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Erosion risk and desertification risk at Pyrgos, Greece

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Abstract

Summertime forest fires are a major problem in all Mediterranean countries and a factor that contributes in erosion and desertification of large areas. During the summer of 1998, the area of Pyrgos (prefecture of ILIAS, Western Peloponnese) suffered from a wild fire. Large areas of vegetation and forest have been destroyed.

In this study, we examine the erosion risk and desertification risk for these areas, taking into consideration the following parameters: Geology, slope gradient, type of vegetation, soil type, soil depth and rainfall.

For the best management of the data, we used the GIS technology and the equipment of the Remote Sensing Laboratory. First, we digitized all the available maps of the area at a scale of 1:50000 (1:20000 for the vegetation map). Then, we created the DEM, the slope map and the aspect map of the whole area. For the destroyed areas, we made a classification for the erosion risk, taking into consideration the surface geology, the rainfall erosivity and the percentage of the slope. Then, we made a second classification for the possibility of natural regeneration, taking into consideration the soil type, the soil depth, the aspect class and the vegetation type. Finally, we estimated the desertification risk, as the sum of the classes of the two previous classifications.

1 Introduction

The area under study (figure 1) is situated in the Western Peloponnese prefecture of ILIAS, between the area of Ancient Olympia and the city of Pyrgos. Pyrgos is

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built at the discharge of Alfios River. Alfios with a main channel of more than 110 Km drains an area of about 3600 km2 and is the biggest river of the Peloponnese. The whole area is very cultivated and there is degradation caused by human activities. The seismicity of the area is high. The city of Pyrgos has twice suffered many damages. First at 1965 when it was affected by a strong earthquake (Ms=6,1) (Papazachos [5]) and more recently at 1992 (Ms=4,6).

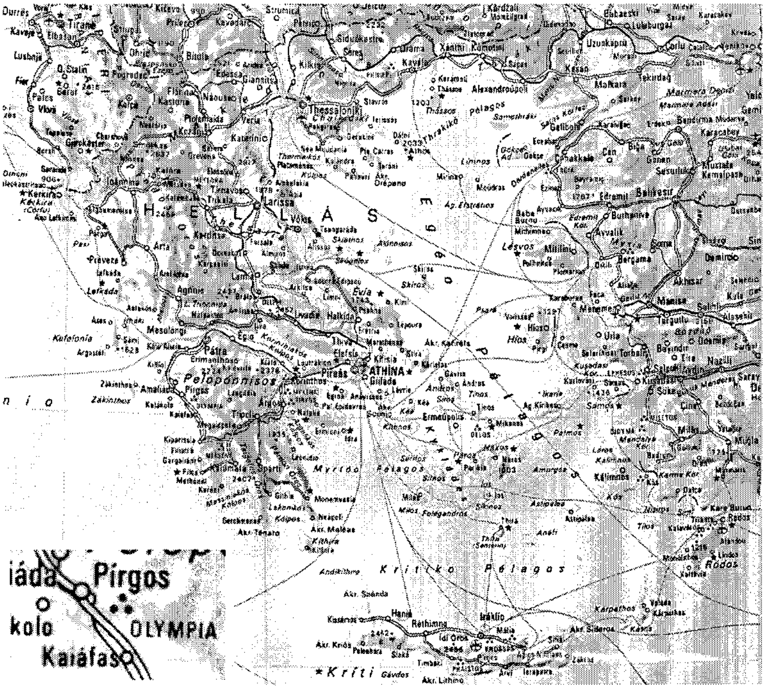

Figure 1: The area under study.

Two geotectonic zones cover the area under study (Papanikolaou [4]). The geotectonic zone of Gavrovo-Pylos and the geotectonic zone of Pindos. Also post alpine deposits cover a big part of the area.

