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Land-use adjustment modeling with a modified oil refinery environmental impact assessment evaluation method supported by GIS

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Abstract

The primary purpose of an oil refinery land use and its environmental risk is potential risks of an oil refinery project and its potential impacts on environmental parameters in order to establish Integrated Environmental Impact Assessment Method (IEIAM). Dynamic social and economic impact of different environmental factors on different spatial and temporal scales, the regional land use planning has become a complicated process. The purpose of this study was to develop a new model for development and regional planning of land use in large-scale modeling of the interaction between land use and demand in the small scale. Integrated assessment of land suitability in frame of production and compilation benchmark maps, including the ecological impacts, proximity effects, access and restrictions applying intelligent methods and multi-criteria decision making was modeling in Geographical Information System (GIS) system and requirements area to various utilization breakdowns on demand units by using regression analysis of existing data was determined. The developed IEIAM system by using current five years data of Tehran and Isfahan oil refineries were assessed in Isfahan and Isfahan provinces and the allocation to different applications in urban, rural, agriculture and industry in the years between 2008 till 2012 was performed. The results indicate that in regional land use plan modeling, consider to land appropriateness integrated assessment, land use demand, change rules of user demand simultaneously are essential in this method.

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Introduction

In case of limited general overview of revives assessment parameters, sometimes it will lead to wrong consequences (Erikstad *et al.* 2008). The noticeable item of society responsibility is conditions in different phases quality and local parameters in multi-criteria occurrence (Escofet & Bravo-Pena 2007). Totally decision-making on integrated EIA plan can be a great environmental pollution prevention and project policy framework (Feldmann., 1998). In theoretical base studies for strategic environmental assessment it can lead to environmental impact assessment policy for each projects (Fischer T.B., 2003). Oil refineries studies for environmental protection were examined researches and studies about climate change (Huang *et al.* 2005). Different methodologies in Europe for strategic impact assessment to proceed to a plan for environmental screening make a real recognition of environmental assessment and screening such as Spain in large scale studies (Garcia-Montero *et al.* 2008). The instruments potential for sustainable development, environmental parameters and assessment usually are not required for judgment (George, 1999). The EIA in Europe has different items and some important corrections to directly consequences are needed in overview such as Ireland (Geraghty, 1996). The EIA and strategic environmental assessment are necessary tools that utilization of programming lead to find the major environmental problems (Gontier *et al.* 2006). Planning the EIA for different phases, sustainable development, important changes and predicts the correct analysis for every project is necessary and large scale vision (Haapio & Viitaniemi 2008). Commonly, in the case of industrial plants in large scale environmental problems have been most interested for assessment (Hanssen., 1998). The responsibility of planning to consumers, environmental banderol, production phases, and methods for impact assessment need to deep analysis and much information about the pollutants (Hertwich *et al.,* 1997). The EIA plan consists of analysis of impact sources, ecosystems, connection between impact source and targets, measurements and sustainable development (Hoepner., 1999). Environmental impact assessment (the EIA) was conceived entirely in and for a developed, Western society situation in the 1970s and 1980s. Today, most states apply the EIA in one way or another, including the "countries in the transition" phase from socialism to a market-based economy and political democracy (Holm-Hansen J., 1997). In products the environmental life cycle assessment (the LCAs) identity parameters (Huijbregts *et al.* 2005) in many countries such as Canada base on the environmental impacts, integration of public participant and environmental monitoring (Hunsberger *et al.* 2005) are methodological issues for examine and evaluate the decision-making process (Ijäs *et al.* 2010). Experimental studies have disclose the EIA targets with measurement of parameters and decision-making process (Jay *et al.,* 2007) for study area, criterion study, area work maps (Joao., 2002) in different goals of environmental assessments systems, effective environmental management with integration sustainable development in many countries for environmental management (Keen & Sullivan., 2005). The EIA system is a developed study base on the environmental correction process, environmental performances in developing countries (Keysar *et al.,* 2002) by introducing the industrial pollutions, air pollutions and ecological damages (Krieg & Faber., 2004) but for Europe countries such as Norway the value of environmental parameters and its damages integrated for EIA planning by consideration of strategic environmental assessment (Kværner *et al.,* 2006). As a result, this study sought to suggest a new method of estimating geographical location of oil refineries in Iran.

Materials and methods

Two methods have been determined for EIA oil refineries in Iran:

- Environmental Risk Assessment (ERA)
- Geographical Information System (GIS)

In tables 1 till 3 are Environmental Risk

Assessment (ERA) method has been discussed completely. In these tables base of the Environmental Risk Assessment method are already used in this project.

The two parts are combined in this project:
1-Environmental parameters and activities conducted to determine the parameters in the design-construction and operation stages.
2-Environmental Risk Assessment (ERA) has been used in for in the evaluation the method. Base on two these steps the software designed and prepared for EIA of Iranian oil refineries by case studies of Tehran and Isfahan oil refineries.

