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ORIGINAL ARTICLE

Environmental Assessment of Municipal landfills (Case study: East Azerbaijan Province/Iran)

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ABSTRACT
Municipal landfills, not suited to environmental criteria, pose numerous threats to the environment. East Azerbaijan Province has 21 counties and 62 cities, where 2400 tons of solid wastes are disposed of every day. Among the cities, Tabriz is the only one with a sanitary landfill, which its pit has been utilizing since two years ago. Thus, environmental study of existing landfills is required to control environmental impacts of improper disposal of solid wastes in this province. In this paper, landfills of the cities in East Azerbaijan Province were environmentally assessed using Oleckno method. The results indicated that out 4 of 19 municipal landfills are in good conditions, 7 cases are acceptable and 8 cases were unacceptable. These unacceptable landfills need to be dislocated and relocated.
***Key words**: East Azerbaijan, landfills, Oleckno method, Environmental Impact Assessment (EIA)*

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INTRODUCTION

Traditionally, disposal of residues was a major challenge of the man, the easiest way to tackle it was by dispersing the wastes on flat surfaces or incinerating them out of cities. For a long time, this method has been conventional throughout the world as the most practical method way without considering their adverse impacts. Today, this is still common is undeveloped countries. Problems of insanitary burial of wastes and their environmental damages especially those of industrial and hospital wastes have gradually replaced scientific and accurate land filling methods with aforementioned traditional ones [1].
In this case and in order to prevent deleterious impacts of wastes and to conduct an optimal management, National Solid Waste Management Act (2003) consisted of 23 clauses and 9 bylaws was ratified, which classified the wastes to five groups: normal, industrial, hospital, agricultural and special; and required establishment of executive management specialized in solid waste management [5].
Sanitary landfill as a branch of solid waste management includes a specific engineering operation to bury the wastes in the earth, decrease its volume and avoid damaging the environment by creating soil covers on them. By installing ventilation ducts and leachate transfer network, pollutions from the generated gases and diffusion of leachate is prevented [6].
Sanitary landfill is a controlled method of disposing of wastes by which solid wastes are evicted from human environments, buried beneath the soil, and return to nature, in the long run, depending on type and composition, while necessary care should be taken in site selection.
As a matter of fact, collection and disposal of waste in accordance with advanced scientific principles dates back to 40 years. In 1989, the first collection, transfer and landfilling system was established by the Municipality of Tehran outside the city. In 2005, the first study on the landfills of Tehran Province was carried out by using Oleckno method [4]. Unfortunately, despite long history of municipal landfilling in East Azerbaijan, no comprehensive study was performed in this regard. For this purpose, using Oleckno method efforts are made to both environmentally assess and classify landfills of East Azerbaijan Province.
To avoid hazards of leachates in landfill sites, Oleckno introduced an indicator for selection of suitable sites. This indicator is based on soil type, precipitation and groundwater levels and the following equation was used:

O=P+S+W

Leachate composition depends on lifetime of the landfill, precipitation and the nature of wastes buried in the soil. 200 organic compounds were identified in municipal sanitary landfills of solid wastes, 35 of which potentially jeopardize health of human and the environment [9].

Potential of a landfill to pollute the environment is comprehensible with respect to biodegradation processes, i.e. a landfill produces the wastes in three phases including solids (degraded materials) liquids (leachate) and gases, particularly carbon dioxide and methane. Landfill site and the wastes resulting from degradation potentially are capable to pollute the environment through atmosphere (air), lithosphere (earth and soil) and hydrosphere [9].

In a study on landfills of Tehran Province using Oleckno method, Arbab et al (2005) revealed that 74% of the landfills are in good conditions, 25% are acceptable and 11% are in unacceptable [1].

Monavvari et al (2010) assessed landfill sites in Rasht and Andisheh cities using monavari95-2, compared the results for each site to find weakness and strengths, and concluded that due to forest ecosystems and surface water the landfill of Rasht is inappropriate, and that of Andisheh City is unfit due to inconsistence with standardized engineering of waste disposal [13].

