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Prioritization of Environmental Sensitive Spots in Studies of Environmental Impact Assessment to Select the Preferred Option, Based on AHP and GIS Compound in the Gas Pipeline Project

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ABSTRACT: Environmental assessments are essential in order to align the process of country's progress towards sustainable development. It is important for the project to be implemented in direction of sustainable development, which is to carry out a project in such a way that in both short and long term, the greatest advantages and the least harm are inflicted on the environment, economy, communities, and culture. Environmental assessment of gas pipelines is classified as a linear projects; therefore, the design and implementation of an appropriate method in accordance with the project's linearity, due to the use of GIS tools and multi-criteria decision-making methods, can be a good innovation for this study, in comparison to previous similar projects. The purpose of this study is to identify the best option for gas pipelines. Once the project's study scope is specified, the study based the sensitive environmental parameters of the area (based on the requirements of environmental impact assessment reports) on two methods of Analyzing Hierarchical Process (AHP) and overlaying methods for sub-parameters, ranking and prioritizing the area of evaluation. Based on the results, the first and second priorities belong to the parameter of distance and position in the protected areas with a weight of 29.9% and hydrology with a weight of 24.7%, followed by slope, vegetation, land use, and fault, which are ranked third to seventh, respectively. After identifying the best map option, the study extracts the critical points for the construction of pipelines, identifies the negative effects of the project, and presents the environmental impacts and preventive measures, reduction and compensation of negative effects in both construction and operation phases, along with a summary of the Environmental Management Program (EMP).

Keywords: Environmental sensitive spots- EIA- Gas Pipeline- AHP- GIS- Overlaying method.

INTRODUCTION

Iran is one of the main actors of energy supply and demand, especially in terms of oil and gas, both in the area and the world. What is more, maintenance of energy production capacity in this country has always been of particular account, with one of important challenges to accomplish oil and gas projects is the destructive environmental, social, and cultural impacts of projects for this purpose. Environmental, social, and cultural assessments are necessary tools to align the country's development process towards sustainable development. Air, soil, and water

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pollutions only include environmental section of destruction effects, derived from accomplishing oil and gas projects; however, these cases affect cultural, social, and economic problems of areas under project implementation in local, regional, and national levels (Fathabadi, 2014).

Environmental Impact Assessment (EIA) is concerned with systematic identification and evaluation of potential impacts (effects), both beneficial and harmful, of proposed projects, plans, programs, or legislative actions related to physicochemical, biological, cultural, and socio-economic components of the entire environment (Padash, 2017; Rashidi et al., 2018).

Environmental assessment of pipelines, categorized as linear projects, will differ from other projects in terms of many technical and methodological aspects (Fallahnejad, 2013; Mubin & Mubin, 2016, McCoy & Rubin, 2008), thus it seems necessary to develop and design an appropriate methodology for such categories of projects in accordance with their linearity (Kerzner & Kerzner, 2017; Cloke et.al. 2017). Moreover using appropriate tools such as RS and GIS is inevitable to achieve suitable results (McCall & Minang, 2005; Reshmidevi et al., 2009).

Salehi Moayyed and Karimi (2007) in a research titled “EIA of Gas Pipeline from Hamedan to Bijar”, identified all activities in two phases of construction and operation and chose two methods of explanatory checklist and Leopold matrix, using RS and GIS, as evaluative method to investigate gas pipeline of Hamedan to Bijar.

Fathabadi (2014) in his research called “Environmental, Social, and Cultural Assessment in Oil and Gas Projects” introduced a diagram based on the type of study industry for environmental, social, and cultural assessment and in the end proposed some recommendations related to improvement of theses assessments' current status in oil and gas industries (Fathabadi, 2014).

Yousefi and Hosseinzadeh (2012) in a research titled “Environmental Impacts Assessment Using Iranian Matrix Method; Case Study: Gas Pipeline of Birjand to Sarbishe” after collecting data and information, clarified existing status of the environment, using Iranian matrix method in order to investigate the impacts and negative/positive consequences in implementation and exploitation phases of the project on the environment in physical, biological, ecological, economic, and social environments in two phases of identification and assessment of environmental impacts (Wang et al., 2011; Padash, 2017; Mohammadi et al., 2016).

Khaleghi and Mahdi (2012), in a research titled “Investigating the Assessment of Oil and Gas Pipelines’ Impacts Using Leopold Matrix Methodology and Ad-Hoc Checklist”, first evaluated the whole path integrally through matrix method, then to investigate positive/negative impacts of project implementation on the environment in each one of determined homogeneous zones (Hoffman, 2004; Warner, 1974).

A final detailed environmental impact assessment project (Keystone XL Project), implemented to acquire environmental permission of LP pipeline in 2014 in the USA by the research team and cooperation of valid agencies via GIS system, discussed the proposed items and studied and evaluated the area’s environmental status, to propose some strategies at the end (United States Department of State Bureau of Oceans and International Environmental and Scientific Affairs, 2014).

The gas pipelines project is part of a linear project, in the sense that, on the contrary, radial projects, in which the effects and impacts of two-phase operations and construction of circle center, which are exactly the location of the project (or core area) in proportion to radius of the circle, is low.

Bypassing various ecosystems, these project categories will disrupt their structure and function. Similarly, they will have negative effects and negatives. Obviously, the intensity and extent of these effects are reflected by the distance from the tube axis.

The matrix method, as a common method, has general judgments of mean and no specific time and spatial separation in the evaluation. However, this method achieves the principle of standardization, relative scienticity, and repeatability of evaluation indicators.

Therefore, if we can achieve a method or tool to cover such deficiencies, we have achieved an environmental assessment with applicable results.

