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Establishment of Effective Environmental Criteria for Oil Products Farm Site Selection, The First Guideline

Hamdireza Kamalan [1], and Ghazaleh Jazani [2]

[1] Ph.D. Civil and Environmental Engineering, Assistant Professor, Dean of Civil Engineering Faculty, Islamic Azad University – Pardis Branch

[2] M.Sc. Civil and Environmental Engineering, K.N.Toosi University of Technology

Abstract. The main objective of this research program is to establish a guideline for oil products farms site selection. Site selection process should follow criteria to find the best fitted place for the industry based on "maximum benefit" principle along with economical, social, and environmental considerations. On this basis, a long list of criteria was gathered from the literature. Then, it was changed to short list criteria through consulting a group of experts. The short listed criteria were evaluated and weighted through an Analytical Hierarchy Process (AHP). As results show, natural disasters with weight of 11.07 is the most important criterion in site selection among 22 ones. The next five most important criteria are (i) oil tanks farm location with respect to surface water resources, (ii) physico-chemical soil characteristics, (iii) groundwater resources, (iv) groundwater table depth, and (v) groundwater quantity.

Keywords: Oil Products Farm, Site Selection, Environmental Criteria, AHP, Guideline

1. Introduction

Oil industry is the most important Iranian industry, and its products are used with variety of consumers. In order to supply the oil products in the least cost and time consumption, Oil Product Farms (OPF) is constructed. Based on consumers demands, different types of oil products are stored and then distributed [1].

Since the oil products are categorized as hazardous material in environment literature [2], OPF as high volume reservoir posses high potential of environmental hazards, which can disturb and pollute the environment considerably. On this basis, establishing environmental criteria in site selection is by far the most important issues in this regard [3].

In OPF site selection, one is to choose a place in a way to minimize the total cost of construction and also production and/or services distribution. On the other hand, negative environmental and safety impacts of the facility construction and maintenance should be minimized, too [4]. Although site selection had been the concern of geographysts, economists have completed their theories. In fact, site selection theories usually provide criteria to find the best fitted place for an industry based on "maximum benefit" principle. Previously, economical benefit (least cost and most revenue) was an essential consideration for this selection and environmental and safety criteria received less attention [4].

Similarly, the main criteria for oil industry site selection were economical ones such as cost of transportation and operation and there is no environmental and safety criteria for fuel farm site selection were considered [4].

In deed, there are some guidelines which provide some environmental criteria for landfill site selection [5] [6], and Geographical Information System (GIS) is the most useful tool in this regard [8]. Establishment of effective parameters in site selection is the heart of these studies; nevertheless, the values of parameters have not been considered authentic [8]. However, attentions have been drawn mostly toward socioeconomic criteria in similar studies on urban gas stations [4] and power plants [7].

Investigations showed that there is still no study on OPF site selection focusing on environmental parameters. Also, there is no investigation on establishment of an inventory of effective environmental criteria, as well as, their importance for OPF.

To set the importance of each parameter, there are different methods of parameters weighting such as ranking, rating, and pair-wise Comparison. All decision making parameters are prioritized in ranking technique, while importance value is allocated for decision making parameters in rating technique. Usually normalization through a mathematical process will follow to prioritize these values. However, pair-wise comparison is a systematic process to compare decision making parameters two by two. Priority and importance of each are established through a table afterward [9].

Selection of the above mentioned methods depends on importance, ease, accuracy, understandability for decision maker. The last method is the most accurate one which are mostly used for all kinds of decision making, especially Multi Criteria Decision Making (MCDM) [9]. Accordingly, there are different theories and consequently different methods for site selection as a decision making activity. GIS is the most used tool in this regard [5 - 7]. Recently MCDM approach with pair-wise tool is used to weight options which can be considered as a great assist for GIS [6].

On this basis, pair-wise comparison has been selected based on its accuracy as an MCDM approach to establish the environmental criteria for OPF site selection.

