

RESOURCE MANAGEMENT OF RENEWABLE ENERGY OF FOREST FUEL IN SOUTH-WEST FOREST DISTRICTS OF ROMANIA

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Abstract. The main purpose of this paper was to describe the patterns of the forest fuels in the Berzasca and Moldova Noua forest districts. After the carried out investigations in the mentioned forest districts, there can be observed a lack of concern regarding the fire-affected trees removal as well as the reforestation of the burned areas. During the field observations, a large amount of chaotic growth vegetation was observed, which can represent a determinant of the fire spread. Following the experimental research on forest structure, there were established 6 types of forest fuel models which best fit the studied territory. In this context, the forest fuel models were obtained by classifications realised by considering the type, coverage, horizontal and vertical distribution of the vegetation, elements which were evaluated in the field as well as on the basis of the field-taken photographs. Forest fuels analysis was implemented in order to obtain cartographic data of the specific vegetation in the studied area using FARSITE and FlamMap computer programs.

Keywords: fire management, forest district, forest fuel models, renewable energy.

AIMS AND BACKGROUND

The importance of forests in ecological equilibrium maintenance on the one hand, and their destruction, on the other, lead to the need for cooperation in various fields of all specialists working in different institutions, productive sectors, agriculture research and forestry and not least the local authorities¹. Forest is the most important renewable energy resource whose disappearance has serious consequences for the future of mankind².

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Due to recent catastrophic wildfires, forest fuel reduction has become one of the most discussed topics in forest engineering research. Considerable money and resources are being spent in the attempt to seek answers for these tough questions. Lack of information, especially concerning mechanical fuel reduction methods, has concerned several studies³.

By applying equations to assess the heterogeneity, there was found that fragmentation and ecosystem dynamics in space of the Banat mountains⁴ is a phenomenon that leads to identification of the same connectivity elements and corridors networks with functional role in the whole mountain units. A mild climate with Mediterranean influences, along with geological structure, relief and hydrography, provides favourable conditions for formation and conservation of different types of ecosystems of great scientific value, as well as some passages (Fig. 1).

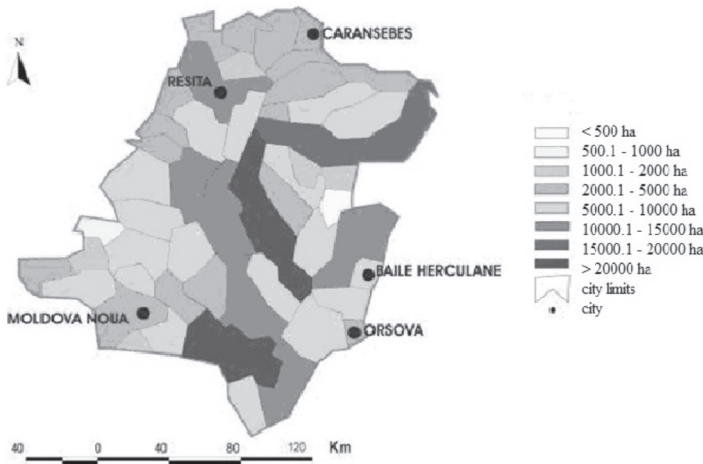


Fig. 1. Distribution of forest areas in the region of the Caras-Severin county

Taking into account the natural potential, spatial relationships and the heterogeneity of Banat mountains ecosystem, there were set intervals in conjunction with anthropogenic inserts and their manifestation vectors, since the human activity generates an ecological footprint⁵. A fuel model is a set of fuel elements placed in space that defines specific hazards in case of forest fire as well as the latter propagation behaviour. Fuel models are usually accompanied by a series of images which assign qualitative and quantitative estimates of fire behaviour by employing fire scenarios⁶. Given this advantage, fuel models are used in the forest fire management. Such models were developed in Europe for analysis regarding the determination of the forest fires behaviour based on specific fuel elements⁷. Field measurements are made on the spatial distribution of fuel elements in cells of $25 \times 25 \times 25$ cm interrupted by trees. Distribution of vegetation is illustrated in

which present the Mediterranean-influenced climate. Usually, these zones present characteristic vegetation which is composed of a great number of tree species.