MATERIALS AND METHODS

The 30-inch gas pipeline of Damavand-Firoozkooh starts from east side of the fifth existing pipeline stations in Tehran in Boomehen, with geographic coordinates of 37, 39, and 35 north latitude along with 41, 49, and 51 in the eastern longitude, of the existing station in protected area of Jajrood. After passing Firoozkooh road, it finishes at the beginning point of Damavand- Imam Zadeh Hashem Gas Pipeline, with geographical coordinates of 35, 39, and 52 north latitude as well as 52, 05, and 59 eastern longitude (HGSCE, 2015; Geokavandish, 2014). Fig. 1 shows the position of stations and the direction of gas pipeline.

The study area is located in ultra-cold humid climate, with the measured mean of annual temperature in three selected stations, i.e., Hoomand Absard, Abali, and Ahmadabad, being equal to 10.8° C. The average annual rainfall in these three stations is 356.74 millimeter. The study zone is also located under Hilerood and hydrologic unit of Karaj-Jajrood in terms of hydrologic divisions. Considering that the path of pipeline has been from west to east and many rivers in the area stretch from north to south, it is quite inevitable to practically consider each pipeline path in the area as well as the confluence with available rivers, for which there is no other choice except disconnecting the river. Siahrood (Damavand) and Tar Rivers have confluence with Debi 3 and 1 cubic meter per second at kilometers of 4 and 18, respectively (National Geography Organization of Iran, 2003 and 2005; www.irimo.ir/).

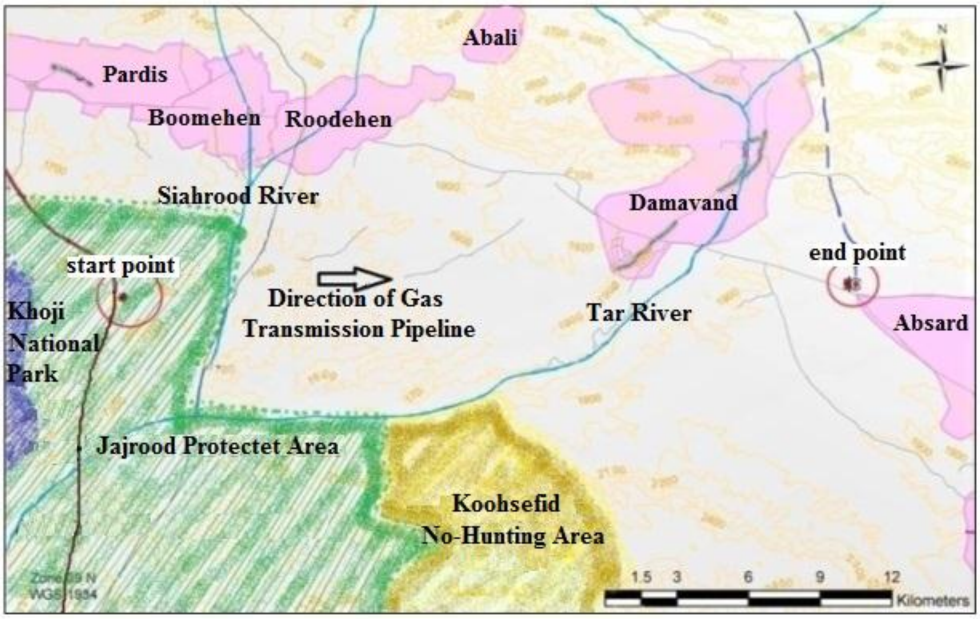

Fig. 1. Position of Damavand-Firoozkooh gas pipeline stations

The majority of study area is filled with sediments and tuffs, and the path of gas pipeline not having any confluence with any active faults of the area. Instead, it only has confluence with two inactive main faults and five sub-faults (Geocavandish Consulting Engineers, 2014).

Dominant species in the study area include Artemisia aucheri – Astragalus. Generally, it is possible for 16 species of mammals, 14 species of birds, 11 of reptiles, and 2 species of amphibians to exist in the area. According to IUCN list and national categorization, therer are no mammals in danger of extinction in the study area (Ziaee, 1996; National Geography Organization of Iran, 2003 and 2004).

As aforementioned, the beginning station is located in the protected zone of Jajrood, with the existing station's space, equal to 7250m^2, making the use of available stations much more appropriate than creating a new station in terms of the environment, due to being forced to get a tributary of the fifth available, located in the protected area as north-south. Fig. 2 illustrates the protected area of Jajrood zoning (Environmental Protection Agency, 2015).

Gas transmission project is considered a linear project. In other words, unlike radial projects, where impacts and consequences of two construction and exploitation phases' activities are reduced from the center of the circle which is the project location (or non-separated area) toward circle's radius, by passing different ecosystems, the project will mess up the structure and its function, leaving negative impacts and consequences to this extent. It is obvious that the severity and domain of these impacts and consequences have a reverse relation with distance from the tube axis, i.e., the greater the distance from settlement axis, the less severe the impacts and consequences. At this point, one should choose a method should which on one hand can reflect the proposed explanation above and has minor defects on the other. The matrix method as a common one has general judgement of mean and lacks special time and place segregation in the assessment. In spite of this, the principles of standardization, relative scientificity, and repeatability of assessment indices will be obtained by means of this method (Yavari, 2003).

