ENVIRONMENT IMPACT ASSESSMENT (E.I.A.) FOR THE EVALUATION OF FOREST ROADS IN MOUNTAINOUS CONDITIONS

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Keywords: environment, impact, forest opening up, road construction, photogrammetric method

Abstract: *This paper deals with the recording of the anthropogenic impact to the natural environment, especially the impacts by the road construction. The main objectives of this investigation were the objective and practical evaluation of different route alternatives, prior to the construction's fulfillment and adjustment in relation to the principles impacts evaluation to the landscape and environment by road construction and opening up of the forest. As research area was chosen the forest complex of Down Olympus. There is a review of generated practical criteria for the evaluation of the intensity of the impact and the absorption of the forest ecosystem and the gradation of the weight of criteria from the questionnaire that was sent to all special scientists (Forest offices) in Greece. The media that were used for the collection of landscape environment information (road evaluation) were aerial slides, thematic maps, while; G.I.S. and analytical photogrammetric method were used for the data processing. Finally, E.I.A of existing roads with different absorption were compared. At the end of the paper, from the results of the research the relative conclusions were drawn-up and suggestions made.*

1. Introduction

The Environment Impact Assessment (E.I.A.) in German terminology is called Umwelt-verträglichkeitsprüfung (U.V.P.). As E.I.A. means an assessment of impact on environment the U.V.P. means to test if the activity is compatible with the environment. The zero (0) solution that refers to forest without roads is technically and economically impossible (Heinimann, 1994). In the construction of forest road, E.I.A. can be defined as, the test if the road construction is compatible with the environment.

For the first time, during 1977, an Environment Impact Assessment (E.I.A.) was undertaken in Greece, during the dam construction plan on the Aoos and Nestos rivers for the production of electric power. During the same year (1977), the E.I.A. was referred to in the Law Nr. 743 but without practical use. In 1986, the E.I.A was referred to in the Law (Nr. 1650) for the protection of the environmental regulations especially in articles 3-6, so that the Greek legislation could be adapted to EU directions.

Despite the above-mentioned facts, it was found that in Greece, a real E.I.A. was rarely undertaken. Therefore, the existence of an E.I.A. is of great importance for the European Countries, for forest opening up, according to law claim with practical form. For a successful opening up project it is necessary to take into consideration the net cost of road construction as well as the cost arising from the positive and negative effect to the Environment (Doukas and Akca, 1998; Doukas, 1994; Becker, 1995). The total cost is the sum of partial cost (Warner, 1973).

The purposes of this paper were the following:

1. To find the principles impacts evaluation to the landscape and environment by the road construction and opening up of the forest.
2. The objective and practical evaluation of different route alternatives, prior to the construction's fulfillment.
3. To produce a matrix and a profile list, to find the weights/ significance of criteria and the ability of ecosystem to absorb the impact of road construction.
4. To find a new planning technique according to the aims of opening up and terrain conditions, which can compare alternatives of road construction, before the road has been constructed.

For this purpose, the area of research was the forest complex of Down Olympus.

2. Method of work

The method, which will be applied, should be practical, effective and easy to use before the road construction. For this reason:

1. We have generated practical criteria to evaluate the intensity of the impact and absorption (Buerger et al., 1987; Zundel, 1990; Sedlak, 1993). The grading of these criteria depends on the following principle: We accepted a situation as ideal (=100%) for the forest protection by road construction. The percentage of deviation from this ideal situation will be subtracted from 100%. The result will be the grading of the criteria.

2. We have graded the weight of criteria from questionnaires that were sent to all special scientists (Forest offices) in Greece. This gradation depends on many parameters such as (Koutsopulos and Kophitsas, 1984):
   - The effect period.
   - The influence area.
   - People's sensitivity.
   - Social and political desire.

   The evaluation of these parameters will be difficult and therefore the description of an E.I.A. in a profile form will be a necessary addition.

3. We have used analytical photogrammetric method and G.I.S., for the collection of landscape environment information (road evaluation).

4. E.I.A. of existing roads, with different absorption along the roads, in the research area of complex of Down Olympus, was compared.

