Sustainable Development of Greek Mountainous Forest Operations Using Digital Terrain Models

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Abstract:
In 1992, the international community accepted the concept of sustainable development as a framework. While many people agree with this general goal, there is still a lack of useful concepts and tools to implement sustainable development on the level of projects and processes. In 2009, in Copenhagen found out that while the ices melt interest for the environment "freezes" because of the economic crisis. The sustainable development is the best answer to this bleak outlook. The principal objective of the paper is to optimizing the forest operations using digital terrain model (DTM) in the frames of sustainable development for Greek mountainous conditions. Forest operations are one engineering sector aiming to maximize efficiency while minimizing adverse effects. Sustainable development of the planet depends, in fact, on cycling of resources rather than their extraction and eventual discard following use. Eventually D.T.M. provides the basis for developing a wide range of applications related to both the protection and rational management of the natural environment. The D.T.Ms. can be used in combination with Geographic Information Systems (GIS) to create a land information system, necessary for the protection and sustainable development of forest areas.

Keywords: natural environment, digital terrain model, sustainable development

1 Introduction and study's problem area

The broad area of Forest Operations comprises the analysis and design of systems and processes for the sustainable management and utilization of forests and landscape. Topics of particular interest include: Forest Technology and Harvesting, Bioenergy and Renewable Bio- Resources, Forest Engineering, Transport systems and Logistics, Environmental impact analysis and Technical impact assessment. Also the aspects and needs of human labor involved in these systems and processes should be taken into consideration.

Forest operations consist of all technical and administrative processes required to develop technical structures and facilities, to harvest timber, to prepare sites for regeneration, to maintain and improve quality of stands and habitats, etc (Sessions and Garland 1999).

According to Leibundgut (1961), forestry followed everywhere the road construction and a forest is economic and exploitable only by a good road network.

Station for the forestry sector in our country was in 1953 when for the first time forest sustainability, conceptually integrated, and was written down in designing specifications for management plans in forests. In sustainable managed forests, roads, their network and technical specifications have to be in accordance with natural conditions and land uses (Abegg and Hünerwadel 1983), expected logging operations (FAO 1998) and landscape aesthetics.

An important role for the systematic and rational approach of needs as users and as natural environment, in order to optimize the forest roads design, plays the knowledge and the assessment of the existing geometry of the forest roads as well as the contribution of up-to-date topographical data and methods that are used for their setting out and construction. The most contemporary leading-edge technology is the digital terrain model (D.T.M.).

A DTM is a topographic model of the "bare earth" that enables users to infer terrain characteristics. A DTM - also sometimes called digital elevation model (DEM) - generally refers to a representation of the earth's surface (or subset of this), excluding features such as vegetation, buildings, bridges, etc. The DTM often comprises much of the raw dataset, which may have been acquired through techniques such as photogrammetry, LiDAR, IfSAR, terrestrial surveying, etc.

The DTM that was calculated with the methods that were mentioned above can have the form of triangles in the space (triangular model), lines that scan the region at one or two or more given directions, grid in the space (grid or grill or ware model) as well as contour lines. Thus we have depiction of DTM in the screen of PC and designing in the plotter from different points of sight and different form (Sabbaidis and Mpantellas 1992).

The management of the digitizing information with the help of the modern technology can contribute in the better ecological management and protection of the forests (Doukas 2004).

The principal objective and scope of this paper is to optimizing the forest operations using digital terrain model (DTM) in the frames of sustainable development for Greek mountainous conditions.

2 Materials and methodology

The DTM was produced by the use of digital photogrammetry and from topographical measurements with GPS. The existing road network applied based on topographical measurements with GPS.

The suit of AutoCAD program was used in order to calculate the: slope, aspects, distance between the operational places and the proposed roads length. Also it was used for the geo-reference of the map, the digitalisations, the geo-entries, the acreage calculations, the elaboration and creation of map.