Zamorano, Molero and their colleagues (2008) used GIS to evaluate a landfill in south Spain. In this method, five main indicators were considered: surface waters, groundwater, atmosphere, soil and human health. Environmental indicators were used to assess qualitative impacts of landfills on the environment. Indicators of pollution impacts and hazards were introduced, classified and weighted. Then, geographical information of each indicator was prepared by GIS, which was weighted based on the criteria concluding that a selected site suited for land filling [14].

Bolhasani et al [6] assessed environmental impacts of municipal landfills of Markazi Province using Oleckno method. The results showed that among 26 landfills in Markazi Province 7 were in good conditions, 12 were acceptable and 7 were unacceptable. Salimi et al [9] used Oleckno method tostudy new landfill sites in Isfahan City and its suburban townships, which their weight was 40 indicating an appropriate and good conditions for landfilling. Navaser et al [10] studied and evaluated conditions of the landfill in Ahvaz using Oleckno index and British Columbia method. The results showed that Ahvaz Landfill obtained 24 weights (rated as good in Oleckno method).

MATERIALS AND METHODS

This study was based on data collection, observation and information analysis as follows:

- Collection of data on characteristics of municipal landfill in East Azerbaijan through national and international research, and gathering information on wastes produced in any of the cities of East Azerbaijan Province.
- Determination of characteristics and locations of landfills in any of the cities of East Azerbaijan Province via personal visit.
- Evaluation of location of landfills in any of the cities via Oleckno evaluation method

Table1: The indices of rank determination in Oleckno method

Criteria	index	Soil depth	index	Soil type	index	Precipitation
Unacceptable 20>	3	1.5-3	12	Clay/silt or clay/sand	21	<250
acceptable 21-23	8	6-9	5	Soft clay/sand	7	255-760
Good 24-40	9	>9	4	Mud	6	765-1780
–	–	–	0	Sand/gravel	–	–

Based on rating formula of land filling in Oleckno method

O = P + S + W

Where

O= Rating of a landfill

P= average annual precipitation

S= soil type

W= groundwater depth (m)

Conditions of the study area are studied in terms of groundwater, local soil type and precipitation levels. As seen in the Table1, these three parameters are weighted based on their levels and types. Finally if sum of the rates for each parameter is lower than 20, it means the landfill in question is insanitary, between 20 and 24 is acceptable and between 24 and 40 is in good conditions.

In this paper, initially thematic maps were used. A GPS device was also used to identify the location of municipal landfills in each city and to evaluate them. Then, thematic maps were presented and landfill locations in East Azerbaijan were shown by Arc GIS and EXCEL was used to analyze the obtained data.

Study area

East Azerbaijan Province with total area of 45491km^2 lies within 45°7' to 48°20' eastern longitude and 36°45' to 39°26' northern latitude (Fig.1).

Figure1. East Azerbaijan counties

Figure2. The landfill location, water basin

Since many groundwater tables in East Azerbaijan supply drinking water of the cities, Oleckno method was used to evaluate the landfills with respect to groundwater tables. To classify landfills in terms of hazards of leachate and groundwater pollution the indices in Table 1 were used.

RESULTS AND DISCUSSION

Table 2 shows the amount of wastes produced in each city.

Table 2. The amount of wastes produced in each city.

amount of wastes produced (tons)	The city of landfill
42	Azarshar
15	Osku
200	Ahar
16.5	Bostan Abad
80	Bonab
1400	Tabriz
40	Jolfa (Hadishahr)
15	Soofyan
45	Sarab
18	Shabestar
40	Ajabsheer
21	Kaleybar
140	Maragheh
120	Marand
40	Malekan
95	Miyaneh
20	Varzeghan
18	Heris
35	Hashtrud

Oleckno rating indices were used to evaluate each of these landfills, which are presented in Figs.3-6 and the results are shown in Table3.

