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Identifying and mapping the protective forests of southeast Mt. Olympus as a tool for sustainable ecological and silvicultural planning, in a multi-purpose forest management framework

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ABSTRACT

Rural development in forested lands and high altitude ecosystems created new regimes and disturbances that set protective function of forests as the most fundamental of all forest functions. Considering protective forests as engineering structures against natural hazards and risks, such as erosion, able to replace costly manmade infrastructures, a methodology is presenting aiming at their spatial identification in a changing mountainous environment. The methodology followed is based on field observations, calibrated models, topographical, geological and climatic data as well as human presence indicators combined properly in a GIS environment. Analysis showed that some forest soils are prone to erosion hazard unable to absorb disturbances like selective logging, revealing the protective role of their forest cover. The spatial identification of the forests with a particular protective function is the necessary step required for the design of a sustainable management of high elevated ecosystems.

1. Introduction

Multi-purpose forest management is gaining more and more attention nowadays. Since forest management for wood production and other commercial purposes remains the dominant interest in many Mediterranean countries, such as Greece, the need has emerged for optimal management, including other possible functions a forest may offer. Moreover, rural development in forested lands and mountainous ecosystems has created new regimes and disturbances, thus setting, in many cases, the forest's protective function as one of vital importance. Kräuchi et al. (2000) recognize the forest's protective function as of primarily importance, under the stress of increased population density and pressure from emerging tourism in mountainous environments. Heinimann and Stampfer (2003) theorized protective forests as engineering structures that consist of structural systems (stand structure, stand texture) and of structural members (trees), in an effort to maintain and endorse their potential function. In other relevant studies, Motta and Haudemand (2000) characterize protection as the most fundamental of all forest functions.

A definition for a forest with a particular protective function is presented by Zampa et al. (2004) based on 'article 42 cpv. 2 Ofo'. According to them, a forest with a particular protective function is located on a slope where there is a direct risk for human life or for material goods of high value, due to avalanches, landslides, erosion, debris flows or falling rocks. In addition, Renaud et al. (1994), as well as Berger and Rey (2004) acknowledge that forests can partially or totally control some natural hazards such as erosion, floods, rockfalls and avalanches. Motta and Haudemand (2000) separate the protection function of mountain forests to general protective role, with a contribution to surface soil conservation, watershed management, air quality and the human-specific role of protecting people, buildings, roads, rail traffic and power supply from natural hazards such as avalanches, rockfalls, landslides, erosion and floods. Berger and Rey (2004) induced terms of active protection (possible in the hazard departure zone with avalanches, flood and erosion) and passive protection in the transition and stopping zones, especially for erosion. The object-protection function is usually referred to as direct protection in the literature (e.g., Schönenberger, 2000; Dorren et al., 2004), whereas the site-protection function is of great importance, since a forest stand needs to protect its site against processes, such as extensive soil

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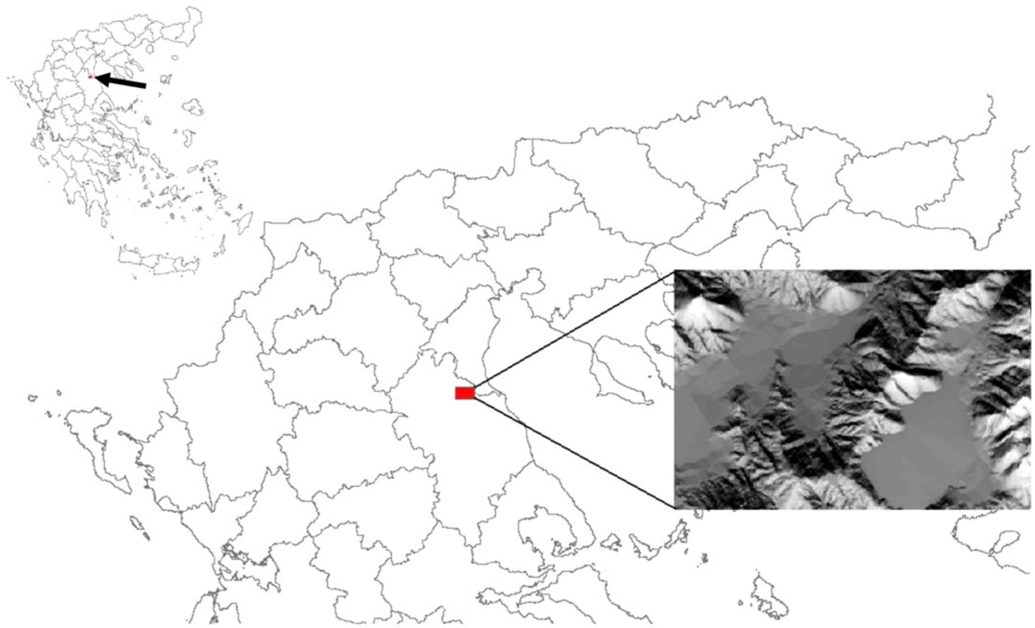

