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Ecological impact assessment of Parchin-Pasdaran Road on Khojir National Park using Pastakia Matrix

Mahtab Tavakoli*, Mojtaba Shirzad

Department of Environment and Energy, Science and Research Branch, Islamic Azad University, Tehran, Iran

*Email: mht.tavakoli@yahoo.com

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Abstract

Khojir National Park is situated in eastern Tehran Metropolitan City, within Jajroud Protected Area. Crossing a part of Parchin-Pasdaran Road from the national park makes it necessary to study and identify the road impacts on the wildlife and recommend mitigation strategies. By dewatering Mamlou Dam, a part of the existing Parchin-Pasdaran Road will be sunk. In order to affect a lesser extent of the park, the alternative road should be constructed away from the sensitive habitats and close to the existing road, as much as possible. The current study compared the impacts of both roads on the national park. The Pastakia method was used to predict, assess and compare the impacts caused by the existing and alternative roads. As regards, the obtained results indicated no significant negative impact by the alternative road, so it was preferred to the existing road. In the end, some strategies were suggested to mitigate the significant adverse impacts.

Keywords: Ecological impact assessment, Environmental statement, Khojir National Park, Pastakia Matrix

Introduction

Road network development is a key element in the economic and cultural prosperity of each country. However, the damaging impacts of road networks on biodiversity and animal species of a region cannot be neglected. One of the first impacts of road networks is its adverse effect on landscape causing changes in spatial patterns, the general function of ecosystems as well as displacement of wildlife species. Due to the linear form, roads increase the marginal habitats

and decrease the area of interior habitats. Road accidents are also another obvious impact of roads on wildlife species. Raising awareness about the negative effects of roads on natural systems has resulted in an increased number of studies on the assessment of such impacts in order to predict necessary mitigation measures for preventing loss of landscape integrity and decreasing road accidents. Reducing the negative impacts of roads to achieve a sustainable transport system requires a holistic and comprehensive approach integrating socioeconomic and ecological factors (Seiler, 2004). Jajroud Protected area and Khojir National Park are among the world's first protected areas enjoying unique, biological, and mountain characteristics as a result of situating between Alborz Mountain Range. It has also a rich diversity of plant and animal life. Having the habitat of indicator animal species such as *Capra aegagrus*, *Ovis vignei*, *Panthera pardus*, *Lutra lutra*, *Varanus greseus caspicus*, Khojir National Park is of particular importance.

Material and methods

The study area

The study area is a road with an approximate length of 7600 m and a width of 13 m. By including the tunnel, 4,380 m of the road is located within Khojir National Park and about 3200 m is situated in Jajroud Protected Area. Around 980 meters of the road length is located within a mountain called Sari-Ghale (Tehran Provincial Directorate of Environment Protection, 2009). Dewatering Mamlou Dam, a part of the existing Parchin-Pasdaran Road at the southern side of the Khorjin National Park will be sunk, so it is necessary to construct a new, alternative road to maintain communication of the Parchin military area with northern Tehran. It was tried to choose the construction route of the alternative road away from the fragile habitats, close to the existing road. In this manner, a lesser extent of the park would be affected.

The research methodology

For the environmental impact assessment of the Parchin-Pasdaran alternative road, due to high sensitivity of the region as well as the strategic nature of the project, a method enjoying the following features was required.

- Ability to show the impacts spatially, determine the most vulnerable zones, and present spatial alternatives to mitigate the adverse impacts
- Having a qualitative nature to show the quality of the impacts
- Having a quantitative nature to reflect the intensity of the impacts

In this research, in order to Rapid Environmental Impact Assessment (REIA) of Parchin-Pasdaran Road, Pastakia method was used. In this method, the most important activities of the

project are initially selected. It is worth noting that important activities, the origin of the impacts, and affected factors are chosen based on expert opinion. Afterward, the impacts of the project activities on components of physicochemical, eco-biological, socio-cultural, and techno-economic environments were separately assessed based on the assessment criteria including importance, extent, duration, reversibility as ynergistic effects of the impacts. After assessing based on the mentioned criteria and doing simple mathematical calculations, the extent of the impacts was specified in terms of being extremely positive up to extremely negative. Ultimately, using the matrices and charts related to the environmental components and the predicted impacts, the proposed alternatives were compared. In this study, for environmental impact assessment of roads, the construction phase of road construction was initially investigated and then, the operational phase of the roads and highways were investigated, separately.