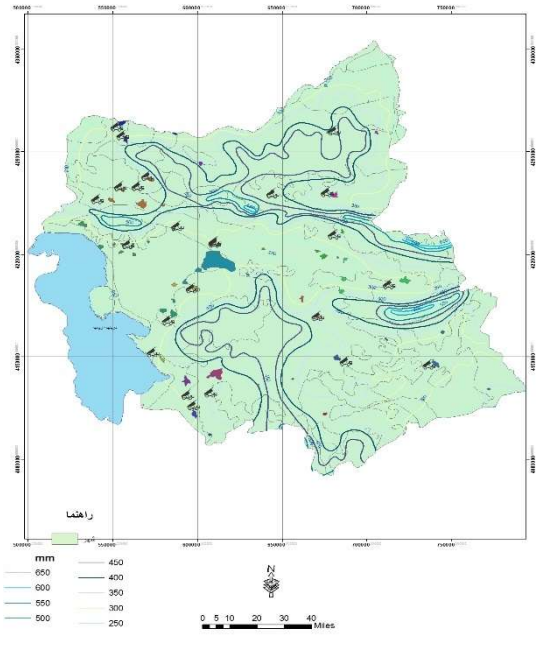

Figure3. Soil texture

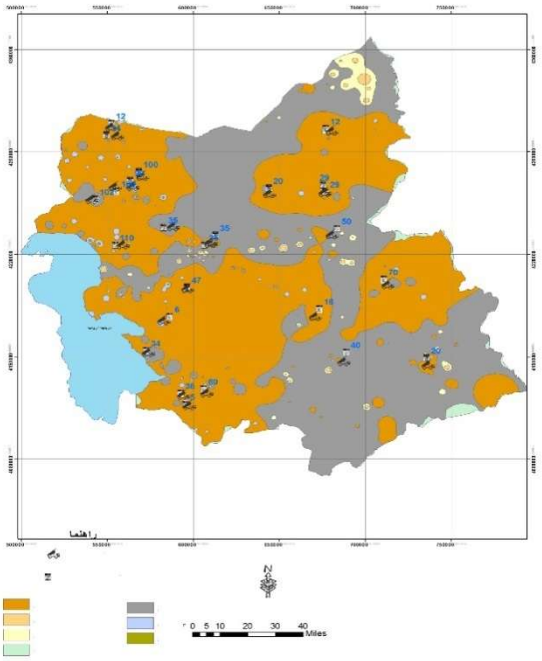

Figure4. Precipitation

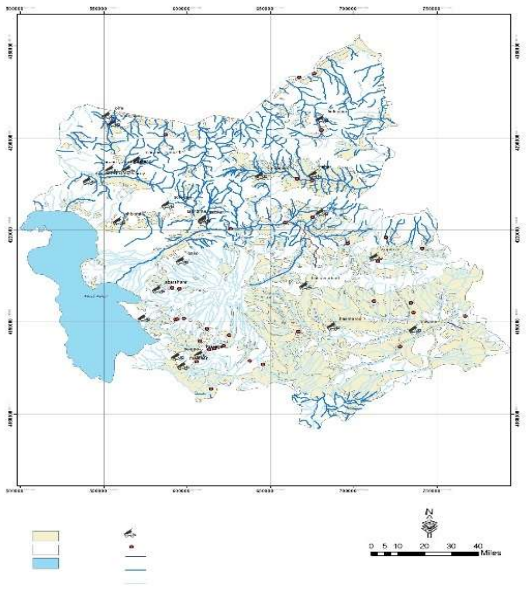

Figure5. Hydrography

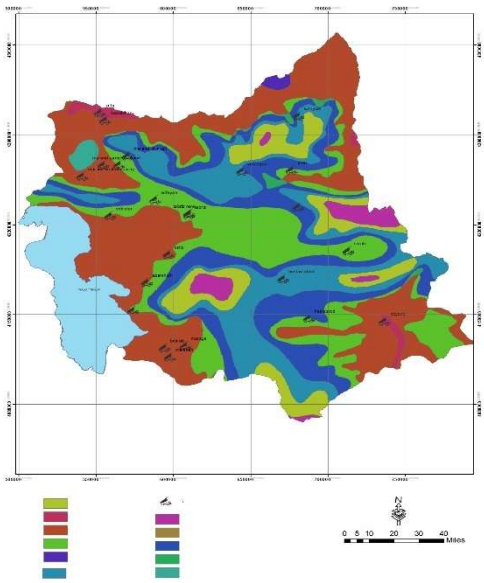

Figure 6. Climate

Groundwater levels, landfill preparation, control of leachate, gas and odor are hygienic standards of a landfill [7]. Being located opposite prevailing winds or at least 8km far from an airport [8] and not in rainy areas are other criteria [7].