Fig. 1. Study area.

erosion or the occurrence of debris flows (Rey and Chauvin, 2001; Dorren et al., 2004).

Protection forests form a part of the natural landscape and their maintenance is less costly than technical measures (Cattiau et al., 1995). In this sense, 'ecological engineering' term has been defined as the design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both (Mitsch, 1998; Osman and Barakbah, 2006). Furthermore, eco-engineering has also been defined as the long term, ecological strategy to manage a site with regard to natural and man-made hazards (Stokes et al., 2008a; Abdi et al., 2010). The spatial identification of protection forests is a first step towards to this direction, due to equilibrium that may offer between forest stability, soil conservation and human presence protection. Despite the succinctness of protective forest definitions, the task of their recognition and mapping on various scales does not seem to be a simple case, as a necessary step to design the construction of mountainous ecosystems intermingled with human development on a sustainable basis, especially for some such hazards as erosion. This may be attributed to the variety of the factors involved in order to recognize and capture potentially erosive areas as a whole, or areas that will present similar problems in the future. In literature, a distinction has been made by Rey and Berger (2006) in an effort to capture potentially erosive areas, by dividing geological formation into two classes, those containing marls and limestones and those composed only of marls. Berger (1996) evaluated the natural hazard forest control level, based on the estimation of a Hazard Mastering Index, dependent upon types of natural risks (frequency, intensity, and origin regard to forest crops) and forest crops involved, together with the degree of protection provided by stable tree population patterns. Mapping protective forests against avalanches or rockfalls is a rather simpler task, due to the fact that literature provides slope thresholds and extensive investigations of the factors involved. In the current research, the methodology which is applied to the classification of forest stands with the particular protection role is based on erosion hazard evaluation, in conjunction with general non-stable slope phenomena and values that will possibly be affected. Consequently, this paper attempts to identify, assess and classify forest stands located in mountainous areas with a particular protective role in a multi-purpose framework, in order to further apply silvicultural treatments to improve and sustain their potential role. The methodology followed is based on field observations, measurements and topographical, geological and climatic data combined properly in a GIS environment.

2. Materials and methods

2.1. Study area

The study area is located on the southeastern slopes of Mt. Olympus, Thessaly, Central Greece, within the province of Elassona (Fig. 1). The study area covers a surface of 74.9015 km^2 (between 39°59′–39°55′ N and 22°23′–22°30′ E). The mean elevation is 1014.89 m (min: 760 m–max: 1588 m) and the average mean slope is about 23% (12.954°). Since no meteorological station exists within the project area, we had to rely on data of proximal meteorological stations. According to those, the climate is a typical sub-Mediterranean with analytical values of mean monthly rainfall presented in Table 1. The study area is covered by forest (29.9307 km^2), shrub or rock dominated lands (12.2178 km^2) and agricultural lands or pastures (32.2398 km^2). Two small villages are located within the area, namely Karya (900 m a.s.l.) and Kallipeuki (1020 m a.s.l.). The main characteristic of the study area is the small number of houses that have been constructed during the last decades, intermingled, in several locations, with wildland vegetation. The hydrographic network is composed by the main river (length within the area: 9.75091 m) and secondary streams which contain water only during the winter. The forest comprises of *Pinus nigra* Arn., which is the main species and *Abies borisii regis* in some aspects. Within the forest stands the understory regeneration is mainly *A. borisii regis* saplings, thus creating mixed conifer forest conditions. The dominant shrub species is *Quercus coccifera* and *Juniperus oxycedrus* (Zagas et al., 2002). The geological formation of the wider area belongs to the Pelagonian zone (Mountrakis, 1986). It comprises by ophiolites and cretaceous limestones, post-cretaceous thrusts, triassic-eocene carbonate successions, metavolcanic rocks, siliclastic and carbon-

Table 1
Data from proximal meteorological stations (source: Greek Ministry of Agriculture). There is no more recent data from the meteorological stations, since their function was discontinued in 1991 and 2002 respectively.