Totally ERA laws and regulations based on three stages severity impact, , impact type and significant impact. In each part some items have been considered. These items are the base of evaluation of environmental risk assessment method. Each part discuss of ERA details, terms and conditions. These details give a clear help of user for understanding of steps of decision making base on the ERA. Each subtitle of these five steps describes the effects of construction and operation phases on the environmental parameters by measuring the risks of these effects by decision making of expert team. These formulas are base calculations of ERA method. By using of these items the result of ERA will be consider in the software for getting results of EIA of oil refinery. Base on the ERA framework procedure and EIA of this project evaluation are these tables.

Table 1. Severity impact.

1	Negligible	Tolerable–No significant impact over environment and human
2	Moderate	Tiny change of nature, limited impacts over environment and human
3	Critical	Demolition of environment and moderate controllable pollution
4	Catastrophic	High pollution and impacts over environment and human

Source: National Iranian Oil Company (NIOC)-2012

Table 2. Impact types.

Positive	Desirable, with appropriate impact over economical, social and cultural environments.
Negative	Undesirable, with inappropriate impact over economical, social and cultural environments, unwanted.
No impact	No change, with no impact over economical, social and cultural environments.

Source: National Iranian Oil Company (NIOC)-2012

Table 3. Significant impact.

1 time per month	Green	no impact - low
2 times per month	Yellow	minor impact - moderate
3 time per month	Orange	major impact - high
4 time per month	Red	critical impact - extreme high

Source: National Iranian Oil Company (NIOC)-2012

Case studies

Tehran and Isfahan Oil Refineries

Tehran oil refinery

Oil refinery and environment interactions were studied given the size of the job and environmental features in the framework of different units of an oil refinery (executive, constructional, operational and processing) and different environmental (physical, biological, socio-economical and cultural) parameters. The major environmental impacts and

consequences of oil refineries include gas emissions, effluents, solid wastes, noise, odor and negative visional and aesthetic impacts (Ardalanie, 1989).

The following are the details of the oil refinery facility of the case study:
Name: Tehran Oil refining Co.
Date of establishment: 1965-1968
Date of operating: 1969 (South refinery)-1973(North refinery)
Nominal capacity: 220,000 barrels per day
Operational capacity: 240,000 barrels per day
Feed: Light crude oil of Ahvaz –Asmari oil field, crude oil of Maroon/Shadgan, Middle Asia
Production units: Crude oil distillation, viscosity control unit, liquid gas recovery, gasoline hydrogenated refining and gasoline conversion, hydrocracker, Hydrogen, Nitrogen, Sulfur recovery, Amine gas treatment (Khosravanie, 2001).

Table 4. Tehran oil refinery productions.

Real average of products	Capacity (1000 liter per day) product
Liquid gas	1259
Gasoline	1700
Jet fuel	6989
Light Naphtha	383
Kerosene	3442
Gas oil	12872
Furnace oil	7549
Crude engine oil	1878
Bitumen production feed	2160

Source: Iranian petroleum ministry

Environmental impact assessment of oil refinery in Iran is one of the most important parts for the environmental protection. So the scope for this project can cover all the oil refineries in Iran for environmental impacts assessment and knowledge of environmental management for oil refineries to help protect the environmental. The operational phase is under test and the productions and materials need to quality control as technical programming and flow sheet of major unit operations and material balance flow is under revise for till getting better results of productions. The figures 1, 2 are maps, legends of Tehran oil refinery.

Fig. 1. Tehran map consisting of Tehran oil refinery.

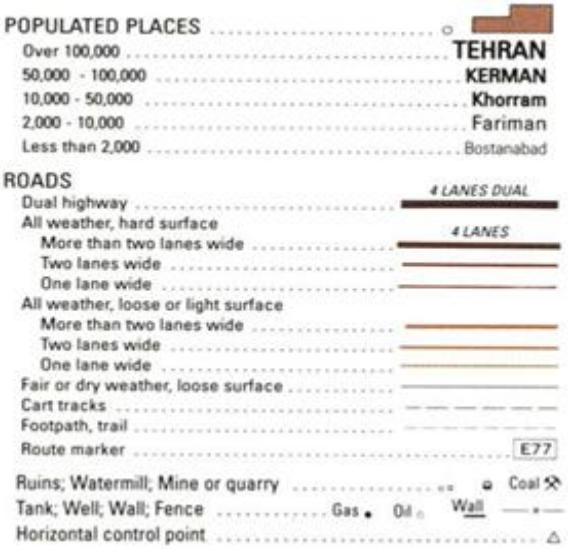

Fig. 2. Isfahan oil refinery map legend.