Most of the burned area is covered is covered by the following formations:

1. Holocene sequence of gravel sand and silty sand with a top layer of alluvium loam lying 1,5 to 2 m. above the present level of the Alfeios River.
2. Vounargos formation: Non-rhythmical alternations of clays, marls, mudstones, sandstones and sands with some intercalations of conglomerates along the margins of the basin, with often horizontal transitions and small unconformities. The maximum thickness is over 1000m.
3. Lalas formation: Over 200 m thick in the northern part of the sheet decreasing to 20 m in the southwest. Gravel with pebbles of whitish grey limestone (75-80%), dark limestone (2%), flysch sandstone (10%), chert (13%), quartzite (2%),

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local sandy intercalations. Fluvial sediments of a braided system, deeply weathered in the uppermost part loam with pebbles.
4. Helidoni formation: Sequence of sand with sandy gravel, silt and clay. Locally thin coal seams of reddish yellow colour. The deposits are characteristically developed near Chelidoni village. The fauna is poor in species but rich in individuals,indicating marine, brackish, lacustrine and partly fluvial facies. There is also a series of E-W faults and a series of NNE-SSW faults.
The climate of the area is a Mediterranean marine type with mild winters and warm summers. The average annual rainfall in the area is around 821.9mm and it is very close to the average annual rainfall of the country, which is 821.3mm (Mariolopoulos [2]). The average temperature is around 17,15 °C but in the summer it ranges from 35 to 45 °C. The average relative annual humidity is near 68,7% that is considered normal.

The seismicity of the area and the presence of postalpine formations is a major factor that contributes to the phenomena of erosion and landslides. The landslides phenomena are very usual and plenty of them that have been recorded in the area of Ilias County. Those that need extensive attention are: Moni Kremastis, the settlement of Neraida, the community of Pefkon, the community of Lala and the community of Duka (figure 2). Another major factor is the forest fires that destroy the vegetation. In 1998 a wild fire destroyed about 200 km^2 of vegetation and forest. Hereby, we present a study for the area in which we try to estimate the erosion and the desertification risk as the sum of the following parameters: Geology, slope gradient, type of vegetation, soil type, soil depth and rainfall.

2 Data sets and processing

For the study we used the GIS equipment of the Remote Sensing Laboratory. First, we digitised the following maps:
2 topographic map sheets Olympia and Tropaia, scale 1:50.000 (Hellenic Army Geographical Service, 1988)
2 soil map sheets OLYMPIA and TROPAIA, scale 1:50.000 (Ministry of Agriculture)
16 vegetation maps sheets Korifi, Mouzakio, Persena, Foloi, Kontobazena, Pyrgos, Alfiousa, Olympia, Basilakio, Xrisoxorio, Servos, Kayiafas, Smerna, Platiana, Kalithea, Matesi scale 1:20.000 (Ministry of Agriculture).
1 geologic map sheets OLYMPIA, scale 1:50.000 (Institute of Geologic and Mineral Researches)
1 map with the limits of the burned area, scale 1:50.000 (Forest Service of Pyrgos)

From the digitised topographic map, we created a digital elevation model for the area, with a pixel size of twenty meters (figure 2). From the DEM, we created a slope map (figure 3).

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The first parameter that we took under consideration was the annual rainfall. If there is no much rainfall after the fire or if the rainfall is similar during all the months, it is obvious that there is no erosion. As we can see from table 1, there is a lot of rain during the last three months of each year and almost no rain during the summer months. This event helps the summer fires and also the erosion. Especially in 1998 (the year of the fire) we had no rainfall for three months in the summer; small rainfall during September and October and unfortunately in November we had a maximum of 312,5mm of rain. This is a major erosion factor because the ground cannot absorb so much rain.

Table 1: Rainfall

Month / Year	1995	1996	1997	1998
JAN	231.2	211.5	54.5	91.2
FEB	47.7	154.9	27.5	23.1
MAR	126.5	98.4	39.2	56.8
APR	9.8	32.6	39	8.6
MAY	10.2	30.6	11.7	8.2
JUN	0	7	0	0
JUL	0	0	0	0
AUG	126.3	0	6	0
SEP	103.3	88.6	1.7	74.6
OCT	9.9	164.3	61.3	41.4
NOV	221.4	109.7	163	312.5
DEC	112.2	163	277.6	198.4
Annual Total	998,5	1138	681.5	814,8

The second parameter that we examined was the slope. As we can see in figure 3, the slope in the area ranges from 0 degrees to more than 60 degrees. We made a first classification. The areas that have a slope smaller than 30 degrees were excluded from the study. For all the other areas we made a classification in three parts (30-45 degrees, 45-60 degrees and >60 degrees).

The third parameter that we examined was the geology of the area. As we saw in the introduction, alluvial deposits, sands conglomerates cover all the burned area. These materials don't present any special coherence and contribute in the erosion process. In order to examine in more details the erosion risk we created a synthetic map of the surface geology and the slope map (figure 4). In figure 4 we present the areas that confront the biggest erosion risk. Those areas combine the big slopes and no coherent bedrock.

