A DRAINAGE BASIN ANALYSIS USING GIS TECHNOLOGY TO EVALUATE NATURAL HAZARDS

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ABSTRACT:

The aim of this paper is to deduce possible natural hazards, by studying the geological, geomorphological and hydrological variables using G.I.S. techniques.

As a case study we used the drainage basin of the city of Korinthos, where a catastrophic event has already occurred. This area consists mainly of marine and lacustrine deposits of Pliocene and quaternary age. These sediments consist principally of marls, sandstones and conglomerates, which are characterized by high degree of vulnerability.

The topography of the basin has been studied by constructing a slope gradient map, indicating the 'critical slope ranges'. The basins characteristics were studied by digitizing the whole drainage system and obtaining a GIS-based database.

This spatial information, combined with temporal data (precipitation of Korinthos) was used as input, to obtain the final results concerning possible occurrences of natural hazards. This kind of analysis can be applied to different drainage basins and environments, and might be used for regional planning and forecasting purposes.

One of the most interesting methods of deducing natural hazard events, is to locate high risk areas where additional precautions must be planned. This paper uses all the relevant input data, such as geological, geomorphological and hydrological information of the area, in a digital format, and applies certain GIS-based algorithms to point out high risk zones. As a case study we used the drainage basin at the city of Korinthos.

The digitized drainage system and the outer limit of the studied basin, are printed at figure 1. The main lithologies of this area are Quaternary, Neogene, and Alpine Formations. The basin's lithological map is printed at figure 2. As we can see from the map, the south part of the basin has Alpine formation, while the middle and Northern part has Neogene and Quaternaty formations.

Another importand information layer, that is used to deduce the average % slopes, is that of contours. The contour interval printed at figure 1 is 50 meters. Using the basins perimeter as a boundary outline, we generated a grid of 500x500 meter squares, trimming the grid's cells at the edges of the boundary. Using a GIS-based algorithm, we calculated the average % relief slope of each cell. The mathematical model used at this algorithm is :

$$P = 100 * \frac{\Sigma L * i}{E} \quad \text{(equation A)}$$

,where ΣL is the summit of each contour's length included into the cell,
i is the contour interval,
E is the area included into the cell.

The slopes values were updated to the grid's table, and then processed to produce a color thematic map. For the classification purposes, we used the 'equal count' method, using 3 categories (low, middle and high slopes). Figure 3, visualises this classification with different colors for each class (low=blue, middle=grey, high=yellow).

In the present case the vulnerability of the rocks is represented by a 'low' and 'high' as different degrees of erodibility of the rocks. The 'low' represents the Quaternary and Neogen formations, while the 'high' represents the Alpine ones (figure 4).

The erosion risk of the basin was calculated ceperately for each cell of the the slope's grid. In order to calculate the erosion risk value, we applied the empirical Fuzzy rules (E.F.R.) of the following table, on the variables of vulnerability and slope.

E.F.R. (Empirical Fuzzy Rules)

If	Vulnerability	Is High	*And*	Slope	Is	Med/High	*Then*	Erosion Is	Very High
If	Vulnerability	Is High	*And*	Slope	Is	Low	*Then*	Erosion Is	High
If	Vulnerability	Is Low	*And*	Slope	Is	Med/High	*Then*	Erosion Is	Medium
If	Vulnerability	Is Low	*And*	Slope	Is	Low	*Then*	Erosion Is	Low

The four erosion risk values were updated to the grid, and the 'individual value' thematic map of figure 5 was produced. The red cells (28%) represent 'very high' values, the blue ones (27%) 'high' values, the green (38%) 'medium' values and the yellow cells (7%) represent 'low' values of erosion risk.

The GIS methodology described above, automaticaly calculates the erosion risk factor, and assignes these values to the cells of a generated grid. Using the same methodology, we can study other areas using even smaller grid cells, or producing more erosion risk categories.