Isfahan oil refinery

Esfahan Oil Refining Company's activities in the field of refining crude oil and oil products production and energy security of downstream industries (Esfahan Petrochemical Company, Arak Petrochemical, Sepahan oil refining plant, Jay oil Refining industries and other chemical industries in Iran) began in 1979 and it is now proceeds about 23% of the petroleum products required to produce. The total area of 340 hectares in area and having green space area 5 /114

acres is located in the northwest of Isfahan. Isfahan refinery has seen much progress of crude oil refining per day, so much products in the early 90's, and crude oil refining capacity of the company increased 85% compared to the design capacity of 200 thousand barrels per day has increased to more than 375 thousand barrels (Khosravanie, 2001). Figures no. 8, 9, 10 and 11 are the locations of Isfahan oil refinery.

Production of Isfahan oil refinery

This refinery has many productions that come in the table below. Table 5 presents Isfahan oil refinery productions.

Table 5. Isfahan oil refinery productions.

Real average of products	Capacity (1000 liter per day) product
Liquid gas	1173
Gasoline	1600
Jet fuel	5980
Light Naphtha	434
Kerosene	5221
Gas oil	13264
Furnace oil	8549
Crude engine oil	1998
Bitumen production	3180
feed	4567
Sulfur	17323
Light oil	14562
Heavy oil	

Source: Iranian petroleum ministry

Fig. 3. Isfahan map consisting of Isfahan oil refinery.

Fig. 4. Isfahan oil refinery map legend.

Results

After identifying all the technical, environmental, social and economic factors of the projects, different options to take into consideration when carrying out the projects are assessed in order to remove the worries of the society and to lessen the adverse impacts as far as possible. One the main option that has to be assessed is the "No Option" or "Not-carrying-out-the-project Option". In this option, it would be made clear that what the environmental state of the area would be like if the project is not carried out. The result of this option would serve as the basis for comparison or a yardstick for the projects or plans. (It shows the differences between when the project is carried out and when it is not carried out). In this phase, the main aim is to provide a basis for acceptance or rejection of options. Therefore, here we should take into consideration not only the environmental issues, but also the economical issues should be taken into account, such as how long it would take for the plan to start making profits. Other issues to be dealt with are whether the project is in line with social or cultural features of the area, and whether the assessments for the costs to improve the ways the environment can be utilized are done and are well known. In selecting options issues

such as "the ratio of costs-profits", "public acceptability of the project", or "advantages versus costs" should be considered. In case no option is regarded as not being 100% safe or free-of-damage, the issues to be dealt with would be ways to reduce possible damages to the environment. And if there are other options to reduce the amount of damages imposed on the environment that are not mentioned as parts of projects or plans' activities, that option or options should be considered as a separate independent option to be included in the report.

ERA-GIS (ENVIRONMENTAL)

ERA-GIS results for environmental parameter in each phases

1. Environmental effective points were found
2. Importance ERA indexes were found
3. ERA parameters were completely combined to the different parameters maps
4. ERA Zoning maps were provided for final EIA
5. Environmental pollution maps were provided based on the ERA studies

ERA-GIS (Economical)

ERA-GIS results for economical parameter in each phases

1. Effective economical growth points were found in on maps
2. Direct income people risk maps were provided around the oil refinery
3. Indirect income people risk maps were prepared to determine the correct economical impacts around oil refinery
4. Local business risks maps were provided for EIA
5. Increase new business economical risks were determined in different area

ERA-GIS (Land use)

ERA-GIS results for land use parameter in each phases

1. The effective points of oil refinery land use were found on map.
2. Existing land uses, their distribution and settlement were determined completely.
3. Comparison of per capita and level of each land uses of the current status of the land use plan were found directly related to oil refinery.
4. Comparison of per capita and level of each land uses with consideration of current per capita in Iran and compliance with the criteria were completely done for EIA.
5. According to EIA-oil refinery studied land use classified ERA points and maps were provided in different parts.

ERA-GIS (Social)

ERA-GIS results for social parameter in each phases

1. The effective points of social parameters were determined on the map.
2. Social and cultural reaction impacts on workers and the job process, effects of the people lives, effects of entry and residence foreigners in the region and effects on social activities were studied completely.
3. Effects on increase the different life classification from so rich to poor people and its growing.
4. Social pressure on majority of people without oil expertise
5. Social inequalities resulting from the presence of high-income workers in low-income segments were studied for EIA plan.

In this project GIS-EIA of Tehran oil refinery and effects on located areas around it (Azim abad, Bagher

city, Dorsoun abad, Esmaeil abad-e-moein) and Isfahan oil refinery GIS-EIA part in most effective areas around it (Dehno, Khomeynishahr, Mahmoud abad, Shahinshahr) and different parameters (economical, environmental, land use and social) have been considered to provide the maps based on data collections, expert system decision-makers and GIS information. All these areas pointed on the maps and sat-images of their area on the GIS-EIA study of each oil refinery.

Table 6. Different parameters maps of Tehran oil refinery and located area around it during the project implementation (2008-2012).

