

## Estimating forest harvesting operations to achieve sustainable rural development in Samarina (Greece)

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### ABSTRACT

#### Purpose of the work:

Mountainous areas, with altitude over 700 m, intense relief and slopes between 16–20%, cover 43% of Greece and they are usually characterized by low population density and long-term unemployment. The Greeks have a dependent connection among environment, economy and society as the history illustrates. Many of Greece's historic, cultural landscapes and native ecosystems have been degraded or isolated over the years. There is scientific evidence that Greece's natural/semi-natural forested areas cannot be sustained without watersheds, ridges and other natural corridors that connect its native landscapes and ecosystems. Logging systems are really ancient by using often only mules or horses.

The aim of the work is to estimate how harvesting systems should be technologically upgraded improving forest work and social wellness maintaining at the same time ecological sustainability.

#### Approach:

The study area is held at Samarina region, a mountainous area of Northern Pindos in Greece. Social data were collected with questionnaires and local visits for better understanding of human resources for forest authorities and other administrative information's. DTM, Forest Inventory data and other GIS data have been derived by paper maps and previous studies. A registration of road-net and human resources within the protected area of Valia Kyrna and their contribution as factors for the sustainable development was used. The development of a Spatial Decision Support System that can concern all the conditions that are need in order to make an estimation of the optimal way of harvest a stand is really a challenge.

#### Expected results:

A GIS program is a powerful decision support tool in order to give the opportunity to the offices of Forestry 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.

**Conclusion:**

The potential of social and ecological factors is examined as it concerns the promotion of the protected area within sustainable rural development. Advantages of registration in the form of a spatial tool, especially when many types of information participate, are presented.

**KEYWORDS**

rural sustainable development, GIS, SDSS, human resources, harvesting operations

**INTRODUCTION**

Rapid population growth in urban centers which is usually accompanied by a significant degradation in the quality of life (e.g. air pollution, high density building areas, reduced opportunities for social life etc), has led to an increased demand for recreation areas away from the cities, therefore, appears the sustainable rural development of the mountainous or coastal forested areas and the usage of a multi use forestry policy. Our study area is placed in the forest complex of Smolica at range mountain of Pindos – in Northern Greece. The area is wooded mainly with *Pinus nigra* known in Greek language as “Robola” and it composed of a unique biotope because many rare species are living there (brown bears, wolves, lynx, etc.). The road network is old, but every year the office of forestry improves the network in order to be accessible not only for logging; but also for multi use purposes and recreational reasons. In Greece the forestry is ecologically and less economically oriented and the main reason is that the forest land belongs mainly to the State (Stergiadou 2006).

On May 11, 2006, USDA Rural Development celebrated 71 years of service to America. Much has changed since 1935: the Great Depression and Dustbowl are a distant memory; rural electrification brought the countryside into the modern age; the rural economy has become increasingly diversified. However, one thing has remained constant: the commitment of the men and women of USDA Rural Development to the future of rural communities.

The last decade the ministry of Agriculture and Natural Environment head to a new direction of rural development of mountainous area. The sustainable rural development covers also abandoned areas, which were used former for cattle's and sheep's.

The forest harvesting operations are usually applied from the offices of Forestry or from enterprises'. To estimate and choose a specific harvesting operation till now has to do only with the availability of machineries and workers knowledge. In this paper we are providing two similar programs based on GIS techniques and modeling and they are used as a Spatial Decisional Support System (SDSS); which in interact with the results of questionnaires that have been given to the inhabitants and also to the tourists that have been visited the area, lead us to some conclusions that can be crucial for the final decision of the policy that has to be followed in order to be achieved a sustainable rural development to the area.

**METHODOLOGY**

In that paper three methodologies were used. One is based on ArcGIS and modeling tools for providing a Rule – based SDSS for integrated harvesting planning. Second is IDRISI software which used as modeling tools to assess a model suitable for technical solutions in forest operation. Third is a questionnaire collection that is based on the social opinion about environment, tourist and forestry themes.