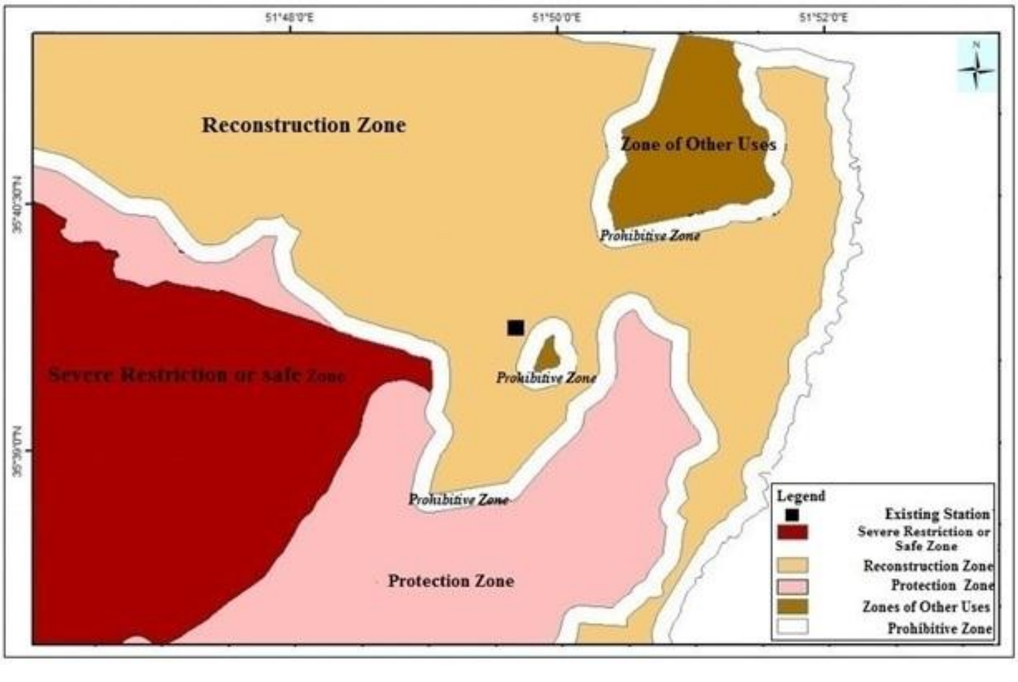

Fig. 2. Position of the available station and the zoning protected area of Jajrood

Therefore, if a method or tool, able to cover these defects, can be achieved, it will mean that we have obtained an environmental assessment with functional results.

For so doing, the study first tried to have real recognition of project location environment and all activities of two phases of construction and exploitation through library studies ad field visits. According to developed methodology, GIS system was necessary not only to be employed in all levels of impact recognition and assessment but to be utilized for studying current statues of environment as well as environmental routing options, providing accurate functional map of lands transportation route for gas, and weighting concerned parameters.

The used method in this research was a combination of both Analytic Hierarchy Process (AHP) and overlay. The latter is in fact a strong tool in Geographic Information System, which combined with AHP can promote assessment methods through qualitative and quantitative methods (Navazi et al., 2017). Accordingly, required parameters got identified first for environmental assessment and weighted through AHP or, using Expert Choice software, relevant informational layers to these parameters was created in GIS environment and finally with overlay layers, final map of area's environmental status has been provided integrally.

Expert Choice software is a strong tool for multi-criteria decision making, based on Analytic Hierarchy Process method, which was first discussed by Thomas L. hour in Pennsylvania University (Nikmardan, 2012). The software has many abilities. In addition to designing the hierarchy diagram of decision making, designing the questions of determining the preferences and priorities, and calculating final weight, it can analyze the sensitivity of decision making toward changes in problem parameters. Above all, in many cases the appropriate diagrams and graphs were used in order to propose results and performances and create a simple and friendly relation with the user (Ghodsipour, 2013).

Analytic hierarchy process is one of the most comprehensive designed systems of decision making with multiple criteria. Able to consider different quality and quantity criteria in the problem, this process intervenes different options in decision making and can analyze sensitivity on criteria and sub-criteria. Moreover, it is based on pair comparison that facilitates calculations and judgments, showing the rate of compatibility and incompatibility of decision, considered one of the top benefits of this technique in multi-criteria decisions (Ghodsipour, 2013; Padash et al., 2015).

AHP is based on three principles:

- Drawing hierarchical tree principle
- Developing and determining priorities principle
- Rational compatibility of judgments principle

The first step in AHP outcome is to create a graphic illustration of the problem where goal, criteria, and options (here concerned sub-parameters) are shown.

First each of the selected measures was given a weight, based on Table 1. Afterwards, these measures were placed in a matrix and were assessed in pairs with each one's weight identified, compared to another one. Then through normalizing, all measures would have the same weight.

After that, having measures' weights and alternative scores, combined weight of each site is obtained through multiplying weight measures with alternatives scores and are classified based on the order of obtained weight.

Finally, compatibilities that may exist in analyzer judgment are determined. The weights are calculated in this study via Expert Choice software and by means of special vector method (Table 1).

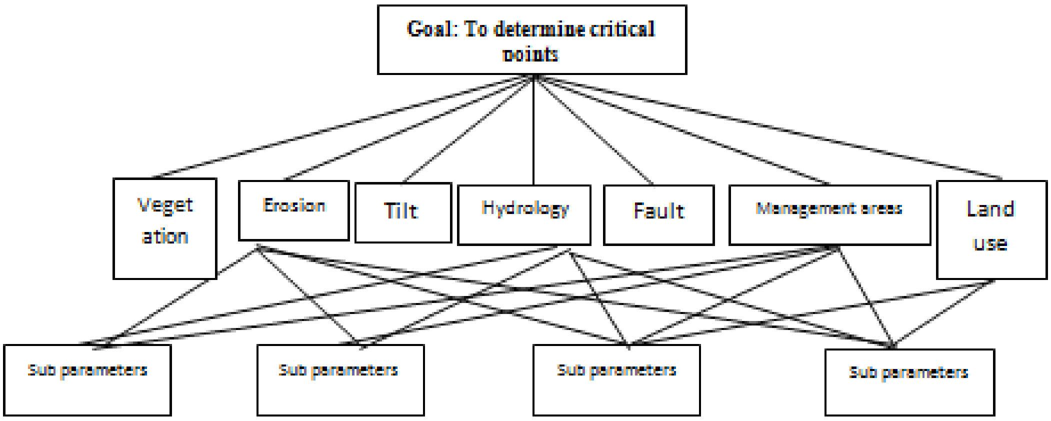

Fig. 3. AHP parameters

Table 1. AHP scale

Explanation	Definition	The degree of importance
Two elements should be equally important.	Equally important	1
One element would be preferable relatively to the other.	Relatively preferable	3
An element is much preferred to the rest.	High prefer	5
An element is much preferred to the rest.	Very high prefer	7
One element would have extremely high preference to the other.	Extremely high prefer	9
Intermediate values in making judgments		2,4,6,8
When element i is compared with j, one of above numbers is allocated to it; when comparing element j with i that number's reverse value will be allocated.		