In this order of reasoning, the research regarding the forest fuel models identification and properties was performed in forests belonging to Berzasca and Moldova Noua forest districts⁸. The research methodology comprised 2 distinct phases. Thus, during the field determinations and observations, which were realised on specific sample surfaces (that could be extrapolated to the entire studied area), were identified fuel models. The following attributes were observed and recorded during field phase: forest stand and shrub vegetation type; herbaceous and dead vegetation type. In case of the stand vegetation type, there were observed and recorded the following characteristics: age, density, species, height, and canopy characteristics. For the shrub vegetation type there were observed and recorded the following attributes: species, density, height and the occupied surface. For the herbaceous vegetation there were observed and recorded the occupied surface and species and in the case of dead vegetation there were observed and recorded the provenience and type. Office phase of the study comprised data centralising and analysis. Following data centralisation and analysis, 12 fuel models were identified: 6 for the Berzasca forest district and 6 for the Moldova Noua forest district. For both forest districts, the forest fuel models were numbered from I to VI.

FOREST FUEL MODELS FOR THE BERZASCA FOREST DISTRICT

The vegetation conditions encountered in the Berzasca forest district, expressed through the recorded and analysed attributes, led to the composition of 6 forest fuel models: type I – trees with average height over 10 m, and density index greater than 0.6, litter in variable proportions, this model is favourable to soil fires; type II – herbaceous vegetation on rocky soils, with rare trees, the model is favourable to soil fires; type III – trees with average height under 10 m, and layer of shrub species presenting a soil coverage greater than 60%, this model is favourable to canopy fires; type IV – herbaceous vegetation distributed on all the surface, this model is favourable to surface fires; type V – trees with average height under 10 m and low coverage, shrub species with coverage over 60%, this model is favourable to canopy fire; type VI – trees with average height over 10 m, affected by previous fires, with density greater than 0.6, different types of litter, this model is favourable to soil fires, and, depending by spatial distribution and number of the trees affected by previous fires – favourable to canopy fires.

FOREST FUEL MODELS FOR THE MOLDOVA NOUA FOREST DISTRICT

For the Moldova Noua forest district were identified 6 forest fuel models: type I – trees with average height under 10 m, and density index greater than 0.6, shrub species with soil coverage greater than 60%, this model is favourable to canopy fires; type II – trees with average height over 10 m and density over 0.6, shrub

species with soil coverage greater than 60%, this model is favourable to surface and canopy fires; type III – trees with average height under 10 m and low density, herbaceous layer with soil coverage greater than 60%, this model is favourable to canopy and surface fires; type IV – trees with average height under 10 m and density over 0.6, herbaceous vegetation under 60% soil coverage and different types of litter, this model is favourable to surface and canopy fires; type V – trees with average height under 10 m and density under 0.6 and different types of litter, this model is favourable to soil fire; type VI – trees with average height under 10 m, affected by previous fires, with reduced density, this model is favourable to soil fires, and in function of the spatial distribution and number of trees affected by previous fires – favourable to canopy fires.

As observed, the last fuel models for each forest district are taking in consideration previous fires, which occurred in the studied zones. The vegetation from these sites is more sensitive to fire hazards, reason for which there have been elaborated specific models according to these situations.

ANALYSING AND MODELLING FUEL MODELS

Behaviour of fuel models to fire may be decided by the management, structure, form and quantity of fuel layers. Therefore, the data collected from the analysed forest districts were processed using the following models.

LIDAR computing model. Figure 3 illustrates an example of a forest which has been reconstructed by combining secondary shaft positions, heights, diameter and canopy height using light detection and ranging (LIDAR) ellipsoidal model⁹. As a result of the measurement scale, the model was validated and about 71% of the

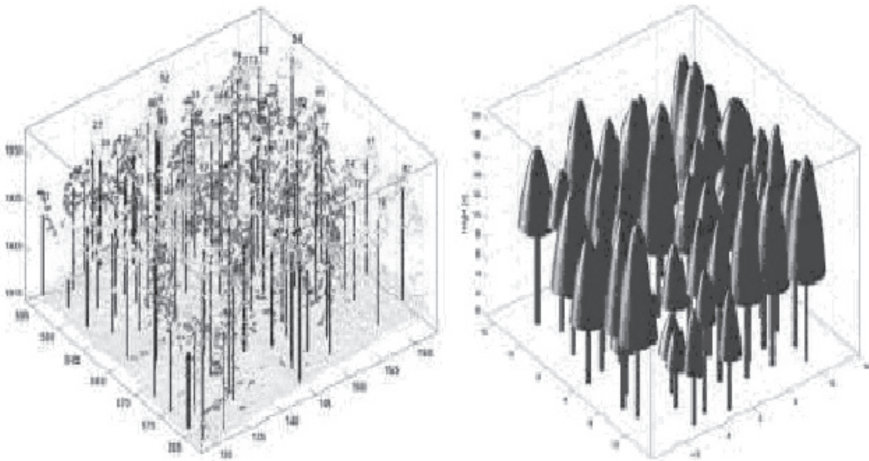


Fig. 3. Individual geometry reconstruction of trees using LIDAR ellipsoidal model

