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First Implementation of Improved Mathematical Matrices for Environmental Impact Assessment Using Quality Criteria: A Case Study in Golpayegan Township Compost Plant, Iran

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Abstract: Environmental impact assessment is an important tool in assuring that development projects will go according to environmental limits. The need for a systematic method of evaluating the environmental effects of a project or a plan has been recognized for several decades. In this study application of improved mathematical matrices for environmental impact assessment was suggested. For this, quality criteria for improving of mathematical matrices are used. Mathematical matrices in association with geographic information system can be used as a strong approach to EIA of most development projects. In mathematical matrices, important criteria for site selection of the plant are studied. Then effects are assessed in GIS and their significance is studied based on which appropriate site for compost plant is selected. In the present study, Golpayegan city in Isfahan Province was selected to perform site selection. Three alternatives for site selection of compost plant are studied. According to the results, alternative 3 was the best. Application of mathematical matrices makes the EI assessors to use GIS in EIA, which results in more accurate, applied and objective results. In this approach, magnitude, extent and duration of impacts, synergistic effects, cumulative effects, controversy among the experts and quality criteria are the criteria included in the formula. This comprehensive approach that also includes compensation criterion will make achieving consensus between proponents and EI assessors a reality.

Key words: Geographic information system % Compost plant % Mathematical matrices % Site selection % Significance

INTRODUCTION

Nowadays, several critical factors are affecting on the Iranian natural resources. Growing the urban population and appearing the new population centers might be the most important factor. In addition, lack of clear strategies, policies and plans based on the National Land-use Management plan, also lack of an evaluation mechanism to evaluate different urban development plans are the second influential factors [1]. Today, huge volume of solid wastes and finding the place for disposing are of the major environmental challenges of urban management. Usually, suitable lands where require all the characteristics of a landfill are far away of the cities which raises the cost of waste disposal dramatically. These limitations have caused bringing the attentions to reusing and recycling of the solid wastes. Previous studies indicate that more than 70 percent of the solid wastes of major cities in Iran are organic materials. This shows the potential of the Iranian cities for developing the compost systems [2]. Golpaygan city is a city in Isfahan province in center of Iran. The information about the solid waste composition from this city shows high percentage of the organic materials, Based on this information the city municipality has decided to establish a compost plant.

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Producing the organic fertilizers from the solid wastes has many economic values addition to environmental benefits where in many cases those economic values can support the costs of the wastes collection and disposal. In other hand, developing a compost plant based on mixed solid wastes can cause many adverse environmental, human health and economic impacts [3]. Therefore, Environmental Impact Assessment (EIA) process where identify, predict and evaluate the impacts on the biophysical and social environment is a proper tool to minimize the adverse impacts [4] and maximize the opportunities and benefits of composting plants. Environmental impact assessment (EIA) is increasingly at the center of public debate regarding the implementation of large-scale infrastructure projects. EIA is a systematic study aimed at appraising the likely effects of development projects on the environment. Under this context, EIA entails the consideration of the relevant environmental issues so that authorities can make well-informed decisions concerning project approval and, if appropriate, set the conditions for the mitigation of the foreseeable impacts [5, 6]. EIA is a group work and an interdisciplinary research during which negative and positive aspects of a development plan is assessed, the ways to limit or control the negative effects are suggested in the form of mitigation measures, based on which the plan is given unconditional or conditional approval or is otherwise rejected [7]. There is a wide range of different EIA methods to assess the consequences of the developmental projects [8]. The application and effectiveness of each method is different than the other and is related to the project type, project activities and the size, the affected environment, and the EIA assessor. However, any method can have its own advantages and disadvantages. Several EIA scientists have evaluated and criticized different EIA methods from different point of views. EIA methods range from simple to complex, requiring different kinds of data, different data formats, and varying levels of expertise and technological sophistication for their interpretation. The analyses they produce have differing levels of precision and certainty. All of these factors should be considered when selecting a method.

In recent years, some of the traditional methods of EIA have been developed as the technology has developed. For example, Geographical Information System (GIS) which is a developed version of “Overlay” method, and now it is one of the most well-known, user-friendly which practitioners apply it frequently. During the last few decades GIS software has gained importance for generating overlays and making site-specific decisions, for example Maitra (2012) used application of GIS and overlay maps in order to environmental impact assessment for dam construction in India [9].