Besides, the closest wildlife habitats to the construction site of the road were identified using the wildlife species dispersion maps. Subsequently, the distance of each habitat to the proposed road construction site was determined through GPS Device.

- The most important variables investigated in the construction phase are as follows:

Clear-cutting, transportation of raw materials, transportation of machinery and equipment, loading, constructing, and equipping the workshop, explosion, construction of public warehouses, transportation of personnel, excavation, affluent generation, affluent generation, canal excavation, foundation excavation, production of concrete, sand harvesting, bridge construction, infrastructure, brick and brick, painting, soil depot, and slope grading.

- The most important factors investigated at the operational phase are as follows:

Vehicle transportation, cleaning the streams beside the road, consumption of pesticides, way stations, parking lots, permanent restoration and maintenance of technical buildings, and cleaning inside the tunnels.

Result and discussion

The result of the Pastakia Matrix

In this research, the Pastakia method was used for the rapid environmental impact assessment of the Parchin-Pasdaran Road. In this method, first of all, the main activities of projects as well as their origin and affected factors are initially identified based on expert opinion. Subsequently, the impact of project activities on the components of physicochemical, bio-ecological, socio-cultural and techno-economic environments was reassessed using the criteria

impact significance, impact extent, impact duration, reversibility an,d irreversibility. After assessing based on the mentioned criteria and doing required, simple mathematical calculations, the extent of the impacts is specified in terms of being extremely beneficial and positive up to extremely negative. Ultimately, using the matrices and charts related to the environmental components and the predicted impacts, the proposed alternatives were compared. Being fast is of advantages of the Pastakia method whereas it takes less time to perform this procedure. Besides, a graphical presentation of the results allows easier comparison of the options. Therefore, it would be another strong point of this approach.

The existing road impacts during the construction phase

The impacts of the existing Parchin-Pasdaran Road on the components of the physicochemical environment at the construction phase are presented in Table 3.

Table 3. The impacts of the existing Parchin-Pasdaran Road on the physicochemical components at the construction phase

Assessment criterion							The impact of activities on environmental components	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
-A	-6	2	2	2	-1	1	mountain-cutting impact on noise generation	PC1
-A	-6	2	2	2	-1	1	mountain-cutting impact on soil erosion	PC2
-A	-8	2	3	3	-1	1	drilling impact on drainage	PC3
-A	-8	2	3	3	-1	1	drilling impact on landform	PC4
-A	-7	3	2	2	-1	1	soil excavation impact on air pollution	PC5
-A	-6	2	2	2	-1	1	soil excavation impact on noise generation	PC6
-A	-7	2	3	2	-1	1	soil excavation impact on surface water quality	PC7
-A	-6	2	2	2	-1	1	explosion impact on noise generation	PC8
-A	-8	2	3	3	-1	1	explosion impact on soil characteristics	PC9
-A	-6	2	2	2	-1	1	The impact of transporting materials on noise pollution	PC10
-A	-6	2	2	2	-1	1	The impact of loading materials on noise generation	PC11
-A	-7	2	3	2	-1	1	The impact of transporting debris on air pollution	PC12
+A	8	2	3	3	1	1	Asphalt pavement impact on the study area	PC13
+A	8	2	3	3	1	1	Land leveling impact on erosion	PC14
+A	8	2	3	3	1	1	Rock embankment impact on sedimentation	PC15

In this study, a total number of 15 factors were considered to assess the impact of the existing road construction on the components of the physicochemical environment. Then, the factors were weighted using expert opinion. For example, based on the Pastakia Method, the mountain-cutting impact on noise generation can b assessed using the following criteria:

A_1 (impact significance): considering that the project magnitude was at local level so a score 1 was assigned to the factor.