**ArcGIS**

The model that has been applied is a Spatial Decisional Support System based on rules that have been set by the forest harvesting experience for an integrated harvesting planning proposal. The inputs for the land analysis are: roads, stands, and management plan data, Digital Elevation Model (DEM), Mechanical Systems, Geology, and Precipitation. The existing road network applied from the topographical maps of the area, the stands applied

from the data of the local office of Forestry, the management plan data taken from the next decade management plan for the area, the DEM was produced manually from topographical maps of 1:20.000, the mechanical systems are chosen from the variety of systems which are used in Greece, the Geology came from geological maps 1:20.000, and the Precipitation from the databank of the Greek Meteorology Service.

The model calculates by using Shape files (.shp) and Data Base files (.dbf) the: slope, roughness of terrain, distance between the operational places and the roads, amount of yield and the gradeability. The slope is used as a percentage and not as degree, the roughness of terrain based on the obstacles that we have inside a stand area. The obstacles were measured as dimensions and as distance between them, classified and given as a percentage (Tab. 1).

Table 1. Terrain obstacles

Surface % occupied	Dimension	Max distance	Class
< 33	< 0,5 m	> 2,5 m	1
33 – 66	< 0,5 m	< 2,5 m	2
> 66	> 0,5 m	< 2,5 m	3

The great ability is a percentage that is calculating by the available data which are used inside the model and based on the soil geology and stability and to the annual precipitation.

The outputs are: Technical Systems as a shape file and table of Costs per Cell, Cost per cubic meter, and Total amount of cost per stand.

## IDRISI

The assessment of the specific model suitability depends mostly on skidding variants from wood stump to roadside. Modern information technology provides new possibilities in the assessment of specific technological solutions in forest operation. There are many studies related to the optimization of the layout of new forest roads (Chung 2001), (Aruga *et al.* 2004), and the feasibility assessment and impacts of changing the forest road density (Košir 2000, Krč 2000).

The most frequent database used for designing the models is Digital Terrain Model (DTM) which serves as a powerful means for acquiring solutions of forest

openness on steep terrains. Similar issues are also addressed by research projects dealing with forest road network density, forest roads layout in relation to the environment (Newnham 1995, Tucek 1995, Yoshimura 1997) and the choice of skidding means mainly comparison between the tractor and cable skidding (Tucek 1999, Stuckelberger 2006).

Literature offers several solutions of a similar problem of how to identify watershed areas. Numerous authors have presented and described algorithms and software tools for extracting topographic structures and water catchments' areas from DTM data (Mark 1983, Jenson and Dominguem 1988). The problem of identifying the water catchments' is similar, but not the same as defining the wood skidding direction. The main difference between the two procedures is in the flow direction – water flows in principal only downhill while wood can be yarded in three directions (uphill, downhill and even).

The selection of skidding means (technology) and skidding direction is derived by model, which make the determination of optimal skidding mean and skidding direction (uphill, downhill, straight)! Wood skidding map was determined by procedure of Multi-Criteria Evaluation of influential factors summarized to Multi-Criteria Evaluation method (Eastman 1993, Eastman 1997). By the MCE method the optimal skidding model was determined. The first step of skidding model determination was procedure for selection of influential factors and their importance.

The criteria for influential factor selection were related to significant terrain, stand and openness condition of forest section. The weight of every influential factor had to be determined on the base of importance Ratio among the selected Factors. The weight was derived by pair wise comparison method (Saaty 1977). For every skidding model its suitability value showing suitability grade on concrete ground plot was calculated. The suitability Value is related to terrain and stand condition expressed by selected influential factors (terrain slope, skidding distance, rockiness,...). The procedure for suitability value calculation was summarized to weighted linear combination of standardized values of influential factors. The standardized values were derived by positive correlation between influential factor value and its suitability for each skidding model separately. For instance steep terrain slopes have high standardized value

for Cable crane skidding model and low standardized value for tractor skidding model. The last step of skidding model determination was the comparison of suitability indexes on every ground plot (¼ ha) expressed by raster cell. The suitability index comparison was enabled through using of pair wise comparison method which distributes the determination of skidding model on the altogether influence of selected influential factors.

