Environmental road construction in dry grasslands

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Abstract

The road as every technical work should upgrade the area that crosses and should not destroy it. In other words, it must be compatible with the environment. The primary concern of a forest engineer should be the compatibility of such infrastructural works with the environment. "Compatibility with the environment" means to define, describe and assess the effects of a road construction work on the environment, and to take measures for its protection. Aim of this paper is to find the evaluation principles as far as the impacts on the landscape and environment by the road construction is concerned and opening it up in order to determine an objective and practical evaluation of different route alternatives, before the construction is completed. A combination of digital photogrammetry and GIS technology was used to evaluate the compatibility between the road and the natural environment. In order to evaluate the compatibility, practical criteria of the intensity of the human influence as well as criteria of the environment absorbency to such interventions were used. The digital maps and the spatial analysis were used for the efficient and reliable evaluation of these criteria. We tried to adapted the already existed assessment criteria for infrastructural works that are used to examine and evaluate the impact on the natural environment of such works, as well as to choose the best (compatible) environmental solution from various alternatives during the phase of the grassland roads' planning. From the analysis of the results of the above criteria we were led to useful conclusions regarding the construction of grassland roads.

Key words: impact, road construction, criteria, intensity, absorbency.

Introduction

The rangelands are natural ecosystems covered by herbaceous or shrubby vegetation, that produce food for both wild and farm animals, while offering other goods and services (Papanastasiou and Noitsakis 1992). Fall on woodlands, because they come from forests that, at some point they have been degraded due to human activities (e.g., fires, illegal logging) and have been converted into lands for grazing. They are therefore common natural ecosystems. Specifically in the area of woodlands, technical works cause loss of vital green space and flood risk in the wider region resulting in continuing degradation of the quality of life in the rest

region. Therefore it is clear that for each forest technical-development work it is necessary to control the compatibility with the environment.

Human impact strongly controls vegetation development patterns, in particular, in mountainous regions, due to tourists (Myers, Bazely 2003, Turton 2005). Roads, including mountain trails, are convenient ways for the movement of non-native species *via* human activities (Trombulak, Frissell 2000, Thiele, Otte 2008). As a result of human impact, roadside grassland vegetation decreases in cover, and native herbaceous plants are excluded by exotic ones (Goudie 2005).

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Aim of this paper is to find the evaluation principles as far as the impacts on the landscape and environment by the road construction is concerned and opening it up in order to determine an objective and practical evaluation of different route alternatives, before the construction is completed.

Materials and methods

The road in construction is about 5,120 km length in the south of Province of Metsovo that is laid in the mountainous mass of Northern Pindos in Greece and includes mountainous settlements and villages. The total acreage of Province Metsovo amounts to 54,479.30 Ha in which 25% i.e. 13,515.20 Ha are grasslands.

We tried to adapted the already existing assessment criteria for forest road that are used to examine and evaluate the impact on the natural environment, as well as to choose the best (compatible) environmental solution from various alternatives during the phase of planning the grassland roads. The absorbency criteria and their importance (weights) are based on the opinions of experts (specialized scientists) and relevant literature and divided into (Drosos et al. 2006):

The rangeland criteria with weight coefficients three (3) are the following:

1. Kind of rangeland. Grasslands: 100%, silvopastoral systems: 75%, rangelands dominated by shrubs: 50%, rangelands dominated by subshrubs: 15%. 2. Rangeland ecological zones. Low zone: 0-600m: 100%,

Semi-mountainous zone: 600-800m: 100%, Mountainous or High zone: 800-1200m: 75%, Pseudo alpine zone: >1200m: 50-25%. 3. The site quality. I: 100%, II: 50%, III: 25%. The grading depended on the fact that some species are more widespread in certain areas only. In general, annual species' appearances are more frequent in low and semi-mountainous zone.

The topographical criteria with weight coefficients two (2) are:

4. The traverse of the ground. High >20%: 5-25%, medium 8-20%: 50%, mild <8%: 100%. 5. Aspects. Less than 1000m: northern: 100%, southern 50%, eastern or western 75%, over than 1000m: eastern or western: 100%, northern or southern: 70%. 6. The terrain relief. Mild: 100%, various: 50%, intense: 15%.