	Parameters			
Location	**Economical**	**Environmental**	**Land use**	**Social**
Azim abad	36	28	28	36
Bagher city	36	28	28	36
Dorsoun abad	36	28	28	36
Esmaeil abad-e-moein	36	28	28	36
	144	112	112	144
Total maps	512			

Table 7. Different parameters maps of Isfahan oil refinery and located area around it during the project implementation (2008-2012).

	Parameters			
Location	**Economical**	**Environmental**	**Land use**	**Social**
Dehno	36	28	28	36
Khomeynishahr	36	28	28	36
Mahmoud abad	36	28	28	36
Shahinshahr	36	28	28	36
	144	112	112	144
Total maps	512			

All maps designed and implementation of four parts of GIS-EIA of oil refineries as case studies, Tehran oil refinery and Isfahan oil refinery. Total maps of this project are 1024 maps for two case studies in four years by developing of four parameters effects on their locations.

Table 8. Different kinds of GIS maps provided for each case study during the project implementation-Tehran oil refinery (2008-2012).

Special Geographical GIS maps	**Numbers of maps of Tehran oil refinery**			
	Azim abad	Bagher city	Dorsoun abad	Esmaeil abad-e-moein
Hill shade	16	16	16	16
Layers	16	16	16	16
Land use	16	16	16	16
Sat-image	16	16	16	16

Slope	16	16	16	16
Tin	16	16	16	16
Zoning	16	16	16	16
Total maps	112	112	112	112

Table 9. Different kinds of GIS maps provided for each case study during the project implementation-Isfahan oil refinery (2008-2012).

Special Geographical GIS maps	**Numbers of maps of Isfahan oil refinery**			
	Shahinshahr	Mahmoudabad	Dehno	Khomeynishahr
Hill shade	16	16	16	16
Layers	16	16	16	16
Land use	16	16	16	16
Sat-image	16	16	16	16
Slope	16	16	16	16
Tin	16	16	16	16
Zoning	16	16	16	16
Total maps	112	112	112	112

Actually for each location and each parameter there are 1024 maps are available as mentioned in the tables above and previous discussion. But for example of GIS-EIA oil refineries two layers maps put here. For final result of GIS-EIA of case studies there are two GIS map layers are coming as follow.

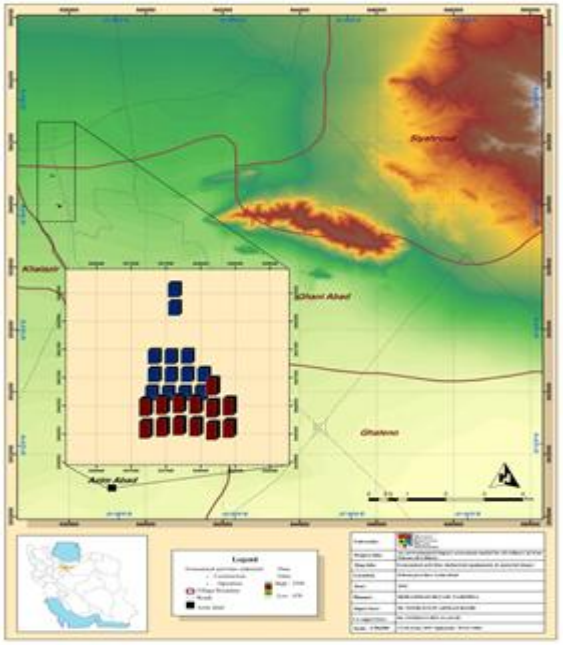

Fig. 5. GIS map located points in case of economical studies for Tehran oil refinery.

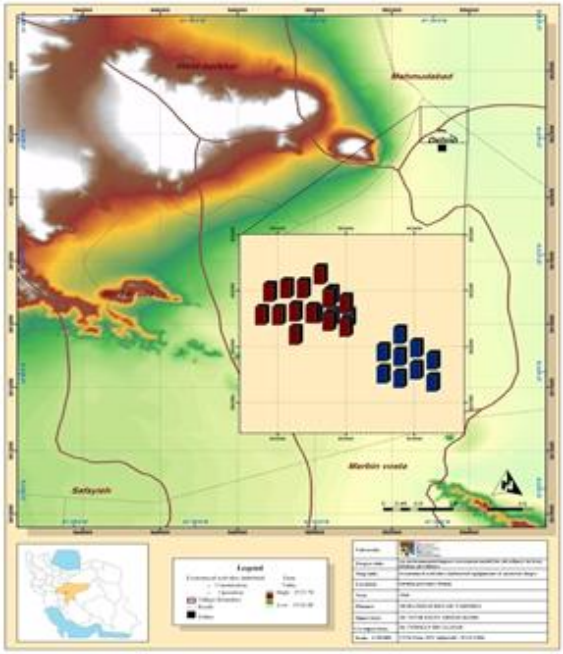

Fig. 6. GIS map located points in case of economical studies for Isfahan oil refinery.

