Environmental impact assessment (E.I.A.) for the evaluation of forest roads in mountainous conditions

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EXTENDED ABSTRACT

This research develops a method anthropogenic impact to the natural environment especially the impacts by the forest road construction. The key issues are: a) Construction work in the field often results in environmental damage, to be more specific to get access to a forested is necessary to take into consideration the net cost of road construction as well as the cost arising from to the Environment. The total cost is the sum of partial cost. b) Human presence demands exploitation of the natural environment. Yet it causes interference some times with a negative effect.

The method, which will be applied, should be practical, effective and easy to use before the road construction. For this reason: 1) Practical criteria must be held in order to evaluate the intensity of the impact and absorption. The grading of these criteria depends on the following principle: We accept a situation as ideal (=100%) for the forest protection by construction. This ideal situation will be described by criteria, 2) the rating of those criteria will result from a survey of forest scientist by questionnaires. The following parameters will be considered: a) the duration of the negative effect, b) the influenced area, c) the sensitivity of the general public to the effect as well as social impact and political desire. (The evaluation of the later parameters will be difficult and therefore the description of an E.I.A. in a profile form will be a necessary addition), 3) Analytical photogrammetric method and GIS will be used to evaluate the road location on the landscape level and with respect to the environment, 4) E.I.A. of existing roads, in the research area will reveal different forms of absorption of negative impacts along the roads. This information will be used to assess the impacts of the planned forest roads.

The research is of practical interest for forest management. The identification and the rating of criteria for assessing environmental impacts of road construction combined with revealing possible mitigating effects through impact absorption will allow for comprehensive evaluations of every forest road according standards set by new EU directions. The E.I.A. is of special interest when comparing different technically doable road alignments at the planning stage. Besides assessing them against the objectives of the access planning additional criteria will be available to include impacts on the forest ecosystems. The latter will affect the road alignment in horizontal and vertical perspective and result in a solution, which is technically and environmentally acceptable. The criteria of assessing environmental impacts of forest roads will be analysed by using methods of conditions and protection of forest ecosystems. Based on the framework of the E.I.A. we must find a compatible solution in order to improve the road on the level both on the serpentine and the road draining system. Analytical photogrammetry and GIS will be used for drawing up the environmental changes. The combination will be used as a decision – support tool together with the: E.I.A. parameters, cost, existing legislation and environmental policy.

UMWELTVERTRÄGLICHKEITSPRÜFUNG (UVP) FÜR EINGESETZT DIE FORSTWEGEN IM GEBIRGIG VERHÄLT

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ABSTRAKT

In dieser Studie wurde eine Methode entwickelt, um den menschlichen Einfluss, insbesondere die Effekte der Waldwegkonstruktion auf die Natur zu untersuchen. Die Hauptüberlegungen sind; a) Umweltschäden sind oft als Konsequenzen von Konstruktionsarbeiten festzustellen; bei der Planung von Zugang in Waldflächen ist die Berücksichtigung von Wegkonstruktions- wie auch Umweltschadenkosten erforderlich. Die Gesamtkosten werden als die Summe verschiedener Teilkosten berechnet, b) Die Natur wird vom Mensch genutzt, allerdings oft mit negativen Konsequenzen.

Die angewendete Methode soll praktikabel, effektiv und schon vor der Wegkonstruktion einfach verwendbar sein. Aufgrund dessen: 1) Praktische Kriterien müssen eingesetzt werden, um die Einflussintensität der Eingriffe und Einflussaufnahme zu schätzen. Die Kriterien werden nach dem folgenden Prinzip eingestuft: Wir akzeptieren eine Situation als ideal (=100%) für den Waldschutz während der Konstruktion. Diese ideale Situation wird nach bestimmten Kriterien beschrieben, 2) die Einstufung dieser Kriterien erfolgt nach einer Umfrage von Forstwissenschaftlern. Folgende Parameter werden berücksichtigt: a) die Dauer von negativen Effekten, b) die beeinflusste Fläche, c) die Sensibilität der Bevölkerung wie auch die soziale Konsequenzen und politische Wille. (Die Evaluierung der oben genannten Parameter ist eine schwierige Aufgabe und deshalb wird die Beschreibung von UVP als Ergänzung benötigt), 3) Luftaufnahmen und GIS werden benutzt, um die Wege umweltfreundlich in der Landschaft zu lokalisieren, 4) UVP von existierenden Wegen, in der Versuchsregion werden negativen Effekten entlang des Weges unterschiedlich aufgenommen. Diese Information wird benutzt, um die Umweltbelastung der geplanten Wege einzuschätzen.

