

Erosional processes in the north-eastern part of Attica (Oropos coastal zone) using web-G.I.S. and soft computing technology

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Abstract

In this paper the erosional process of northeastern coastal Attica is studied. The alpine formation, usually Mesozoic limestones and the post-alpine deposits such as conglomerates, sandstones and marl-limestones characterize the geology of this area.

This area has dramatically changed in the last decade as a result of a rapid urbanization. In June 2001 this coastal area experienced a severe fire event with enormous effect of the vegetation cover. Apart from this damage the outcropping of post -alpine vulnerable formations might accelerate erosion during possible intense rainfall. All these taken under consideration turned us to the construction of an erosion risk map based on web-GIS and soft computing technology. Such approach can be very useful for regional planning and environmental management. Indeed since our first abstract (September, 2001) heavy precipitation has been occurred (November, 2001) and a vast quantity of the weathering material has been mobilized. This fact and the new data sets have strongly proved the usefulness of this study.

1 Introduction

It is well known that land degradation occurs by erosion of soil and surface rocks. These erosional processes are very active in the Mediterranean environments (Poesen, & Hooke, 1977). The intensity of the above processes is much influenced by the amount and the intensity of the precipitation, the

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catchment's characteristics, the lithology, the geological structure and finally the vegetational cover.

The manifestation of the forest fires especially during summer time beeing very frequent tends to accelerate the erosional dynamics and commonly flash floods and extended hill slope erosion have been observed (Photo 1 & 2). The aim of this paper is to assign in the drainage basins of the studied area different zones of erosion risk.

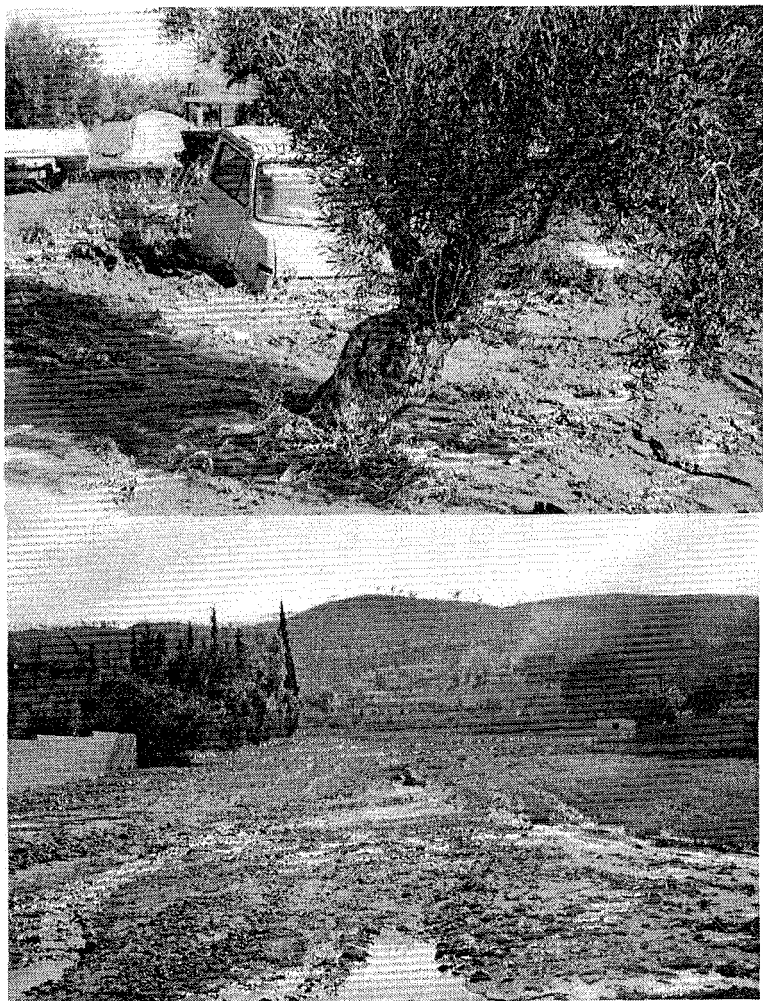


Photo 1 & 2: View close to Oropos village after the heavy precipitation of 5th November 2001.

2 Geological and geomorphological setting

The study area is located in the northern – eastern coastal part of Attica prefecture (Fig. 1). The geological formations are mainly alpine rocks (limestones and ophiolites and radiolarites) of Mesozoic age (Clement, 1983) and neogene and quaternary formation (Fig. 2).