A_2 (impact extent): the project construction will be followed by a negative impact so the score -1 was allocated to the factor.

B_1 (impact duration): as a temporary situation, the score +2 was dedicated to the project construction.

B_2 (impact reversibility): due to the reversibility of the impact, it was scored as + 2.

B3 (cumulatively): the project has no cumulative impact so the score +2 was assigned to the factor.

After determining the scoring criteria, it was time to calculate total scores, as follows:

$AT = (A_1)(A_2)$; (۱)(-۱) = -1
$BT = (B_3)+(B_2)+(B_1)$; (۲)+(۲)+(۲) = ۶
$ES = (AT)(BT)$; (-۱)(۶) = -۶

Finally, the range (R) of the indices was specified using the matrix index ranges.

As mentioned earlier, in Pastakia Method, the extent -A covers a range of scores from -1 to -9. In the example above, the ES was obtained equal to -6 indicating slight changes of negative impacts. The above equations can also be used for the other factors.

Table 4. the impact of the existing road construction activities on the bio-ecological environment

Assessment criterion							**The impact of the activities on environmental components**	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
N	0	1	1	1	0	0	Clear-cutting impact on terrestrial ecosystem	BE1
N	0	2	3	3	0	0	Herbicide impact on aquatic environment	BE2
-A	-8	3	3	2	-1	1	Herbicide impact on habitat of plant species	BE3
-A	-8	3	3	2	-1	1	Herbicide impact on density of plant species	BE4

N	0	2	3	2	0	1	Explosion impact on behavioral pattern of animals	BE5
-A	-8	2	3	3	-1	1	Foundation impact on habitats of animals	BE6
-C	-32	2	3	3	-2	2	bridge building impact on aquatic ecosystem	BE7

At this stage, seven factors influencing on the bio-ecological environment at construction phase were considered. Afterwards, their ES and extent were obtained based on the procedure mentioned above.

Table 5. the impact of the existing road on the socio-cultural environment at the construction phase

Assessment criterion							**The impact of activities on environmental components**	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
-B	-18	2	2	2	-1	3	The impact of supplying borrow materials on local traffic	SC1
-A	-6	2	2	2	-1	1	Noise nuisance to local communities	SC2
-C	-32	3	3	2	-2	2	recruitment impact on public participation	SC3
-C	-32	3	3	2	-2	2	recruitment impact on population density	SC4

At this step, four factors affecting on socio-cultural environment at construction phase were regarded. The factors were then scored to get the extent and ES.

Table 6. the impact of the existing road on techno-economic environment at construction phase

Assessment criterion							**The impact of activities on environmental components**	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
-B	-14	3	2	2	-1	2	The impact of supplying borrow materials on local economy	EO1
-B	-54	3	3	3	-2	3	The impact of manpower on regional income	EO2
-C	-24	2	2	2	-2	2	The costs of land use changes	EO3
-B	-12	1	2	3	-1	2	The costs of road construction	EO4

-B	-12	2	2	2	-2	1	The impact of construction operation on tourism in the study area	EO5

At this step, 5 factors affecting on the techno-economic environment at the construction phase were selected and scored to obtain ES and extent.

The project impacts at the operational phase

The impacts of the existing Parchin-Pasdaran Road on the components of the physicochemical environment at the operational phase are presented in Table 7.

