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ECO-DEVELOPMENT OF A PROTECTED MOUNTAINOUS AREA AND THE IMPROVEMENT APPLICATION OF FOREST ROAD

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Abstract: *Many of Greece's historic, cultural landscapes and native ecosystems have been degraded or isolated over the years. Mountainous area, are covering more than 43% of Greece and they are usually characterized from low population density, and long-term unemployment among the population. This paper describes an improvement application of forest road on an early planning stage and how that can affect an eco-development of the mountainous area. The methodology of the improvement application demand some work of substructure, such as the geometrical elements, the erosion of pavement, etc. The method which was applied has been practical, effective and easy to be used before or after the road construction. Tree principles are the heart of that planning: Techniques friendly to the nature, Respect for the Ecosystem and Economical Aspects. In this paper are analyzed the technical and geometrical elements of the protected area and a construction cost and preservation model of the road. It's also given a suggestion for decreasing the disturbance and the damages that a road construction can cause to a native wild life. Eco-development and environmental construction aspects will be the spine of our research in order to achieve a "multi-use" forestry and an eco-development of the area, respecting the native wild life, fauna and flora in one of the most known bird wild life regions of the Greek territory.*

1. Introduction

Eco-development is given by the definition: "Conservative development based on long term optimization of biosphere resources. It is an approach to development through rational use of natural resources by means of appropriate technology and system of production which take into account and provide for the conservation of nature - Source: GREMES / UNUN" (http://www.eionet.europa.eu/gemet/concept?cp=2434&langcode=en, 2007).

Eco-development refers to development at regional and local levels, consistent with the potentials of the area involved, with attention given to the adequate and rational use of natural resources, technological styles and organizational forms that respect the natural ecosystems and local social and cultural patterns. The term is also used to describe an integrated approach to environment and development (Glossary of Environment Statistics, 2007 & http://stats.oecd.org/glossary/detail.asp?ID=710, 2007).

Forests perform today an ecological balancing function, ensuring effective protection of water, soil, climate and species to a far greater extent than any other type of land use. Their importance thereby increases proportionately to the growing pressures of civilization on the landscape. Proper forestry management methods whose objective is to conserve and utilize forests are linked to the existence of an adequate network of forest roads. Growing pressure on forests for recreational activities also results in increased involvement of the general public and demands for a forestry access road network able to handle these multiple uses. At the same time, construction of roads and their use for forestry as well as public access have inevitable consequences on the forest's regenerative balance and its ecosystem. The general public's sensitivity toward such encroachments keeps pace with the increasingly significant role of the forest as a creator of ecological equilibrium. Greater appreciation and experience of qualitative

and quantitative repercussions have resulted in a growth in environmental-political relevance, and thus public concern of the complex of questions relating to the ecological evaluation of forestry access roads. They also coincide with an increased potential of conflict when determining the appropriate balance between public and commercial use demands.

Even if large expanses, may be deemed to be developed adequately, from forestry point of view there is still a need to upgrade the forest road system, especially in the case of national parks, state and private woodlands. Road improvement and maintenance are needed on a far larger scale in order to bring the system in line with increased operating and public demands. In the research area, projects and proposals which were evidently not optimally planned and constructed have led to public debates in the recent past. As a consequence of, Dadia (Figure 1), which consists of traditional urban landscape, agricultural landscape, forest and local communities in a total size of 43.000 Ha (UNESCO World Heritage Centre, 2007), the lawmakers prompted this to extend their field of vision to the need for regulations and action in the sphere of forest road construction.