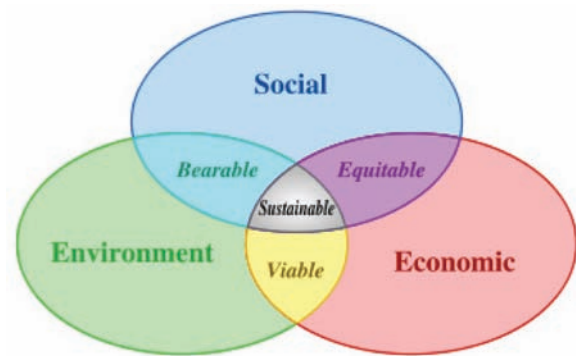
The represented procedure was made with GIS software IDRISI (Eastman 1993). The operations (running IDRISI modules) were written to program files for automatically finishing the thematic map of skidding model determination.

### Social Estimating Procedure

The sustainable development model is a challenge to the conventional form of development (Eastman 1993). Conventional approaches see development as simply modernization of the global along Western lines. Modernization theory holds that the more structurally specialized and differentiated a society is the modern and progressive it is. The term “sustainable development” implies the informed and conscientious management of natural resources, which have been exploited or utilized by humans, so that these resources may be capable of exploitation over time (Christopoulou et. at. 2006).

‘Multiple-use’ forest management practices adopted during the last decades (after the 1970s), have shaped the concept of sustainable forest management. The scope of this concept has been broadened by sustained yield management and nowadays it includes additional features such as forest operations quality, biodiversity and quality of life (Sideridis 2006) (Tab. 2).

To assure that all viewpoints are brought to the table, we should not rely on risk assessment for decision-



*Scheme of sustainable development:  
at the confluence of three preoccupations  
Source: Wikipedia*

Fig. 1. The contribution of Environment, Social and Economics to the Sustainability

making. Instead, we could employ a decision making technique that was described in the National Environmental Policy Act 282 Sustainable Development and Planning III (NEPA) of 1969, a federal law (Fig. 1). NEPA requires that, before certain decisions can be made, all reasonable alternatives must be examined. If this approach is taken, then the public can get involved in describing and discussing all reasonable alternatives. In such a process, all viewpoints can be aired. The key issues are as follows:

- Harvesting operations 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 harvesting operational cost as well as the cost arising from the landscape and the natural environment.
- Human presence demands exploitation of the natural environment.

Yet it causes interference sometimes with a negative effect.

Tab. 2. Environmental, economic and social values

ENVIRONMENTAL VALUES	ECONOMIC VALUES	SOCIAL VALUES
Protect soil & water quality	Sustainable productivity	Rural development & farm forestry
Enhance biodiversity & landscape values	Commercial viability	Sustainable employment
Maintain forest health & vitality		Amenity & recreation
Protect ecological & scientific values		Cultural & archaeological merit
		Other community values

Source: Nieuwenhuis and Tiernan (Sideridis 2006).

**RESULTS**

A GIS program is a powerful decision support tool in order to give the opportunity to the offices of Forestry 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.

Using the ArcGIS program we had the following results:

- Harvesting with cable cranes and as we can see it is easiest to be used for uphill and less for downhill harvesting (Fig. 2).
- Harvesting with sledge yarder and the percentage is nearly the two third of the sloped area (Fig. 3).