Table3. Indices of determination of the rating of landfills in the cities of East Azerbaijan

W	S	P	The Cities
15	Clayey-loamy	313	Azarshahr
15	loamy	288	Osku
25	Clayey-sandy	294	Ahar
16	loamy	280	Bostan Abad
29	Loamy-sandy	263	Bonab
30	loamy	250	Tabriz
12	loamy	284	Jolfa (Hadishahr)

30	loamy	290	Soofyan
63	Loamy-sandy	244	Sarab
87	Loamy-sandy	233	Shabestar
27	Loamy	212	Ajabsheer
8	Loamy-sandy	418	Kaleybar
45	Loamy- sandy	317	Maragheh
72	Loamy-sandy	349	Marand
10	Loamy-sandy	262	Malekan
20	Loamy-sandy	283	Miyaneh
18	Loamy-sandy	300	Varzeghan
25	Loamy	315	Heris
28	sandy	330	Hashtrud

After rating indices of Oleckno method were determined in AzarshahrOsku, Ahar, Bostan Abad, Bona, Tabriz, Jolfa (Hadishahr),Soofyan, Sarab, Shabestar, Ajabsheer, Kaleybar, Maraghe, Marand,Malekan, Miyaneh, Varzeghan, Heris, Hashtrud, landfill assessment was executed, which showed that 7 of them are inacceptable conditions, 4 are good and 8 have unacceptable conditions.[**Table3**]
The traditional method of disposal (piling) is used in 80% of landfills in East Azerbaijan, and in the remaining 20% municipal wastes are disposed of partially sanitarily by trenching and filling.
The majority of the burial sites are fenceless and spread of light objects such as paper, plastic, etc. indicate inobservance of waste transportation regulations resulting environmental and health hazards. The only site containing a true landfill is Tabriz.

Table4. Rating of municipal landfills in East Azerbaijan Province by Oleckno method

Status	**o**	**w**	**s**	**p**	**The city**
Good	28	9	12	7	Azarshahr
Acceptable	21	9	5	7	Osku
Good	28	9	12	7	Ahar
Acceptable	21	9	5	7	Bostan Abad
Unacceptable	20	9	4	7	Bonab
Acceptable	21	9	5	7	Tabriz
Acceptable	21	9	5	7	Jolfa (Hadishahr)
Acceptable	21	9	5	7	Soofyan
Unacceptable	20	9	4	21	Sarab
Good	34	9	4	21	Shabestar
Good	35	9	5	21	Ajabsheer
Unacceptable	19	8	4	7	Kaleybar
Acceptable	21	9	5	7	Maragheh
Unacceptable	20	9	4	7	Marand
Unacceptable	20	9	4	7	Malekan
Unacceptable	20	9	4	7	Miyaneh
Unacceptable	20	9	4	7	Varzeghan
Acceptable	21	9	5	7	Heris
Unacceptable	16	9	0	7	Hashtrud