Station	Altitude	Position		Service	Period	Mean annual rainfall (mm)
		Lat.	Long.			
St. Dimitrios	814	22°14′	40°09′	Ministry of agriculture	1975–1991	752.53
Livadi	1183	22°09′	40°08′	Ministry of agriculture	1975–2002	715.41
Kriovrisi	1030	22°20′	39°59′	Ministry of agriculture	1974–2002	675.80
Pithio	750	22°14′	40°04′	Ministry of agriculture	1973–2002	635.48

ate metasendimentary sequences (Katsikatsos et al., 1982; Faupl et al., 1999).

2.2. Methodology

The methodology which has been applied follows the recommendations of Hamilton (1992) about the protective role of mountain forests against erosion. According to this source it is appropriate to speak about forests as having low erosion rather than no erosion and when putting forests back on mountain land to talk about erosion reduction, rather than prevention. In this sense, based partially on Zampa et al. (2004) working plan combined with Nekhay et al. (2009) notifications about in-stream erosion, we worked according to the following phases in order to map the forest protection zones:

- Mapping of a general forest protection zone. According to Swiss methodology (Zampa et al., 2004), in this category belong woodlands located on areas presenting potential natural risk due to morphologic conditions. The morphologic conditions criterion is a specific slope threshold (21.8° or 40%).
- Mapping of a specified forest protection zone. The universal soil loss equation (USLE), as modified by Dissmeyer and Foster (1981), used to quantify annual forest soil loss in the study area. According to Lane et al. (1992), it is the most widely used method of predicting soil loss in forestry. Similar prediction technologies, such as revised universal soil loss equation (RUSLE), may contribute in estimation efforts of erosion rates during hillslope design (Toy and Foster, 1998; Toy and Chuse, 2005). In this framework, all the woodlands that present annual soil loss equal to or greater than 2 ton ha^{-1} year^{-1} were classified as protective forests. This threshold value follows the recommendations of Zhang et al. (2006), that in any forest land presents soil loss greater than this value the conservation practices or feasible forest operations should be concerned. This methodology was used in this research, in an effort to identify forest stands that are most prone to erosion hazards, or vulnerable forested areas that have a propensity to suffer damages from erosion due to a triggering event, such as logging. In addition, since the USLE model does not consider in-stream, but only rill or gully erosion, a strip area of 50 m around rivers (Nekhay et al., 2009) and 25 m around secondary streams was considered to be relatively susceptible to floods and to the detachment of soil particles by floodwaters, thus classifying any forest located within this buffer zone as a protective forest.
- Values affected theme. Humans or property located within the forest protection zones may be directly or indirectly protected by erosion or torrent floods. In this case, the protective function of mountain forest becomes even more essential, thus setting its classification as a priority action. In the current study different layers of main roads, houses and villages have been created in an effort to evaluate the potential hazard.

2.3. Data elaboration

A topographic map of the Hellenic Army Geographic Service (scale 1:50,000) was used to digitize 20 m contours and create a digital elevation model of the study area (pixel size: 20 m × 20 m). The soil raster theme of the study area, emanates from detailed soil maps (1:50,000) of the National Agricultural Research Foundation. The digitalized road and water (rivers and streams) network theme was created through an interpretation process of aerial photos of the study area. Due to the fact that some houses were completely covered by wildland vegetation, we had to estimate its position *in situ*, with the use of hand-GPS devise (Magellan Explorist 500) to as great as possible accuracy (about 3 m). Data from CORINE 2000 was used (Fig. 2) to extract the type of vegetation and to create the land cover and land use map. For the forest–vector theme creation, CORINE codes 311, 312 and 313 were selected and extracted.