Das Ergebnis dieser Arbeit ist von praktischem Interesse für die Forstwirtschaft. Die Festlegung and Beurteilung von Kriterien für die Einschätzung von Umweltbelastungen wegen Waldwegkonstruktionen in Zusammenhang mit strafmildernden Effekten durch Effektaufnahme wird eine übergreifende Bewertung von allen Waldwegen erlauben. Diese Bewertung wird gemäß festgesetzten EU-Standards erfolgen. UVP ist beim Vergleich von technisch ausführbaren Waldwegen in der Planungsphase sehr wichtig. Neben ihre Beurteilung in Abhängigkeit von ihrem Zugang in der Planungsphase werden zusätzlichen Kriterien zur Verfügung gestellt. Diese Kriterien werden die Einflüsse auf Waldökosysteme berücksichtigen, welche wiederum die horizontale und vertikale Wegausrichtung beeinflussen werden. Daraus wird ein Vorschlag gemacht, der technisch umsetzbar und umweltfreundlich ist. Im Rahmen der UVP sollen Verbesserungsmöglichkeiten bez. Serpentine und Straßenabflusssysteme vorgeschlagen werden. Luftaufnahmen und GIS werden zur Darstellung von ökologischen Veränderungen angewendet. Die Kombination der verschiedenen Methoden wird zusammen mit UVP- Parameter, Kostfaktoren, Gesetzgebung und Umweltpolitik zur Entscheidung für oder gegen eine Wegkonstruktion führen.

1. INTRODUCTION

The term Environmental Impact Assessment (E.I.A.- UVP) means an assessment of impact on the environment caused by anthropogenic interference. This paper deals with the impacts on the natural environment by road construction. In Greece this terminology used for the first time in the Law Nr.743/77 and same years later in the Law Nr. 1650/86, articles 3 to 6, which were referred to as the environmental protection in order to be compatible to the Greek legislation with the European directions that was given to Greece.

Despite the legislation about E.I.A. all constructions are rarely undertake by them, because constructors couldn't estimate the use of them (Stergiadou e.t.all, 2003, Stergiadou et all, 2004). For a successful forest opening up project it is necessary to take into consideration the net cost of road construction as well as the cost arising from the Environment (Doukas, 1994, Becker, 1995, Doukas et all 1998). The total cost is the sum of partial cost (Warner 1973).

The key issues are: a) Construction work in the field often results in environmental damage, to be more specific to get access to a forested area it is necessary to take into consideration the road net cost as well as the cost arising from the landscape and the natural environment. b) Human presence demands exploitation of the natural environment. Yet it causes interference some times with a negative effect.

The area of the National Park of southern Pindos spreading over 6,8 acres, it is the biggest and most important national park of Greece and it is held as the research area. It is situated at the mountain range of Pindos, around 25km north of Metsovo, at the borders of Ioannina and Grevena. Among the developing forestry plants and trees there can be found beech trees, black pine trees, white pine trees, fir trees, maple trees, elms etc. The existing fauna is equally rich and comprises of wild bores, deer, wolves, rabbits, squirrels and various kinds of eagles and hawks. The geology and the flora of the national park are remnants of the ice age, as are twin lakes Flega at the centre of the park (http://menoumeellada.ert.gr/en/tourdetails.asp?id=657).