These neogene formations are mainly sandstones, conglomerates and marly limestones (Voreadis, 1952; Mitzopoulos, 1961; Tataris et al 1970; Koumantakis, 1971). Morphotectonic observations of this coastal area are made by Papanikolaou et al (1988).

The drainage system of this area is characterized by the last part of the drainage basin of Asopos river, originated more west, and some small drainage basins in the eastern part. The western part of the coastal area is dominated by the sediments of Asopos river.

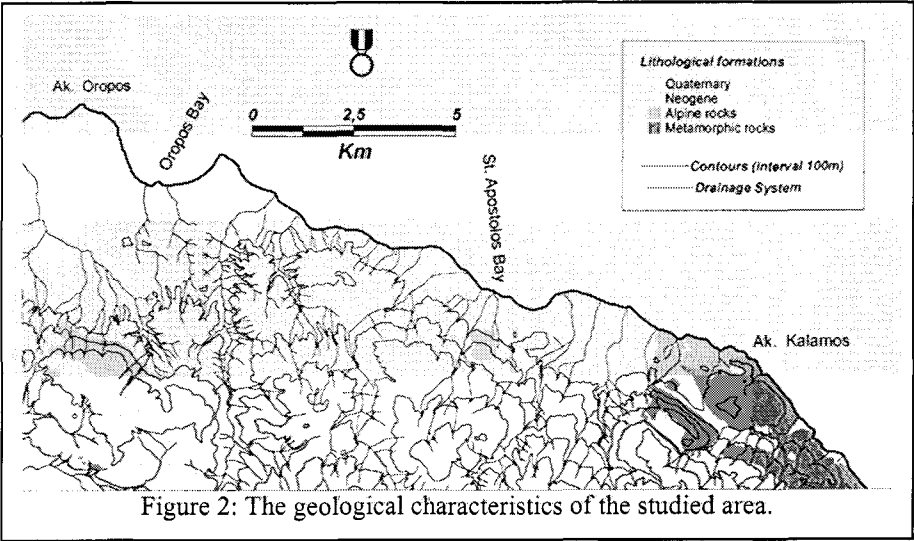


Figure 2: The geological characteristics of the studied area.

The morphology of this coastal area is the result of the neotectonic activity mainly characterized by successive normal faults, approximately East - West orientations and the denudation processes, especially in that part where the neogene and quaternary formations are dominant.

In genteral we distinguish three geomorphological units in this area:

- A flat coastal zone with quaternary sediments
- An intermediate zone of low to medium slopes with neogene formation.
- A hilly zone of medium to high slopes with alpine rocks (mainly limestones).