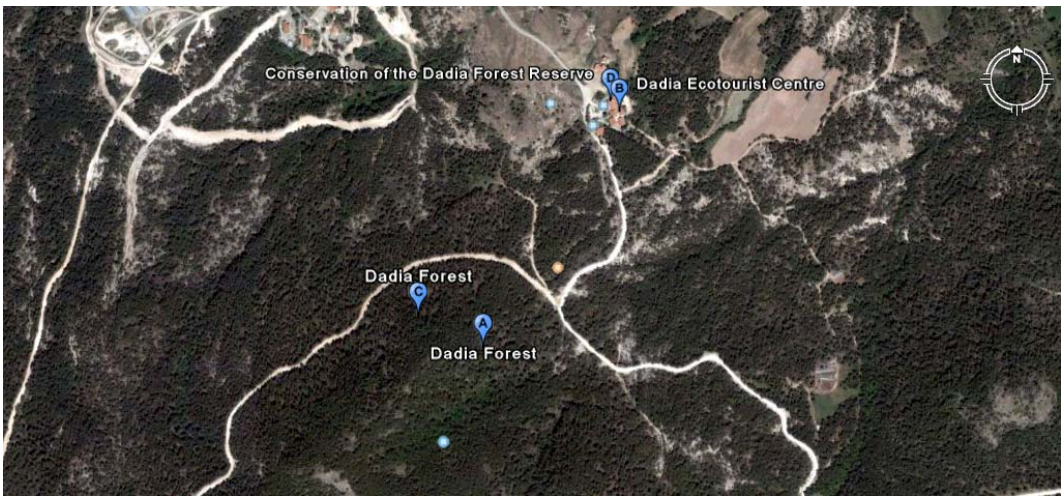

Figure 1: Aerial photo of Dadia forest in Greece

In doing so it quickly became obvious that there were numerous questions to be answered before the problems addressed could be clarified and evaluated from a legal and practical point of view.

1.1. Relevance of forest roads for leisure and recreation

Forest roads are a part of the operational infrastructure, whose primary purpose is forest management. Decisions within the framework of general development planning (road network density, routing) and road standards (cross-sectional design, dimensioning) are initially determined from a technical, economic and individual operational point of view.

On the other hand, forest roads have become increasingly popular with the general public for recreational purposes. In Dadia's protected core they are available to the visitors from outside the region. The intensity of visitors reaches a particularly high level in spring and summer near recreational areas. The multitude of different recreational uses (nature watching, hiking, strolling, cycling, horseback riding, mountain biking) leads to additional conflicts and their aggregate impact occasionally results in an over taxation of the common usage rights of forest access.

As a consequence, the objective of environmentally compatible and ecologically sound forest development should be striven for recognizing and ranking the conflict of interests between forestry on the one hand and nature conservancy and ecology on the other. However, the fact that in many cases these roads play a significant role in enabling public access for increased recreational usage must also be taken into account.

2. Suggestions and recommendations

2.1. Appropriate level of development for Dadia's forest

A stipulation or a generalized, numeric statement of an appropriate access road grid density for Dadia's protected area appears problematic, because the factor "network density" is a mathematical mean. Difficult topographical conditions (steep slopes, wet areas) often rule out neither a meaningful stipulation of this figure, which in any case makes no qualitative statement nor an indication of the need for additional access roads.

Access road networks in Dadia have for the main part reached a state of completion. New construction is usually only necessary for optimizing outdated access road systems. As the example of road system re-optimization by a forest management has shown, this can even result in a reduction in density of the grid whilst at the same time maintaining the standard of access (Becker, 1995). Despite integrated planning and high-level development, without doubt necessary on a regional scale, it should not be assumed that every parcel of woodland could be provided with an access road. However, in each individual case the type of construction and development standard must be assessed and determined.

2.2. Recommended planning density

Planning density depends mainly on:

- difficulty of terrain;
- type of access (vehicular access - logging trails);
- construction standard (contractors usually require detailed plans);
- experience of the planner; and
- sensitivity of the landscape.

Since the beginning of the 20th century to construct a road; needs only the typical procedure. In the case of new road construction it would appear expedient to require that the notification of proposals be accompanied by a topographical map on a scale of 1:5000 or 1:10000 showing the horizontal alignment of the road. Furthermore, the reasons for selecting the alignment should be explained in a brief written description, and a technical report on the design of critical parameters of the planned road (width, type of surfacing) should be included. The proposed course of the road should also be made visible on site before construction work begins. In this way a minimum planning standard will be assured. More precise planning documents, such as earth mass calculations, are only required by the forest authorities in special instances, e.g. in connection with the crossing of watercourses, construction of large-scale embankments, steep sloping sites and proposals in the vicinity of important biotopes.