Social criteria with weight coefficients one (1) depend on the number of humans affected by the road. Distance plays a major role in impact (Table 1).

A questionnaire was drafted with the help of specialized scientists and the relevant literature with the intensity criteria that are divided into layout and construction criteria, as shown in table 1 (Drosos 2009), and they were sent to the forest offices of Greece. The weight coefficients of the intensity criteria were raised from the average score of grading of questionnaires.

To calculate the average intensity value on a scale of 100 (%), we multiply the grade of each criterion by its weight and in the end; we divide the sum of the products by the total sum of weights. The same applies to absorbency. To calculate the forest road's compatibility coefficient we multiply the average absorbency value by the average impact intensity value.

We can construct the road when the compatibility coefficient is above 60% or 0.60. If the coefficient compatibility is between 0.50-0.60 can be done but on certain conditions. If the compatibility coefficient is below 0.50 the effects will be very large and what is needed is to change the layout or to construct technical works to restore the natural environment.

Results and Discussion

The evaluation of the road intensity and ecosystem's absorbency are displayed in table 1.

In order to calculate the road's compatibility coefficient we have: $C_C = C_A \times C_I = 69.70\% \times 88.20\% = 61.48\%$. Where C_C is the compatibility coefficient (%), C_A is the average absorbency value (%) and C_I is the average intensity value (%). Based on the results, we notice that the road under study is classified as acceptable, given the fact that its compatibility coefficient is

61.48%. And since C_I>50% and C_A>50%, the construction is accepted under no special condition.

Table 1. Evaluation of road

Criteria	**Weights**	**Grade %**	**Sum**
a. Criteria of absorbency (A)			
1. Kind of rangeland	3	62	186
2. Rangeland ecological zone	3	84	252
3. Site quality	3	50	150
4. Slope	2	50	100
5. Aspect	2	92.5	185
6. Relief	2	75	150
7. Distance from			
7.1 Tourist resort	1	100	100
7.2. National and country road network	1	100	100
7.3. Railway	1	100	100
7.4. Archaeological site	1	100	100
7.5. Adjacent big city	1	100	100
7.6. Adjacent village	1	100	100
7.7. European path	1	80	80
7.8. Natural or artificial lake or river	1	100	100
b. Criteria of intensity (I)			
Layout			
1. Curve radii	2.10	100	210
2. Gradient	2.01	80	160.8
3. Gross section	2.25	90	202.5
4. Road width	2.04	70	142.8
5. Road gradient	2.52	100	252
6. Distance of hairpin turn	2.13	100	213
7. Distance from stream	1.83	100	183
8. Distance from forest boundary	1.65	90	148.5
9. Distance from dangerous sites	2.40	100	240
10. View of morphological formations	1.83	100	183
11. View of vegetation forms	1.80	80	144
12. View of space projection	1.70	70	119

13. View of compatible constructions	1.60	100	160
14. View of water flows	1.65	20	33
15. Visual absorption capability	1.77	55	97.35
Construction (only for existing road)			
16. Machinery of earth works	2.16	100	216
17. Material	2.08	100	208
18. Seeding and mulching of side slope	1.38	100	138
19. Road drainage system	2.31	100	231

Conclusions

This is the first attempt in order to adapt the intensity and absorbency criteria governing forest roads in rangeland roads. The criteria in table 1 are based on countable values and constitute indexes of environmental consequences from the road to the natural environment. The application of this method is considered to be reliable not only for the estimation of the existing roads but also for the study of their impact to the environment before the construction of new ones. A suitable database is required for the application of the method. Thus, the data processing is achieved quickly and the creation of digitized maps and diagrams for various suggested road nets are obvious. In conclusion, the developmental physiognomy of an area, such as Province of Metsovo, ought to be based on the viable development that is subject of the application of an integrated developmental plan, which depends on the conservation of the natural environment, the activation of the human and social resources, the utilization of the special social, cultural and financial characteristics. To the attachment of the above development model, major role would play the study of the intensity of impacts on the roads that have caused to the natural environment as well as the estimation of its absorbency. The study results will be directly exploited, as improvement standards for the construction of roads in grasslands, under the prism of the compatibility with the natural environment, particularly in regions with cover over than 25% with grasslands.

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