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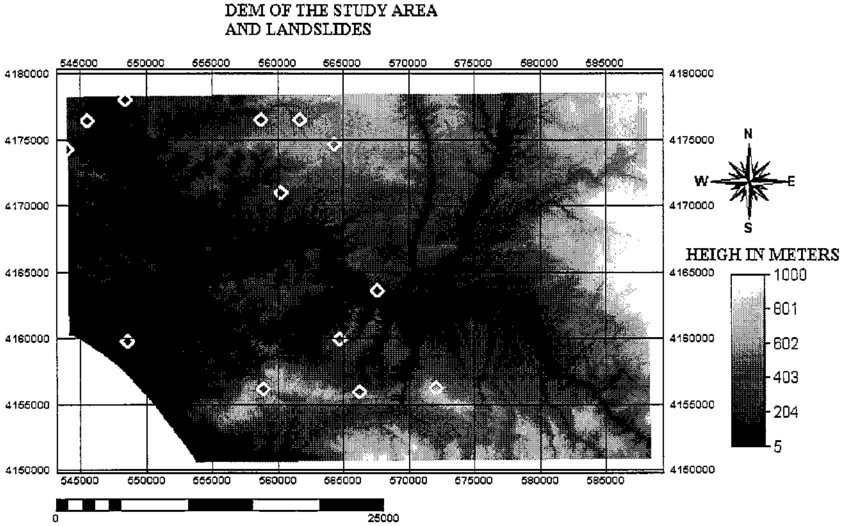

Figure 2: Dem of the area and landslides (with white colour).

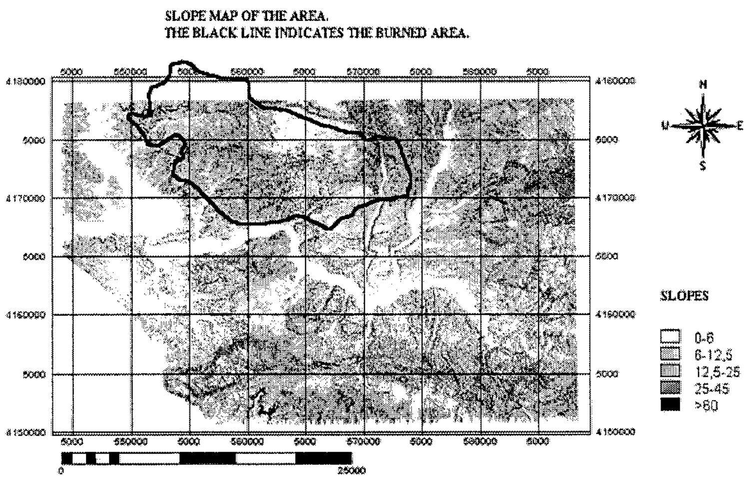

Figure 3: The slope map of the area. The black line indicates the burned area.

After that first classification for the erosion risk, we examined the desertification risk. We made a first classification for the soil map. The knowledge of the soil type and its performance to the erosion and the vegetation type is very important when you examine the possibility of automatic regeneration. Taking under consideration the soil type, the soil depth the aspect and the bedrock, we classified the soil into four different categories: no erosion, medium erosion, high erosion and very high erosion risk, (figure 5). From the four different categories, we kept only the soil types that present high erosion and very high erosion risk.

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Before the fire the area was covered with Pine-Trees (Halepio Juniper), Broad-Leafed (Latifoliates) and Oak trees (figure 6). The Halepios Juniper revives physically after a fire. The revival is influenced from different factors like, the age of the clusters, the age of the cones and of the degree of which the cones are burned (Kailidis [1], Moulopoulos [3]).