It can thereby be assumed that the above-described "minimum standards", as required in a letter of notification - made, if necessary, with the assistance of a forestry official. Any more detailed planning documents require the consultation of expert planners and incur expenses which may run counter to the apparently "low profile" intentions of the law (only notification, no requirement for official approval).

2.3. Recommended dimensioning and layout of roads

Longitudinal section: Gradients in the longitudinal section of the road should be kept at a minimum, but should be in excess of 2 %. A maximum of 8 % is desirable. In exceptional cases gradients of up to 12 % are acceptable for short distances, if this permits substantial savings in the overall segment length.

Site plan: The horizontal alignment in the site plan should be as close as possible to the course of the centre line. Curves should have a minimum radius of 20 m. Centre-line and contour-sensitive alignments are preferable to "streamlined" construction.

Cross-sections: The up-brow should be within as small a width as possible (as a rule on the uphill side 1 m wider than the road with embankment, on the valley side approximately road and embankment width). The roadway width should be approximately 3.5 m with a soft shoulder of about 0.5 m, in adverse topographical conditions (steep slope) approximately 3 m. The roadway should as far as possible be inclined on both sides (watch-glass section) with a camber of about 2 percent in its centre section, increasing to 8-12 percent at its edges, accompanied by a trench on its uphill side on sloping terrain. In order to prevent surface water from collecting, a sufficient number of cross-channels should be incorporated. Diverted water should be allowed to re-percolate into the forest floor.

Embankments: The natural angle of incline must be observed in the construction of embankments. Man-made grassing (using indigenous seeds and plants) should be considered only in the case of acute risk of erosion or if rapid natural plant coverage on extremely exposed surfaces is not to be anticipated.

Turning circles and passing points: depend on the individual situation and should be designed according to demand. Turning areas require a large amount of space; culs-de-sac are thus to be avoided as far as possible.

Storage areas: should be constructed as soft shoulders alongside the road (in sloping terrain on the valley side only). The width of these perimeter storage areas should not exceed the Jib length of a truck-mounted crane (approximately 8 m) if used for longitudinal storage. As far as the terrain permits, these perimeter storage areas should be continuous.

2.4. Standard surfacing for forest access roads

For technical, ecological and economic reasons water-permeable base and surface courses has become the norm in forestry road construction. For the design of the cross-section, and particularly for lateral run-off of water, it is important that the sub-grade and base course are prepared with a camber and not as a flat surface. In the long-term, the so-called watch-glass (arc) or grader sections with varying transverse slopes, increasing gradually to 8-12 % at the perimeter, and side ditches lend themselves to low-cost motor grader maintenance with minimal ecological disturbance. A diagram of a cross-section is shown in the following figure.