Source: Ghodsipour, 2013

Assessment results often remain as the table in assessment by checklists and matrixes. In other words, matrix is unable to show obtained scores based on the position of parameters under impact. To solve this problem in this study and show obtained results from weighing, overlay method has been used, which is accomplished based on a series of relevant maps to environmental features of the area.

These maps are in fact concerned parameters in weighting process which include:

1. The distance and position relative to the areas under the management of the Environmental Protection Agency
2. Fault
3. Vegetation
4. Slope and topography of the study area
5. Erosion of soil
6. Rivers in path
7. Land use in the area

The output of performed tool will finally be a raster layer where all critical points of study path are depicted vividly. This layer is identified in fuzzy between 0 and 1, where each measure is closer to 1, the zones are considered as critical points and whatever it gets closer to zero, those points lack adverse effects in terms of the environment.

RESULT AND DISCUSSION

The study scopes have to be determined in EIA study. In the current paper, they were selected in accordance to project's goals and policies, its micro-activities, and study area's environment. Considering that this transmission line was 30 inch, non-separated zone, also coincident on specific privacy of gas pipelines, included five meter from one side and 12 from the other. The minimum channel width for Damavand-Firoozkooh pipeline was 30 inches in diameter and 1.16 meter long, with minimum channel depth equal to 2.16 and the minimum channel excavation volume of Damavand-Firoozkooh pipeline being 72662m^3 (National Iranian Gas Company, 2011).

Directly under the impact zone, band maximum of 2.5 km from each side of pipeline and indirectly under impact zone, mainly coincident on social-economic borders, the villages were selected within the scope and closest to privacy jurisdiction of the city of Damavand.

Considering that the beginning and end of project were surrounded among two particular limitations, from the north of population centers and existing cities like Roodehen-Boomehen and Damavand-Gilavand up and down the Firoozkooh road and from west and south, respectively, to environmental areas of Khojir National Park, Jajrood Protected Area and Sefidkooh Hunting Prohibited Area, investigation of multiple routes in routing studies was impossible. In spite of this, in primary studies several paths such as current one and two other items got investigated (HGSCE, 2015). Fig. 4 illustrates the proposed options.

Red option (premier) was proposed with the goal of lowest passing of steep slopes, lowest volume of routing, lowest destruction of agricultural lands and orchards in the area, shortest route, meeting privacies, and the greatest distance from human settlement construction. When selecting premier option as the best route, it was necessary to consider all mention factors, which led this option to be introduced as the most appropriate one with lowest destruction. Table 2 presents the characteristics of the proposed options briefly.

The passage of the environmental premier option of Jajrood protected area, one of the priorities of premier option, was a shorter alternative for Jajrood Protected Area, meeting the mentioned protected area zoning. Both Table 3 and in Fig. 5 give a description of passage through the area.

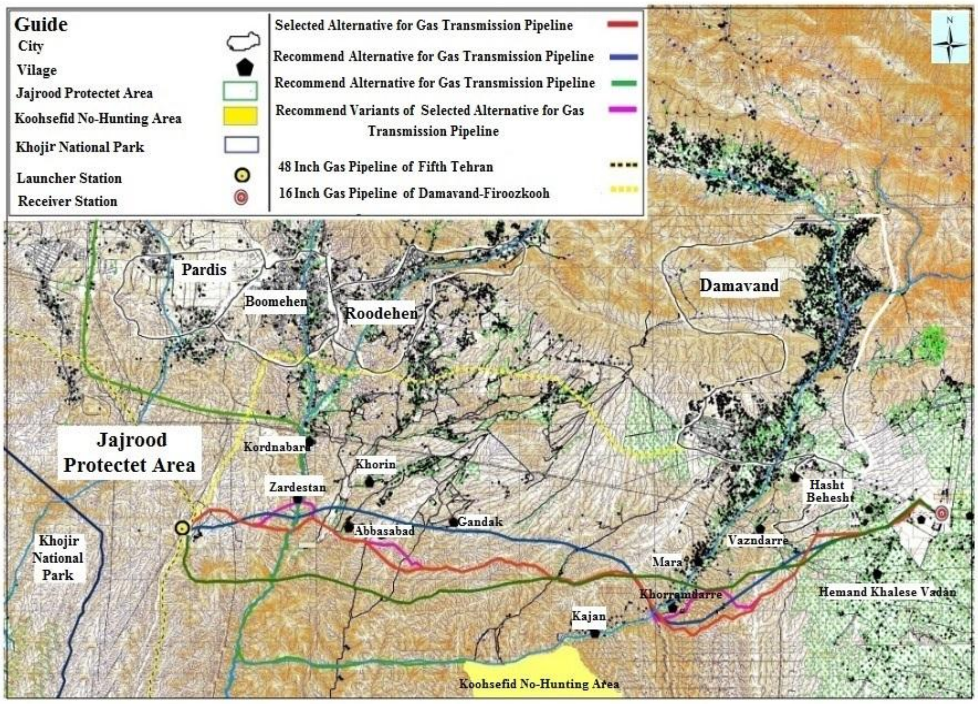

Fig. 4. Proposed options for Damavand-Firoozkooh gas pipeline

Table 2. Characteristics of the proposed options

Option	Line Length (km)	Intersection with faults	Respect the privacy of residential and building areas	Passage length of Jajrood Protected Area (km)	passage length of the security zone of Jajrood protected area
Red	29	-	✓	3	·
Blue	27	-	-	4	5.3
Green	5.27	✓	-	5.4	5.3