trees were properly detected. Individual analysis of trees seems to be the new direction for the forest monitoring and remote management. Working at the individual tree level becomes particularly interesting when there are developed new physical models of fire propagation. This approach is currently used in forest tree distribution. Protection against forest fires is facing currently 2 unresolved problems: map updating with specific fuel types and different vegetation behaviour, the last one depending by various factors of fire amplitude.

FARSITE simulation model of forest fires. Forest vegetation represents a major piece of information when development of the mechanical reaction to fire is taken into consideration. 3D simulation using Fire Area Simulator (FARSITE) cartographic processes for specific vegetation types from the analysed areas are presented in Fig. 4. The FARSITE model is used as a planning tool when analysing the consequences of vegetable fuel management options on the development of forest fire. It is also used to illustrate the effects of the fire on specific behaviours of the vegetable fuel¹⁰. The main advantage of the FARSITE model resides in its ability to develop a mechanical model of fire containing data about complex fuel elements, weather and altimetry. Deterministic nature of the FARSITE model allows the results to be directly related to causal factors.

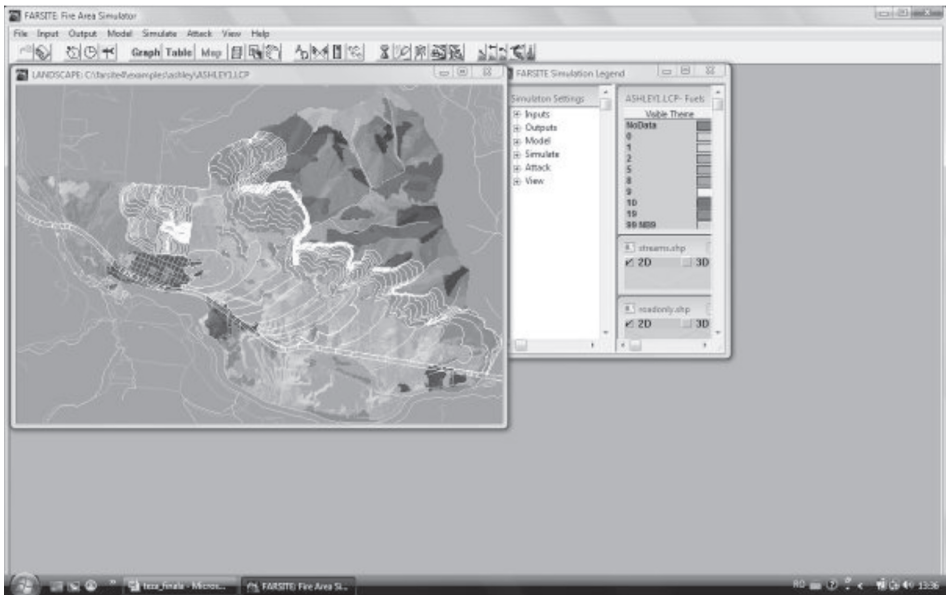


Fig. 4. Specific vegetation mapping using FARSITE program

FlamMap simulation program. This is a computer software which enables the mapping of distribution and characteristics of vegetable fuel elements (Fig. 5).