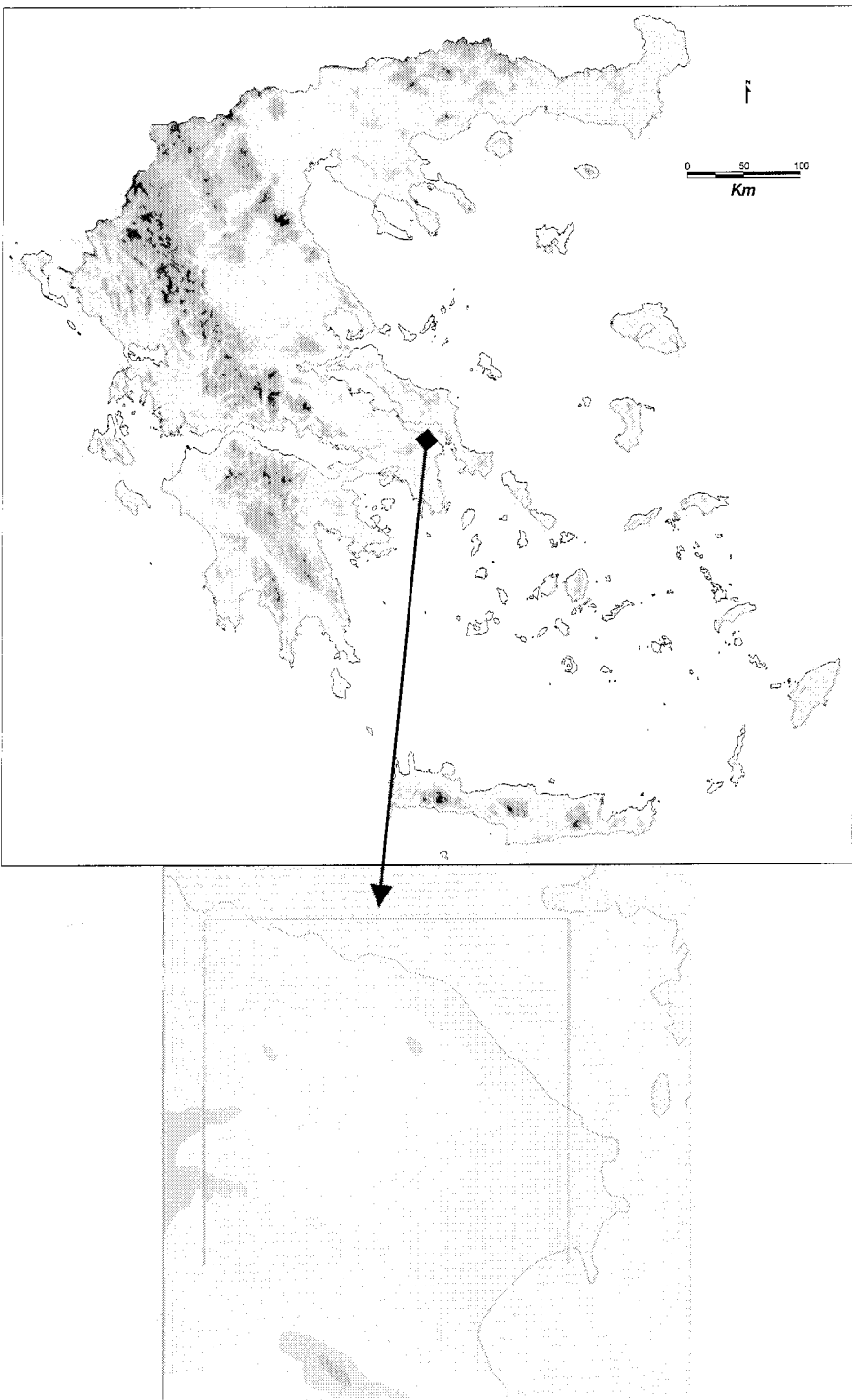


Figure 1: The studied area.

3 Erosional processes of the Oropos coastal zone

A G.I.S. based technology is adopted in this study and the various steps of this procedure are shown in the flow diagram of figure 3:

- Data collection by many field trips, literature, existing topographical and geological maps, aerial and satellite photos.
- Data analysis and creation of different thematic maps.
- Establishing fuzzy logical rules to transform input data to the output map.
- Evaluation of the final output map using new data sets.

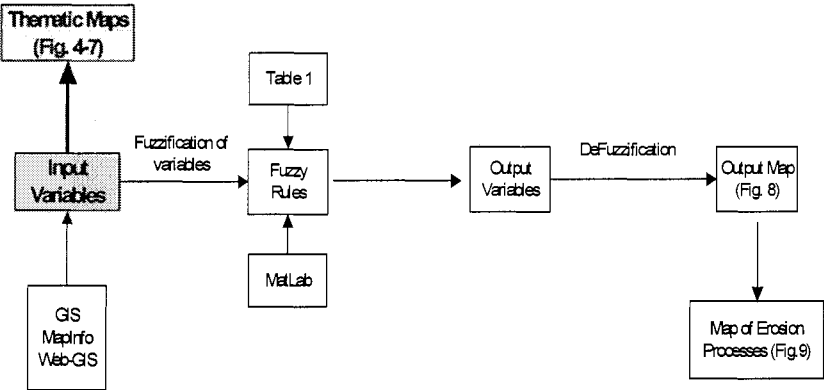


Figure 3: The steps of the followed procedure.

The internet-based G.I.S. environment provides multiple information exchange of these geomorphological and environmental problems.

The software tools which we have used are the MapInfo 6.5 version, MapXtreme web platform and for the fuzzy calculations the Mat-Lab version 2000.

The input variable of this model are the erodibility, the slope gradient, the drainage density and the vegetation cover partially modified by the fire event (Fig. 4, 5, 6, 7). We treat these as fuzzy variables (Zadeh, 1965; Zadeh, 1987; Yager *et al.*, 1987; Dubois & Prade, 1980; Zimmermann, 1991; Klir & Yuan, 1995) as a more realistic approach to overcome boundary and spatial imprecision problems.