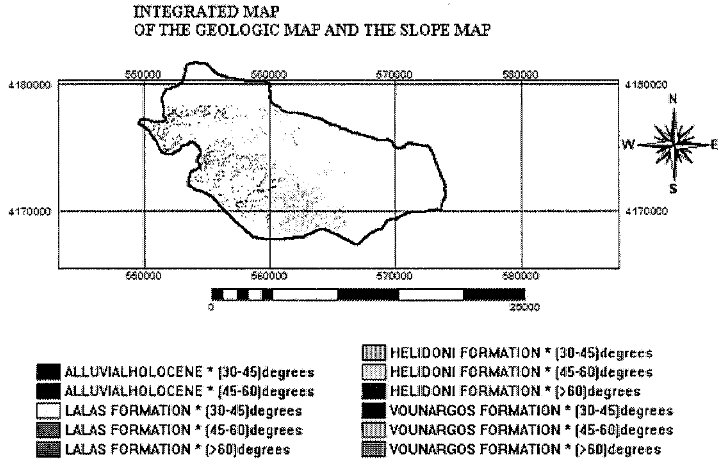

Figure 4: Synthetic map of the geologic and the slope map of the area. The black line indicates the burned area.

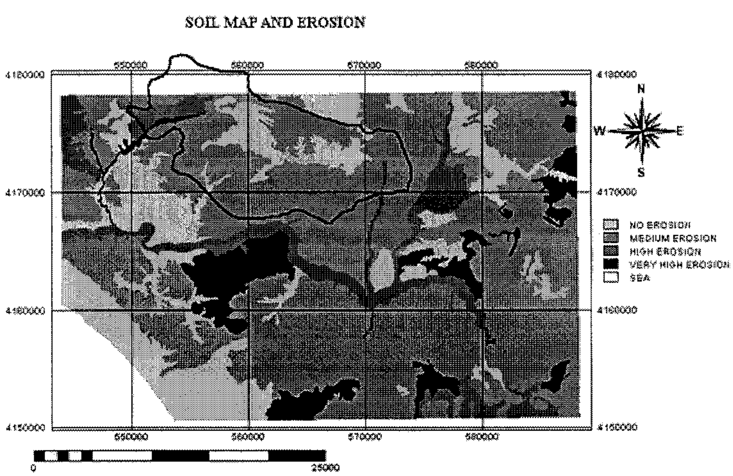

Figure 5: The soil map and the erosion possibility.

Generally, in rocky areas we don't have physical revival. Young clusters 7-10 years old don't revive physically, because they don't have cones. Aged clusters having a part of the top, which is not burned and seated upon less than 50% slopes, are expected to have a successful physical revival. The latiloliotes consist a society that is composed from different species as Ilex (Quercus ilex), Schinos

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(Pistacia lentiscus), Coumaries (Arbutus) etc, that sprout until an altitude of 1.000 meters and are used as a meadow. They can be burned very easily but also very easily they regenerate. Just a few days after the fire they start their regeneration from their roots and they can cover again the burned area in a period from 1 to 3 years. They cannot regenerate if the area presents high slopes or it is burned again. The Oak trees favour the development of bushes, grass and generally cluster of plants. As a result of the presence of bushes and grass the oaks can easily be burned. Even the young trees can easily regenerate.
We produced a synthetic map of the burned area (figure 6) that represents respectively the areas where the soil presents high and very high erosion risk and the vegetation type.

Finally we created a map in which the two classifications are jointly presented (figure 8). In the mapped regions erosion and desertification cannot be avoided.

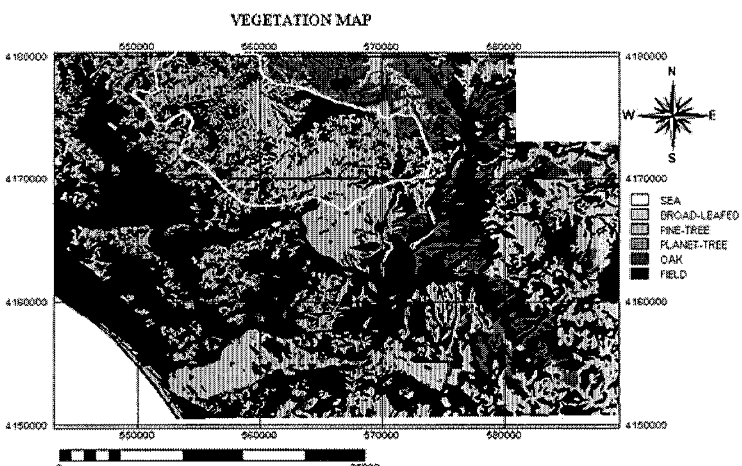

Figure 6: The vegetation map.