References:

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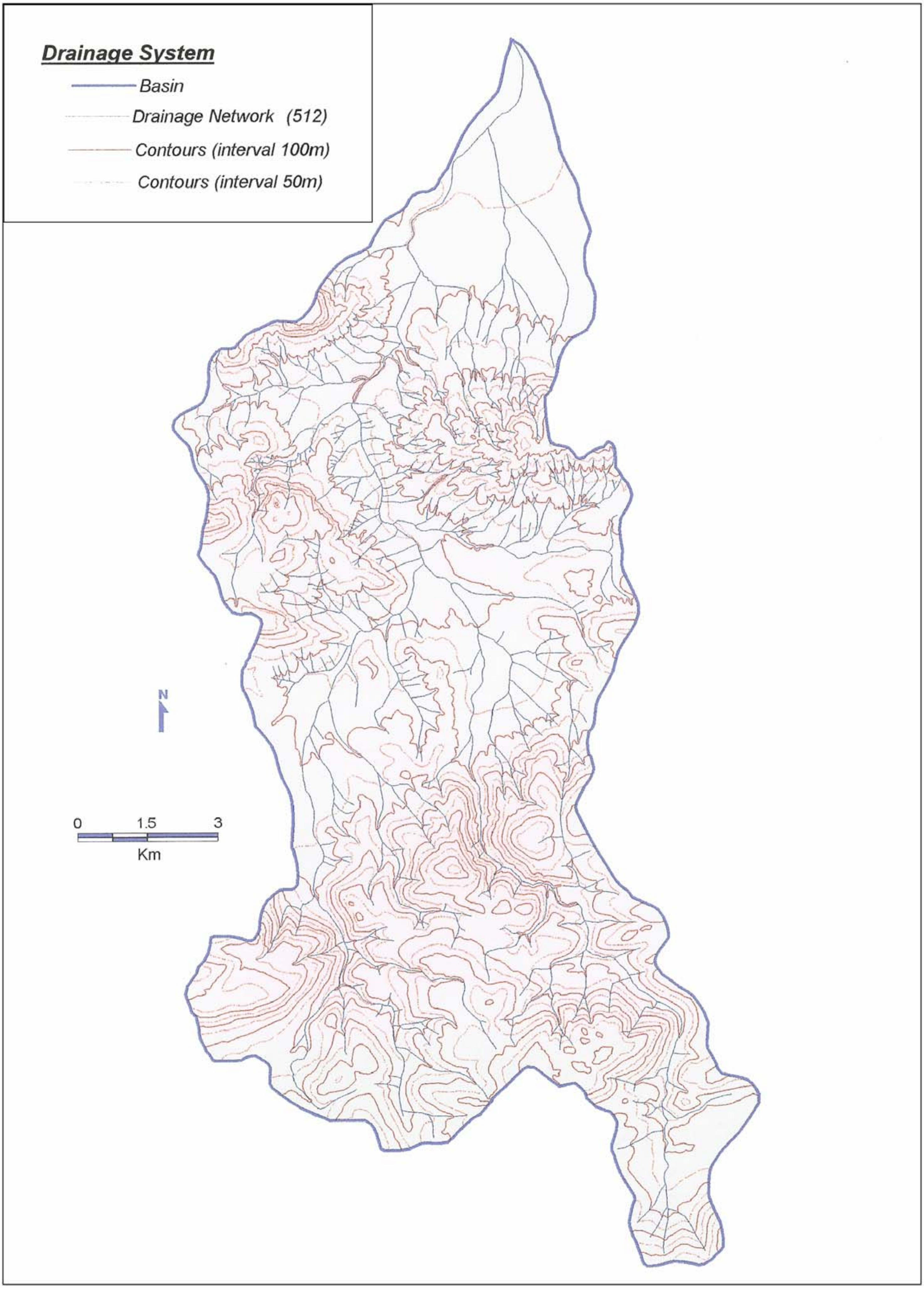
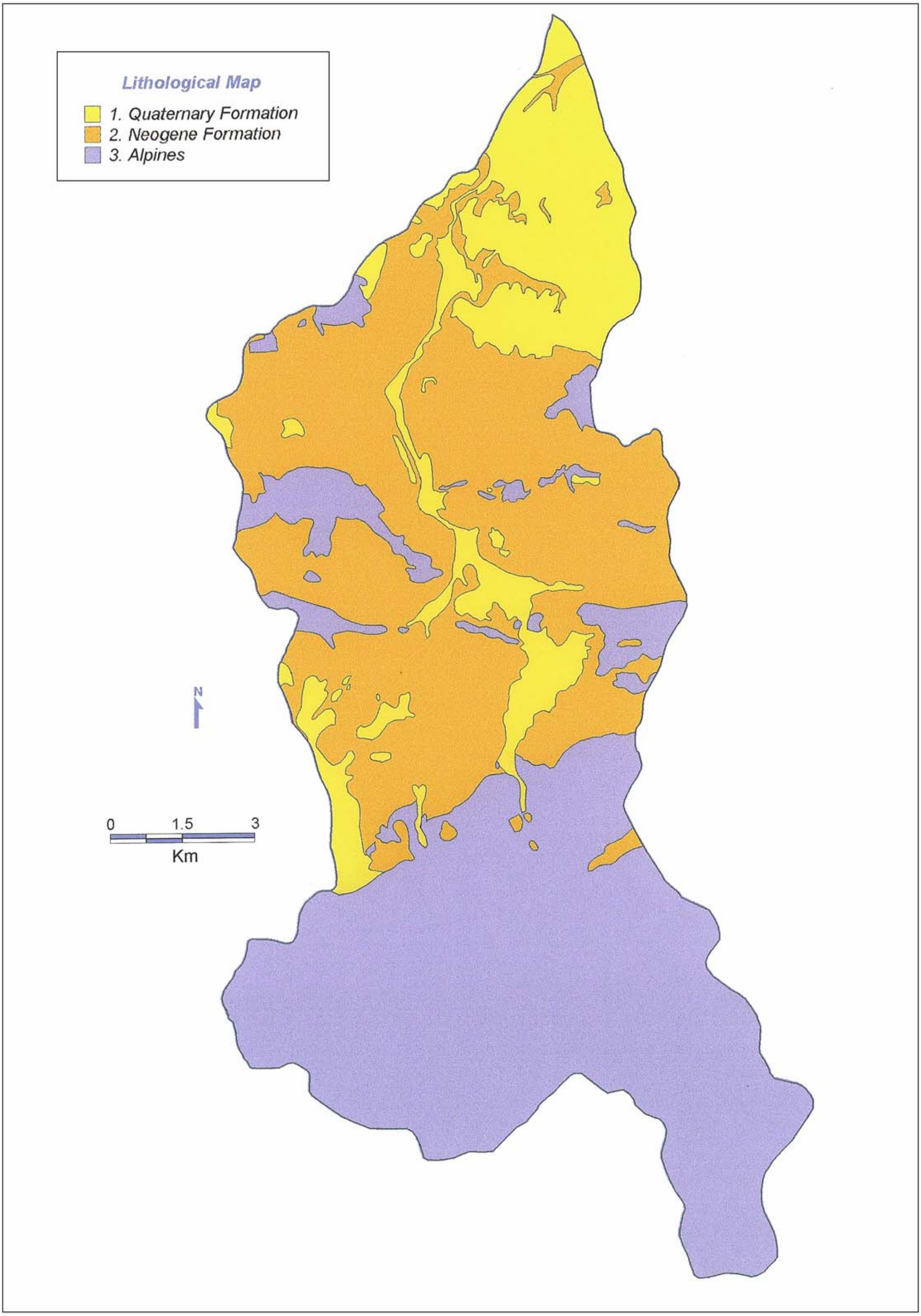