For these reasons simple triangular membership functions are used. For example four degrees of rock's erodibility are adopted: 'Low', 'Medium', 'High' and 'Very High'. The same gradation has been used for all the input variables but the variable related to vegetation cover, 'Burned area', which is considered as a non-fuzzy binary variable. The next step was the formulation of the proper

logical rules (Table 1) to transform input variables to an output one (erosion risk areas). The output variable was the erosion risk index (Fig. 8).

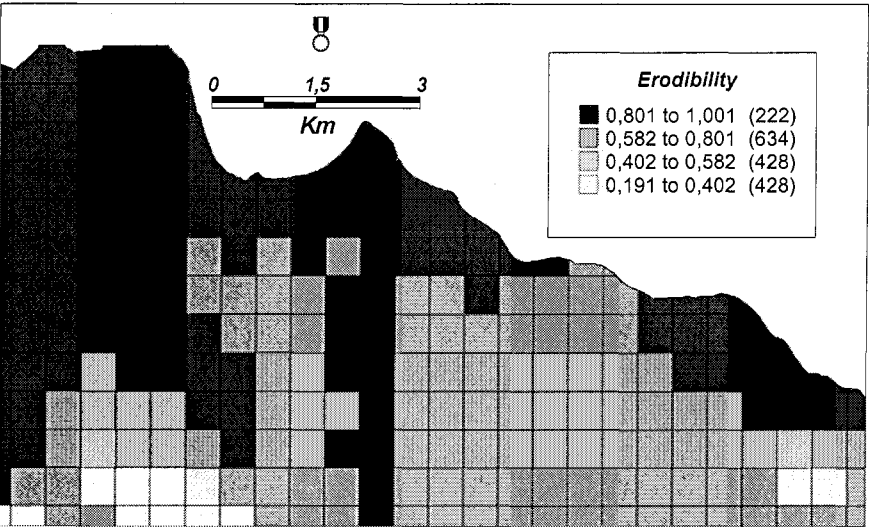


Figure 4: Distribution of Erodibility factor in the studied area.

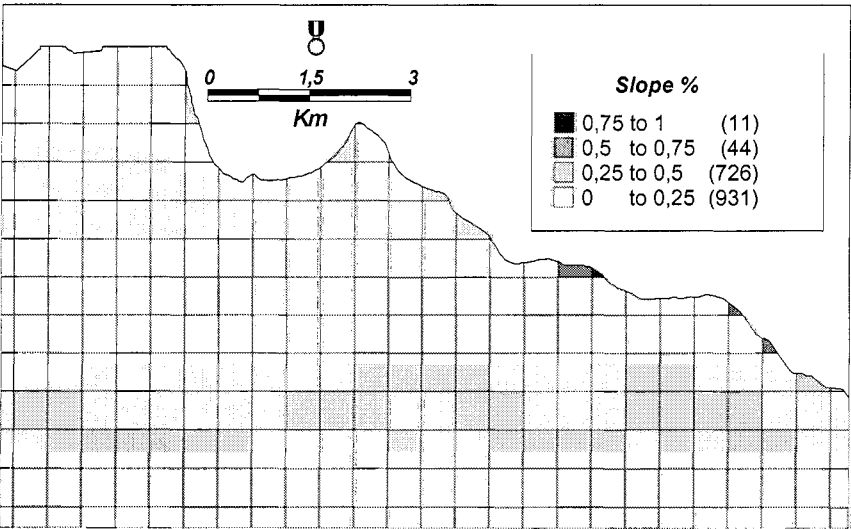


Figure 5: Slope gradient factor distribution in the studied area.