2.4. The USLE model

In order to evaluate erosion risk in the study area, the universal soil loss equation was implemented in a GIS framework. The updated USLE for forestland allows foresters to compare quickly and easily potential soil loss following different harvesting methods and evaluate which method is likely to have the least influence on soil erosion (Hood et al., 2002). USLE is an empirical model taking into account several determining factors, such as the rainfall factor (R), the soil erodibility factor (K), the length–slope factor (LS), the cover management factor (C) and the support practice factor (P) (Karydas et al., 2009), according to the following equation:

$$A = R \times K \times L \times S \times C \times P \qquad (1)$$

where A is the average annual soil loss (ton ha^{-1} year^{-1}), R is the rainfall aggressivity index (MJ mm ha^{-1} h^{-1} year^{-1}), K is the soil erodibility factor (ton ha h ha^{-1} MJ^{-1} mm^{-1}), LS is the slope length and slope steepness factor respectively, C is the vegetation cover factor, and P is the support practice factor.

2.4.1. Rainfall aggressivity index (R)

The rainfall (R) factor is the effect of raindrop impact on runoff (Risse et al., 1993). Rainfall erosivity is defined as the potential ability of rain to cause erosion and given as the product of the total energy of rainstorm and the maximum 30-min intensity (Wischmeier and Smith, 1978). Areas of high annual precipitation and intense thunderstorms generally have higher R values (Hood et al., 2002). In the study area, due to the big difference between lowest and highest elevation value (about 828 m) we had to estimate the R factor for each sector separately. According to Flabouris (2008), the R factor for the prefecture of Larisa is linked with the mean annual precipitation (P_L) though the following equation:

$$R = aP_L \qquad (2)$$

where R is the rainfall aggressivity index (MJ mm ha^{-1} h^{-1} year^{-1}), P_L is the mean annual rainfall (mm), and a is the coeffi-

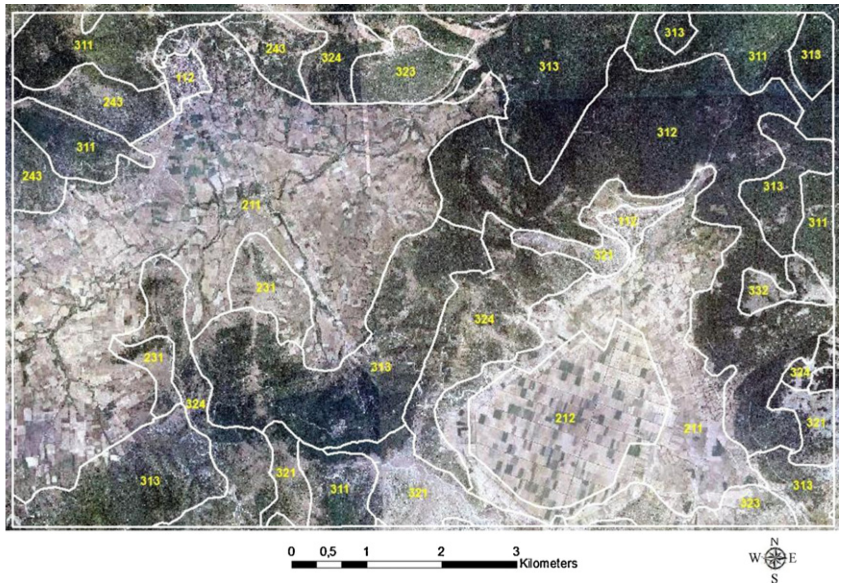

Fig. 2. Corine land cover map of the study area.

cient with dimensions, equal to 0.8 for the prefecture of Larisa (MJ ha^{-1} h^{-1} $year^{-1}$).

The Hellenic Ministry for the Environment, physical planning and public works provides the following equation for the estimation of the mean annual precipitation for this face of Mt. Olympus (Environmental Management of the National Park of Mt. Olympus, 2003):

$$y = 358.9x^{0.0964} \tag{3}$$

where y is the mean annual rainfall (mm), x is the elevation above sea level (m).

Combining Eqs. (2) and (3):

$$R = 0.8(358.9x^{0.0964}) \tag{4}$$

The rainfall erosivity map derived from Eq. (4) by implementing in GIS environment.

2.4.2. *Soil erodibility factor*

The soil erodibility factor (K) reflects each soil type's inherent susceptibility to erosion (Hood et al., 2002). It measures soil particles susceptibility to detachment and transport by rainfall and runoff with respect to a reference parcel (Lastoria et al., 2008). Due to the lack of detailed information, this factor was not easy to be measured. Based on expert opinion and literature (Lastoria et al., 2008; Likoudi and Zarris, 2002) Table 2 was created for each soil type. The K factor value imputed in a raster-grid format of the project area and the soil erodibility map was created.

Table 2
Soil erodibility factor (K).