Table 7. The impacts of the existing Parchin-Pasdaran Road on the physicochemical components at the operational phase

Assessment criterion							**The impact of activities on environmental components**	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
-B	-16	3	3	2	-2	1	impact caused by traveling vehicles on air quality	**PC1**
-A	-7	2	3	2	-1	1	impact caused by traveling vehicles on noise pollution	**PC2**
-B	-14	3	2	2	-1	2	Impacts of salt spray on surface water quality	**PC3**
+B	16	3	2	3	2	1	road improvement impact on air quality	**PC4**
-B	-16	3	2	3	2	1	road improvement impact on surface water resources	**PC5**
+A	8	2	3	3	1	1	Impact of re-lining and repairing the road signs	**PC6**
+B	16	2	3	3	2	1	impact of road accidents on air quality	**PC7**
-B	16	2	3	3	2	1	impact of road accidents on surface water quality	**PC8**
-A	-8	3	3	2	-1	1	impact of road accidents on soil	**PC9**

In this study, a total number of 9 factors were considered to assess the impact of the existing road on the components of the physicochemical environment at the operational phase. Based on the mentioned procedure, the factors were scored to get the extent and ES. Finally, the impacts of the

project activities were investigated on the components of physicochemical, bio-ecological, socio-cultural, and techno-economic environments at the operational phase.

Table 8. The impacts of the existing Parchin-Pasdaran Road on the bio-ecological environment at the operational phase

Assessment criterion							The impact of activities on environmental components	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
-A	-9	3	3	3	-1	1	impact of solid waste transportation on terrestrial ecosystem	**BE1**
-B	-18	3	3	3	-2	1	impact of solid waste transportation on aquatic ecosystem	**BE2**
-B	-27	3	3	3	-1	3	impact of traveling vehicles on indicator mammalian	**BE3**
-B	-18	2	1	3	-1	3	impact of the roadside stop on main habitats	**BE4**
-C	-27	3	3	3	-1	3	Impact of road accidents on indicator mammalian	**BE5**
-B	-18	3	3	3	-1	2	impact of traveling vehicles on habitats of plant species	**BE6**

Table 9. The impacts of the existing Parchin-Pasdaran Road on the socio-cultural environment at the operational phase

Assessment criterion							The impact of activities on environmental components	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
+D	54	3	3	3	2	3	The road impact on future development plans	**SC1**
+C	27	3	3	3	1	3	The road impact on increasing services	**SC2**
-D	-36	3	3	3	-2	2	Road impact on migration	**SC3**
-B	-18	3	3	3	-2	1	Road impact on local population	**SC4**
-C	-32	3	3	2	-2	2	Accident impact on transportation	**SC5**
-A	-8	3	2	3	-1	1	Impact of roadside spots on health indices	**SC6**

+D	34	3	3	3	2	3	Repairmen's impact on security	**SC7**
+B	14	2	3	2	2	1	Road improvement impact on the availability	**SC8**

Table 9. The impacts of the existing Parchin-Pasdaran Road on the techno-economic environment at the operational phase

Assessment criterion							**The impact of activities on environmental components**	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
N	0	3	3	3	0	1	Manpower recruitment	**EO1**
+D	48	2	3	3	2	3	Increasing the price of real estates	**EO2**
+D	27	3	3	3	1	3	Easy access to Parchin Area	**EO3**
+D	54	3	3	3	2	3	Tourism development	**EO4**

The alternative road impacts in the construction phase

In this step, the impacts of the alternative road construction were investigated on the components of physicochemical, bio-ecological, socio-cultural, and techno-economic environments.

Table 10. The impacts of the alternative Parchin-Pasdaran Road on the physicochemical components at the construction phase

Assessment criterion							**The impact of activities on environmental components**	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
-A	-6	2	2	2	-1	1	mountain-cutting impact on noise generation	PC1
-A	-6	2	2	2	-1	1	mountain-cutting impact on soil erosion	PC2
-A	-8	2	3	3	-1	1	drilling impact on drainage	PC3
-A	-8	2	3	3	-1	1	drilling impact on landform	PC4
-A	-7	3	2	2	-1	1	soil excavation impact on air pollution	PC5
-A	-6	2	2	2	-1	1	soil excavation impact on noise generation	PC6
-A	-7	2	3	2	-1	1	soil excavation impact on surface water quality	PC7
-A	-6	2	2	2	-1	1	explosion impact on noise generation	PC8
-A	-8	2	3	3	-1	1	explosion impact on soil characteristics	PC9