In other example, Ijäs et al (2010) has developed the RIAM by considering “The susceptibility of the target environment”[10]. In Iran, EIA system is suffering most from the lack of applying the new and more proper methods as well as some methods are applying in a wrong way. The EIA practitioners are focused more on the traditional methods as they are simple and costless even though not leading to the proper results. Environmental researchers in Iran have encountered serious and new challenges about the methods that can adequately respond to research demands posed by the country’s recent rapid economic and social development. On one side, traditional methods of environmental impact assessment (EIA) have been criticized severely by specialists and on the other, theoretical bases and practical conditions for implementing new methods of environmental impact assessment are not fully appreciated. Hence, the need to development of useful concepts and methods of environmental impact assessment is felt more than ever [11]. The range of evaluating and criticizing scientific methods varies between basic and general concepts of each branch of science. This is the same for environmental impact assessment. For instance, Shopley and Fuggle while reviewing the methods of EIA such as Ad Hoc, Checklist, Matrix, Networks, Map Overlay, Modeling, Evaluation and Adaptive methods [12], classify all the assessment methods in eight groups and check their weaknesses and strengths. In 1986, Duinker and Beanlands studied the concept of impacts and their significance [13]. Then in 1988, Thompson counted 24 ways for ascertaining of impacts significance [14]. Non-parametric statistics such as Bayesian theory [15], Fuzzy logic [16], Neural Networks [17] are examples which are added to the concepts and methods of EIA in recent years, in order to make them more practical and provide acceptable results and a means of consensus among stakeholders. In 1998, Bojorquez-Tapia et al. discussed the use of mathematical techniques in order to improve the procedure undertaken in any EIA [18]. This paper indicates that improvement of environmental impact assessment methods is achievable. In this research improved mathematical matrices is used for EIA, Application of mathematical matrices makes the EI assessors to use GIS in EIA, which results in more accurate, applied and objective results. So, we applied the mathematical matrices developed in EIA process of Golpaygan compost plant and developed the approach by considering some new parameters.

Therefore, in this paper we clearly aim to:

- Apply Developing Mathematical Matrices Approach to assess the environmental impact assessment of Golpaygan compost plant.
- Improve the mathematical matrices developed by
- Considering the new parameters (quality criteria) as supporting data for the impact prediction (Su), Impact probability of occurrence (Pro), Confidence in the prediction of impacts (Con) and finally existence of environmental standards (Stan).
- Use the advantages of the GIS in EIA process to
- obtain more accurate, applied and objective results

MATERIALS AND METHODS

Study Area: For this study Golpayegan township in Isfahan city is selected. This place is situated in Esfahan, Iran. Golpayegan has an area of 3360 hectares located between latitudes 33°27' 15" North and longitudes 50°17' 15" East.

The total area of the township is about 3360 hectares (Figure. 1). For assess the impacts of implementing the best landfill option in the Golpayegan township three alternatives have been selected. These options have been proposed by an environmental research company through surveys and collected information in the region, including the amount of precipitation, Rose Wind, land use, groundwater levels and etc. These options have been examined considering an eight kilometers buffer. Geographical coordinates of the location alternatives to construct the compost plant in Golpayegan Township are shown in Figure 2.

A practical way to achieve better EIAs is to improve matrices so that users can benefit from their advantages and appraise impacts more rigorously. In mathematical matrices the sensitivity of the expert's judgments to alternative perceptions can be evaluated. Mathematical matrices reduce the matrices' weaknesses and allow users to assess the efficiency of contemplated impact mitigation measures. Environmental impact assessments should be based on a procedure designed for a comprehensive and systematic appraisal of all foreseeable environmental impacts of development projects. In general, this appraisal is achieved by following steps:

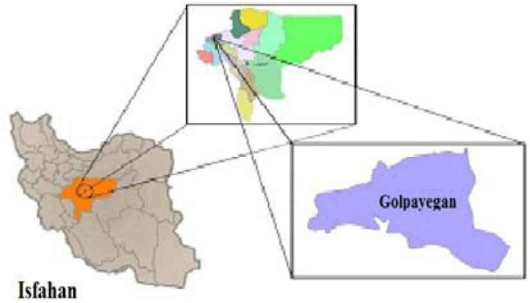

Fig. 1: The Golpayegan township location

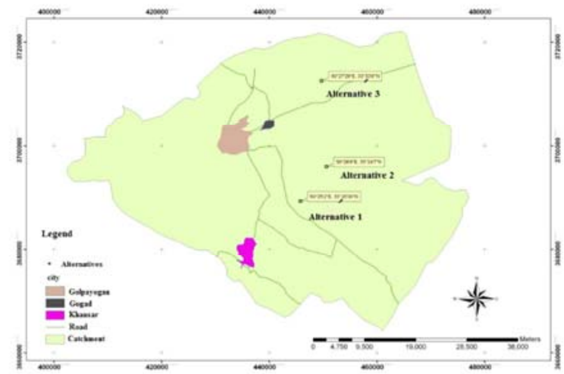

Fig. 2: The location of proposal alternatives for site selection of compost plant

- Project description and environmental characterization;
- Identification and prediction of impacts; and
- Evaluation of impact significance.

In mathematical matrices first, the environmental factors were inventoried. Then, the project activities identified and arranged in a matrix perpendicular to the environmental factors. After determining likely cross impacts, attempts were made to figure out their significance. For this, first three groups of criteria were considered as below:

- Basic criteria
- Supplementary criteria
- Quality criteria

The basic criteria were composed of: Impact magnitude or intensity (M), impact spatial extent (E) and impact duration (D). The basic criteria ranking from 1 to 9 could not be absent in any given study otherwise there would be no impact at all. Hence, the overall basic impacts could be calculated as follows [18].