For environmental parameters in case of oil refineries in Iran Oil contents and So_2 parameters have been considered as major problems in oil pollution and air pollution. These items have also high risk in environment and human life. Surface and

underground water pollution, land contamination, waste water treatment problems, damage to the facilities and waste materials causes of oil content in oil refineries in Iran. About So_2 effects the most effect of this parameter is air pollution, combined factor with water, soil elements in soil, agricultural products and yellow color effects on plants with sulfur factor. With GIS system user can find the most effective points of oil contents in oil refinery and area around the oil refinery. Figure 7 and 9 show the points with GIS system in case of oil content leakage (oil pollution) and So_2 as a factor for air pollution in Tehran oil refinery. Also GIS system can use for locate the future different pollution points.

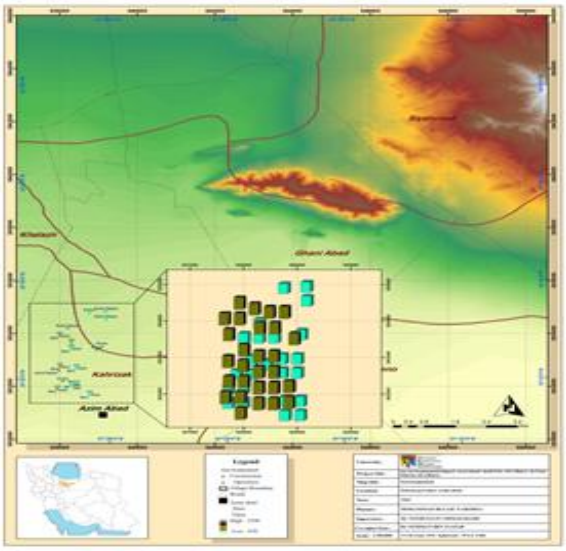

Fig. 7. GIS map located points in case of oil content and So2 pollution for Tehran oil.

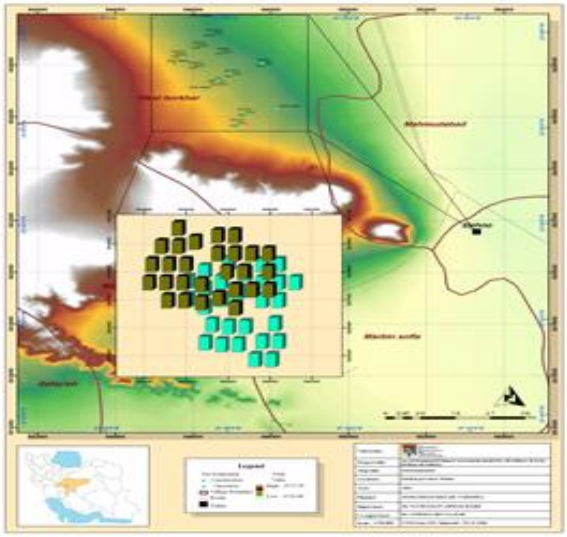

Fig. 8. GIS map located points in case of oil content and So2 pollution for Isfahan oil refinery.

In part of land use parameter determine the oil refinery future development plans, specify land use around oil refinery, current land use around oil refinery, proximity to residential, industrial and commercial areas, roads and other access routes, possibility of oil refinery relocation and assess the value of areas around the oil refinery. Based on the GIS studies Table 10 and 11 present results of the most important factors in land use parameters for Tehran and Isfahan oil refineries. The GIS with complete data can gives the most effective point in case of land use studies for Tehran and Isfahan oil refinery.

Table 10. Occupancy levels and types of land use area of major land use for Tehran oil refinery.

Row No.	Type of land use	Occupancy levels (Km^2)	Total %
1	Residential	177	28/8
2	Commercial-Administrative	26	4/2
3	Industrial-Workshop	27	4/4
4	Transport-Storage	30	49
5	Road network and access	114	18/6
6	Urban services	50	8/1
7	Green area	70	11/4
8	Agriculture (Crop- Garden)	35	5/7
9	Military	44	7/2
10	Arid and No construction	41	6/7
	Total land use	614	100

Table 11. Occupancy levels and types of land use area of major land use for Isfahan oil refinery.

Row No.	Type of land use	Occupancy levels (Km²)	Total %
1	Residential	153	22/3
2	Commercial-Administrative	22	2/2
3	Industrial-Workshop	21	1/5
4	Transport-Storage	27	46
5	Road network and access	106	10/4
6	Urban services	47	5/3
7	Green area	64	4/3
8	Agriculture (Crop- Garden)	32	2/4
9	Military	34	3/1
10	Arid and No construction	37	2/5
	Total land use	543	100