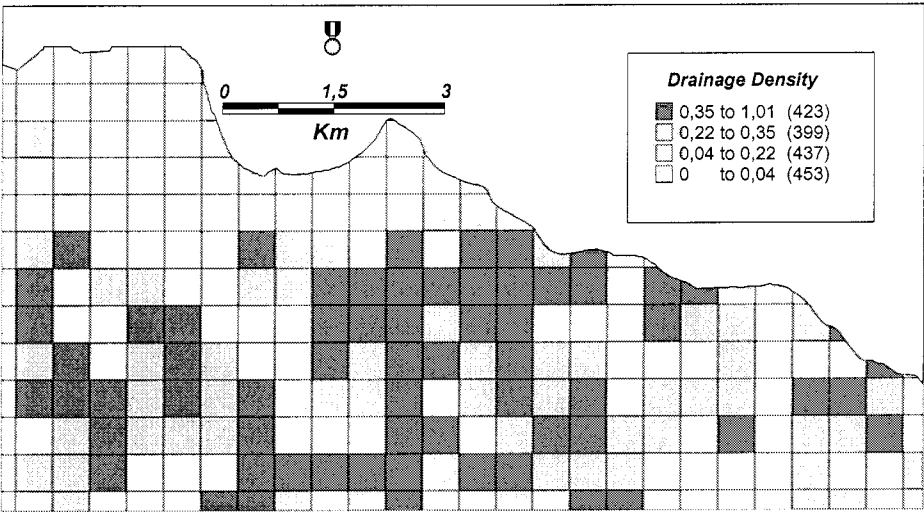


Figure 6: Distribution of Drainage Density factor in the studied area

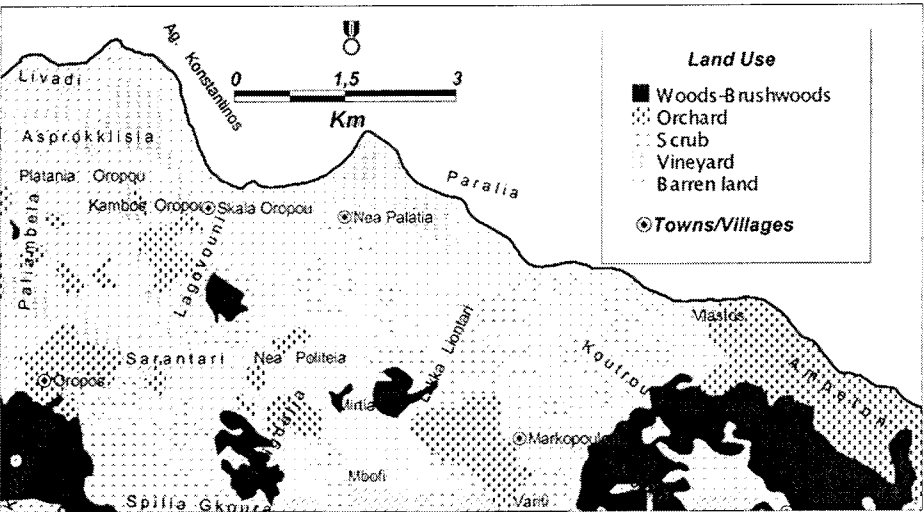


Figure 7: Land use distribution in the studied area

Table 1									
If	Erodibility	Is Very High	&	Area is burned	&		&	→	Erosion Risk Very High
If	Erodibility	Is High	&	Area is burned	&	Slope is Medium	&	→	Erosion Risk Very High
If	Erodibility	Is Medium	&	Area is burned	&	Slope is High	&	→	Erosion Risk High
If	Erodibility	Is Medium	&	Area is not burned	&		&	→	Erosion Risk Medium
If	Erodibility	Is Low	&	Area is burned	&	Slope is High	&	→	Erosion Risk Medium
If	Erodibility	Is Low	&	Area is burned	&	Slope is Medium	&	→	Erosion Risk Low
If	Erodibility	Is Low	&	Area is burned	&	Slope is Low	&	→	Erosion Risk Very Low

The heavy rainfall event of the November 2001 (about 200mm in 48 hours) and the mapping of the erosional - depositional processes (Fig. 9) have provided real data sets to the proposed model. It is obvious that the areas of high erosion risk delineated by theoretical work have been confirmed by field observation.

