SUSTAINABLE MUNICIPAL SOLID WASTE MANAGEMENT (CASE STUDY: SARAB COUNTY, IRAN)

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ABSTRACT

Due to rapid population growth and industrial development in Iran, problems arising from increased generation of solid waste and its subsequent physical and chemical changes are foreseeable in the near future. Existing waste collection and disposal systems will not be able to meet the needs of sustainable waste management. In Iran, the collection, disposal, recycling and solid waste management have significant differences with other countries regarding the type and quality of waste. Applying technology without knowledge of the waste materials and adaptation to local factors is not worthwhile. In other words, when proposing a proper waste management plan it is necessary to identify the current situation of the area and the appropriate method should be adopted. Study ahead as a descriptive approach aims at examination of the potential ways for management of municipal solid waste in a sustainable manner. In the meantime, Sarab County, Iran was selected as a case study. The county, with an area of 18.3 km^2, is 59.7% of the total area of East Azerbaijan Province. In current circumstances, the cities of Sarab County produce approximately 49 tons of solid waste each day. The physical composition of the produced solid waste consists of 79% wet and 21% dry waste, respectively, collected and disposed in an unsanitary manner. Contamination of natural resources cannot be far from our minds. Potential ways of managing such a waste problem in developing countries are discussed.

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1. INTRODUCTION

According to reports presented by the UN and the Department of Environmental Protection of Iran, in developed countries nearly 80 percent of municipal waste is recycled and returned to the consumption cycle and the rest is burned or dumped in landfill sites. By contrast, in Iran only about 8 percent of municipal waste is recycled and the rest are buried mainly with unsanitary methods. Therefore in this context, fundamental steps must be taken to minimize worst consequences of unlawful dumping in Iran.

In recent years, the rapid expansion of urban areas throughout the world causes over-consumption of natural resources, resulting in production of tremendous amounts of domestic waste [1-4]. Lack of attention to environmental issues in many cities threatens the landfill environment as a hazardous factor [5, 6]. Such health hazards have converted the waste management issue into a necessary and inevitable affair. A large proportion of municipal solid waste has characteristics that threaten human health and all living creatures [7]. Pollution of air, soil, surface and underground water as well as the development of a favorable environment for noxious insects and animals is considered among the most important problems of the unsanitary disposal of waste [8-10]. Either alone can impact citizens with comfort and health risks, fatal disease outbreaks or even mass mortality. Clearly, one of the biggest challenges facing municipal managers is waste disposal [11].

In recent years, problems derived from population expansion and following unprincipled burial of household waste threaten the citizens' health and environment in Sarab. Considering that Sarab is among cities dealing with rapid population growth, presenting an appropriate plan for waste management based on standards provided by the Department of Environment Protection of Iran, the US Environmental Protection Agency (EPA) and the Water, Soil and Air Protection Agency (British Colombia) requires attention. Lack of attention to the sanitary collection and disposal of the solid waste in Sarab will be followed by damage and deterioration imposed on the natural resources as well as on the citizens' health.

2. THE STUDY AREA

Sarab is a county in Ardabil Province (a small province in northwestern Iran) located between latitudes 37°45′28″–38°15′28″ N and longitudes 46°59′14″–47° 56′32″ E (Fig. 1). Based on the latest administrative divisions of the country, it has two districts, Markazi and Mehraban, including 9 rural districts allong with 167 residential and 19 depopulated villages. Due to the climatic and geographic situation of Sarab, the economy of the area revolves around husbandry and farming. Considering the appropriate soil and water as well as adequate human resources in the study area, residents are often engaged in agricultural occupations.

Regarding the population policies in the region, the annual rate of population growth is projected to increase by 1.1% in 2021. Table 1 gives the urban and rural population projections for 2021.

3. WASTE COMPOSITION IN SARAB

Just like any other city in the world, in Sarab City waste management is a significant proportion of the budget. Nevertheless, the issue is unfortunately given less importance by some countries, particularly third world countries. Sarab County with its population of 136,500 people (of which 38700 live in Sarab City) faces increasing waste production as well as its resulting outcomes due to expansion of urbanization along with the geographic situation, including being a tourist destination and immigrant-receiving city in different seasons.