$$MEDij = \frac{1}{27}(Mij + Eij + Dij) \quad (1)$$

The supplementary criteria were consisted of: Synergistic effects (S), Cumulative effects (A) and Controversy over assigning the values (C). This second group of criteria could be absent from any given study depending on the nature of the development activity, time and budget. These criteria are ranked from 0 to 9 and the overall supplementary score is calculated as follows [18]:

$$SACij = \frac{1}{27}(Sij + Aij + Cij) \quad (2)$$

Quality criteria are composed of: Supporting data for the impact prediction (Su), Impact probability of occurrence (Pro), Confidence in the prediction of impacts (Con) and finally existence of environmental standards (Stan). The overall quality criteria could be calculated as follows [19]:

$$EX = \frac{1}{36}(Su + Pro + Con + Stan) \quad (3)$$

The ten criteria (Mij, Eij, Dij, Sij, Aij, Cij, Su, Pro, Con and Stan) were each measured on an ordinal scale corresponding to expressions related to the effect of an activity (j) on an environmental component (i). The relative importance of each criterion was evaluated through verbal expressions that corresponded to a scale from zero to nine. The relative importance of each criterion was expressed as follows: nil (0), nil to low (1), very low (2), low (3), low to moderate (4), moderate (5), moderate to high (6), high (7), very high (8) and extremely high (9) [18]. The highest figure was assigned to an interaction whenever there was uncertainty about the value of a criterion, so as to reduce the chance of underestimating an impact (precautionary principle), thereby minimizing risk [20]. Supporting data have been provided through consultation, GIS and modeling. Impact probability of occurrence have provided through expert opinion and experimental methods. Impact probability can be classified as table 1.

As MED cannot be zero so the range would be as below:

$$3/27 \le MEDij \le 1$$

Table 1: Classification of impact probability in mathematical matrices

Score	Impact probability
20 <	1
20-30	2
30-40	3
40-50	4
50-60	5
60-70	6
70-80	7
80-90	8
> 90	9

The range for SAC will be as below:

$$0 \le SACij \le 1$$

Actually the MED is synergized by SAC. In mathematical matrices, the impact (I_{ij}) can be written as [19]:

$$Iij = MED^{(1-SACij)(1-EX)} \quad (4)$$

And finally, the significance of the interaction (G_{ij}), which takes into consideration the mitigation measures (T_{ij}), is obtained from the following equation:

$$Gij = Iij[(1-(Tij/9))] \quad (5)$$

Mitigation measures (Tij) was expressed on an ordinal scale from zero to nine.
The significance can be classified as below:

Low= 0-0.24 Moderate= 0.25-0.49 High= 0.50-0.74 Very High= 0.75-1

Arc GIS, IDRISI and ALOHA software were used for quantification of impacts [21-23].

RESULTS AND DISCUSSION

The first step in EIA is to define and describe the present environmental situation and to determine those environmental parameters that are going to be affected by implementing the target project and the related accomplished activities. Determining and defining the environmental parameters and project activities needed for process evaluation has been done according to the environmental conditions and alternatives, surveys, examined resources and expert opinions. In this study, those environmental impacts were reviewed that are created during the construction of compost plant which include visual pollution, soil erosion, soil pollution, noise pollution, odor pollution, water surface levels and groundwater pollution, habitat loss, biodiversity loss, vegetation (natural cover) loss and public hygiene.

Visual Pollution: Visual Map is used to define the amount of visual pollution. Finally, doing scrutiny of Visual Map in three alternatives, it was realized that the highest rate of visual pollution is in alternative 3 and the lowest is in alternative 2.

Soil Erosion: Extracting the information from susceptibility to erosion map, it was found that the rate of soil erosion in the region is the least in alternative 2 and is the most in alternative 1. Soil erosion map is shown in Figure 3.

Soil Pollution: According to the scrutiny done, the most rate of soil pollution has been detected in alternative 1 and the least is in alternative 3. The resulting map for the soil pollution is shown in Figure 4.

Noise Pollution: After combination of the resulting maps for noise pollution (vegetation density, distance of residential area and toposhape) and extraction of information of them, it appears that the lowest noise pollution is of alternative 3 and the highest is of alternative 1. Figure 5 shows the noise pollution area.

Odor Pollution: Odor dispersion was modeled in ALOHA software. Finally, odor pollution was obtained through reviewing the information gained from modeling and also combination of residential area distance maps, toposhape map and vegetation cover, using MCE (Multi Criteria Evaluation) approach. Modeling of odor dispersion and final map of odor pollution are shown respectively in Figure 6 and 7. Extract of information from odor pollution map shows that the most odor pollution is relevant to alternative 1. Also alternative 2 has the least amount of odor pollution.

Surface Water: Existence of many rivers in alternative 1 makes the region vulnerable against surface water pollution. Alternative 3 has the least amount of surface water levels that leads to less vulnerability against pollutions.

Ground Water: Groundwater depth in alternative 1 is the most among all and it is the least in alternative 3. Hence, by implementation the project in alternative 3, the least negative impacts will be affecting the under groundwater levels.