Table 3. Zoning characteristics of Jajrood Protected Area

Distance	Area zoning
3 km in the area	Zone or reconstruction area
128 m distance	Zone or protection area
More than 400 m distance	Zone or other used area

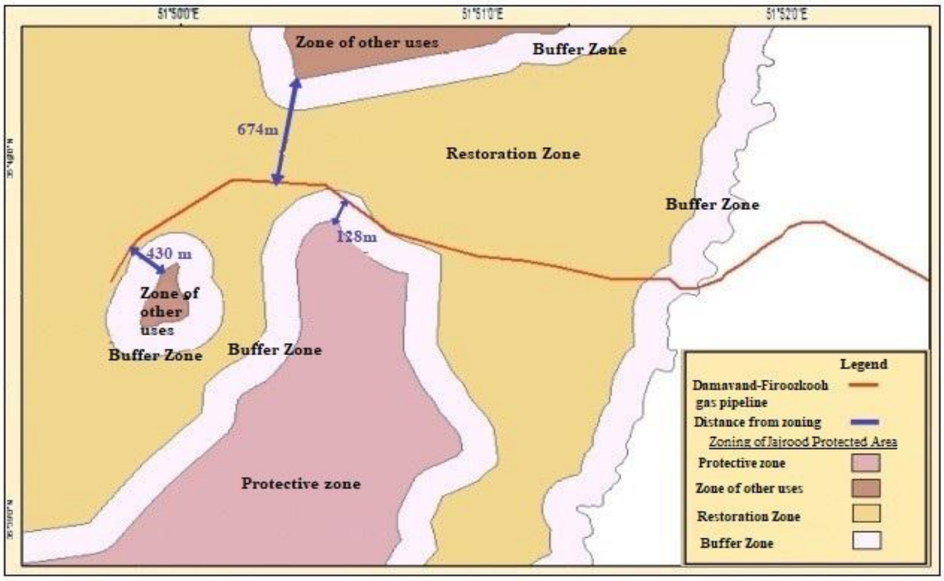

Fig. 5. Zoning Jajrood Protected Area

Investigation of technical characteristics of the project shows that micro activity in both phases of construction and exploitation included feasibility stage, designing, and construction that in turn include:

- Soil operation (including road construction, digging canals, screening soil preparation, filling channel, additional soil transportation, etc.)
- Mechanical operations (including transportation and hyphae, welding, insulation, piping, etc.)
- Crossing barriers operation (including the passage of asphalted roads, rivers, railways, etc.)
- Hydrostatic testing operations
- Cathodic protection operation (HGSCE, 2015).

Both prediction and analysis of the impacts show that the main impacts of the project on the area's environment were the following cases:

- Change in topography, landform, and soil erosion due to excavation and removal of extra soil and construction, development of access road, and also digging and explosion (David, 2010)
- Temporary change of Damavand and Tar riverbed

- Demolition of external border of Jajrood protection area
- Possible accidents, caused by the construction and operation of the project
- Favorable impact on air quality during exploitation as a result of the substitution of fossil fuels with gas fuel
- Increasing employment of local people during construction of the project
- Changes in the landscape due to excavation operations and buried pipes
- Preventing the migration of people from the area due to this type of development project
- Increase in the levels of the area's welfare and public services
- Increase in health and safety levels (HGSCE, 2015).

The use of several methods to assess a plan made it possible to take advantage of each method, wherein each method's defects would be compensated by the existence of another one in a great extent. A method like the checklist is one of the best to describe causal relations and the way of impacts emergence but due to its limitations in showing the impacts and spatial expression of cumulative effects, it is not adequate by itself. With the aim of demonstrating the emergence position of the impacts and different effects' overlap, informational layers layover can demonstrate and interpret the emergence of phenomena such as synergy or cumulative effects well. Thanks to this method, places more exposed to the impacts or with more sensitivity are determined and locational and executive priorities are clarified to utilize effective reduction actions for controlling and reducing impacts. Particularly, plans such as transmission pipeline plan, which in linear in nature, inflict varied impacts in different places of their path due to passage through different ecosystems along with ecologic changes.

Pic. 1 and 2 show the obtained results of AHP, using Expert Choice software, with their weights, demonstrated in Fig. 6 and Table 4.

Furthermore, Figures 1 and 2 illustrate the weighed substrate and layers, based on the determined parameters, which are the output of Expert Choice software, demonstrated in Fig. 7 and Table 5.