3.1. Waste Production in Sarab

Currently, almost 50 tons of waste is generated in Sarab County every day. A direct relationship between factors such as population growth, technology advances, economic growth and income with waste production, the mentioned rate will definitely increase in coming years. Such a high volume of waste generation reveals the need to establish an integrated waste management system in accordance with environmental standards more than ever before. Table 2 demonstrates the amount of waste produced in Sarab within the years 2004 to 2021. As can be seen, putrescible materials and agricultural waste consist around 80% of wet composition of the waste while solid wastes make up the rest.

3.1.1. Physical composition of the waste in Sarab

The physical composition of waste is an important factor from the viewpoint of sustainable waste management. As can be concluded from Table 3, putrescent materials (70%) are the highest proportion of the physical composition of the solid waste in Sarab while the lowest refers to metals and textiles in amounts of 1 and 2%, respectively.

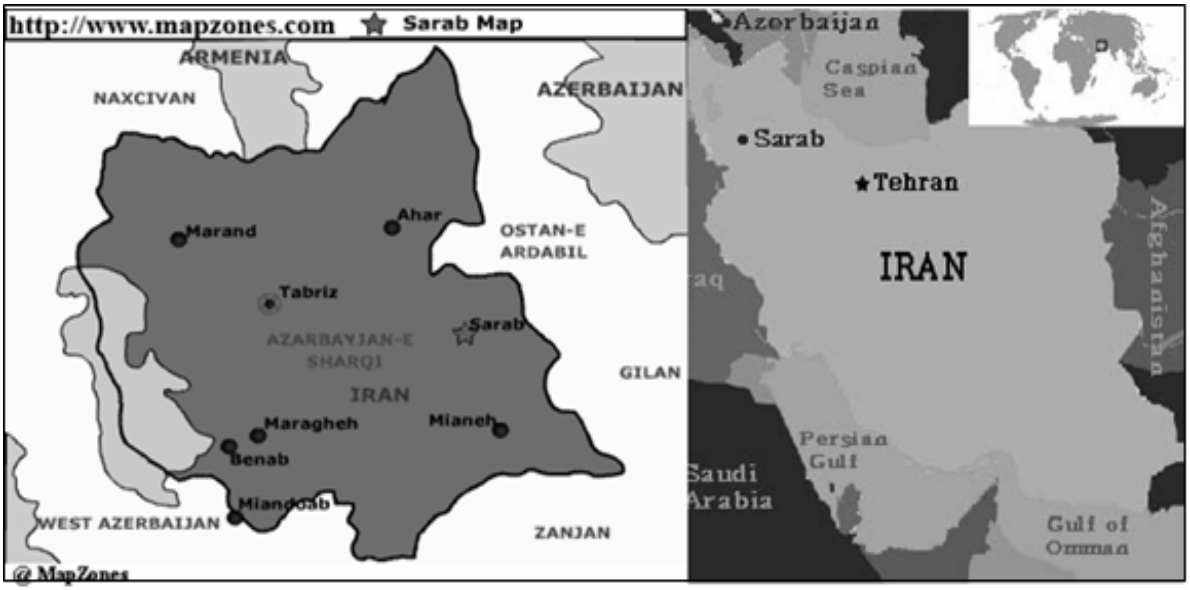

Figure 1 Situation of the study area in Iran

Table 1 Projection for urban and rural populations in Sarab County in 2021

Population type	Population projection				Growth rate Percent
	2009		2021		
	people	Percent	people	Percent	
Urban population	55189	39.15	72380	45.16	2.28
Rural population	85796	60.85	87878	84.84	0.2
Total	140985	100	160258	100	1.07

Table 2 Amount of waste produced in Sarab County; 2004 through 2021

Year	Population	Wet production per capita (g)	Amount of generated waste (tonnes)		
			Daily	Monthly	Annually
2004	50727	900	45.65	137	16436
2009	55289	900	49.76	143	17914
2021	72380	1000	72.38	2170.4	26057

Table 3 Physical composition of solid waste in Sarab County

Components	Weight percentages of the components
food waste and putrescible materials	70
Paper and paperboard	5
Plastic	8.8
Metal	1
Glass	1.8
Fabric	2
Agricultural and garden waste	9
wood	1.3
Miscellaneous materials	1.2