The road network is old, but every year the office of forestry improves the network and works on opening up of the forest, in order to be easily visited. The roads that have been chosen are two of the main forest roads in the heart of the National Park of Southern Pindos. The first forest road is ahead from the village Perivoli to the Warerfalls (photo1) and it is the central road of the National Park. The second forest road is a secondary road that connects the E6 path with the village Pades. Both of the roads used only for tourist reasons and only sometimes are used by cars or tracks of the office of forestry. So the intensity isn't really enormous.

Photo 1. First Forest road Perivoli - Warerfalls

Photo 2. Second Forest road E6 - Pades

2. Methodology

The methodology that was followed was practical, effective and easy to use before or after a road has been constructed (OECD, 1994). For this reason:

- Practical criteria have been held in order to evaluate the intensity of the impact and absorption (Trzesniowski, 1993). The grading of these criteria depends on the following principle: We accept a situation as ideal (=100%) for the forest protection from construction. This ideal situation will be described by criteria.
- The rating of these criteria came as a result from a survey of forest scientists by using questionnaires. The following parameters have been considered: a) the duration of the negative effect, b) the influenced area, c) the sensitivity of the general public to the effect as well as the social impact and political desire. (The evaluation of the later parameters will be difficult and therefore the description of an E.I.A. in a profile form will be a necessary addition) (Eskioglou, 1994, Koutsopoulos et all 1984, Mousiopoulos, 1999).
- Analytical photogrammetric method and GIS will be used to evaluate the road location on the landscape level and with respect to the environment.
- E.I.A. of existing roads, in the research area will reveal different forms of absorption of negative impacts along the roads (Heinimann, 1992, Sedlak, 1993, Weiss, 1986). This information will be used to assess the impacts of the planned forest roads.

The equation that gives the compatibility with the natural environment is:

$$\mathbf{C(\%) = MA(\%) \; X \; ME \; (\%),}$$

Where C(%): Compatibility, MA(%): Mean Absorption, ME(%): Mean Intensity.

The identification and the rating of criteria for assessing environmental impacts of road construction combined with revealing possible mitigating effects through impact absorption will allow for comprehensive evaluations of every forest road according standards set by new EU directions. The E.I.A. is of special interest when comparing different technically dual road alignments at the planning stage. Besides assessing them against the objectives of the access planning additional criteria will be available to include impacts on the forest ecosystems. The latter will affect the road alignment

in horizontal and vertical perspective and result in a solution, which is technically and environmentally acceptable. The criteria of assessing environmental impacts of forest roads will be analysed by using methods of conditions and protection of forest ecosystems. Based on the framework of the E.I.A. we must find a compatible solution in order to improve the road on the level both on the serpentine and the road draining system.

3. Results

Based on questionnaires which have been given to the office of forestry of National Park of Southern Pindos area we composed a table (table 1) where all the criteria of absorption and intensity with their weights and the evaluation of forest roads have been presented $F.R.C_1$ and $F.R.C_2$.

TABLE 1. Criteria of absorption and Intensity on forest roads at Southern Pindos

CRITERIA OF ABSORPTION					
1. Terrain conditions	**Weights**	**$F.R.C_1$**		**$F.R.C_2$**	
		Grade %	**Sum**	**Grade %**	**Sum**
1.1 Forest	**3**	100	300	70	210
1.2 Mixed forest	**3**	65	195	65	195
1.3 High forest	**3**	100	300	100	300
1.4 Selection forest	**3**	50	150	50	150
1.5 Mean height	**3**	75	225	75	225
1.6 Side quality	**3**	50	150	50	150
1.7 Productivity	**3**	-	-	-	-
1.8 Slope	**2**	25	50	25	50
1.9 Exposition	**2**	85	170	85	170
1.10 Relief	**2**	100	200	100	200
2. Distance from					
2.1 Tourist places	**1**	100	100	100	100
2.2 Highway	**1**	100	100	100	100
2.3 Railway	**1**	-	-	-	-
2.4 Archaeological Sites	**1**	-	-	-	-
2.5 Town	**1**	100	100	100	100
2.6 Village	**1**	90	90	90	90
2.7 Path way	**1**	100	100	100	100
SUM	**29**		**2230**		**2140**
Avarege clause			**76,9%**		**73,8%**