2. Material and Method

In this study, all activities of potential environmental hazards have been determined after identification of all sections of OPF. Since utilities (electricity, water, land, access roads …) are quite important for sustainable operation, all environmental factors which affect site selection have been investigated through literature review, site visits, and experts consultation. Then, these factors have been categorized in three classes as physicochemical, biological, and human-made environment.

Initially, a list of 96 effective environmental criteria for oil products fuel farm site selection has been provided and among them 22 criteria have been selected as more effective and important ones.

Since the aim of this study is to provide a framework for environmental site section of OPF, second step is weighting of each environmental factor. The most used method for this purpose is Analytical Hierarchy Process (AHP) [5]. By means of Expert Choice (EC2000) software, which requires interviewing a group of experts [7].

Accordingly, a group of experts consisting different specialties relevant to OPF site selection has been consulted as follow: (i) Environmental management, (ii) Environmental engineering, (iii) Different branches of civil engineering, (iv) Economy, (v) Health-Safety-Environment (HSE), (vi) OPF management and specialties, (vi) Process engineering, (vii) Oil products specialties, (viii) Natural resources, and (ix) Sanitary engineering.

Results of interviews have been loaded into EC2000 software, and the results of running this software are presented in the following section.

3. Results

As it has been mentioned previously, a list of 22 criteria has been provided. The list presented in table 1, contains criteria which have no clear legal, technical, and environmental limitation or obligation on.

Table 1- Effective Environmental Criteria for Oil Products Farms (OPF) Site Selection

Sub-Criteria	Criteria	Environment
OPF location With Respect to Surface Water Resources	**Surface Water**	**Physico-Chemical Environment**
Importance of Surface Water Resources		
Surface Water Use		
Importance of Groundwater Resources	**Groundwater**	
Groundwater Flow Gradient		
Groundwater Quantity		

Sub-Criteria	Criteria	Environment
Groundwater Table Depth		
OPF location With Respect to Groundwater Resources		
Natural Disasters (flood, seismic conditions, and land slide probability)	**Land and Soil**	
Land Use		
Slop and Topography		
Physico-chemical Soil Characteristics (permeability, stability or subsidence, and soil corrosiveness)		
Unfavorable Climate Conditions (storm, hurricane, lightning, avalanche, frost and kindred phenomena)	**Climate, Air, Noise**	
Precipitation		
Prominent Wind Direction		
Proximity to Special Habitats (plants)	**Flora**	**Biological Environment**
Proximity to Special Habitats (animals)	**Fauna**	
Land Possession	**Socio-Economic Environment**	**Human-Made Environment**
Transportation Economy		
Availability of Utilities		
Public Objection		
Proximity to Cultural, Historical, Archeological and Religious heritage	**Cultural Environment**	

Selecting AHP method, interviews results were entered into EC2000 software, and pair-wise comparisons were applied afterward. The results of importance weight of factors in physicochemical, biological, and socioeconomic environment are presented in tables 2, 3, and 4, respectively.

Table 2- Physico-chemical Factors' Weight (%)

Weight	Sub-Criteria	Criteria
2.63	OPF location With Respect to Surface Water Resources	**Surface Water**
0.53	Importance of Surface Water Resources	
0.99	Surface Water Use	
1.05	Importance of Groundwater Resources	**Groundwater**
1.06	Groundwater Flow Gradient	
1.87	Groundwater Quantity	
1.9	Groundwater Table Depth	
2.18	OPF location With Respect to Ground Water Resources	
6.14	Natural Disasters	**Land and Soil**
1.48	Land Use	
1.4	Slop and Topography	
2.29	Physico-Chemical Soil Characteristics	
1.07	Unfavorable Climate Conditions	**Climate, Air, Noise**
0.66	Precipitation	
0.76	Prominent Wind Direction	

Table 3- Biological Factors' Weight (%)