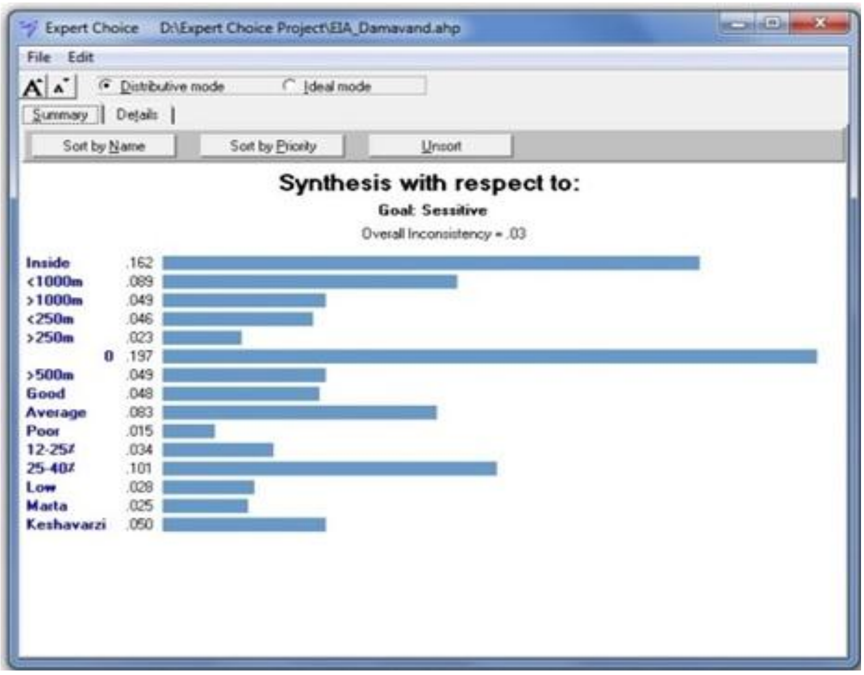

Fig. 6. Weighed substrate of the study

Table 4. Weights of study substrate

Weights	Substrates	Informational layers
0.540	Within the region	
0.297	Closer than 1 km	Distance to the regions
0.163	Further than 1 km	
0.667	Distance below 250 m	Fault
0.333	Distance above 250 m	
0.80	Intersection with the main river	Hydrology
0.20	Further distance than 500 meters from the main river	
0.333	Pastures	Usage
0.667	Agriculture and Garden	
0.25	25-12	Slope
0.75	25-40	
0.54	Good pasture	
0.297	Average pasture	Vegetation
0.163	Poor pasture	
0.667	Average	Erosion
0.333	Low	

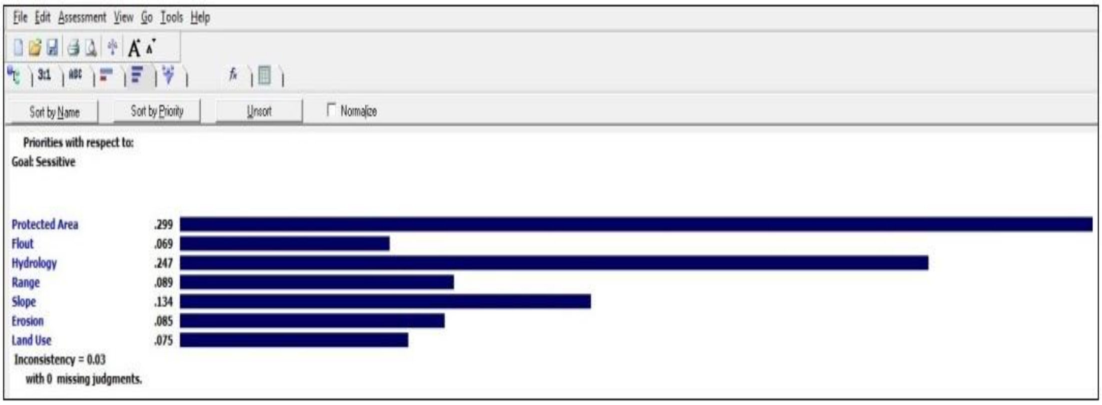

Fig. 7. Weighing layers of study

Table 5. Weights of the study layers

Informational layers	Areas	Fault	Vegetation	Slope	Erosion	Hydrology	Usage	Total
Layers weights	29.9%	6.9%	8.9%	13.6%	8.5%	24.7%	7.5%	100%

As shown in Table 5, distance and position parameter toward protected areas was in the first priority since there was a 3-km rout in Jajrood protected area with a weight of 29.9%. Afterwards, hydrology was in the second priority because of the intersection with two constant rivers, having a weight of 24.7%, followed by slope, vegetation, land use, and fault in third to seventh priorities, respectively.

CONCLUSION

Considering sustainable development, it is of utmost importance for a project to be implemented. This means that implementing a project is supposed to be in a way that involves the majority of benefits and the least damages for the environment, economy, society, and culture both in long term and short term. To train the required expert forces, create structures and necessary regulations, use successful experience in this field, and use experts' opinions will be definitely effective to promote the position of the environmental impacts (Fathabadi, 2014).

Based on identification and prediction of proposed environmental impacts, important effects of the project on the study area's environment for separation of three physical, biological, and human environments can generally be described as follows:

In physical environment, the most important negative impacts in project's construction phase will be inflicted on landform, soil quality, air, and surface water sources. Once exploited by the project also with strengthening gas delivery to area, air polluters will be practically reduced. In biological environment, the most important negative impacts will be on Jajrood protected area and as a result drought ecosystem of the area. In human environment, the most important negative impacts in the project's construction phase will be directed at agriculture, land use, safety, and area's perspective. The local population will be employed temporarily which is considered a positive effect of construction phase on human environment. During project exploitation, promotion of life quality, level of welfare and health, tourist attraction, and reduction in inhabitants' migration will also be regarded as positive effects of this phase on human environment.

According to Fig. 8, which shows the environmental impact assessment of Damavand-Firoozkooh gas transmission pipeline via informational layers overlay, the mentioned line is in critical zones from 0 to 4 and from 17.4 to 18.6 km, with one zone, located between 0 and 4 km off Damavand-Firoozkooh gas transmission pipeline, being in high sensitive environmental area as well. For critical analysis of these areas, results of weighing and prioritizing informational layers toward each other as well as the study area's environmental information can be mentioned. Based on final prioritization, distance and position layers to protected areas, rivers in rout, fault, soil erosion, slop and topography, vegetation and land use are prioritized respectively. The layers' prioritization, applied for classification of critical areas, is based on this also and through combination of these parameters with the study area's environmental characteristics, critical zones are classified as well.