-B	-14	2	3	2	-1	2	The impact of transporting materials on noise pollution	PC10
-A	-6	2	2	2	-1	1	The impact of loading materials on noise generation	PC11
-A	-6	2	2	2	-1	1	The impact of transporting debris on air pollution	PC12
+A	8	2	3	3	1	1	Asphalt pavement impact on the study area	PC13
+A	8	2	3	3	1	1	Land leveling impact on erosion	PC14
+A	8	2	3	3	1	1	Rock embankment impact on sedimentation	PC15

Table 11. the impact of the alternative road on the bio-ecological environment during the construction phase

Assessment criterion							The impact of activities on environmental components	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
-B	-16	3	3	2	-1	2	Clear-cutting impact on terrestrial ecosystem	BE1
-C	-32	2	3	3	-2	2	Impact of using herbicide on aquatic environment	BE2
-A	-8	3	3	2	-1	1	Impact of using herbicide on habitat of plant species	BE3
-A	-8	3	3	2	-1	1	Impact of using herbicide on density of plant species	BE4
N	0	2	2	2	0	1	Explosion impact on behavioral pattern of animals	BE5
N	0	1	1	1	0	1	Foundation impact on habitats of animals	BE6
-C	-32	2	3	3	-2	2	bridge building impact on aquatic ecosystem	BE7

Table 12. the impact of the alternative road on the socio-cultural environment at the construction phase

Assessment criterion							The impact of activities on environmental components	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
-B	-14	3	2	2	-1	2	The impact of supplying borrow materials on local traffic	SC1
-A	-6	2	2	2	-1	1	Noise nuisance to local communities	SC2
+A	6	2	2	2	1	1	recruitment impact on public participation	SC3
+A	6	2	2	2	1	1	recruitment impact on population density	SC4

Table 13. the impact of the alternative road on the techno-economic environment at the construction phase

Assessment criterion							The impact of activities on environmental components	
R	ES	B3	B2	B1	A2	A1		
+B	16	3	3	2	2	1	The impact of supplying borrowed materials othe n local economy	EO1
+B	16	3	3	2	2	1	The impact of manpower on regional income	EO2
-C	-28	2	3	2	-2	2	The costs of land use changes	EO3
-B	-12	1	3	2	-1	2	The costs of road construction	EO4
-A	-5	1	2	2	-1	1	The impact of construction operation on tourism in the study area	EO5

The alternative road impacts in operational phase

In this step, the impacts of the alternative road were investigated on the components of physicochemical, bio-ecological, socio-cultural, techno-economic environments.

Table 14. The impacts of the alternative Parchin-Pasdaran Road on the physicochemical components at operational phase

Assessment criterion							The impact of activities on environmental components	
R	ES	B3	B2	B1	A2	A1		
-C	-28	3	2	2	-2	2	impact caused by traveling vehicles on air quality	**PC1**
-A	-6	2	2	2	-1	1	impact caused by traveling vehicles on noise pollution	**PC2**
-B	-14	3	2	2	-1	2	Impacts of salt spray on surface water quality	**PC3**
-C	-28	3	2	2	-2	2	road improvement impact on air quality	**PC4**
-B	-16	3	2	3	-2	1	road improvement impact on surface water resources	**PC5**
+A	8	2	3	3	1	1	Impact of re-lining and repairing the road signs	**PC6**
-A	-6	2	2	2	-1	1	impact of road accidents on air quality	**PC7**
-C	-32	2	3	3	-2	2	impact of road accidents on surface water quality	**PC8**
-A	-8	3	3	2	-1	1	impact of road accidents on soil	**PC9**

Table 15. The impacts of the alternative Parchin-Pasdaran Road on the bio-ecological environment at the operational phase