The opening-up percentage was calculated by creating on the digitized map, a zone of width twice as the mean horizontal skidding distance:

$$S = 2 \times RE_m^{hor}$$

where S is the skidding distance (m) and RE_m^{hor} is the mean horizontal skidding distance at both sides of the forest road in the study area (m). The model that has been applied based on rules that have been set by the forest harvesting experience for an integrated harvesting planning proposal. The management plan provided data such as harvesting, wood stoke etc.

3 Area of study

The mountain of Farmakas (Longitude: 22^o 30′ 10′′, Latitude: 37^o 46′ 20′′) - with 1616 meters altitude - towers above the north-western edge of Argolida Prefecture. The Farmakas is a majestic mountain, overgrown with trees (especially fir trees), which owes its name to the many therapeutic herbs (medicines) that grow on the slopes and diligently collecting the old, to use for each disease (Figure 1).

4 Results of the study

Using the AutoCAD program we had the following results:

In figure 2 is shown the map of the area with contour lines and existing road network as it derives from the DTM of the digital photogrammetric station. While in figure 3 is shown the map of the harvesting area with the new road network after the opening up study as it derives from the DTM and the opening up percentage is 62.98%.

5 Conclusion – suggestions

In this paper we give a visual potential of how can forest operations can be planned in order to have a sustainable development (management and utilization) of forests, considering low prices for harvesting and the best outcomes from the timber that will get always depend on a flexible and reliable forest road network.