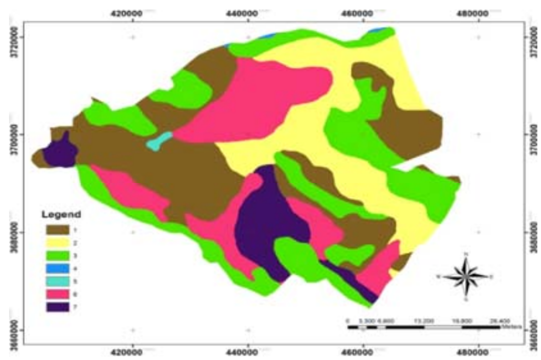

Fig. 3: Soil erosion map

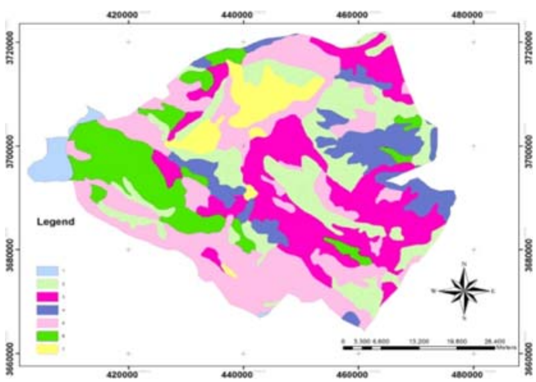

Fig. 4: Soil pollution map

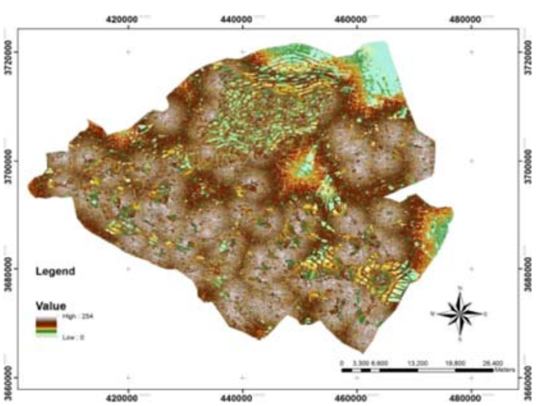

Fig. 5: Noise pollution map

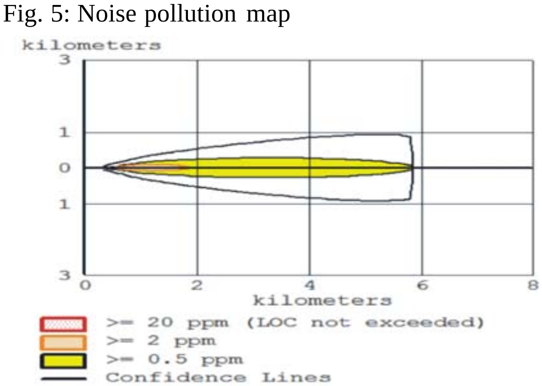

Fig. 6: Modeling of odor dispersion

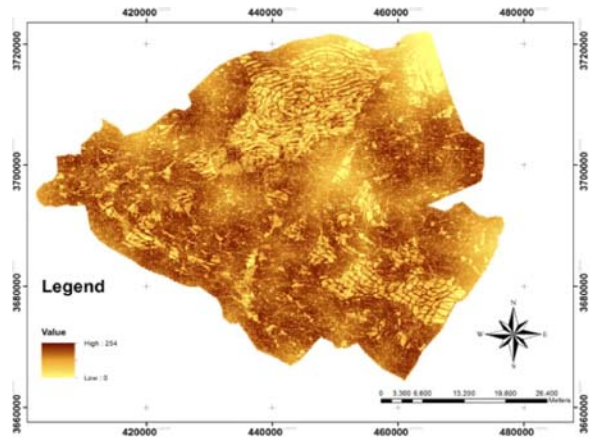

Fig. 7: Odor pollution map

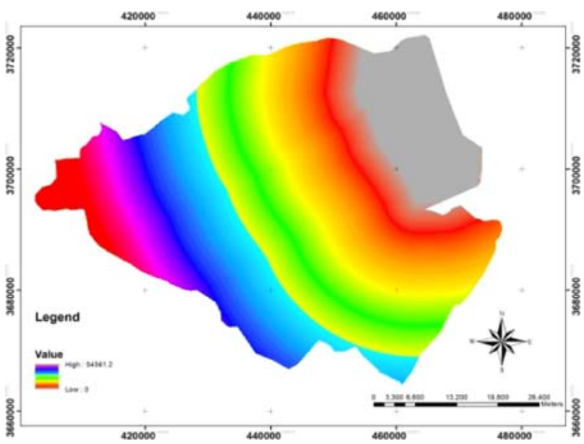

Fig. 8: Distance map of protected area

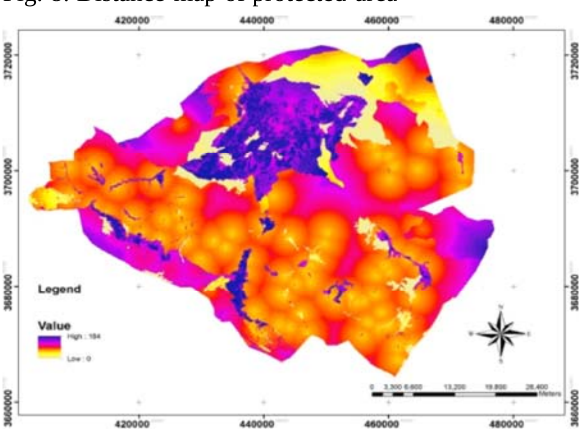

Fig. 9: Biodiversity map

Loss of Habitat: Since the protected areas are indicators of important and valuable habitats, the distance map of these regions, shown in Figure 8, was used to assess the effects of landfills on habitat loss. From this viewpoint, alternative 1 will be at lower negative risk than other alternatives and alternative 3 will be at the higher risk.