CRITERIA OF INTENSITY					
1. Terrain allocation	**Weights**	**F.R.C_1**		**F.R.C_2**	
		Grade %	**Sum**	**Grade %**	**Sum**
1.1 Curve radius	2,1	100	210	80	168
1.2 Gradient	2,01	80	161	70	141
1.3 Gross section	2,25	90	202	80	180
2. Road width	2,04	70	143	70	143
3. Road gradient	2,52	100	252	90	227
4. Serpentine	2,13	100	213	90	192
5. Position of road					
5.1 Distance of water flow	1,83	100	183	80	147
5.2Distance of forest boundary	1,65	100	165	70	116
5.3 Area with construction problems	2,40	80	192	70	168
6. Picture of landscape					
6.1 From terrain	1,83	100	183	100	183
6.2 Vegetation	1,8	100	180	100	180
6.3 View effect	1,7	100	170	100	170
6.4 Compatible constructions	1,6	100	160	90	144
6.5 View of water flow	1,65	100	165	100	165
7.Visual absorption capability	1,77	90	160	100	177
8. Forest road construction (only for existing road)					
8.1 Earth works machinery	2,16		151	70	151
8.2 Material	2,08	70	208	100	208
8.3 Seeding and mulching of side slope	1,38	100	124	80	110
8.4 Road drainage system	2,31	90	162	50	116
SUM	**37,21**		**3384**		**3086**
Avarege clause			**90,9%**		**82,9%**

The equation that gives the compatibility with the natural environment is:

C(%) = MA(%) X ME (%),

Where C(%): Compatibility,
MA(%): Mean Absorption,
ME(%): Mean Intensity

a. First forest road C_1 Category (F.R.C_1) – (Perivoli– Warerfalls):

C(%) = MA(%) X ME (%) => C(%) = (76,9 X 90,9)% = 69,9%,

So the coefficient of compatibility C with the natural environment is *almost 70%.*

b. Second forest road C_2 Category (F.R.C_2) – (E6-Pades):

C(%) = MA(%) X ME (%) => C(%) = (73,8 X 82,9)% = 61,2%

So the coefficient of compatibility C with the natural environment is *almost 61%.*

It is obvious that both the forest road is compatible with the natural environment.

4. Conclusions

Based on the above results we came out with the following conclusions:

1. The first forest road shows compatibility almost 70%, so it is over than the 50% which is necessary in order to accept the existing road as a compatible road with the natural environment.
2. The second forest road shows compatibility nearly 61%, so it is also over than the 50% which is necessary in order to accept the existing road as a compatible road with the natural environment.

So both the forest roads are accepted and there are no suggestions for technical specifications of the staking grade line in order to be improved.

According to the research results it is suggested:

1. The proposed research is of practical interest for forest management.
2. A list of criteria (table 1) and their weights to evaluate the intensity of the impact from road construction and the absorption ability will be very useful and practical for the assessment by the Environmental Impact Assessment. Such a profile form based on European Union directions, will be useful to every office of forestry.
3. It could be very useful to have alternative road construction solutions for comparison based on the new planning technique according to the aims of opening up the forest, terrain conditions and the protection of forest ecosystem, before the forest road is constructed.
4. The staking grade line of one road in a Digital Terrain Model will be easiest to use for the comparison of more than one road alternative, in order that the best solution be taken.
5. Road segments exceeding this threshold will be identified for re-design purposes to minimize negative impacts on the environment.
6. It is of maximum importance in sensitive ecological systems such as Mediterranean forest areas, to have a realistic concept by designing the opening up of forests.
7. The uses of Environmental Impact Assessment as a decision tool it is of a major importance for having a Sustainable Development of a forest.
8. The existence of a profile form based on European Union directions for Environmental Impact Assessment can be used also as a tool, for re-design purposes of existing roads.

The existing legislation and the local environmental policy which held in Greece can give new directions to the offices of forestry in the section of construction works. The ministry of Environment, Physical Planning and Public Works is trying these days to reform a law that concerns for the Environment from the Public Works, using E.U. directions.

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