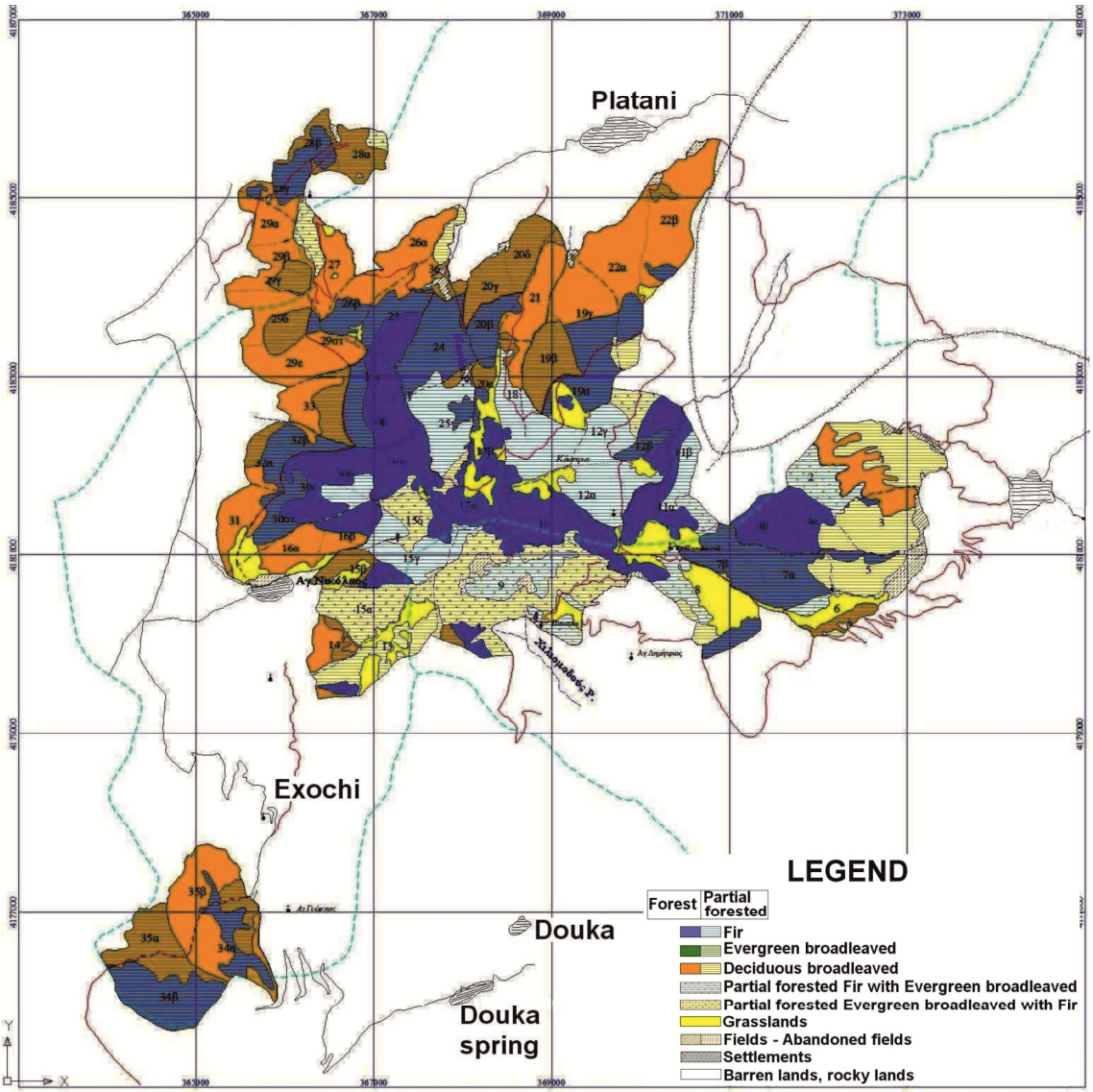

Figure 1: Silvicultural map of the research area

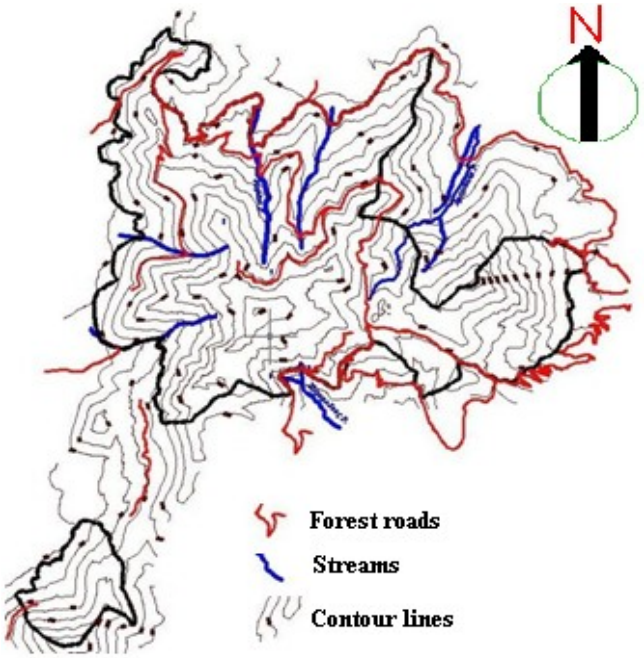

Figure 2: Map of the area with contour lines and existing road network

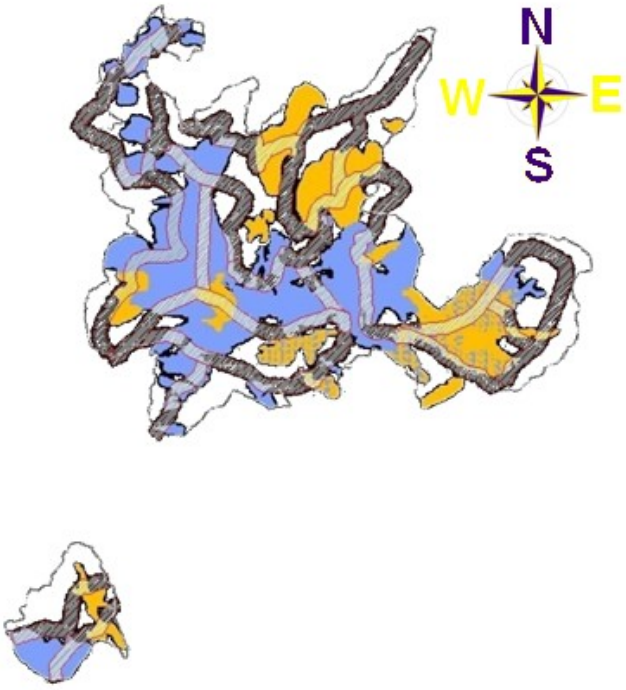

Figure 3: Map of the harvesting area with the new road network after the opening up study