Soil	K factor
Gneiss and amphibolites	0.01
Volcanic rocks	0.01
Crystaline Schist	0.01
Calcareous and dolomites	0.013
Marls	0.02
Sands	0.052
Alluvial deposits	0.029

2.4.3. *LS factor*

The effect of topography on erosion has been incorporated in the LS factor. L is the slope length factor and S is the slope steepness factor. They are usually estimated together as LS factor in a GIS environment. In general terms, erosion rates decrease as hillslope steepness decreases and as hillslope length decreases (Toy and Chuse, 2005). The hillslope length factor of the original equation has been replaced by the upslope contribution area for the estimation of the effect of the flow coverage factor on erosion (Moore and Burch, 1986; Mitasova et al., 1995, 1996; Desmet and Govers, 1996; Terranova et al., 2009). The LS factor can be calculated by the following commonly used equation (Ozcan et al., 2008):

$$LS = \left(\frac{\chi \times \eta}{22.13}\right)^{0.4} \left[\sin\left(\frac{s}{0.0896}\right)\right]^{1.3} \tag{5}$$

where χ is the flow accumulation (derived from ArcGis 9.3), η is the cell size (20 m), θ is the slope steepness (degrees).

Finally, an upper bound of 160 m was assumed according to Engel (1999) technique (Lastoria et al., 2008).

2.4.4. *Vegetation cover factor*

The C factor represents the effect of ground, tree and grass covers on reducing soil loss in non agricultural situation (Kouli et al., 2009). Wischmeier (1975) identified three subfactors for C: canopy cover, surface cover and below surface effects. Dissmeyer and Foster (1981) suggested that the following subfactors affect the C value: (1) amount of bare soil, (2) canopy, (3) soil reconsolidation, (4) high organic content, (5) fine roots, (6) residual binding effect, (7) onsite storage, (8) steps (9) contour storage. In the present study the C factor estimation is based on CORINE land cover classification and the values published by Lastoria et al. (2008). According to this source the 311, 312 and 313 codes correspond to 0.004 of C value, presenting an undisturbed regime of mountain forest of Southern Olympus.

2.4.5. *Support practice factor*

Support practice factor (P) is the ratio of soil loss with a specific practice to the corresponding loss with up and down slope tillage (Zhao et al., 2009). Since no erosion control practice implemented in the project area, the support practice factor was assumed to be equal to unit (1.0) value (Ozcan et al., 2008).

2.4.6. Logging disturbance evaluation

Logging disturbance expressed in a mathematical form is not easy and it can only be visually estimated (e.g., Hood et al., 2002), based on Dissmeyer and Foster (1981) nomographs. Harvesting is presented as an anthropogenic activity responsible, among others, for the degradation of forest ecosystems (Hüttl and Shneider, 1996). The traditional forest management in this area is under Forest Service's responsibility and for more than fifty years aimed at wood stock production rather than other values. The wood stock receiving procedure is based on a management plan including a repeated 10-year period selective logging for each sector in which the forested area has been divided. The logging procedure took place in 2008 and 2009 by the Forest Service in three forest sectors. Stand characteristics such as crown base height, crown dimensions, diameter at breast height and site characteristics such as the amount of bare soil, fine roots and organic material were estimated in an effort to evaluate the logging disturbance on the protective forest cover. It should be noted that no cranes were used for logging needs, only tractors which carted trunks into forest roads, creating vertical channels across contours. In one occasion, logging exposed 25% of bare soil, 40% of which had 3.7 m of canopy over it. The bare soil composed by fine root mat and the topsoil's organic content was about 6.5 cm thick. No steps were encountered. Using the nomographs presented by Dissmeyer and Foster (1981) for each sub factor the following values can be attributed:

Bare soil: (0.15), canopy: (0.86), soil reconsolidation: (1.0), high organic content: (0.70), on-site depression storage: (0.9), fine root: (0.22), and steep formation: (1.0). The cover management factor for this site, thus, becomes:

$$C = 0.0179$$

The visually estimated C value immediately after logging for the other two managed sectors was 0.0164 and 0.0158, quite close to the first value. It is obvious that selective logging effects on initial C value may vary enough, depending on several factors and logging techniques. Thus, a need for a specific threshold is emerging in order to be used during forest management planning procedure. This threshold value is provided by the literature. According to Kitahara et al. (2000) it is possible to control the C value <0.03 if forest floor disturbance is minimized. Using this general value as a lower limit and assuming that the logging procedure expanded in all the forested area, then the potential erosion rate can be estimated immediately after logging.