Assessment criterion							The impact of activities on environmental components	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
-A	-8	2	3	3	-1	1	impact of solid waste transportation on terrestrial ecosystem	**BE1**
-B	-18	3	3	3	-2	1	impact of solid waste transportation on aquatic ecosystem	**BE2**
-B	-16	2	3	3	-2	1	impact of traveling vehicles on indicator mammalian	**BE3**
-A	-7	3	2	2	-1	1	impact of a roadside stop on main habitats	**BE4**
-B	-18	3	3	3	-2	1	Impact of road accidents on indicator mammalian	**BE5**
-A	-9	3	3	3	-1	1	impact of traveling vehicles on habitats of plant species	**BE6**

Table 16. The impacts of the alternative Parchin-Pasdaran Road on the socio-cultural environment at the operational phase

Assessment criterion							The impact of activities on environmental components	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
+D	54	3	3	3	2	3	The road impact on future development plans	**SC1**
+D	54	3	3	3	2	3	The road impact on increasing services	**SC2**
+D	36	3	3	3	2	2	Road impact on migration	**SC3**
+B	18	3	3	3	2	1	Road impact on the local population	**SC4**
-C	-32	3	3	2	-2	2	Accident impact on transportation	**SC5**
-A	-8	3	2	3	-1	1	Impact of roadside spots on health indices	**SC6**
+D	54	3	3	3	2	3	Repairmen’s impact on security	**SC7**

+B	14	2	3	2	2	1	Road improvement impact on the availability	**SC8**

Table 17. The impacts of the alternative Parchin-Pasdaran Road on the techno-economic environment at the operational phase

Assessment criterion							**The impact of activities on environmental components**	
R	**ES**	**B3**	**B2**	**B1**	**A2**	**A1**		
+B	18	3	3	3	2	1	Manpower recruitment	**EO1**
+D	48	2	3	3	2	3	Increasing the price of real estates	**EO2**
+E	108	3	3	3	3	4	Easy access to Parchin Area	**EO3**
+E	72	3	3	3	2	4	Tourism development	**EO4**

Table 18. summary of the existing road scores at the construction phase

-E	**-D**	**-C**	**-B**	**-A**	**N**	**+A**	**+B**	**+C**	**+D**	**+E**	**Impact extent / environment**
0	0	0	0	12	0	3	0	0	0	0	physicochemical
0	0	1	0	3	3	0	0	0	0	0	bio-ecological
0	0	2	1	1	0	0	0	0	0	0	socio-cultural
0	0	1	4	0	0	0	0	0	0	0	techno-economic
0	0	4	5	16	3	3	0	0	0	0	**Total scores**

At this stage, the summary of the existing road scores was determined in the construction phase. As mentioned earlier, the rows of the matrices were filled with the scores of the environments while the columns were allocated to the extent of the impacts. According to the calculations performed, the extent of each impact was written separately and then their total sum was computed. In Table 18, the total scores of the extent –A is most of all which represents a slight negative impact and changes.

Table 19. summary of the existing road scores at the operational phase

-E	**-D**	**-C**	**-B**	**-A**	**N**	**+A**	**+B**	**+C**	**+D**	**+E**	**Impact extent / environment**
0	0	0	4	2	0	1	2	0	0	0	physicochemical

0	0	1	4	1	0	0	0	0	0	0	bio-ecological
0	1	1	1	1	0	0	1	1	2	0	socio-cultural
0	0	0	0	0	1	0	0	0	3	0	techno-economic
0	1	2	9	4	1	1	3	1	5	0	**Total scores**

Table 20. summary of the alternative road scores at the construction phase

-E	-D	-C	-B	-A	N	+A	+B	+C	+D	+E	Impact extent / environment
0	0	0	1	11	0	3	0	0	0	0	physicochemical
0	0	1	2	2	2	0	0	0	0	0	bio-ecological
0	0	0	1	1	0	2	0	0	0	0	socio-cultural
0	0	1	1	1	0	0	2	0	0	0	techno-economic
0	0	2	5	15	2	5	2	0	0	0	**Total scores**

In Table 20, the greatest value belongs to the extent –A.