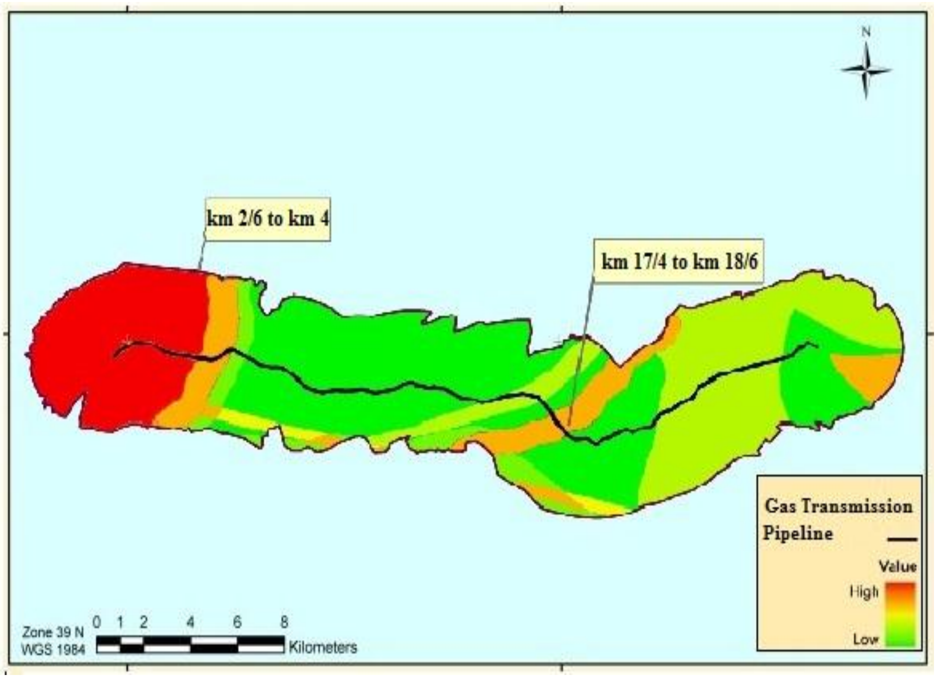

Fig. 8. Determining sensitive points

On the other hand, results from assessment of this method confirm that most areas of high environmental sensitivity are located within the range of 3 km from the beginning of the pipeline and its intersection with rivers. Based on this, in order to minimize the range of negative effects of the proposed plan, there has been attempts to consider sensitive points in environmental management and monitoring plans. Tables 6 and 7 propose environmental consequences and recommended actions and strategies in order to minimize the effects of construction and exploitation phases, with Tables 8 and 9, demonstrating the environmental monitoring plan in these two phase.

Table 6. Environmental consequences and prevention actions, minimizing and compensating negative effects in the construction phase

Type of negative impact	Project Activity	Control method (prevention, reduction, compensation)	Responsible	The supervisory organ
Demolition and soil erosion	Soil operation	Prevent extra leveling and minimize it, via geosynthetic by means of silt fence, surviving vegetation (to the direct of dominate wind (western) and in accordance to guidance of general administration of Tehran province environment	Health, Safety and Environment (HSE) Contractor	General Administration Tehran Province Environmental
	Hydrostatic test	Avoid leaving the water test on the ground after conducting an experiment on water samples with no prolonged maintenance (used water should be given to farmers to water their lands and reuse it)		
Temporary Demolition of Siahrud and Tar Riverbed	Crossing transmission line (piping)	Pass the minimum width of Tar riverbed Pass under depth of scour in Tar river And pass the mentioned river during its water deficit season		
air pollution (spreading suspended particles)	Soil operations	Avoid getting dust by spraying water and soaking the ground		
	Transportation	Run engine development machinery and timely repair them		
noise pollution	Transportation	Run engine development machinery and timely repair them		
Demolition vegetation (rangeland species)	Cleanly shaven	Avoid deleting additional cuts Restore vegetation (in accordance to General Administration Tehran Province)		
Land use change (Demolition agricultural land and orchards)	Cleanly shaven	Purchase land at an affordable price		
Reduction of health and disease outbreak	Manpower Recruitment	Monitor HSE continuously during the performance and monitor all sanitary workers' cases		

Table 7. Environmental consequences and prevention actions, minimizing and compensating negative effects in exploitation phase

Project Activity	Type of negative impact	Control method (prevention, reduction, compensation)	Responsible	The supervisory organ
Possible leakage of gas from the pipeline Possible explosion	The possibility of soil contamination Potential contamination of water resources (Pollution Tar River) The possibility of air pollution The possibility of the destruction of vegetation and animals wildlife	Visit the pipeline periodically and in an alternating manner Carry out leak detection operations multiple times per year Ensure detailed engineering operations in accordance with the gas company to increase the safety factor And prevent any leak or possible explosion	HSE exploitation of Gas Company	General Administration Tehran Province Environmental

Table 8. Environmental monitoring plan of Gas Transmission Line of Damavand - Firoozkooh in the construction phase

Type of impact	Monitoring location	Monitoring Periodicity	Monitored Parameters	Responsible for Monitoring and control
Air pollution	Location of project operations Residential areas' adjacent lines	According to self-reported monitoring plan (Quarterly or once a year)	The operation of construction machinery	Contracted contractor
Soil pollution	Workshop, garage, and location of fuel tanks		OIL measurement	
	Discharge of the water site from hydrostatic test		Anions and cations in the soil, PH, EC	
Noise pollution	Location of project operations		Environmental sound includes: Leq, Lmin, Lmax	
	Residential areas' adjacent line		Environmental sound includes: Leq, Lmin, Lmax	

Table 9. Environmental monitoring plan of Gas Transmission Line of Damavand - Firoozkooh in the exploitation phase

Type of impact	Monitoring location	Monitoring operation	Monitoring Periodicity	Monitored Parameters	Responsible for Monitoring and control	The supervisory organ
Air pollution and accidents' occurrence	Leak detection tests along the way	Leak detection with electronic equipment	Annually	gas leak	Operator Gas Company	HSE Region 3 Gas transfer operation
	Testing casing (coating) on the whole route	Test casing with opening detection device (DCVG)		coverage Resistance		
	Review of the existing stations	Check how the depreciation And leak detection devices statues		gas leak		

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REFERENCES

Cloke, J., Mohr, A. and Brown, E. (2017). Imagining renewable energy: Towards a Social Energy Systems approach to community renewable energy projects in the Global South. *Energy Research & Social Science*, *31*, 263-272.