2.5. Riparian buffer zones

The forest areas can intercept the slope runoff from upper bare areas and transfer it to interflow, thus planting protective forests along river bangs preserve natural water sources from pollution (Korets and Onuchin, 2008). According to the same authors, one environmental parameter for the identification of protective forests might be the evaluation of the erosion processes. In addition, an area of 50 m around rivers and streams was considered to be prone to flooding and to the detachment of soil particles by floodwaters, as identified by Nekhay et al. (2009). In the current research, the digitized river network layer was the base for the creation of 25 m buffer zones around streams that contain water only during winter and of 50 m buffer zones around rivers, on both sides. The intersection with the forest layer leaded to the creation of riparian forest protective zones.

Table 3
Spatial buffer strips around human property.

Value	Zone of influence
Roads	50 m
Houses/infrastructures	50 m
Villages	500 m

2.6. Values affected

The protective role of mountain forests becomes an issue of paramount importance especially when it is linked with human infrastructures located in the area. In an effort to map forest protective zones that affect human properties in a direct way, influence zones were created around them. These influence zones follow the spatial rules of Table 3.

3. Results

3.1. General forest protection zone

To complete this task two criteria were applied in a slope-grid raster layer: slopes smaller than 40% (21.8°) and slopes bigger than this value. After the intersection of forest layer with the class 2 slope, the general forest protection zone was created. The surface covered by this zone is about 13.678 km^2, or the 45.7% of the total forested area and it is analytically presented in Fig. 3.

3.2. Specified forest protection zone

The implementation of Eq. (1) in GIS framework resulted to the estimation of potential erosion rates in the study area. The annual rate of erosion, in the undisturbed forested area, is below the critical value of 2 ton ha^{-1} year^{-1}, thus no propensity of gully or rill erosion can be recognized. Almost all the forest area presents erosion values within this threshold and some inclinations located in the boundary line can be attributed to an error occurring during the conversion process of vector to raster files. The mean value of the erosion in the forested area is 0.2205 ton ha^{-1} year^{-1} (St. Dev.: 0.2066 ton ha^{-1} year^{-1}).

After the simulated logging, the annual erosion rate, in several locations within the forest boundaries, exceeds the threshold value of 2 ton ha^{-1} year^{-1}, revealing the protective role of the removed stand. The mean value of the erosion in the forested area became 0.9922 ton ha^{-1} year^{-1} (St. Dev.: 0.9297 ton ha^{-1} year^{-1}). The forested area suffering erosion damages after logging is about 10.8552 km^2 or the 36.27% of the total forest area and it can be mapped as a specified forest protection zone against erosion. The spatial identification of this area is analytically depicted in Fig. 4.

3.3. Riparian buffer zones

Following the spatial rules of buffer zone creation around rivers and streams in combination with forest layer, the identification of riparian protective forests was feasible. It occupies an area of about 3.349 km^2, or the 11.189% of the total forested area, as it is illustrated in Fig. 5.

3.4. Values affected

The intersection of the buffer strips with the two forest protective zones, the general and the specified lead to the creation of two layers that should be of top priority during forest management planning because they are directly related to human values. The area occupied by these two layers is presented below:

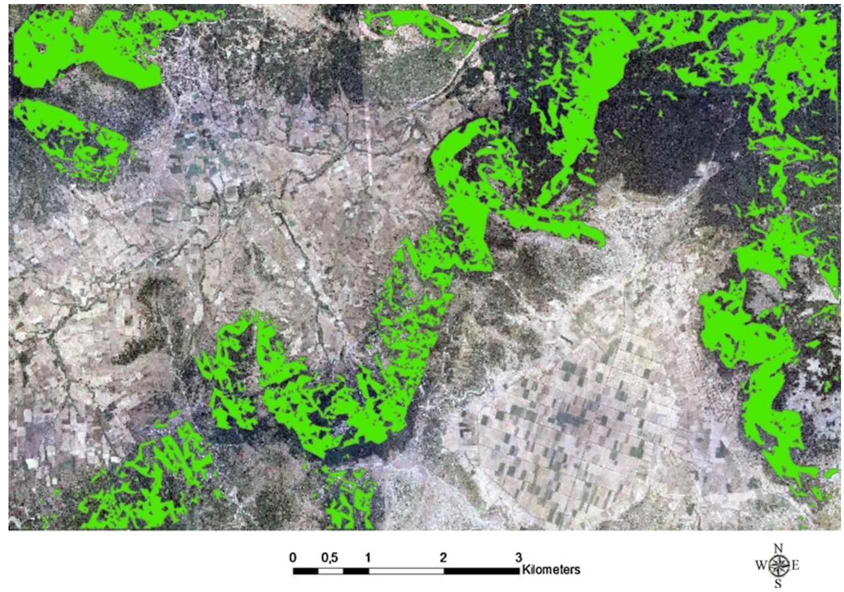

Fig. 3. General forest protection zone (Green colour). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of the article.)

Human values proximal to general forest protection zone: 0.845 km^2 or 2.823% of the total forested area.
Human values proximal to specified forest protection zone: 0.634 km^2 or 2.118% of the total forested area.

4. Discussion

Erosion is one of the main problems of the mountain forests of Greece (Zagas, 1998) and the most acute environmental problem at the same country (Tsitsoni, 2001; Spanos et al., 2005). Haigh and Gentcheva-Kostadinova (2002) suggested that forestation in conjunction with surface leaf litter mulching is an effective method against ground loss procedure. According to Norris and Greenwood (2006), in urban areas of United Kingdom bioengineering techniques had been applied to combat the problems of soil erosion and shallow landslides. They defined as bioengineering technique the implementation of vegetation as a practical alternative to other methods of soil stabilization such as soil nailing or geosynthetic reinforcement. Simultaneously, the raising invasion of human activity to mountainous ecosystems leaded to new regimes and disturbances, creating the need for a revisited ecosystem management in order to be protected human lives and values, in a sustainable basis. In this case, spatial discrimination of the existing protective forests rather than reforestation is required, for further reinforcement actions to endorse their protection function.

In an effort to identify protection forests, three classes of forest protective zones were created based on spatial criteria such as slope, annual erosion rates estimation and the proximity to streams and rivers. A separate theme of influenced human infrastructures was used to distinguish locations consisting first priority during the ecological and silvicultural planning and in general, the ecosystem management design. The results clearly showed that the specified

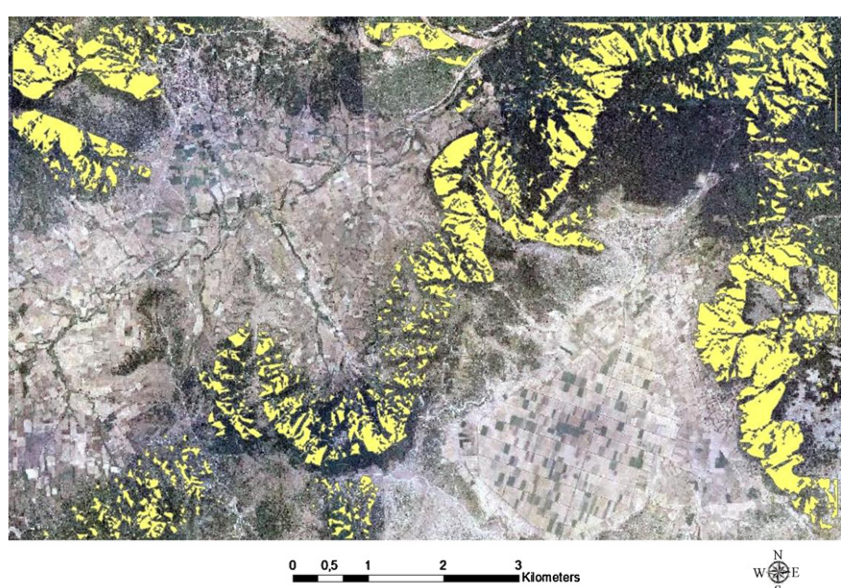

Fig. 4. Forest areas that present high erosion rates after selective logging (Yellow colour). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of the article.)