Table 21. summary of the alternative road scores at the operational phase

-E	-D	-C	-B	-A	N	+A	+B	+C	+D	+E	Impact extent / environment
0	0	3	2	3	0	1	0	0	0	0	physicochemical
0	0	0	3	3	0	0	0	0	0	0	bio-ecological
0	0	1	0	1	0	0	2	0	4	0	socio-cultural
0	0	0	0	0	0	0	1	0	1	2	techno-economic
0	0	3	5	7	0	1	3	0	5	2	**Total scores**

In Table 21, the highest total score is allocated to the extent –A which represents slight negative impacts and changes.

Conclusion

Pastakia Matrix results

Table 21. comparison of the existing and alternative roads at the construction phase

-E	-D	-C	-B	-A	N	+A	+B	+C	+D	+E	Impact extent / Environment
0	0	2	5	15	2	5	2	0	0	0	**Alternative road**
0	0	4	5	16	3	3	0	0	0	0	**Existing road**

Comparing the existing and alternative roads in the construction phase it was revealed that the alternative road has 2 positive impacts and 5 slight positive impacts while the existing road has 3 slight positive impacts. Besides, the alternative road has 5 slight negative impacts, 5 negative impacts, and 2 medium negative impacts while the existing road has 16 slight negative impacts, 5 negative impacts, and 4 medium negative impacts.

Table 22. comparison of the existing and alternative road at the operational phase

-E	-D	-C	-B	-A	N	+A	+B	+C	+D	+E	Impact extent / Environment
0	0	3	5	7	0	1	3	0	5	2	Alternative road
0	1	2	9	4	1	1	3	1	5	0	Existing road

Comparing the existing and alternative roads in the operational phase, it was revealed that the alternative road has 2 positive and beneficial impacts, 5 distinguished positive impacts, 3 positive impacts and 1 slight positive impact while the existing road has 5 distinguished positive impacts, one medium positive impact and one slight positive impact. Besides, the alternative road has 5 slight negative impacts, 5 negative impacts and 3 medium negative impacts while the existing road has 4 slight negative impacts, 9 negative impacts, 2 medium negative impacts and 1 negative impact. A comparison of the obtained results of the construction phase indicated that the positive impacts of the alternative road covering the range between "slightly positive" and "positive" will be more than the existing road imposing impacts within the extent of "slightly negative" and "greatly negative". Accordingly, an environmental impact assessment of the given options in the construction phase suggested that the alternative road is more acceptable than the existing road. As regards, the slight negative impacts of the alternative road in the construction phase is local and related to the physicochemical environment, they can be minimized by performing appropriate mitigation measures. However, the alternative road has a great positive value on a national scale, without any distinguished or great negative impacts.

Recommendations

1- Considering that explosion noise could be a nuisance for the fauna during pregnancy, depending on the pregnancy type and duration of indicator animals, the explosion should be done in late summer, within daylight hours.

2- In order to prevent landslides or other major soil movements, excavation operations should be avoided in potentially sensitive and unstable areas. It is also possible to fix the exaction walls by using appropriate materials such as cement and retaining walls.

3- Sapling planting on erodible surfaces is highly recommended to prevent soil erosion. Mulching would be another proper alternative in this case.

4- For preserving the wildlife habitats from being further destroyed, the alternative road must cross through the parts imposing the least damage to the sensitive habitats.

5- To avoid increasing hunting violations and declining wildlife population as due to the construction of access roads, severe control, the establishment of suitable checkpoints, and deployment of police officers could be effective.

6- In order to avoid vehicle horning problems that disrupt migration and breeding and change behavioral patterns of animals, training drivers by installing no horning signs could be useful.

7- The dust damage of vehicle traveling which causes problems for the animal and plant species in the area can be controlled by sprinkling.

8- By controlling the speed of vehicles through training drivers and installing warning signs, it could be possible to reduce the risk of a motor vehicle collision with wildlife species intending to cross the road.

9- In order to avoid environmental and social problems caused by building workshops, it is necessary to select their site appropriately. They should enjoy proper management, as well.

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