Effectiveness of wastewater management in rural areas of developing countries: a case of Al-Chouf Caza in Lebanon

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Abstract Alike many developing countries, Lebanon lacks a national wastewater management strategy that can effectively protect public health and environmental quality. This has led the local communities and municipalities to plan and implement their own arrangements for wastewater treatment systems. However, most municipalities still lack the human and financial resources, management capabilities, and environmental awareness necessary to implement wastewater management in an environmentally sound manner. As such, the effectiveness of these systems, particularly with regard to the quality of the treated effluent, warrants evaluation. Accordingly, a performance evaluation of the treatment/disposal systems, taking three villages in Al-Chouf Caza in Lebanon as a case study, was carried out. The conducted field work, visual assessment, and laboratory analyses of effluent discharges revealed that the existing systems for wastewater treatment in the three villages are either not properly functioning or operational but ineffective and, consequently, hardly achieve any treatment higher than primary. Although developing countries are being encouraged to implement wastewater treatment systems with the promise of financial aid from developed nations, it is important that local conditions are considered carefully to make full use of any aid. It is very crucial to take into account the economic status of the community and the municipality in question. There is no point in adopting the most advanced technology for wastewater treatment if there is no mechanism to ensure maximum efficiency.

Keywords Wastewater · Rural areas · Management · Effectiveness · Developing countries · Lebanon

Introduction

Hot climate, uneven rainfall distribution, and increasing drought periods in addition to population increase and consequent overutilization of fresh water resources led to global water shortage, with the Middle East and North Africa being the driest regions (World Bank 1996; Bakir 2001). The efficient allocation of resources and finding alternative resources of water are two main challenges that face the decision makers and planners of the region. Sewage disposal has long been and
still remains a major factor in the deterioration of surface water bodies (Massoud et al. 2003). Therefore, a comprehensive strategy needs to be developed for cost-effective treatment of municipal wastewater in order to meet surface water discharge standards. Moreover, the treated effluent could be considered a substitute or a supplementary resource for freshwater in irrigation (Oron et al. 1999; Bazza 2003).

In Lebanon, water quality monitoring studies regularly identify that the organic and microbial pollutants are the major contaminants of surface water bodies (El-Fadel and Massoud 2001; Jurdi et al. 2002; Massoud et al. 2006a, b). The discharge of raw domestic wastewater is the major contributor of these pollutants. Almost all rural communities in Lebanon lack adequate sanitation services that can protect public health and environmental quality. While numerous projects are underway to construct wastewater treatment plants, up till now, there are practically no operational wastewater treatment plants (SOER/MOE 2000). The general trend for wastewater management in urban areas along the seashores where the majority of the population resides has been limited to a deteriorated wastewater collection system that typically discharges into the sea. In other urban and rural areas, septic systems are commonly used. Untreated wastewater is directly dumped into rivers, irrigation channels, and valleys, creating a severe risk for public health and the environment. From an institutional point of view, various bodies are responsible for the wastewater sector. Their responsibilities are intermingled and not well defined. Legally, no one comprehensive environmental law exists in the country; instead, specific issues are addressed separately.

Absence or delay in implementing a nationwide effective wastewater management strategy in Lebanon has led the local communities and municipalities to plan and implement their own arrangements for decentralized wastewater treatment systems. However, most municipalities still lack the human and financial resources, management capabilities, and environmental awareness necessary to implement wastewater management in an environmentally sound manner. As such, the effectiveness of these treatment systems, particularly with regard to the quality of the treated effluent, warrants evaluation. Accordingly, this research study was conducted taking three villages in Al-Chouf Caza (district) in Lebanon as a case study. The specific objectives of the study include:

- Performance evaluation of the treatment/disposal systems, taking wastewater quality, receiving environment characteristic (site conditions affecting septic suitability, proximity to surface water bodies, population density, and land use patterns), and cost effectiveness and affordability issues into consideration
- Assessment of the existing administrative framework, as well as laws and regulations pertaining to domestic wastewater discharge limits and treatment requirements
- Assessment of the public health and environmental risks as a result of the existing sanitation services

**Description of the study area**

Al-Chouf Caza is located in Mount Lebanon Governorate with an estimated area of about 464 million square meters. It is characterized by a Mediterranean climate with a moderately warm dry summer and autumn and moderately cold, windy, and wet winters with almost 80% to 90% of total precipitation occurring between November and March. Scattered rainfall events begin to occur in October. Three villages in Al-Chouf Caza (Fig. 1) employing three different wastewater treatment systems were chosen. A form of secondary wastewater treatment (activated sludge) plant with a design population of 3,500 people is employed in the first village, Bchetteen. The plant was designed to accommodate wastewater with a biochemical oxygen demand (BOD) load up to 240 mg/l and reduce it to about 30 mg/l. The treated effluent is discharged into a nearby river.

In the second village, Mazraat Al-Chouf, the treatment plant comprises three successive ponds. The ponds are excavations in the ground with no waterproof liners to prevent leaching into groundwater. The raw sewage enters the first pond and

![Fig. 1 A GIS map of the study area](image)