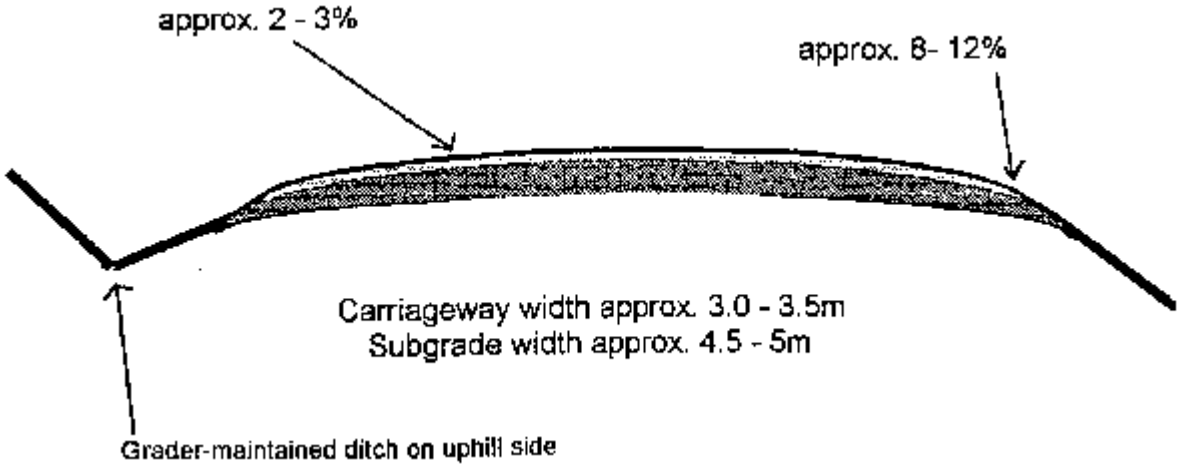

Figure 2: Modern grader or watch-glass section (schematic)

2.5. Recommendations for environmentally compatible road construction

1. Excavators - together with bulldozers if necessary - are preferable on construction sites with slopes exceeding 50 % and in ecologically sensitive areas where the roadway must be kept as narrow as possible.

2. Blasting is to be avoided if possible. Hydraulic chisel hammers should be used instead.

3. Construction equipment should be supplied with biologically degradable hydraulic fluids, oil binders and suitable tools for sealing leaks. If contractors are used, this stipulation should be made at the tendering stage.

4. Only machines should be used which are well maintained and do not lose any significant amounts of fuel or lubricant. It will thereby be necessary to rely on the scrutiny of the contractor, since the vast majority of road construction machines are not subject to compulsory independent inspection. Machines should be checked daily for leakage of mineral oils.

5. Transport of fuels must conform with the Ordinance pertaining to Transport of Hazardous Materials on Roads or exceptions to the same.

6. Consideration should be given to incorporating a bonus system into the contractual stipulations for the exemplary execution of construction work, and alternatively for making deductions for shortfalls in goal achievement.

7. Contractors whose standard of performance has been exceptional should be especially recommended. Conversely, poor performers should be excluded from future tendering procedures.

8. A flexible schedule should be drawn up containing a broad outline of seasonal construction projects. Special consideration should thereby be given to humidity conditions, the growth of vegetation and possible resulting delays in the progress of construction work.

9. New road construction should be avoided altogether in "specially protected biotopes" according to the Law and existing roads should be examined with a view to reducing their width or closing them completely. The same applies to construction in forest types represented by a very limited overall surface area.

10. In sensitive woodland areas, road construction work should be executed in a particularly cautious manner, for instance when cutting into steep inclines, crossing running water or skirting on damp areas with standing water.

11. Each new road construction project should be re-examined with a view to abandoning it in favour of other technical means. If the decision is made to proceed with new construction, alignment, design and choice of materials should be determined according to ecological principles. Possible subsidies should also be oriented toward this.

2.6. Suggestions for choice of materials and surfacing

If less foreign materials are used for road construction, the adverse ecological impact can be minimized. Before commencing a new construction project or comprehensive maintenance work, an appraisal should thus be made of the suitability of natural materials already available on site and the extent to which they permit the striven for construction standards to be attained. It is often possible to construct roads with natural materials brought from only a short horizontal distance or to obtain materials by the soil exchange process.

The potential of employing the soil exchange process to obtain suitable material for a load-bearing sub-grade or base course is probably considerably greater than presently exploited.

After a succession of negative experiences, the practice of excavation can only be recommended when the open cut produces materials of a quality similar to that expected from a quarry (grading curve, material hardness) and when quality control is possible. In addition, there should not be the slightest risk of contaminants or harmful substances.

If suitable construction material cannot be extracted from the immediate vicinity by the above-described process, the following criteria should be observed when obtaining materials from external sources:

1. Mineral material can be obtained inexpensively as pre-screened material.

2. Increased quality approaching the level of quality-controlled material with an almost even grading curve usually permits a reduction in the necessary course thickness, but results in increased costs. This increase in quality and price is accompanied by a reduction in inspection requirements and an improvement in the safety margins important for insurance purposes.