Table 4 Chemical analysis of combustible municipal solid waste in Sarab County

Components	Carbon	Hydrogen	Oxygen	Nitrogen	Sulfur
Putrescible materials, including food and wet household waste	11.8	1.6	9.2	0.6	0.1
Paper and paperboard	2.1	0.3	2.1	0.01	0.01
Plastic	5.2	0.62	2.0	0	0
Metal	0	0	0	0	0
Glass	0	0	0	0	0
Textile	0.97	0.12	0.55	0.1	0.15
Agricultural wastes	2.2	0.27	1.7	0.15	0.3
wood	0.51	0.44	0.44	0.002	0.1
Miscellaneous materials	0.49	0.02	0.02	0.005	0.2

3.1.2. Chemical Composition of Waste in Sarab

Determination of the chemical composition of solid waste is helpful in selecting the appropriate recycling method. Chemical analysis of combustible municipal solid waste in Sarab County is presented in Table 4.

4. CHALLENGES FACING THE COUNTY FOR SUSTAINABLE WASTE MANAGEMENT

The major challenges facing Sarab County for sustainable waste management fall into three broad categories:

1) Lack of paying attention to participatory based-management: Unfortunately, there is no care for public participation through waste management in Sarab. Although 70% of the waste consists of putrescible materials, no compost factory exists throughout the city. Besides, a no waste separation at source plan has been implemented in the region so far. Thereby, a huge proportion of the waste is disposed of without any economic gains.
2) Lack of relevant regulations: as in many developing countries [12, 13]. Guidelines on solid waste management have lots of shortcomings. There is an urgent need to present appropriate instructions and circulars for improvement of solid waste management along with prevention of unhealthy waste disposal throughout the city. Generally, it can be claimed that there is no incentive policy to encourage the private sector to participate in the waste management process.
3) Incompetence of structural aspects: the relevant authorities' lack of experience and knowledge, ignoring legal provisions, poor cooperation among stakeholder organizations, lack of long term planning, frequent changes in management based on the overall decision making process, insufficient budget and the lack of effective enforcement mechanisms are some of the causes of inappropriate waste management in Sarab.

4.1. Proposed Strategies

Based on the available opportunities, a combination of the following strategies is suggested among the potential solid waste management methods.

Waste separation at source: As concluded from the physical analysis of the waste in Sarab County, putrescible materials are a large proportion. Such a volume doesn't have the purity required to be converted into compost. To achieve the requisite purity, a separation process is to be implemented properly at a fertilizer production site. Hence, a systematic recycling program with emphasis on waste separation at source must be performed to increase the putrescible waste purity up to 90 or 95%.

Landfill: One of the main problems of sanitary waste disposal in Sarab County is lack of a centralized land-fill site. Unfortunately, there is a separate area for landfilling in each village, which negates comprehensive management of the solid waste. Besides, most of the mentioned sites suffer from many health problems because the waste is openly dumped at sites without compliance with environmental and health regulations. Currently, due to lack of fencing as well as the regular covering of the garbage, stray animals enter the waste disposal site. Therefore, a sanitary landfill site must be considered based on international standards to manage the disposal of waste in a healthy way whereby landfilling will continue to be a significant method for sustainable waste management [14].

The following recommendations suggest a path toward implementing sustainable waste management in Sarab.

- Prioritizing the respondent groups and providing training programs tailored to these groups (public, decision makers, and industrialists) [15, 16]
- Training contractors and those involved in waste collection, especially the informal sectors.
- Education through mass media
- Encouraging non-governmental organizations, associations and city and village councils, schools, universities, and holding training programs for men and women
- Identification of capabilities and limitations for reducing waste production and developing recycling programs [17]
- empowering human resources required for various sectors in order to reduce waste and increase recycling
- motivating the private sector to minimize waste and increase recycling
- enhancing existing recycling units
- conducting comparative studies regarding countries that have achieved great success in the field of recycling
- Providing guidelines for recycling and reuse of waste
- Establishing the necessary facilities for separating waste at the household level
- Creating interest among the people, local authorities, municipalities and environmental agencies to support the recycling [18, 19]

- Identification, organization, and legitimacy of the actual and potential markets for recycled products
- Training for the continuous care and control of waste disposal
- Accelerating transfer and/or closure of municipal waste disposal sites affected by unsanitary conditions
- Organizing and supervising the activities of people who are illegally working in the field of recycled materials [20]

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