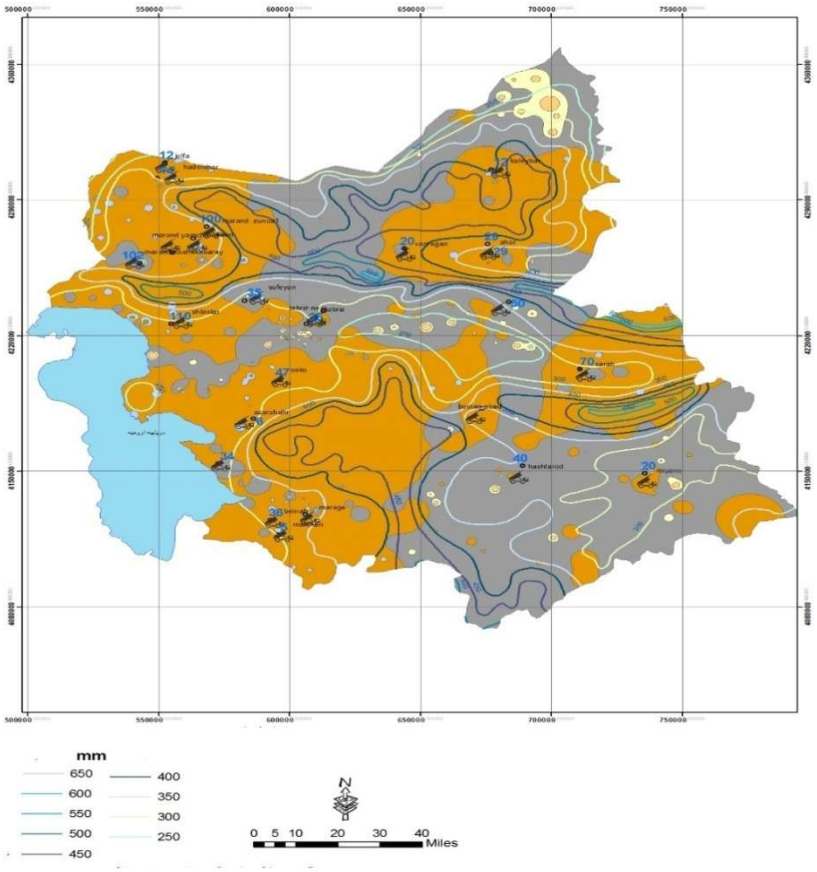

Figure7. Location of landfills-soil texture- precipitation-soil depth

CONCLUSIONS

Sanitary landfill is conventional method to dispose of municipal solid wastes and the resulting leachate serves as a strong sewage. The fluid creates acute and chronic toxicity in the environment and contaminates water and soil sources by mixing with surface waters and infiltration to groundwater[8].

Based on the results, amongst municipal landfills the following cities has acceptable conditions: Tabriz, Maraghe ,Heris , Hadishahr, Soofyan, Osku and Bostanabad. Then, it is recommended to not only dispose of the wastes of these cities sanitarily and scientifically by following engineering regulations, but landfills in other adjacent cities would better be transferred to these areas due to their appropriate conditions, if possible. Landfills in Azarshahr, Ahar, Shabestar, and Ajabsheer are in good conditions, which implementation of methods such as trenching with suitable soil covers, while following control methods are recommended to continue landfilling process in these areas. Landfills in Bonab, Sorab, Kaleybar, Malekan, Miyaneh, Varzeghan, Hashtrud and Marand are in unacceptable conditions, which should be rehabilitated or dislocated as fast as possible.

Oleckno index has some limitations, e.g. in addition to rainfall levels, soil permeability also affects leachate formation, because low gradient of land and high permeability of soil causes stormwater to stay longer in the area and furthers infiltration capacity of the landfill, and consequently increases leachate information, while this was not considered in Oleckno index [11].

The following are suggested as a proposed template for future functions throughout the province:

- Use of suitable soil covers in landfills to prevent from pollutions of groundwater and surrounding areas.
- Use of Impermeable layers on the floor bottom of landfills to prevent from groundwater pollutions
- Monitoring landfill entries and installation of signposts there to preclude forbidden and hazardous residues
- Use of light and portable fences to prevent from spread of light objects such as paper and plastics in all landfills as well as green fields, plantations and embankments.
- Execution of suitable sanitary landfilling techniques to control output gases in order to avoid combustion and formation of greenhouse gases, and leachate control by treating them using

physical, chemical and biological processes such as activated sludge, aeration, sedimentation and filtration ponds or leachate collection and its reinjection into the landfill.
- Establishment of compost plants, incinerators or necessary equipment and sufficient environmental justifications, where sanitary landfill or other methods do not suffice.
- Periodic and regular spray before and during disposal in all landfills, for wastes not to be exposed to insects and their propagation before burial.
- Planting proper vegetation in burial sites and landfills to assimilate and control rainwater and slow down interference currents into waste masses in the landfills
- Designing and making pathways suited to transportation vehicles for improved access to the landfill
- Guarding the landfills and blocking access of unauthorized individuals and travelling salespeople to segregate and collect valuable wastes
- Substitution of traditional and improper methods with sanitary ones in compliance with engineering and technical regulations in all landfills
- Conversion of unacceptable conditions to acceptable and good by rehabilitating municipal landfills.
- Replacing over capacitated old landfills or those spatially inappropriate at present with new ones.

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