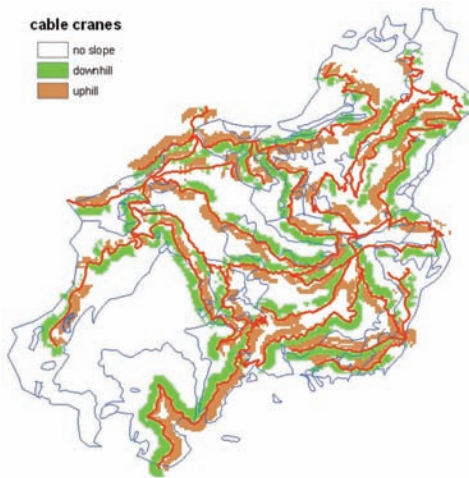


Fig. 2. Harvesting with cable crane

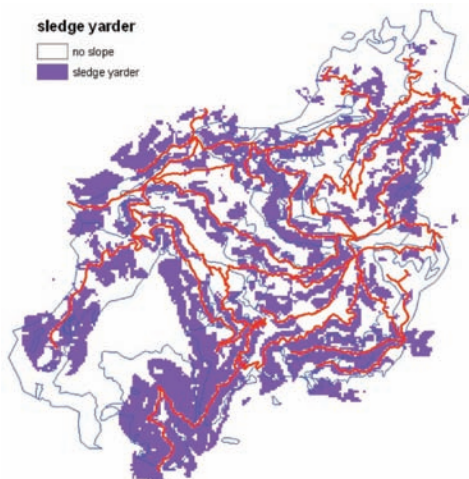


Fig. 3. Harvesting with sledge yarder

- Harvesting with tractor is the common way for that area, but as it is shown only a small percentage can be economically afforded (Fig. 4).

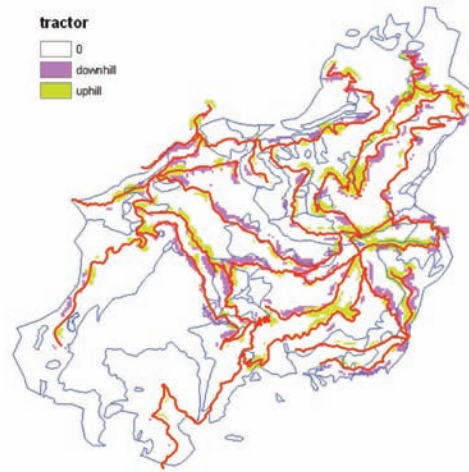


Fig. 4. Harvesting with tractor

Using the ArcGIS program we make an economical approach in order to be shown how every harvesting system is going to cost to the community (Fig. 5).

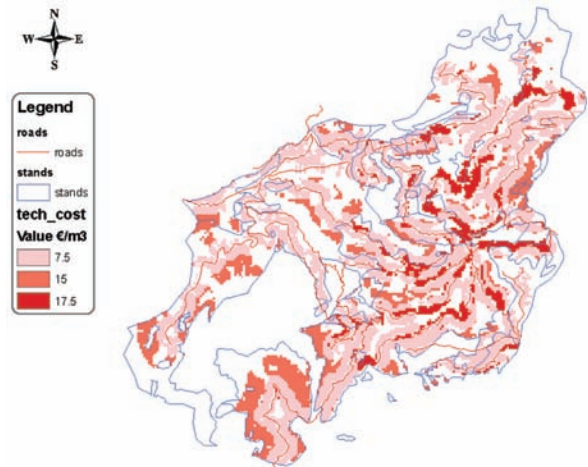


Fig. 5. Research area's road network, stands and Value €/m³

The next map give in a two dimension map; the tree different ways of harvesting that are proposed to the research area (Fig. 6).

The IDRISI program proposed tree different ways of harvesting: Manually, with a tractor and a cable crane. In the following map we can see how they are

applied to the research area, depending on the slope degree (Fig. 7).