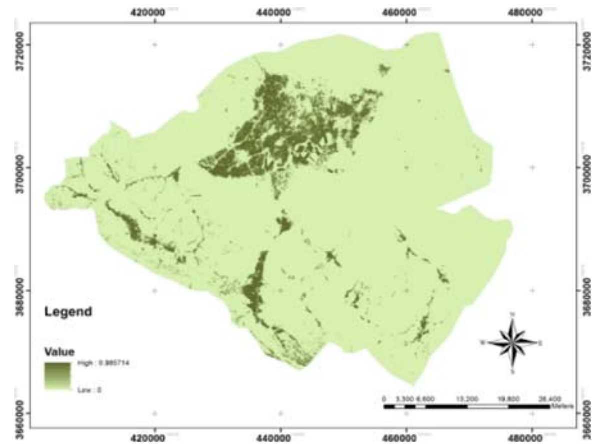

Fig. 10: Density of vegetation cover map

Biodiversity: Biodiversity map was obtained from combination of vegetation cover map, residential area and land use map by using MCE (Multi Criteria Evaluation) approach. Biodiversity factor in alternative 2 is higher than alternative 1 and 3. So, project implementation in alternative 2 will have higher negative effects. The related biodiversity map is shown in Figure 9.

Land Use: For determining building destruction and construction activities the land use map was used and it was found that alternative 3 receives greatest impacts of these activities, because alternative 3 is adjacent to irrigated agricultural lands and urban areas.

Loss of Vegetation Cover: By implementing the project, the highest loss of vegetation will happen in alternative 3. NDVI (vegetation density map) is shown in Figure 10.

General Hygiene: To study public hygiene considering the issue that this parameter is affected by residential area distance, urban and rural area maps were combined and the distance map for them was prepared that is shown in Figure 11. According to the investigations done, it was determined that project implementation in alternative 1 will cause greatest negative effects on public hygiene.

Also, resulting maps for project activities were prepared as follows:

Drainage: Map of Digital Elevation Model was used to prepare the drainage map. Drainage map is shown in Figure 12.

Access Roads: Distance of roads map is shown in Figure 13.

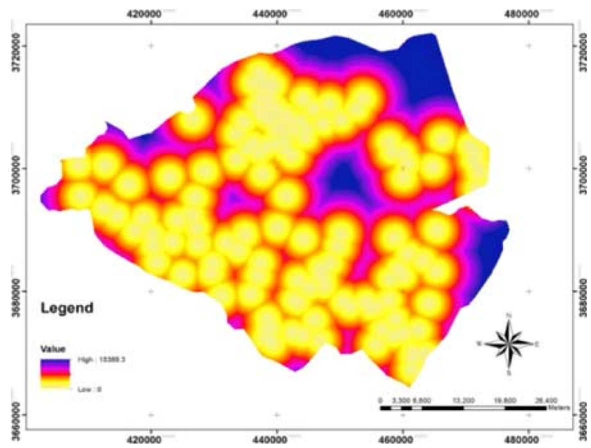

Fig. 11: Distance map of residential area

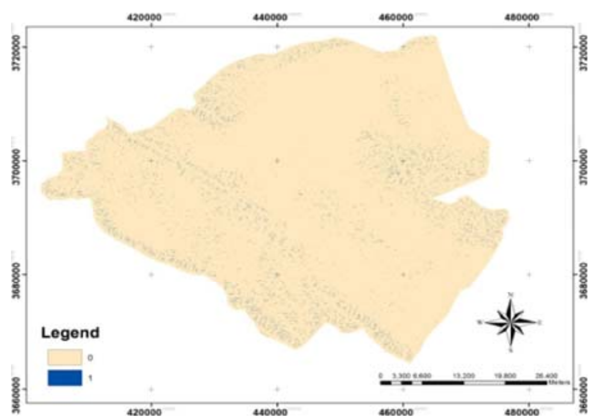

Fig. 12: Drainage map

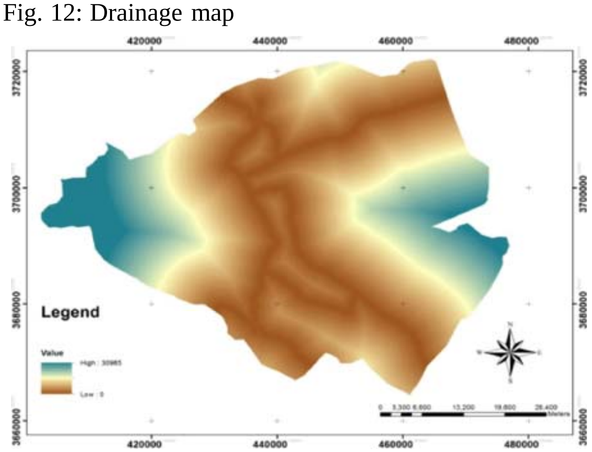

Fig. 13: Distance of roads map

Transportation: To investigate this activity, the same residential areas distance map was used, that is shown in Figure 11.