Environmental Protection Agency, (2015) zoning digitized files of Jajrood protected area, Tehran, Iran.

Fallahnejad, M. H. (2013). Delay causes in Iran gas pipeline projects. International Journal of Project Management, 31(1), 136-146.

Fathabadi, E. (2014) Environmental, Social and cultural assessment in oil and gas projects, Scientific-extension journal of exploration and production of oil and gas, No. 115.

Geokavandish (Consulting Engineers), (2014) soil and geological reports of Damavand-Firouzkooh gas pipeline. Tehran, Iran.

Ghodsipour, H. (2013) Analytical Hierarchy Process (AHP). Amir Kabir University, Tehran, Iran.

HGSCE. Hamoon Gostar San'at Consulting Engineers (2014) P & ID maps of Damavand-Firoozkooh gas transmission pipeline. Tehran, Iran.

Kerzner, H. and Kerzner, H. R. (2017). *Project management: a systems approach to planning, scheduling, and controlling*. John Wiley & Sons.

Khaleghi A. and Mahdi A (2012) Impact assessment of oil and gas transmission pipelines by using Leopold matrix methodology and Ad-Hoc check list. Second conference of planning and environmental management, University of Tehran, Tehran, Iran.

McCall, M. K. and Minang, P. A. (2005). Assessing participatory GIS for community-based natural resource management: claiming community forests in Cameroon. *Geographical Journal*, *171*(4), 340-356.

Mohammadi, M., Jozi, S. A. and Pursina, S. (2016). Assessing environmental effects of aromatizing unit by comparing leopold, modified leopold, and icold techniques. *Journal of Fundamental and Applied Sciences*, *8*(3), 746-768.

Mubin, S. and Mubin, G. (2016). Risk analysis for construction and operation of gas pipeline projects in Pakistan. Pakistan Journal of Engineering and Applied Sciences. Pakistan Journal of Engineering and Applied Sciences, [S.l.], jun. 2016. ISSN 2415-0584. Available at: <http://journal.uet.edu.pk/ojs_old/index.php/pjeas/article/view/226>

McCoy, S. T. and Rubin, E. S. (2008). An engineering-economic model of pipeline transport of CO2 with application to carbon capture and storage. *International journal of greenhouse gas control*, *2*(2), 219-229.

National Geography Organization of Iran (2003) Gazetteer of country rivers, Publications of geography organization, Ministry of defense and armed forces logistics, Tehran, Iran.

National Geography Organization of Iran (2004) Guide atlas of Iran provinces, Publications of geography organization, Ministry of defense and armed forces logistics, Tehran, Iran.

National Geography Organization of Iran (2005) Joint action plan (ground) scale: 1:250,000, Tehran, Iran.

National Iranian Gas Company, (2011) Privacy rules of natural gas transmission pipelines in the vicinity of buildings and installations, roads, power lines, railways and oil pipelines, National Iranian Gas Company, Tehran, Iran.

Navazi, A., Karbassi, A., Mohammadi, S., Zarandi, S. M. and Monavari, S. M. (2017). Incorporating climate change risk management into mitigation and adaptation strategies in urban areas. Indian journal of Geo Marine Sciences, 46(6), 1183-1192.

Nikmardan, A (2012) Introduction of Expert choice software with a summary of AHP contents, Sientific Information Database, Amirkabir University of Technology, Tehran, Iran.

Padash, A., Bidhendi, G. N., Hoveidi, H. and Ardestani, M. (2015). Green strategy management framework towards sustainable development. *Bulgarian Chemical Communications*, *47*, 259-268.

Padash, A. (2017) Modeling of Environmental Impact Assessment Based on RIAM and TOPSIS for Desalination and Operating Units. *Environmental Energy and Economic Research*, 1(1), 75-88. doi: 10.22097/eeer.2017.46458

Rashidi, J., Rhee, G., Kim, M., Nam, K., Heo, S., Yoo, C. and Karbassi, A. (2018). Life Cycle and Economic Assessments of Key Emerging Energy Efficient Wastewater Treatment Processes for Climate Change Adaptation. *International Journal of Environmental Research*, *12*(6), 815-827.

Reshmidevi, T. V., Eldho, T. I. and Jana, R. (2009). A GIS-integrated fuzzy rule-based inference system for land suitability evaluation in agricultural watersheds. *Agricultural systems*, *101*(1-2), 101-109.

Salehi Moayyed M. and Karimi S (2007) Environmental Impact Assessment (EIA), Hamadan to Bijar gas pipeline with emphasis on the use of RS and GIS. Environmental Studies, 33(41), 33-44.

United States Department of State Bureau of Oceans and International Environmental and Scientific Affairs (2014). Final Supplemental Environmental Impact Statement for the Keystone XL Project Executive Summary, Applicant for Presidential Permit: Trans Canada Keystone Pipeline, LP.

Wang, R., Li, F., Hu, D. and Li, B. L. (2011). Understanding eco-complexity: social-economic-natural complex ecosystem approach. *Ecological complexity*, *8*(1), 15-29.

Yavari, A.R. (2003) The First National Conference of Iran Environmental Assessment

Yousefi M. and Hosseinzadeh Z. (2012) Environmental impact assessment by using Iranian matrix (case study: Birjand Sarbishe gas transmission pipeline), Second conference of environmental management and planning, Tehran, Tehran University.

Ziaee, H. (1996) Field guide of Iran's mammals, Environmental Protection Agency, Tehran, Iran.

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