.9	402	76	8	25.8
Algeria	35.5	1.5	11	6.2	322	64	7	20.7
UAE	7.5	7.9	0	4	22	83	1	4.2
Israel	7.6	1.8	1	2	100	58		1.7

use of treated wastewater gained increased attention since the mid 1940s, especially in arid and semi-arid areas (Westcot, 1997) and is continuing to be considered as a reliable source of irrigation water to satisfy increasing agricultural demands. TWW reuse has been implemented in many countries to irrigate different crops and has increasingly been integrated in the planning and development of water resources in many countries such as Jordan and Tunisia (Batarseh et al., 2011; El Ayni et al., 2011).

Due to the unique characteristics of treated wastewater, its reuse has many challenges that cannot be ignored, such as health issues, water quality, and long and short-term effects on soils and crops (Ahmadi and Merkley, 2009). TWW reuse has also implications on the groundwater (below lands irrigated with TWW) resulting in potential contamination of groundwater with fecal coliforms and parasite ova (Abd El Lateef et al., 2006). In addition to its advantages in augmenting agricultural water supplies, reuse of TWW results in saving plant nutrients (Martínez et al., 2012).

With the technical advances in tertiary treatment of wastewater, even the risks of augmenting drinking water supplies with treated wastewater can be satisfactorily and safely managed (Rubiano et al., 2012). However, for various economic and social factors, the reuse of TWW is still limited to agricultural and industrial purposes. In the MENA region, there are major constraints causing slow and uneven reuse of treated wastewater (Qadir et al., 2010). These constraints include inadequate information about reuse, incomplete economic analyses of wastewater treatment and reuse options, high cost of wastewater collection and treatment, lack of cost-recovery mechanisms, mismatch between water pricing and water scarcity, preference of fresh water to wastewater, inefficient irrigation and water management schemes (Qadir et al., 2010). These constraints are forming legal, social and economic obstacles for efficient and sustainable reuse.

Regulating the reuse of treated wastewater in agriculture is an essential and important step for developing countries especially those in arid and semi-arid areas. Such regulations should encourage the utilization of treated wastewater to enhance water supply for agriculture, improve food safety and reduce poverty in agricultural and rural communities.

At the same time, these regulations should protect public health, allow safe reuse and take local cultural and socio economic conditions into consideration. As an example of semi-arid areas, the West Bank is taken as a case study to evaluate technical, social, economic, legal and regulation challenges facing treated wastewater reuse in agriculture. Considering the socio-economic conditions in the West Bank, the reuse of treated wastewater in agriculture is essential in developing the agriculture sector, improving food security and reducing poverty for a large portion of the population in the rural areas of the West Bank. The move toward nation building requires regulating the reuse in a set of regulations and standards considering local cultural, environmental and socio-economic conditions. Considering the environmental impacts of treated wastewater on ground water resources shared between the West Bank and Israel, regulating treated wastewater involves facing unique challenges considering the huge differences in income and thus affordability among residents in the West Bank and Israel.

2. Water, agriculture and sanitation in the West Bank

The West Bank with an area of 5655 km² and a population of 2.6 million people is located within the semi-arid and arid areas of the Middle East (PCBS, 2011). Recent data show that the Gross Domestic Product (GDP) in the West Bank is estimated at 4979 USD/capita/year compared to 29,359 USD/capita/year in Israel (World Bank, 2012). Agriculture has been a major contributor to the GDP and labor employment in the West Bank. However, agricultural contribution to the GDP dropped to about 5.3% in 2010, and its contribution to labor employment reduced to about 13% of the labor force in the past 10 years (PCBS, 2011). Although the area irrigated in the West Bank is only 2% of the total land area (or 13,000 ha), irrigated agriculture produces about 38% of the agricultural production. The most limiting factor to irrigated agriculture is water availability, which is a common factor for agricultural restriction in arid and semi-arid areas. Thus, enhancing agricultural water supplies will improve the food security and

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