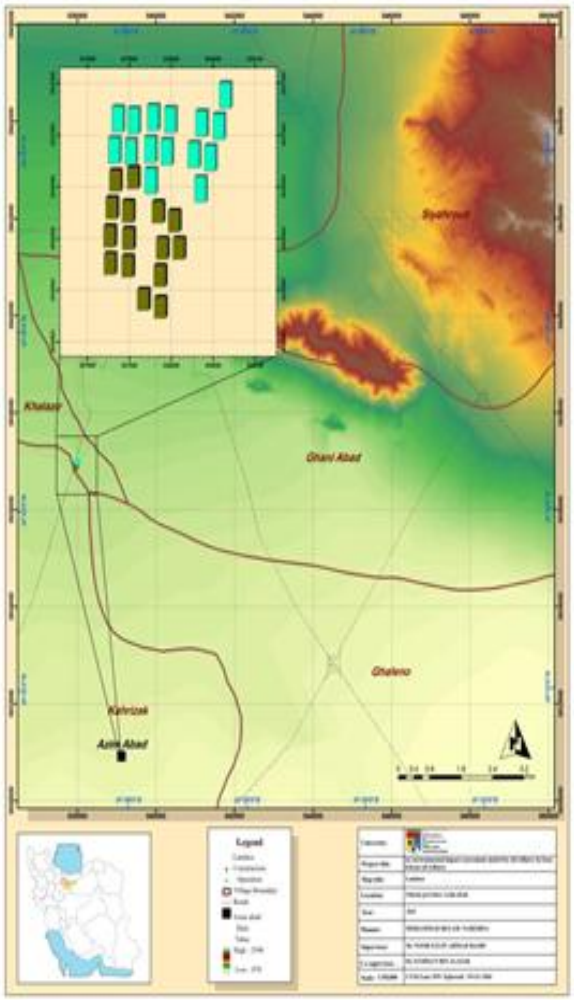

Fig. 9. GIS map located points in case of land use for Tehran oil refinery.

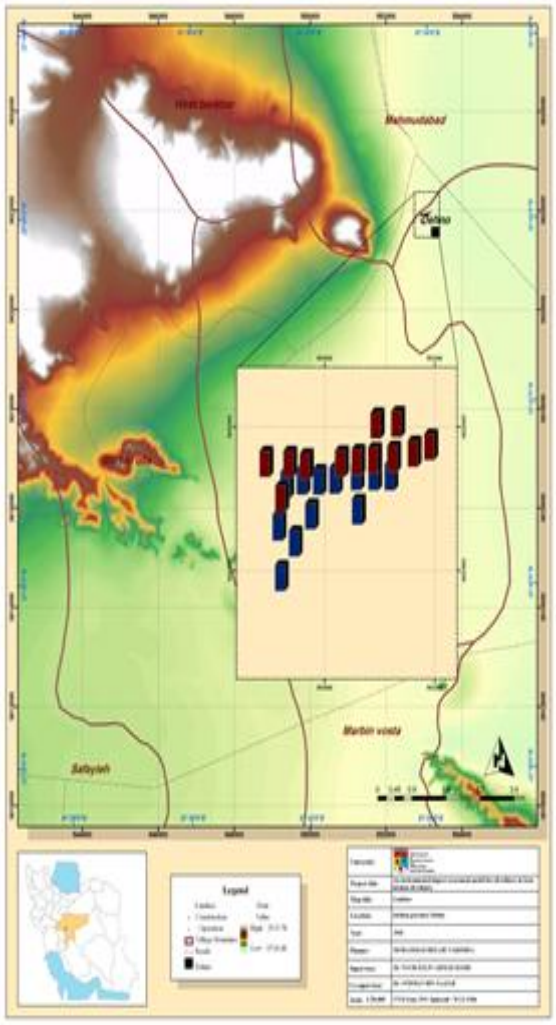

Fig. 10. GIS map located points in case of land use for Isfahan oil refinery.

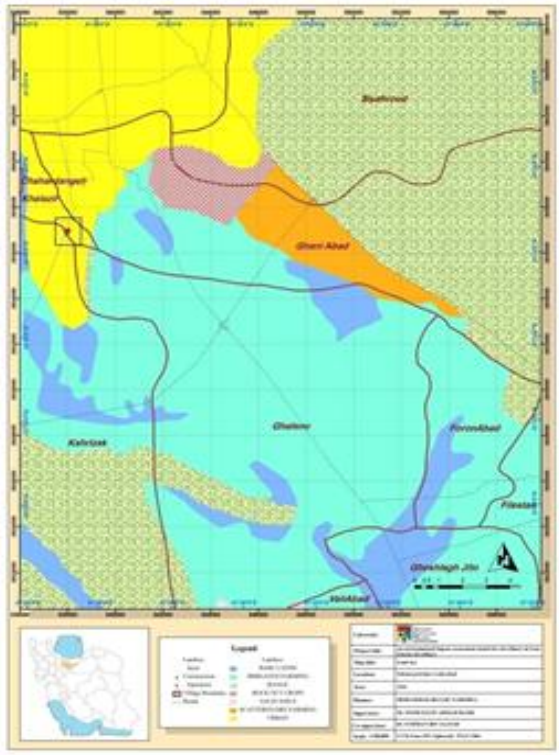

Fig. 11. GIS zoning map in case of land use for Tehran oil refinery.