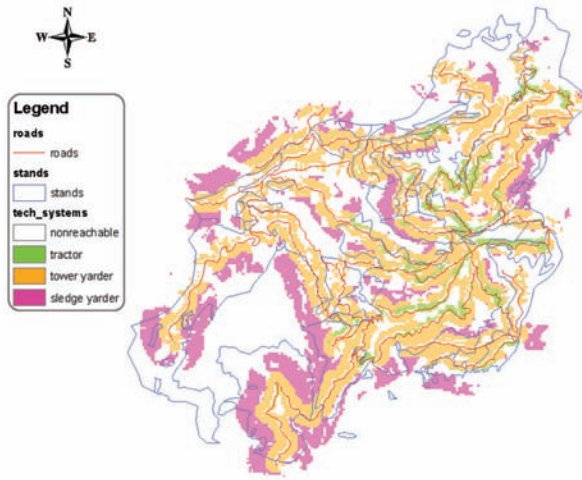


Fig. 6. Tree types of harvesting

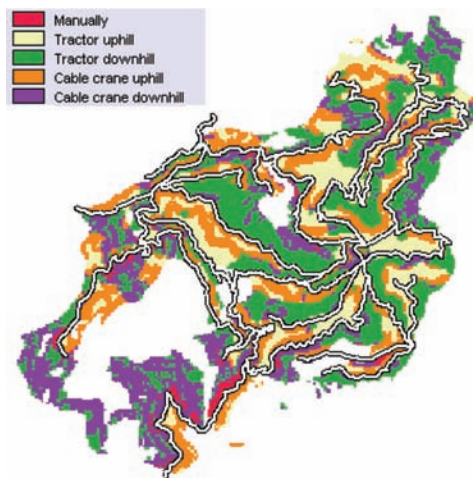


Fig. 7. Three types of forest operation by tractor, cable crane and manually

Considering the results of using the modeling tools based on ArcGIS and IDRISI software we come to the conclusion that both of them are giving an integrated harvesting planning that can be used from the Forestry officers and enterprises who are dealing with that kind of work. Unfortunately till today on the area only the tractor and the manual ways for forest operations are used. We hope that the new generation of foresters will adapt the proposed harvesting planning because it is costless, quickest and safer due to the new technology.

The cattle-raising is also taking place to the area and that makes the things more complicated for fully mechanized forest operations. This area characterization as “protected forest” makes us more to concern about the micro environment that consist a unique biotope at the Smolika Mountain. In order that to be more specific we made an analysis of the internal environment of Samarina (Tab. 3).

The analysis of table 3 gives us that: snow duration and mountain walking at paths E4 & E6 are evaluated as very strong points of the area. The natural resources, the sightseeing's, the facility sufficiency, the accommodation capacity and the local traditions are characterized as strong points but from the other hand the weak points as it is the accessibility, the connection with mean road network, the developed archaeological sites, the tourism duration and the small scale by tourist guide in website and the absence of traditional settlements and the price rating make Samarina a touristic place for the few.

Is pointed out that the natural resources, the accessibility, the connection with mean road network, the traditional settlements the facility sufficiency, the hospitality of the residence, the price rating, the accommodation capacity and the world spread through the website for the touristic availabilities that can get somebody to this area; are the most important points. As unimportant seems to be the Human resources and the tourism duration.

As we said the tourism duration is only the three months of the summer and especially August and other three months in the winter, usually between January and March for skiing. That gives the opportunity to the nature to recover from the “tourist invasion” and also make it a good place for cattle-breeding. Samarina can be a multi rural developed place where everybody can find what he wants.

## CONCLUSIONS

The potential of social and ecological factors is examined as it concerns the promotion of the protected area within sustainable rural development. Advantages of registration in the form of a spatial tool, especially when many types of information participate, are presented and give us a visual potential of how can forest operation can be planed in order to have a sustainable

development considering low prices for harvesting and the best outcomes from the timber that will get.

We propose for the future:

1. monitoring, by making demonstrations of new machines, trying to introduce new technology and new way of thinking harvesting
2. making know tourists that also cutting are part of the management of the forest (by placing explaining tables along paths)

3. demonstrating the use of GIS programs as powerful decision tools
4. give opportunities to the youngest stuff to learn a GIS software and how they can used it for the benefit of the nature.

Tab. 3. Analysis of the Internal Environment of the area

Strength & Weakness	EVALUATION				IMPORTANCE		
	Very Strong	Strong	Week	Very Week	Very Important	Important	Unimportant
Natural Resources		•			•		
Accessibility			•		•		
Sightseeing		•				•	
Development of Archaeological Sites			•				
Snow duration	•					•	
Traditional Settlements				•	•		
Mountainous Paths E4 & E6	•					•	
Human resources			•				•
Facility Sufficiency		•			•		
Connection with mean road network			•		•		
Seasonal Tourism	•					•	
Tourism Duration			•				•
Hospitality of residence	•				•		
Price rating				•	•		
Accommodation capacity		•			•		
Local traditions		•				•	
Local cuisine			•			•	
Marked by tourist guides in websites			•		•		

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