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Greywater use in Israel and worldwide: Standards and prospects

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ABSTRACT

Water shortage around the world enhanced the search for alternative sources. Greywater (GW) can serve as a solution for water demands especially in arid and semi-arid zones. However, issues considered which include acceptability of GW segregation as a separate water treated stream, allowing its use onsite. Consequently, it is the one of next forthcoming water resources that will be used, primarily in the growing mega-cities. It will be even more rentable when combined with the roof runoff water harvesting and condensing water from air-conditioning systems. Reuse of GW is as well beneficial in the mega-cities subject to the high expenses associated with wastewater and fresh water conveyance in the opposite direction. The main problem associated with GW reuse is the quality of the water and the targeted reuse options. At least two main options can be identified: the public sector that is ready to reuse the GW and the private sector which raises extra issues related to the reuse risks. These risk stems from the on yard use of GW, relatively close to the household location.

The main focus of the Israeli guidelines for GW use is on the private and single house. The problem is less rigorous in public facilities, where the amounts are relatively large and the raw GW is relatively diluted. The two main principles adopted for reuse are: (i) greywater can be minimally treated since it differs from the black wastes, and; (ii) no contact exists with the resident around. The aggravated standards are an indication of the sensitivity issues related to the problem.

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1. Introduction

1.1. General

Water scarcity is one of the biggest challenges which are faced in arid and semi-arid regions however, is slowly approaching also the mega-cities (Guidelines, 2002; Al-Jayyousi, 2003; Government of Western Australia, 2009; Allen et al., 2010). Greywater (GW) is part of the household wastewaters (McIlwaine and Redwood, 2010; Al-Mashaqbeh et al., 2012). Accordingly, household wasted water consists of two major components: (i) black wastewater which consists of the toilet wastes that contains feaces, urine and the streams generated by the kitchen sink and the dishwashing machine, and; (ii) greywater wastes that originates from residential clothes washers, bathtubs, showers, bathroom sinks and laundry machines. In Australia the GW (also referred to as sullage) under the regulations, consists of all non-toilet wastewater. Actually, the GW consists of the "dirty water" excluding the kitchen sink and the dish-washing machine. According to the different sources the amount of GW is between 50% and 70% of all the water disposed by every household [regardless of total amount] (Gerba et al., 1995). The main differences of GW from black wastewater are as follows: (i) greywater contains only about a tenth of the nitrogen (ammonia, nitrite and nitrate), since it is the major urine source; (ii) since black water (containing feacal material) is excluded from GW there is a decreased load of feacal pathogenic organisms; (iii) the organic content of GW decomposes more rapidly than black water and assimilation is assisted even further biodegraded when GW is reused by direct application in the root zone. This water, after adequate treatment can be reused close to the house for lawn irrigation mainly, preventing the long-range distance transportation in the expanding mega-cities (Al-Hamaiedeh and Bino, 2010). However, there are several works that recommends the use of GW even for agricultural crops irrigation, although for different water qualities (Finley et al., 2009; Misra et al., 2010; Pinto et al., 2010) (Fig. 1).

Greywater from single seweraged household has the potential to be used for irrigation and/or toilet flushing. It can be reused for ornamental, garden and lawn watering subject to GW treatment and its' quality level. In some cases the use is GW is safe enough, due to minimal contact with the public. There

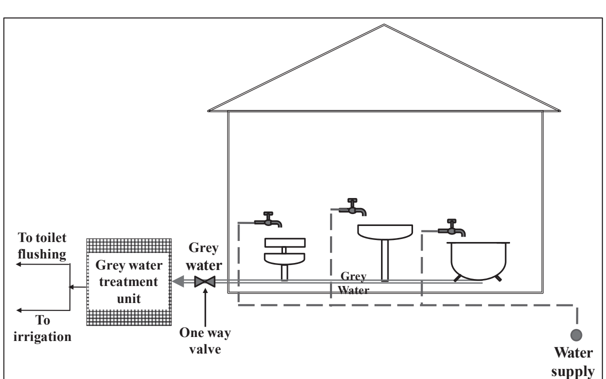

Fig. 1 – Schematic of Greywater collection system and reuse options.

are however, residents who take the risk and use GW after settling only or applying a modification of constructed wetland.

The first permit to use GW was given in Israel during 1994 for the reuse of shower water in public Sport Centers (Ministry of Health, State of Israel, 1994). It was realized that in public places it will be much easier to control the effluent quality in comparison to the private houses. The amounts of GW in public places are large and the raw disposed water tends to be diluted. Since then the reuse of GW went through dramatic developments where the main issue refers to the GW quality and the dilemma of public facilities *vs.* the private sector. The issues related to the detergents content in the GW are less problematic. Most of the detergent are now biodegraded relatively fast (in less than an hour) and do not pose any potential growth risk on ornamental plants however, some precautions must be maintained (Al-Mashaqbeh el al., 2012). It was previously stated clearly that one of main solution for GW disposal in arid zones is the reuse option (Denlay and Dowsett, 1994). Scanning the literature, GW has been used to a large extent in several main countries around the world. Australia has developed guidelines for GW reuse, *"Australian Guidelines for Water Recycling: Managing Health and Environmental Risks", and* reuse is encouraged through a program that offers Australian $ 500.- rebates for the installation of a GW system. The State of Arizona proposes the contractors, who will install a GW system in new building, with a discount on the construction (McCabe, 2013). There are US GW federal policy regulations that even offer financial incentives for installing GW reuse systems in new residential homes (Yu et al., 2013) (mostly, they are in semi-arid to arid region and are advised of using GW according regulations, like Arizona, California, Texas). Several other countries also have incentive programs for installation of GW systems, including Korea, China and Cyprus (Zeng et al., 2013). In Tokyo, Japan, installing GW systems is mandatory for buildings with an area of over 30,000 m^2, or with a potential to reuse 100 m^3 per day. Several municipalities in Spain, including Sant Cugat del Vallès near Barcelona and several other municipalities in Catalonia, have passed regulations to promote GW reuse in multistory buildings (Domènech and Saurí, 2010). The European Council Directive 91/271/EEC states that "treated wastewater shall be reused whenever appropriate" however, the level and method of treatment left ambiguous (UNEP, 2006; Somogyi et al., 2009).

Greywater is a significant water source that is always growing linearly with the populations' development (Simpson and Oliver, 1996). It can be used efficiently close to the houseyard for garden irrigation or even for tree watering. Greywater can as well be used for golf courses, public parks and enriching ground water. It can as well be used for the toilet flushing in private and public places.

1.2. Health risks

Greywater might contain pathogenic bacteria, oils, fats, detergents, soaps, nutrients, salts and particles of hair, food and lint. The pathogenic microorganisms include bacteria, protozoa, viruses and parasites, where some concentrations are high enough to enforce health risks. Therefore, a level of caution must be exercised with GW reuse. It can be achieved by preventing any human contact with GW. It may have an