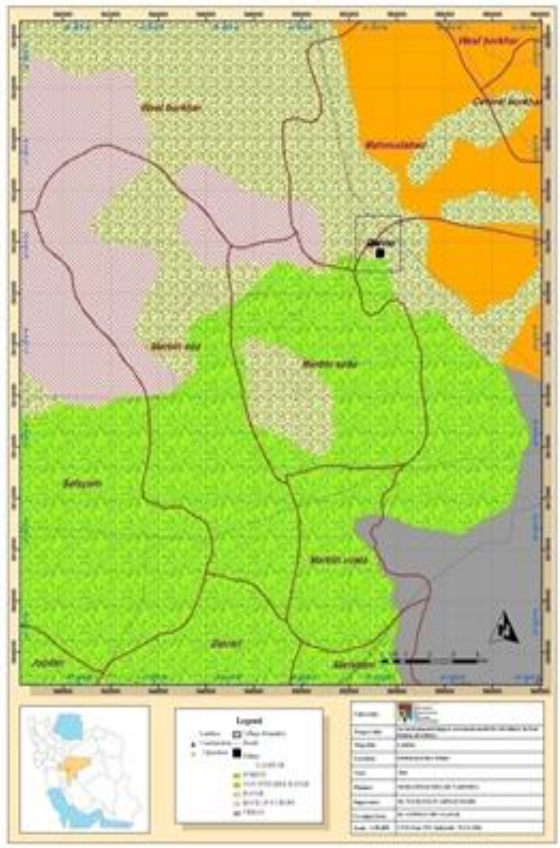

Fig. 12. GIS zoning map in case of land use for Isfahan oil refinery.

In the field of social studies base on the field studies, data collection and local assessments for oil refineries some items have been noticed for better results in social studies such as; cultural effects, environmental knowledge and historical problems. In summarize of these data the final result obtained for social studies in case of Tehran and Isfahan oil refineries. These major items are most effective problems for locals to be faced with new changes in their lives, because of oil refineries construction and operation for these reasons like; new people immigration for working in different parts, cultures varieties, religious differences, different educations, ethnic differences, historical effectives on ancient cultural and religious buildings and monuments. The most effective points by GIS map provided for both Tehran and Isfahan oil refineries. Figures 20 and 21 are shows social parameter studies most effective points in case of Tehran and Isfahan oil refineries.

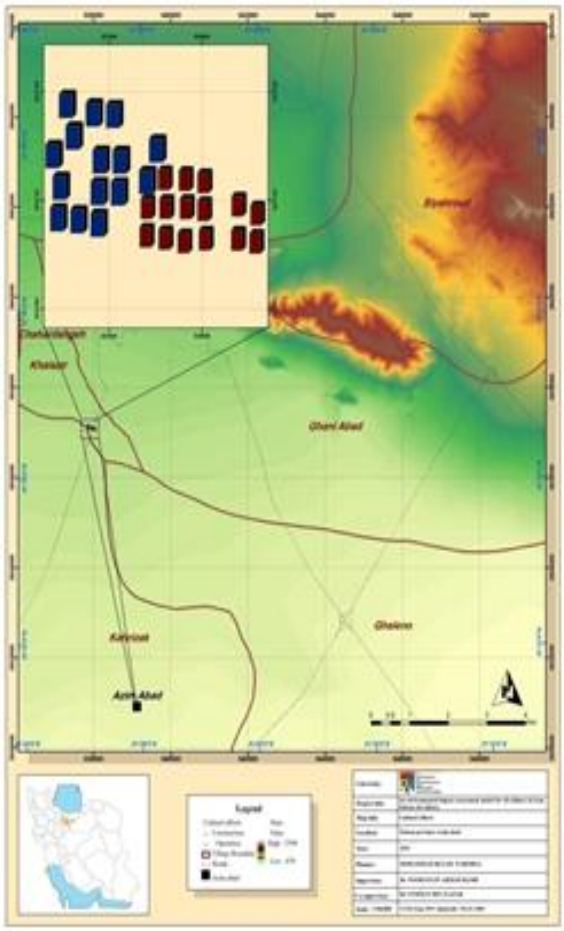

Fig. 13. GIS map located points in case of social studies for Tehran oil refinery**.**