Maps Extracted Information Results: Resulting map were used for more scrutiny and determination the levels of their impressibility from environment in IDRISI. Extracting in IDRISI software provides statistical information of desired layer for users. This information includes the average, minimum value, maximum value and the standard deviation and in this study we used the mean value of layers for analysis. The results of maps processing in three alternatives for environmental parameters and for project activities are shown respectively in Table 2 and 3. Since parameters that have been studied are different, their change ranges are also different in a large extent. Moreover, some of the parameters have measures and others are with no measure and even dimension. For example, measure of groundwater is Meter and the measure of excavation (derived from slope map) is Percentage.

For quantification purposes and using the resulted information from maps, the resulted figures through multiplication of Table 2 and 3 for each of alternatives were used in ranking and scoring the related mathematical matrix tables. Multiplication resulted figures are listed in Table 4 to 6 separately for each of alternatives.

The results of implementations in this method for three alternatives are shown in Table 7 and 8 respectively. In this table EX and Gij represent the overall quality criteria and impacts significance respectively. a

In this study, the evaluation process was done based on extracted figures from the map and not only impacts were quantified, but also the used method is repeatable and could be usable and reliable in the next different evaluations by different experts. Using the introduced factors in mathematical matrix will provide better and more acceptable results. Finally, the significance of the effects are ranked in four significance classes: very low (0-0.24), low (0.25-0.49), high (0.5-0.74) and very high (0.75-1) (Bojorquez-Tapia *et al*. 1998). Classification results of effects significance are provided in Table 9.

After classifying effects significance to be represented as a model based on mathematical principles, the following formula was used to select the best alternative:

$$\sum_{i=}^{n} xi * wi = Ai \qquad (6)$$

where A_i = the final figure of effects on the target alternative, X_i = Total effects figure in the target group, W_i = Weight allocated to the effects group.

Weights allocated to the effects group are as follows:

VL=0.1, L= 0.2, H= 0.3, VH= 0.4

Table 2: The results of processing of maps in three alternatives for environmental parameters

Environmental parameters	Alternative 1	Alternative 2	Alternative 3
Visual pollution	0.88	0.86	0.99
Soil erosion	5.36	2.16	3.86
Soil pollution	4.81	4.04	2.08
Noise pollution	221.24	205.12	195.92
Odor pollution	213.36	202.08	207.90
General hygiene	1904.05	4581.399	3383.27
Surface water	0.0079	0.0074	0.0059
Ground water	24.15	22.24	18.70
Loss of habitat	20290.58	10496.18	5174.068
Loss of biodiversity	54.09	67.16	62.56
Loss of natural cover	0.017	0.006	0.055

Table 3: The results of processing of maps in three alternatives for project activities

Project activity	Alternative 1	Alternative 2	Alternative 3
Excavations	0.92	0.94	0.99
Clearing of trees	0.017	0.006	0.055
Drainage	0.0065	0.0109	0.0060
Access roads	1269.925	7027.97	3796.868
Destruction of building	0.89	0.85	0.46
Transportation	1904.05	4581.399	3383.27

Table 4: Interactions between environmental parameters and project activities in alternative 1

Project activity / Environmental parameters	Excavations	Clearing of trees	Drainage	Access roads	Destruction of buildings	Transportation
View shed pollution	0.809	0.014	0.0057	1117.53	0.78	1675.56
Soil erosion	4.93	0.091	0.0348	6806.79	4.77	10205.70
Soil pollution	4.42	0.081	0.0312	6108.33	4.28	9158.48
Noise pollution	203.54	3.76	1.43	280958.20	196.90	421252.02
Odor pollution	196.29	3.62	1.38	270951.19	189.89	406248.1
General hygiene	1751.726	32.36	12.37	2418000.69	1694.60	3625406.40
Surface water	0.007268	0.00013	0.000051	10.032	0.007	15.04
Ground water	22.21	0.41	0.15	30668.68	21.49	45982.80
Loss of habitat	18667.33	344.93	131.88	2576514.80	18058.61	38634278.84
Loss of biodiversity	49.76	0.91	0.35	68690.24	48.14	102990.06
Loss of natural cover	0.015	0.0002	0.00011	21.58	0.015	32.36

Table 5: Interactions between environmental parameters and project activities in alternative 2

Project activity / Environmental parameters	Excavations	Clearing of trees	Drainage	Access roads	Destruction of buildings	Transportation
View shed pollution	0.808	0.005	0.0093	6044.05	0.73	3940.003
Soil erosion	2.03	0.012	0.0235	15180.41	1.83	9895.82
Soil pollution	3.79	0.024	0.044	28392.99	3.43	18508.85
Noise pollution	192.81	1.23	2.23	1441577.20	174.35	939736.56
Odor pollution	189.95	1.21	2.20	1420212.1	171.76	925809.1
General hygiene	4306.51	27.48	49.93	32197934.73	3894.18	20989216.79
Surface water	0.006956	0.00004	0.00008	52.0069	0.006	33.902
Ground water	20.90	0.13	0.24	156302.05	18.90	101890.31
Loss of habitat	9866.4092	62.97	114.40	73766838.15	8921.75	48087188.55
Loss of biodiversity	63.13	0.40	0.73	471998.46	57.08	307686.75
Loss of natural cove	0.005	0.00003	0.000065	42.16	0.0051	27.48

Table 6: Interactions between environmental parameters and project activities in alternative 3