3. Transport of materials over long distances causes substantial environmental problems. In the practice of forest access road construction, hauling distances of up to 100 km are not uncommon. In terms of overall ecosystem compatibility, a "sensible" decision on choice of material must include suitable weighting for the hauling distance factor. A disproportionately long hauling distance for mineral construction material should swing the decision, for example, in favour of a local, environmentally compatible and quality-controlled, recycled construction material, or alternatively, limited local excavation of materials in the form of a small-scale quarry for road construction purposes.

4. Materials whose presence can impact the surrounding area should be avoided at all costs in the acidic soils of important biotopes and in florally sensitive zones. This should be taken into account when selecting materials.

5. Because of their tendency to generate a strong microclimate in the vicinity of the forest floor, dark materials intensify the barrier effect for small animals. This should be borne in mind particularly in areas with pronounced amphibian migration.

2.7. Suggestions for use of Recycling materials and industrial by-products

1. Employment of recycled building materials and industrial by-products is only viable for environmentally compatible forestry road construction if at least the same material compatibility standards are applied as for public highway construction under current laws and subsequent regulations. This automatically rules out the employment of residual materials that have not been processed under stringent conditions of quality control. Such materials, such as unsorted building rubble, fall under the category of waste and are not to be considered as construction material.

2. For the purposes of forest road construction in the Dadia, an application which relegates residual materials to limited applications in road construction outside of hydrogeologically sensitive areas - and obviously outside of ground water preservation zones I and II - can be recommended as a basis.

3. Furthermore, for precautionary and technical reasons:

   - If residual materials are used, the minimum distance from the sub-grade to the highest groundwater level should be > 1 m.

   - Unsealed surface courses should be understood as "permeable" and not as "semi-permeable" for the purposes of the ordinance.

   - After a detailed examination of the regulations to determine the suitability of construction materials for forest road construction in Study area, only quality controlled slag’s and steel mill sand, as well as the recycled construction material-dolomiti and chopped tires; merit consideration, and then only in the forms as shown in the matrix.

4. Before employing quality-controlled residual materials for this purpose, documentation should be assembled, to include a precise definition of the material, a certificate of quality control and a plan showing the area in which it is to be employed (scale 1:25000 or 1:10000), indicating its

hydrogeological implications. The basis for this is provided by the map of water table formations in Dadia and the regional soil maps as referred to in the notes on the ordinance.

5. In addition to the requirements relating to the protection of water resources, to ensure that the greatest possible importance is attached to the specific ecological requirements placed on forest road construction (ecological weighting and sensitivity to the surrounding forest vegetation as a natural environment), the use of residual materials which produce a distinct alkaline reaction in aqueous solutions must be warned against in areas or instances where lateral water run-off is likely to carry away nutrients and result in a transformation of the surrounding area. The same applies to the employment of residual materials for surface courses in areas where dust generation from the basic material could cause an undesirable change in the roadside flora. This type of impact will be felt most in the alkaline soils of important biotopes or in nature reserves and should be avoided.

6. For the verification of quality assessment, in addition to the certificate of suitability, the seller or supplier of the material must provide the results of monitoring studies carried out by himself or by a third party. Furthermore, it is recommended that for every truckload delivered a confirmation of material characteristics and origin is required in the form of an individual delivery note signed by the driver.

7. When the use of residual materials is under consideration, thought should always be given to the cost of verification of quality assessment and of the simplified water authority permit, as well as to the hard-to-define residual risk with regard to the content of potentially harmful, but hitherto unknown or unidentified substances.

8. A "sensible" choice of materials that harmonize with the integral ecosystem must include appropriate weighting of the hauling distance factor. A disproportionately high cost for hauling mineral construction materials to the site can be a substantial argument in favour of using locally available, approved and suitable residual materials.

3. Conclusion

Thus, it is clear that for each forest technical work, it is absolutely necessary to assess its compatibility with the environment. Due to the needs of modern society and the multiple goals of forestry, the forest roads in protected area of Dadia's Forest must be improved in order to be more accessible to humans and vehicles concerning the environmental criteria in order to avoid damages to the nature.

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