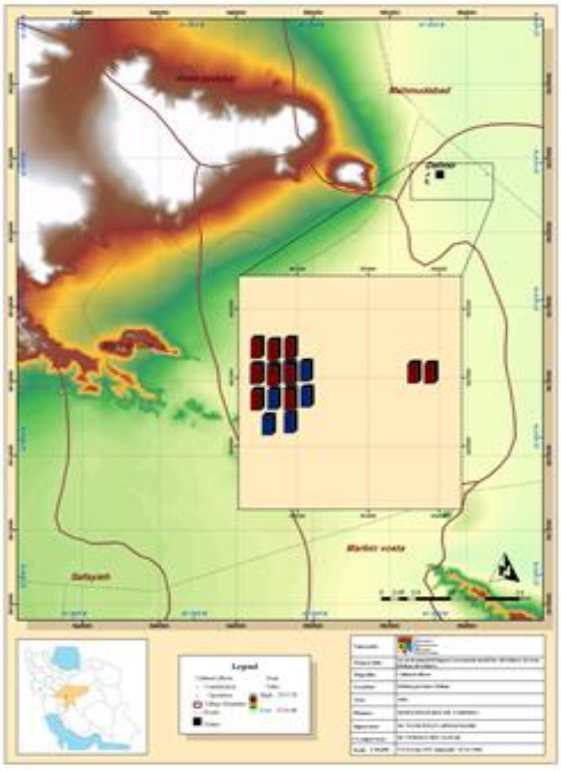

Fig. 14. GIS map located points in case of social studies for Isfahan oil refinery.

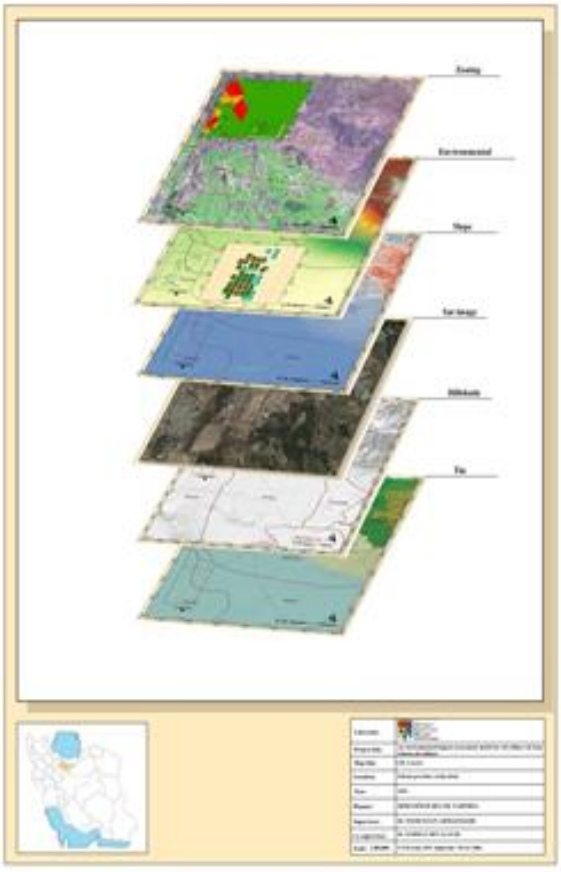

Fig. 15. GIS-EIA map layers of Tehran oil refinery.

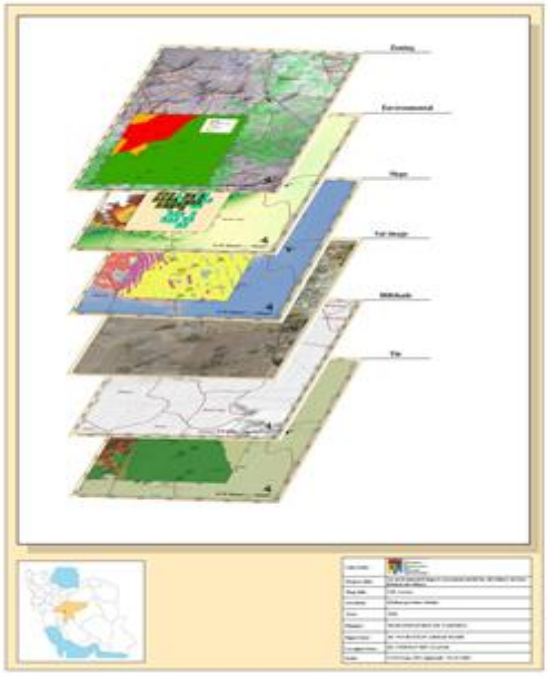

Fig. 16. GIS-EIA map layers of Isfahan oil refinery.

Conclusion

Environmental impact assessment management program for Tehran and Isfahan oil refineries have different parts. The EIA study in both construction and operation phases, data analysis and effective points have been found inside and around Tehran and Isfahan oil refineries indicate that pollution for oil refinery personnel and population centers around it caused by Tehran oil refinery

Acknowledgement

EIA plans for oil refineries are different in Iran and most of them cannot give a good view for direct environmental effects in four major EIA plan in Iran such as; environmental, economical, social and land use. The most important is a good EIA framework for oil refineries that can use for other parts of oil industry in Iran like this existing method based on the ERA-GIS method and map modeling. On the other hand this model with some modifying can use in other parts of Iran's oil industry.

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