3. Results

We have received 120 answers to our questionnaires from Greek forest offices. Table 1 presents the criteria of absorption and intensity with their weights and the evaluation of forest roads C1 and C2 in the forest complex of Down Olympus. The compatibility with the natural environment is given from the following equation:

$$C\,(\%) = MA\,(\%) \times ME\,(\%) \qquad (1)$$

where C (%), MA (%) and ME (%) are the Compatibility, Mean Absorption and Mean Intensity.

a. In forest road C1:
In the C1 forest road (Table 1), a mean absorption MA = 66% and a mean intensity ME = 92% was found. The coefficient of compatibility (C) with the natural environment is 61%, according to the equation (1).

b. In forest road C2:
In the C2 forest road (Table 1), a mean absorption MA = 66.7% and a mean intensity ME = 74.1% was found. The coefficient of compatibility (C) with the natural environment is 49.4%, according to the equation (1). In figure 1 shows the impact of the less distance between the serpentines. The second road it is not compatible with the natural environment because of the criteria 4 and 8.4.

4. Conclusions and suggestions

According to the above-mentioned results we have the following conclusions:

1. For the C1 forest road the compatibility is over than 50%, the existing road can be accepted as a road compatible with the environment.
2. For the C2 forest road the compatibility is less than 50%, the existing road can not be accepted as a road compatible with the environment and the technical specifications of the staking grade line should be improved.

Based on the research's results the following are suggested:

1. It will be very practical and useful for the assessment by the E.I.A. to have a list of helpful criteria, (Table 1) and their weights to evaluate the intensity of the impact of road construction and the ability of absorption in order to make a profile form for every forest road on the basis of European Union directions.
2. It could be very useful to have alternative road construction solutions for comparison based on the new planning technique according to the aims of forest opening up, terrain conditions and the protection of forest ecosystem, before the forest road is constructed.
3. The staking grade line of the first road in a Digital Terrain Model will be very helpful (more easy) for the comparison of more road alternatives in order to find the best solution for the natural environment.
4. In sensitive ecological systems such as Mediterranean forest areas it is very important, from technical and economical design view, to have a realistic concept, within the framework of an E.I.A.
5. If in a forest road (like C2) the coefficient of compatibility (C) with the natural environment is less than 50%, we must improve the profile of the forest road wherever we can. This means we must construct without serpentines, but with normal curve radius (Figure 1). For a compatible road we should improve the road in the serpentine (4) and the road drainage system (8.4).

Research will also be continued in other forest roads. A decision-making depends on the weight of the parameters, cost, existing legislation and the environmental policy.

Figure 1: The impact of the less distance between the serpentines

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6. Appendix

Table 1: Evaluation of forest roads C_1 and C_2 in the forest complex of Down Olympus

		C_1		C_2	
a. Criteria of absorption (A)	**Weights**	**Grade %**	**Sum**	**Grade %**	**Sum**
1. Terrain conditions					
1.1. Forest	3	100	300	90	270
1.2. Mixed forest	3	100	300	70	210
1.3. High forest	3	100	300	80	240
1.4. Selection forest	3	80	240	70	210
1.5. Mean height	3	40	120	40	120
1.6. Site quality	3	50	150	50	150
1.7. Productivity	3	25	75	25	75
1.8. Slope	2	20	40	25	50
1.9. Exposition	2	70	140	80	160
1.10. Relief	2	100	200	100	200
2. Distance from					
2.1 Tourist places	1	90	90	90	90
2.2. Highway	1	100	100	90	90
2.3. Railway	1	*	*	*	*
2.4. Archaeological sites	1	100	100	100	100
2.5. Town	1	100	100	100	100
2.6. Village	1	50	50	70	70
2.7. Path way	1	*	*	*	*
b. Criteria of intensity (E)					
1. Earthwork allocation					
1.1. Curve radius	2,10	100	210	40	84
1.2. Gradient	2,01	82	165	60	120,1
1.3. Gross section	2,25	40	90	60	135
2. Road width	2,04	80	163	70	142,8
3. Road gradient	2,52	100	252	80	201,6
4. Serpentine	2,13	100	231	50	106,5
5. Position of road					
5.1. Distance of water flow	1,83	100	183	100	183
5.2. Distance of forest boundary	1,65	100	165	100	165
5.3. Area with construction problems	2,40	100	240	90	216
6. Picture of landscape					
6.1. Form of terrain	1,83	100	183	80	146,4
6.2. Vegetation	1,80	100	180	100	180
6.3. View effect	1,70	100	170	100	170
6.4. Compatible constructions	1,60	100	160	*	*
6.5. View of water flow	1,65	100	165	*	*
7. Visual absorption capability	1,77	100	177	80	136
8. Construction of forest road (only for existing road)					
8.1 Earth works machinery	2,16	70	151	70	151,2
8.2. Material	2,08	100	208	100	208
8.3. Seeding and mulching of side slope	1,38	100	138	90	124,8
8.4. Road drainage system	2,31	90	208	20	46,2

* It does not exist in this road.