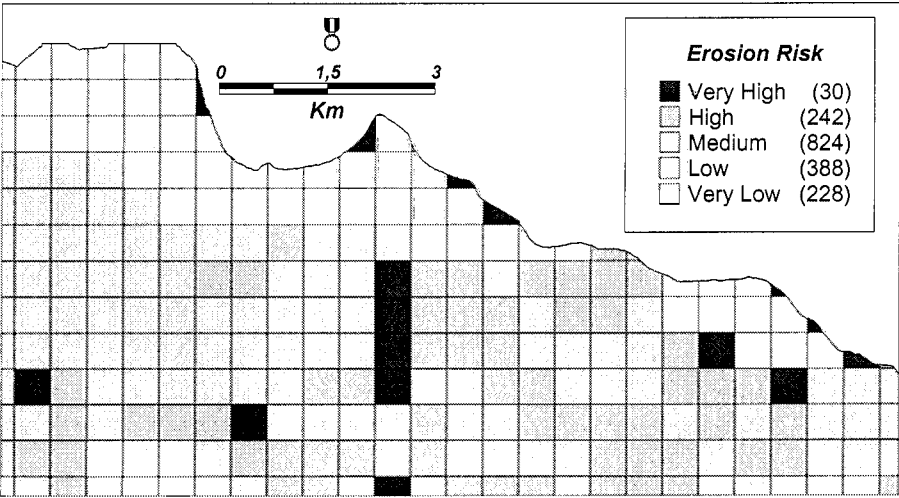


Figure 8: Map of Erosion Risk distribution in Oropos area.

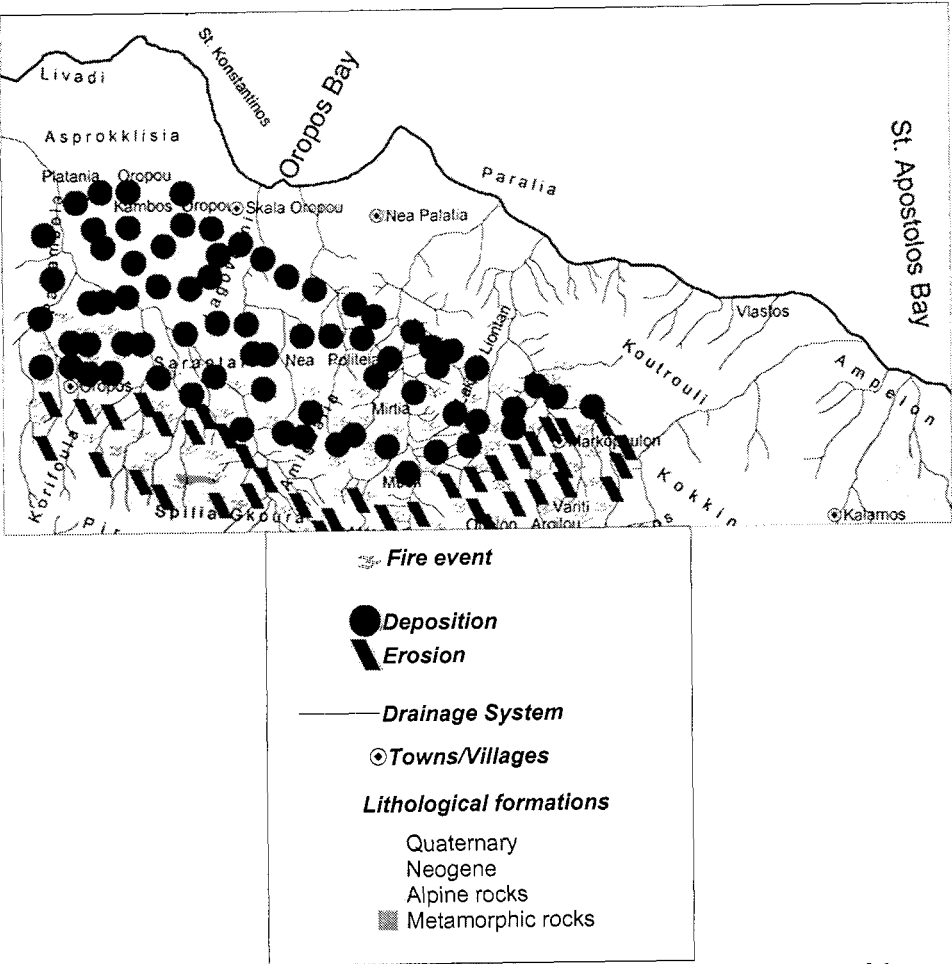


Figure 9: Map of the dominant erosional processes after the rainfall event of the November 2001

4 Conclusions

Erosion risk map have been constructed in a GIS web framework using fuzzy set theory. This relatively simple model demands only a few variables and the formulation of the proper transforming rules. The final output map shows the erosion risk index. New data from this area have confirmed the proposed model. This kind of approach to erosional processes is very important for local planning and environmental protection.

5 References

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