Unfortunately till today on the area only animals and the manual way for forest operations are used. The cattle-raising is also taking place to the area and that makes the things more complicated for fully mechanized forest operations. We hope that the new generation of foresters will adapt other more mechanized methods of harvesting because it is costless, quickest and safer due to the new technology.

The D.T.M. helps in the better and more rational growth, protection and exploitation of mountainous regions. The idea today is to build valuable products upon DTM, extending their usefulness, but also addressing real issues that incorporate other spatial information. The link of DTM Surface - Processes - Other Spatial Data is critical to understand. The issues are about change, accordingly, the link back to DEM should also not be ruled out, since DEM show changes upon the surface. DTM is a powerful decision support tool in order to give the opportunity to the Forest Offices to choose the optimal way of harvesting a stand and also to realize visually the effect's of such a kind of work; that is going to be held to the inhabitants and to the tourists of the area.

Today visualisation is an important role for DTM; it enables real world fly-through and walk-through of landscapes.

Accessibility is the most critical factor influencing feasibility of following operations in Mediterranean mountainous terrain. Transportation consists of two phases, off-road and on-road, which are heavily dependent on each other. Availability of sophisticated computers, specialized software, and digital terrain models are now the backbone of the engineering work in developing road networks. The most advanced software for the layout of both road network and harvesting patterns, are able to generate integrated plans semi-automatically.

The visualisation of DTM enables us to monitoring land activities, such as road network construction and harvesting regimes, with adverse watersheds effects mainly, and harvesting activities, such as off-road traffic and felling, cause several site disturbances like soil erosion and soil compaction.

Many people misjudged the significance of the DTM and its role for sustainable development of mountainous areas. There is a considerable body of knowledge on forest operations technology, even for sensitive mountainous areas. Improving the understanding of natural processes and their interactions with land use activities is important.

Sustainable development of the planet depends, in fact, on recycling of resources rather than their extraction and eventual discard following use. It forms part of the novel orientation in environmental management and sustainable development, moving away from "end of pipe" to "begin of pipe" approaches (Odum 1989).

DTM needs to be available to users quickly; this includes Internet downloadable files usually, which should be geo-referenced for immediate use.

The most precise but also expensive method to create a DTM is the use of topographical crews, which uses techniques that vary from total stations up to G.P.S. receivers, with the essential software for the determination of coordinates in the three-dimensional space.

The management of the digital information with the help of the modern technology, as is the Digital Terrain Model (D.T.M.), in collaboration with the Geographic Information System (G.I.S.) and the Global Positioning System (G.P.S.), can contribute in the better ecological management and protection of forests. The digital information can be useful in other applications such as: photogrammetrical backgrounds of forest maps' drawing up, Environmental Impact Assessments (E.I.A.), forest fires, land planning (Uses of land). Other fields benefit from this combination are, the development of in-car navigation systems, automatic vehicle location systems, transportation planning and engineering, environmental modelling and analysis, urban planning, telecommunications, agriculture and public health.

Sustainable development, development in general, wants "guts" and not a unilateral effect of a man, a field, a single political will, a modern development law. It should be done a lot of things together. It's about exploiting wealth, the existence of appropriate human resources, operation of infrastructure, creation of modern institutional framework, the culture of a society. And yet, development initiatives are not always immediate return. An investment that starts today can yield in a few months or few years. But they must go on.

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