Project activity / Environmental parameters	Excavations	Clearing of trees	Drainage	Access roads	Destruction of buildings	Transportation
View shed pollution	0.98	0.054	0.0059	3758.89	0.45	3349.44
Soil erosion	3.82	0.212	0.0231	14655.91	1.77	13059.43
Soil pollution	2.05	0.114	0.012	7897.48	0.956	7037.209
Noise pollution	193.96	10.77	1.17	743882.37	90.12	662851.04
Odor pollution	205.82	11.43	1.24	789368.85	95.63	703382.66
General hygiene	3349.43	186.07	20.29	12845829.59	1556.30	11446515.89
Surface water	0.0055	0.0003	0.00003	21.26	0.002	21.74
Ground water	18.51	1.02	0.11	71001.43	8.60	63267.22
Loss of habitat	5122.32	284.57	31.04	19645253.21	2380.07	17505289.73
Loss of biodiversity	63.93	3.44	0.37	237532.06	28.77	211657.62
Loss of natural cove	0.054	0.0030	0.00033	208.82	0.025	186.08

Table 7: Values of the Quality Criteria in 3 alternatives

Project Activity / Environmental parameter	Excavations			Clearing of trees			Drainage			Access roads			Destruction of buildings			Transportation		
		EX			EX			EX			EX			EX			EX	
Alternatives	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Visual pollution	0.55	0.55	0.58	0.16	0.16	0.16	0.22	0.16	0.16	0.25	0.27	0.28	0.33	0.33	0.33	0.47	0.52	0.5
Soil erosion	0.61	0.63	0.63	0.61	0.5	0.63	0.13	0.13	0.13	0.63	0.66	0.63	0.55	0.58	0.66	0.63	0.69	0.69
Soil pollution	0.61	0.63	0.63	0.13	0.13	0.16	0.19	0.16	0.16	0.11	0.19	0.19	0.16	0.16	0.16	0.19	0.19	0.19
Noise pollution	0.72	0.72	0.75	0.58	0.55	0.63	0.22	0.22	0.22	0.80	0.83	0.80	0.77	0.80	0.83	0.80	0.83	0.80
Odor pollution	0.16	0.16	0.16	0.25	0.22	0.27	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.19	0.19	0.19
General hygiene	0.16	0.16	0.16	0.13	0.13	0.13	0.11	0.11	0.11	0.16	0.16	0.16	0.25	0.27	0.27	0.41	0.47	0.44
Surface water	0.44	0.47	0.5	0.30	0.27	0.27	0.47	0.44	0.44	0.27	0.30	0.30	0.13	0.13	0.13	0.19	0.19	0.19
Ground water	0.44	0.47	0.5	0.30	0.27	0.27	0.47	0.44	0.44	0.27	0.30	0.30	0.13	0.13	0.13	0.19	0.19	0.19
Loss of habitat	0.5	0.55	0.58	0.55	0.47	0.58	0.44	0.38	0.38	0.63	0.69	0.63	0.38	0.63	0.69	0.61	0.66	0.63
Loss of biodiversity	0.5	0.52	0.55	0.55	0.47	0.58	0.27	0.25	0.25	0.5	0.55	0.52	0.36	0.52	0.58	0.38	0.44	0.41
Loss of vegetation cover	0.52	0.55	0.58	0.69	0.61	0.72	0.41	0.33	0.33	0.58	0.63	0.63	0.47	0.58	0.61	0.66	0.72	0.69

Table 8: Values of the impacts significance in 3 alternatives

Project Activity / Environmental parameters	Excavations			Clearing of trees			Drainage			Access roads			Destruction of buildings			Transportation		
		Gij			Gij			Gij			Gij			Gij			Gij	
Alternatives	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Visual pollution	0.60	0.67	0.41	0.66	0.64	0.61	0.38	0.29	0.32	0.46	0.41	0.46	0.59	0.55	0.50	0.63	0.49	0.57
Soil erosion	0.62	0.41	0.11	0.31	0.39	0.21	0.36	0.27	0.27	0.48	0.31	0.40	0.49	0.29	0.40	0.58	0.68	0.50
Soil pollution	0.71	0.76	0.74	0.42	0.38	0.35	0.28	0.35	0.26	0.26	0.38	0.33	0.35	0.39	0.34	0.46	0.48	0.44
Noise pollution	0.49	0.64	0.76	0.60	0.63	0.41	0.40	0.41	0.33	0.50	0.31	0.40	0.52	0.62	0.72	0.50	0.31	0.40
Odor pollution	0.29	0.31	0.27	0.34	0.36	0.30	0.26	0.27	0.23	0.33	0.35	0.31	0.30	0.26	0.26	0.38	0.44	0.41
General hygiene	0.56	0.45	0.52	0.63	0.53	0.60	0.32	0.28	0.29	0.41	0.52	0.49	0.52	0.43	0.49	0.60	0.48	0.55
Surface water	0.39	0.58	0.67	0.56	0.43	0.27	0.57	0.52	0.61	0.57	0.65	0.61	0.56	0.51	0.48	0.55	0.63	0.57
Ground water	0.40	0.31	0.21	0.66	0.45	0.30	0.60	0.53	0.64	0.55	0.65	0.61	0.59	0.59	0.56	0.57	0.63	0.60
Loss of habitat	0.31	0.50	0.60	0.63	0.49	0.41	0.52	0.60	0.65	0.52	0.43	0.61	0.74	0.78	0.80	0.63	0.55	0.66
Loss of biodiversity	0.48	0.35	0.43	0.60	0.67	0.52	0.49	0.41	0.44	0.57	0.41	0.50	0.63	0.70	0.70	0.60	0.48	0.54
Loss of vegetation cover	0.30	0.39	0.21	0.53	0.60	0.43	0.59	0.64	0.51	0.60	0.52	0.52	0.63	0.75	0.58	0.61	0.70	0.53