3 Conclusions

In this study we tried to locate areas in the prefecture of ILIAS near the city of Pyrgos, which might be dangerous for erosion and desertification. With the help of the GIS technology we located some areas that presents a number of characteristics that favour the erosion and the desertification risk.

The whole area presents very dry summers with high temperatures that favour the forest fires and a big rainfall during the last three months of the year. The sudden and high rainfall helps the erosion because the soil cannot absorb the water. Post alpines sediments with no coherence cover these areas. The surface water very easily displaces these sediments. Also the slope is high and favours the displacements of the sediments. These characteristics favour the landslides and the erosion.

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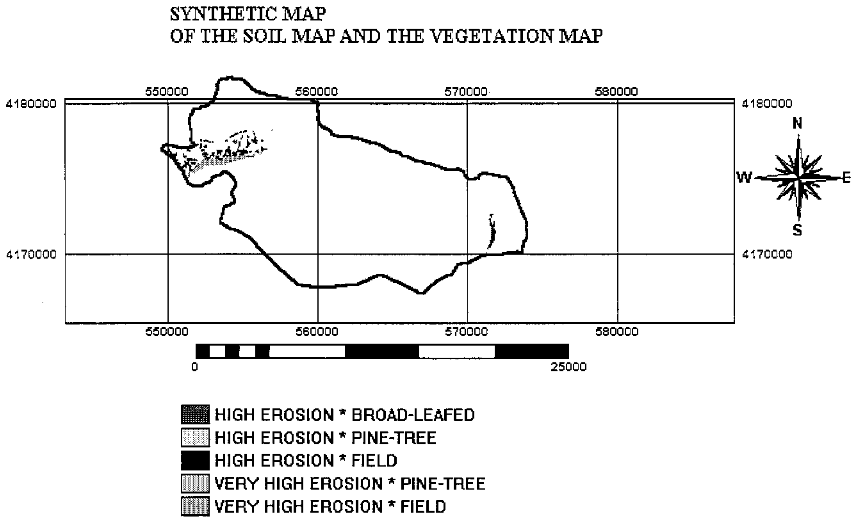

Figure 7: Synthetic map of the soil map and the vegetation map.

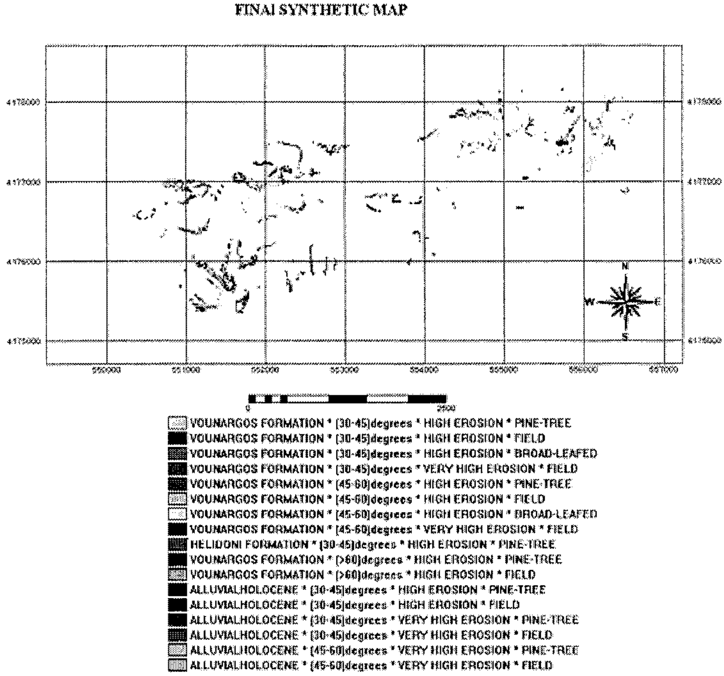

Figure 8: The final synthetic map.

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In addition the soil covers present a high erosion risk. Before the fire of 1998 the area was covered by Pine-Trees, Broad-Leafed or it was cultivated. The fields do not regenerate. The Pine-Trees and the Broad-Leafed do not regenerate in areas which present very high slope. So these areas present also a very high desertification risk because they cannot be regenerate after the fire. The man must plant these areas again as soon as possible after the fire in order to prevent the desertification.

The usefulness of GIS technology should be noticed. We had to use 22 different scale map sheets and to locate areas that present many different characteristics. The use of GIS helped us to control so many and different kinds of data.

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