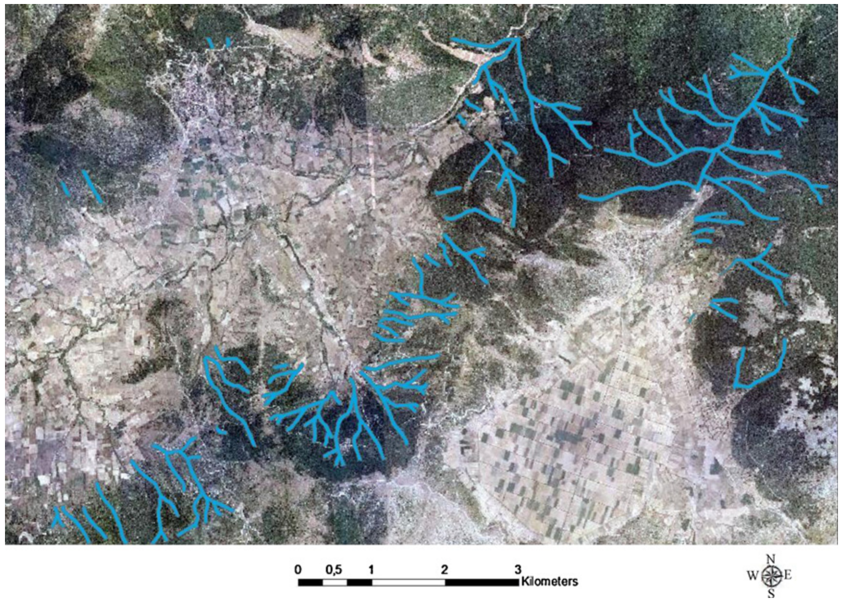

Fig. 5. Riparian forest protection zones (Blue colour). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of the article.)

forest protective zones does not completely fall within the general forest protective zone, thus taking into consideration only the criterion of slope, during ecosystem management planning, may not be as accurate and, furthermore, a more detailed study is required.

The estimation of the modified canopy cover factor, after simulated selective logging, was based on visual observations due to the fact that no other method could have been used. It is the first time an attempt to estimate such a parameter is being made in Greece and no literature data were available for comparison and validation. Additionally, the *C* values from only three plots were available, certainly not enough for statistical analysis, and the time limit of the 10 years rotation of the selective logging excluded further estimations. Using the different values of *C* factors after logging, led to different sizes of specified forest protective zones and a limit value was needed which could only be obtained from the global literature. Other estimations of the *C* factor emanate from Özhan et al. (2005) research and the values presented fall well within those that were used in the current research, while the estimated mean erosion values are in agreement with those reported by Hamilton (1992) about erosion rates in forest ecosystems.

The specified forest protection zone map was based on logging effects evaluation and their possible effects. However, it is possible for some forested lands to present high erosion rates during the first application of the USLE equation without simulating any disturbance. In this occasion, the forest located in these areas should be characterized as a protective forest and the silvicultural interventions are necessary to endorse their protection function (Tsitsoni and Zagas, 1994).

In protective forests, the protection function has been considered to be the dominant forest function (Brang et al., 2006). Nowadays, society is trusting technical protective works than protective forests because of the lack of quantitative data on the efficacy of protective forests (Dorren and Berger, 2006). The methodology which has been applied in this research, led to the spatial discrimination of the forest stands with a particular protection function against erosion combined with quantified annual erosion rates, revealing their efficacy. Furthermore, based on this discrimination it is possible to study the structure of these stands and to apply silvicultural treatments in order to ensure and to expand this role, mainly by manipulating and enhancing natural regeneration. If regeneration is missing or low then an old forest is less stable and its potential role decreases (Berger and Rey, 2004). It should be noted that the estimated erosion rate refers to a short time after logging. The invaded vegetation affects the *C* value for the next years and it can be expressed as a function of time (Kitahara et al., 2000). Thus, the vegetation can act as a protective barrier between the soil and the natural elements which stimulate erosion (Stokes et al., 2008b).

Conclusively, the effect of the forest protection cover is essential in maintaining and preserving forest soil. Hypotheses don't derive conclusions that all forests are charged with a protective role that should be taken under consideration during forest management planning. Any activity that results in forest cover disturbance, such as logging, should be applied after careful planning due to its negative effects and, most importantly, due to the non-reversible damages that it may lead to. In the current paper an attempt has been made to identify and map forest protective zones in a changing high-elevated environment, dominated by steep slopes and characterized by increasing rural development. The application of the universal soil loss equation is quite simple and can be applied during forest management planning. The preservation of the already degraded forest soils of Greece is the only solution to combat the hazard of desertification, which threatens all countries of the Mediterranean region.

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