Table 9: Classification results of impact significance

Alternatives	Impacts classification		Excavations	Clearing of trees	Drainage	Access roads	Destruction of buildings	Transportation	Total of impacts
	0-0.24	VL	0	0	0	0	0	0	**0**
١	0.25-0.49	L	7	3	7	5	3	2	**27**
	0.5-0.74	H	4	8	4	6	8	9	**39**
	0.75-1	VH	0	0	0	0	0	0	**0**
	0-0.24	VL	0	0	0	0	0	0	**0**
٢	0.25-0.49	L	6	6	7	7	4	6	**36**
	0.5-0.74	H	4	5	4	4	5	5	**27**
	0.75-1	VH	1	0	0	0	2	0	**3**
	0-0.24	VL	3	1	1	0	0	0	**5**
٣	0.25-0.49	L	3	7	6	6	5	3	**30**
	0.5-0.74	H	4	3	4	5	5	8	**29**
	0.75-1	VH	1	0	0	0	1	0	**2**

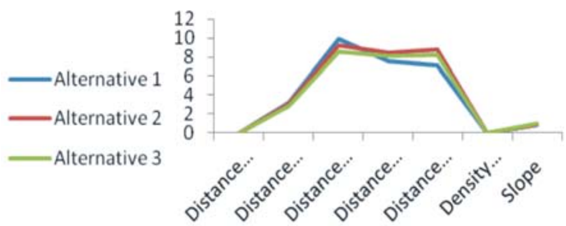

Fig. 14: Shows important parameters in site selection of compost plant in three alternatives

The final resulted figure using formula 6 for each of the alternatives is as follows:

$A_1 = 17.1$, $A_2 = 16.5$, $A_3 = 16$

So, according to the results, alternative 3 is the best alternative to construct the compost plant in. In whole, alternative 3 is introduced as the first, alternative 2 as the second and alternative 1 as the third priority. Graph 14 shows important parameters in locating compost plant in three alternatives. In Y axis, Lns of the figures resulted from parameters extracting and in X axis, important parameters in site selection of compost plant are shown.

The results of implementing this method show that alternative 3 can be considered and introduced as the best alternative or option for constructing the compost plant. By studying the maps and table 2, we can attribute the reason of the above claim to issues as:

- Lower levels of soil pollution in alternative 3 comparing with other alternatives
- Lower levels of noise pollution in alternative 3 comparing with other alternatives
- Lower levels of important resources of surface water in alternative 3 comparing with other alternatives
- Lower levels of groundwater depths in alternative 3 comparing with other alternatives

However, by implementing the project in alternative 1, the highest rate of soil erosion, soil pollution, odor pollution, groundwater pollution and noise pollution will appear.

CONCLUSION

Mathematical approaches to handling imprecise concepts have been developed and used in different situations. If the identification and characterization of alternative options is implemented with sufficient objectivity and mathematical rigor, then the selection of particular option should be very well justified and/or simplified-even in the most sensitive and contentious situations [24]. This approach has flexibility through inclusion of compensation criterion and controversy which help in bringing about consensus among proponents and EI assessors and therefore, will create more justifiable results in comparison with subjective approaches. Using mathematical matrix reduces final disagreement between decision-makers with regard to policies that has taken and offers a model based on mathematical calculations. Also its mathematical nature causes that impacts calculation has a strong support and this problem can be useful in justification for policy makers to adopt the method as acceptable. Also, since in evaluation by mathematical matrix method, mitigation to reduce project negative impacts on environment is also considered, the results have more strength [25].

Impact evaluation and significance determination pose substantial challenges to many environmental professionals both those working with EIA and those in other areas of environmental management. Often, a central question in these processes is how to maximize assessment accuracy while simultaneously ensuring that the results obtained remain understandable [10]. Mathematical matrix method is one of the methods that have been developed to find a balance between these issues. The use of mathematical techniques facilitates the manipulation of different kinds of data, ranging from direct field measurements, the outcome of quantitative simulations, and even expert knowledge and non-expert intuition. Hard data can be used to define the basic criteria, while values constitute the basis for the supplementary criteria. Iterative analyses allow interdisciplinary teams to estimate the efficiency of the mitigation measures and to explore alternative scenarios. Environmental impact assessments can be enhanced by including these prerequisites more rigorously, as shown by this case study. The effectiveness of an assessment is increased by using mathematical matrices. Mathematical matrices can increase the effectiveness of EIAs in handling data, mainly because users are forced to explicitly define the direct interactions and higher- order interdependencies between variables [26, 27]. Furthermore, the results of mathematical matrices allow the interdisciplinary team to estimate the efficiency of the mitigation measures and to easily explore alternatives. Mathematical matrix method is flexible and can be useful as a tool for discussions among interested parties. Therefore, in this research mathematical matrices were found useful in selection of the best alternative of the compost plant.

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