Weight	Sub-Criteria	Criteria
2.63	OPF location With Respect to Surface Water Resources	**Surface Water**
0.53	Importance of Surface Water Resources	
0.99	Surface Water Use	
1.05	Importance of Groundwater Resources	**Groundwater**
1.06	Groundwater Flow Gradient	
1.87	Groundwater Quantity	
1.9	Groundwater Table Depth	
2.18	OPF location With Respect to Ground Water Resources	
6.14	Natural Disasters	**Land and Soil**
1.48	Land Use	

Weight	Sub-Criteria	Criteria
1.4	Slop and Topography	
2.29	Physico-Chemical Soil Characteristics	
1.07	Unfavorable Climate Conditions	**Climate, Air, Noise**
0.66	Precipitation	
0.76	Prominent Wind Direction	

Table 4- Human made factors' weight (%)

Weight	Sub-Criteria	Criteria
15.55	Land Possession	**Socioeconomic Environment**
12.71	Transportation Economy	
15.19	Utilities	
15.66	Public Objection	
5.22	Proximity to Cultural, Historical, Archeological and Religious heritage	**Cultural Environment**

Table 5- Effective Environmental Criteria for Oil Products Farms (OPF) site selection (%)

Weight	Environmental Factors
11.73	Natural Disasters
5.05	OPF location With Respect to Surface Water Resources
4.36	Physico-Chemical Soil Characteristics
4.09	OPF location With Respect to Groundwater Resources
3.75	Groundwater Table Depth
3.64	Groundwater Quantity
2.82	Land Use
2.73	Slop and Topography
2.68	Public Objection
2.64	Land Possession
2.59	Availability of Utilities
2.25	Unfavorable Climate Conditions
2.18	Transportation Economy
2.05	Importance of Groundwater Resources
2.05	Groundwater Flow Gradient
1.91	Surface Water Use
1.3	Precipitation
1.23	Prominent Wind Direction
1.02	Importance of Surface Water Resources (Except the surface water use)
0.89	Proximity to Cultural, Historical, Archeological and Religious heritage
0.82	Proximity to Special Habitats (Flora)
0.76	Proximity to Special Habitats (Fauna)

4. Discussion

To sum it up, the results presented in tables represent the importance of each environmental criterion. For example, weight 2.63 in table 2 shows relative importance of OFP location with respect to surface water resources. Higher weight means higher importance; in this way through comparing the weights, decision making will be easier. On the other words, the list has an ability as presenting priorities in a specific environmental (i.e., physico-chemical environment). Discussion on results can be categorized in three classes as follows:

4.1. Physico-Chemical Environment

In oil industry, hazard potential such as firing and explosion are the most important parameters in site selection. On this basis, as the tables show, a natural disaster criterion is by far the most important one. OPF location with respect to surface water resources, physicochemical soil characteristics, and OPF location with respect to ground water resources are classified as the next priorities. The reason for this fact is the importance of pollution prevention to the extent.

4.2. Biological Environment

More distance between OPF and natural habitat mitigate the adverse impacts of fuel farm construction and operation. On this basis, both proximity to special habitats for flora and fauna have been considered as the most important criteria in this environment. This distance is a distance further than legal freeze boundary in national environmental regulations. According to the results, distance to flora special habitat is slightly more important than fauna one.

4.3. Human-Made Environment

Socio-economic factors have got much more importance than cultural factor (proximity to cultural, historical, archaeological and religious heritage). Table 4 shows that utilities, land possession, and public objections are classified as the first priority with slight difference. For fuel farm construction, similar to all other construction projects, land acquisition is the biggest deal which may lead to social stress. Furthermore, fuel-tank truck transportation can be considered as a potential for (i) firing, (ii) oil products leakage, (iii) public objections. Besides, budget supply for land acquisition is by far the most concerns of decision makers.

As it is clear, availability of utilities makes the construction and operation cheaper. Thus, this parameter is categorized as a priority.

5. Conclusion

Concluding the investigations, table 5 presents a guideline for oil products farms site selection with environmental considerations. All effective environmental criteria with their importance value are sorted in this table.

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