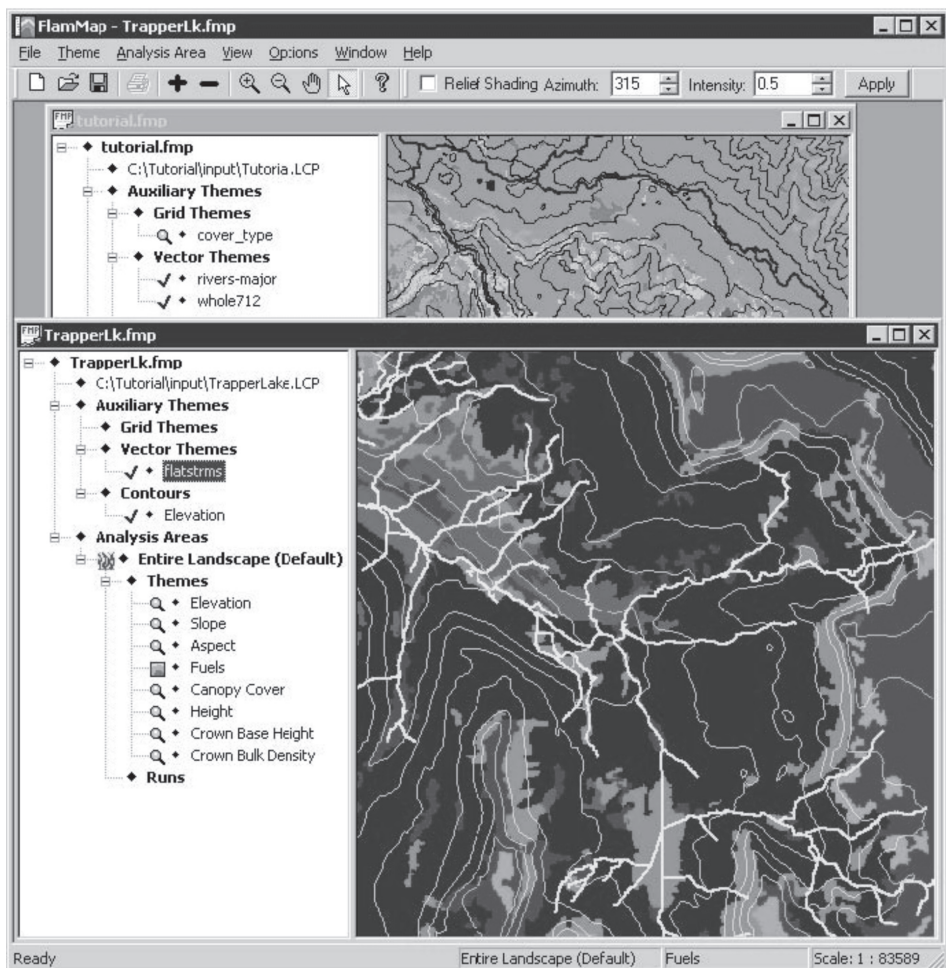


Fig. 5. Specific vegetation mapping with FlamMap program

RESULTS AND DISCUSSION

As a result of the field investigations, there were identified in the studied zones forests in which occurred in the past different types of fires. These situations were categoriaed by considering different fuel models. In case of the forests in which the fire hazard is great (vegetation type and climate) were elaborated specific forest fuel models, presented in the paper for the 2 forest districts. After data analysis, there resulted 12 fuel models, 6 for each forest district. These models made the extrapolation basis for all the vegetation conditions from the studied area. According to field observations and the realised fuel models, the vegetation distribution from the Berzasca forest district could favour mostly ground fire, while in the

Moldova Noua forest district surface and canopy fires are more probable. Since now, in Romania there were not implemented suitable fire fuel models for the specific conditions of the south-western forest regions (fire corridor). There can be also mentioned that in the closer future, there appears the necessity for forest fire modelling as a consequence of the climate changing. For example, there can be considered the Russian Federation situation having cold climate and northern forests where there were not encountered major problems regarding the forest fires, until the last years (2010 was a problematic year).

The obtained results can be useful to decision-makers from the Ministry of Agriculture, Forest and Sustainable Development, forest and agricultural departments, the top management of forest districts, fire risk assessors and staff in charge for the fire prevention and intervention from emergency county inspectorates. After the developed studies, we consider that implementation of sustainable forest management in the county of Caras-Severin involves the making of important strategic actions: improvement of the regulations/norms in specific domain, reducing the number of forest fires, removing trees affected by fires, application of the intensive forest management and long recovery, ensuring the development of mixed stands with mosaic structure, optimising the composition of the future forests by promoting the natural regeneration, native species with high economic value and environmental stability, adaptation of forest infrastructure to the new ownership structures that result from the process of property restitution in order to increase competitiveness of the forestry sector, maintaining the annual harvest volume of wood according to the forest potential, the creation of forests having soil protective functions and the establishment of erosion control management, increasing the total area of forests through afforestation activities.

CONCLUSIONS

The Caras-Severin county was not chosen randomly for this study purposes. The main reason in choosing this area was represented by the great number of forest fires from this county. There are a lot factors responsible for the increasing number of fires, e.g. lack of prediction instruments; not using a fire risk analysis method; lack of citizens education, not rebuilding of the forests affected by fires. Forest degradation by fires has many other consequences as soil erosion, disappearance of plants or animals, pollution, landslides, extreme weather¹¹⁻¹³.

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