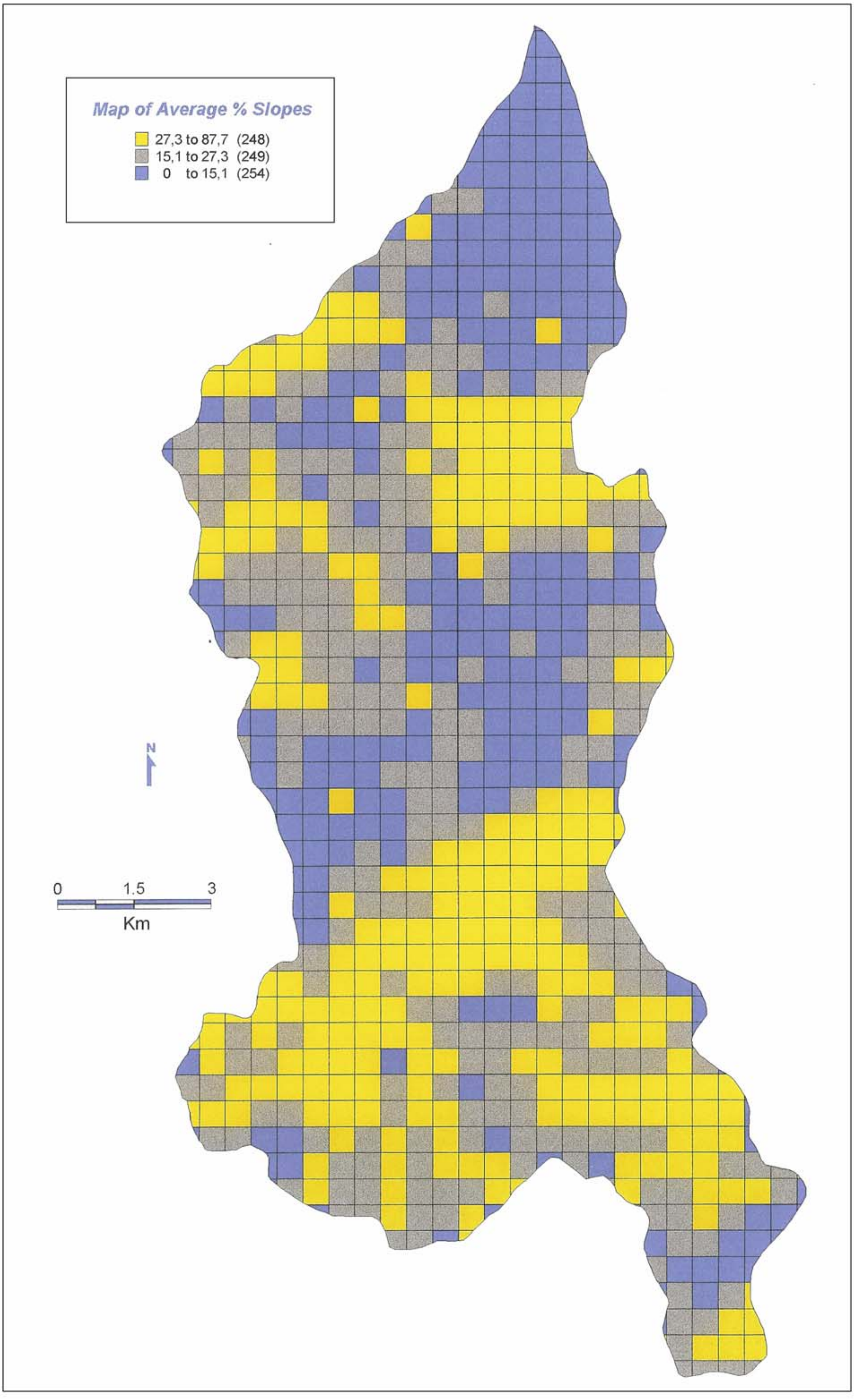
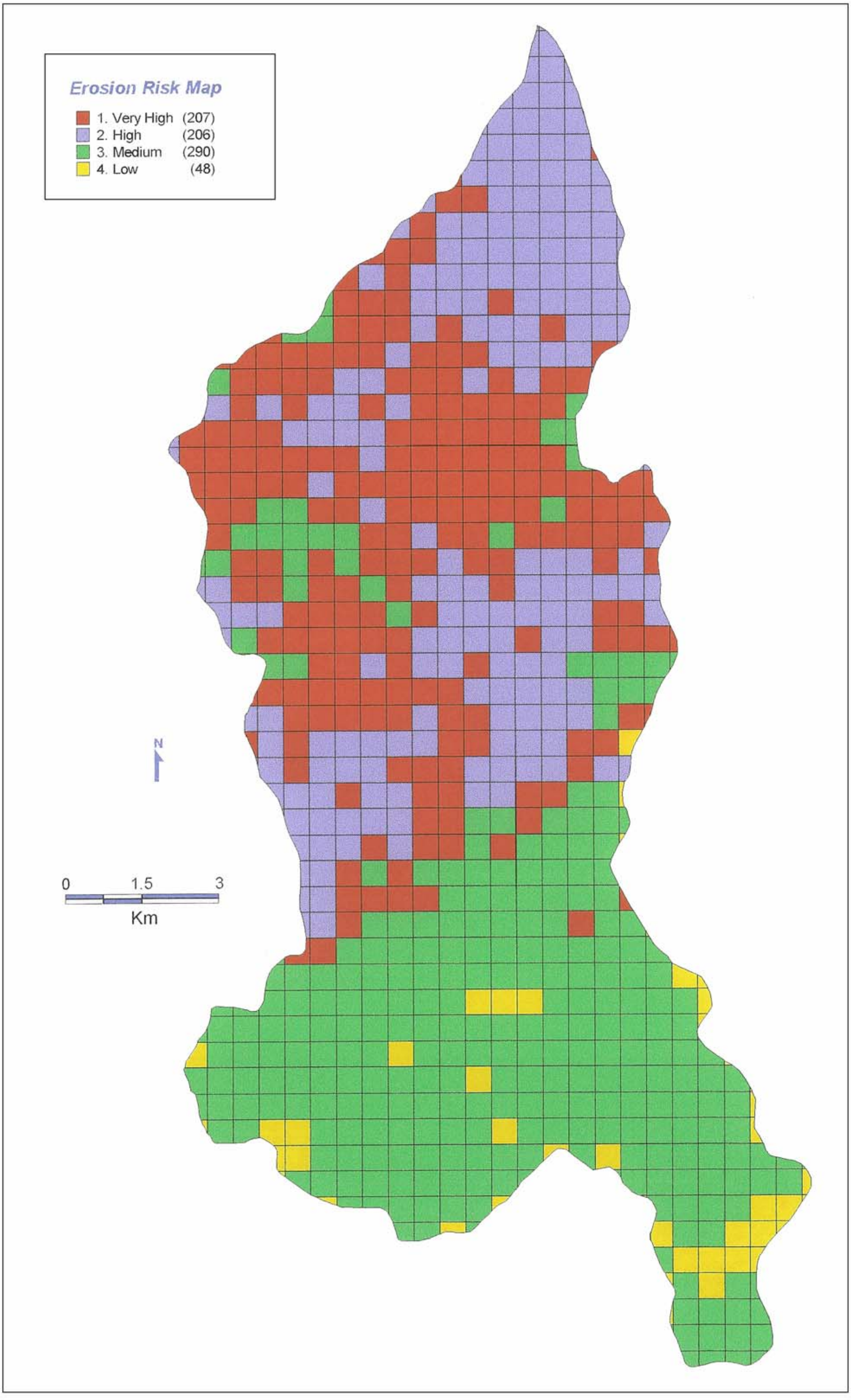
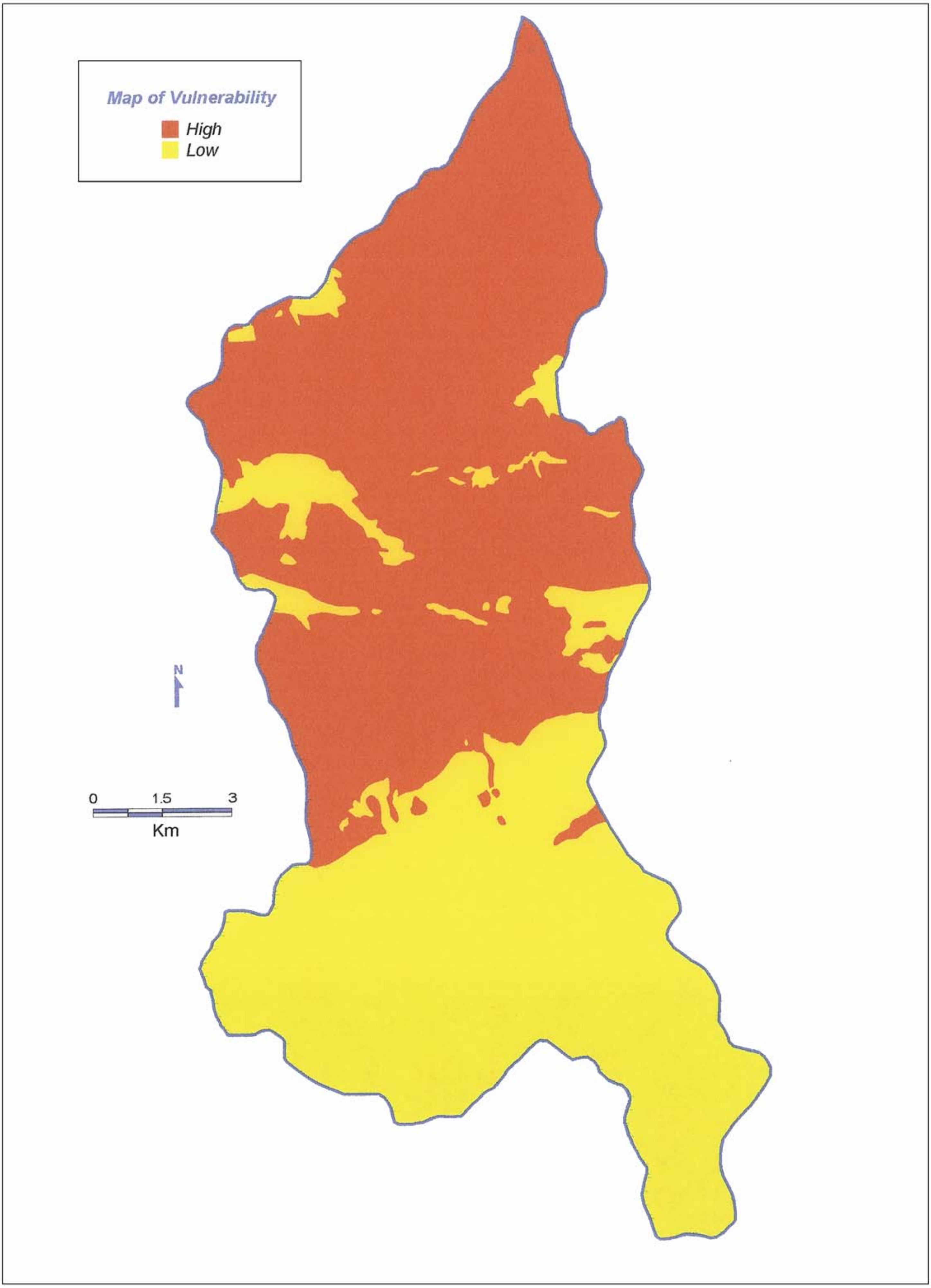

Drainage System
Basin
Drainage Network (512)
Contours (interval 100m)
Contours (interval 50m)
N
0
1.5
3
Km


Lithological Map
1. Quaternary Formation
2. Neogene Formation
3. Alpines
N
0
1.5
3
Km



Map of Average % Slopes
27,3 to 87,7 (248)
15,1 to 27,3 (249)
0 to 15,1 (254)
N
0
1.5
3
Km


Erosion Risk Map
1. Very High (207)
2. High (206)
3. Medium (290)
4. Low (48)
N
0
1.5
3
Km


Map of Vulnerability
High
Low
N
0
1.5
3
Km