Coupling of Remote Sensing Methods and hydrological data processing for evaluating the changes of Maliakos Gulf coastline (Greece), in the wider area of Sperchios River basin.

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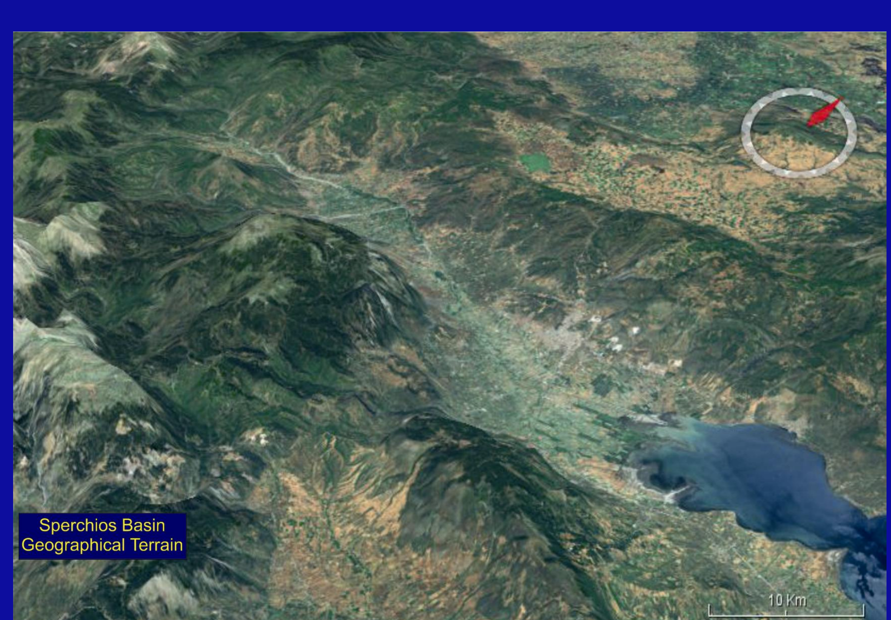
Abstract

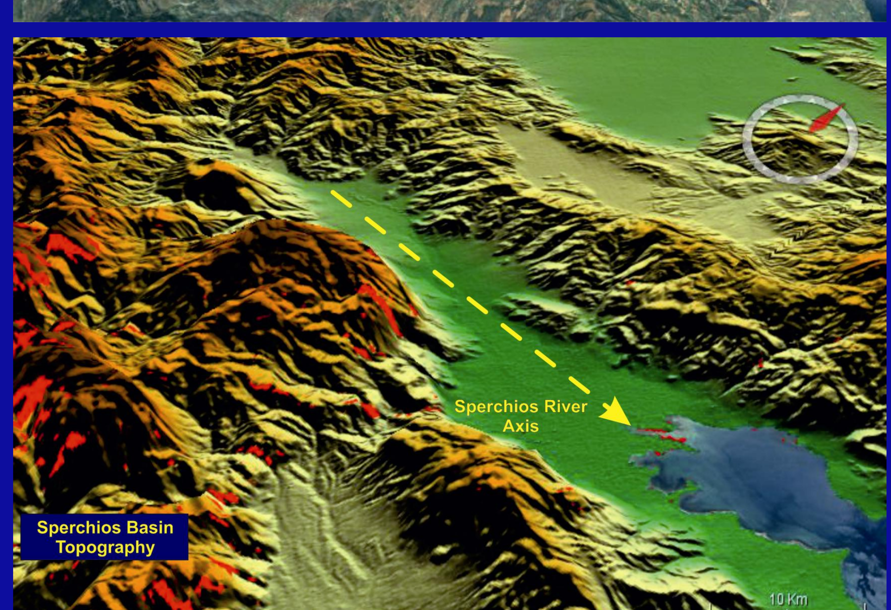
Sperchios river basin covers an area of 2116 km^2, with an average altitude of approximately 810 m, while the river is recharged by many streams of permanent and periodic flow. The high gradients which are present within approximately 2/3 of the total length of the river course form a rather mountainous topography -streamy, with crucial flooding peaks and very intense sediment loads yield-. On the contrary, within the last downstream part of its course, the river is transformed gradually into a lowland relief, where cases of severe flooding have been observed and reported. The deltaic alluvial part of the valley covers an area of approximately 200 km2 with a highly increasing formation rate during the last 150-200 years; estimated at 130 acres annually. The aim of this research is the monitoring and assessment of coastline changes within the coastal deltaic part of a typical Mediterranean hydrological basin, by coupling remote sensing techniques with available hydrological and climate data

1. Introduction

The Basin of Sperchios River is located in the northern part of the water compartment in the east of Sterea Ellada . The average altitude is about 810 m (N. I. Kakavas, 1984). The river's basin average annual surface overflow is 693 hm^3 (D. Koutsogiannis, 2003). The flow path of Sperchios river is about 82,5 km, flows from the eastern sides of Timfristos mountain and discharges in Maliakos gulf. The river's embouchure, is ``Natura`` protected areas (D. Koutsogiannis, 2003).

The area of the study is delimited from south and southwest by the old (natural) river's riverbed and in the north by the new riverbed which was created after the partial diversion of the river. From the east, part of the western coastline of Maliakos gulf constitutes the natural border of the area of interest.

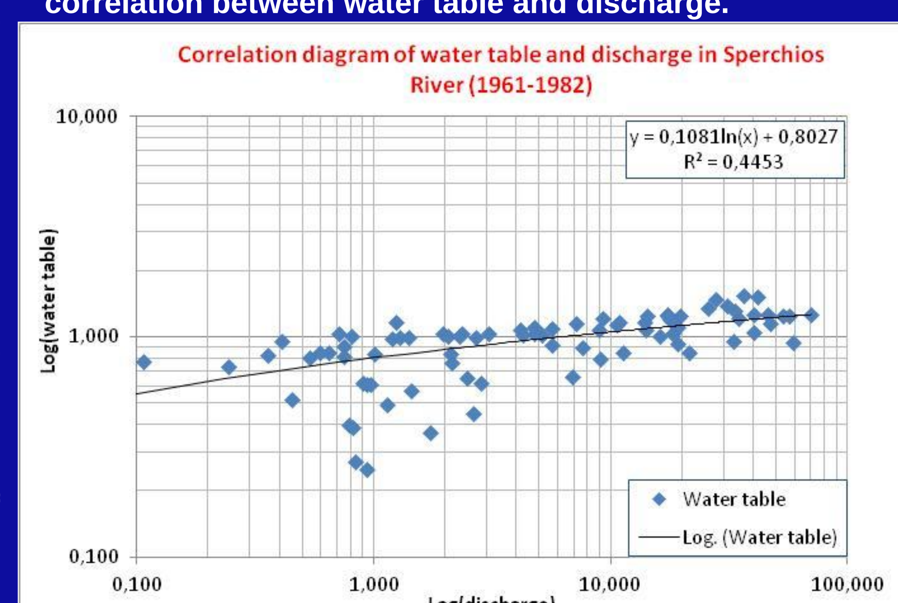


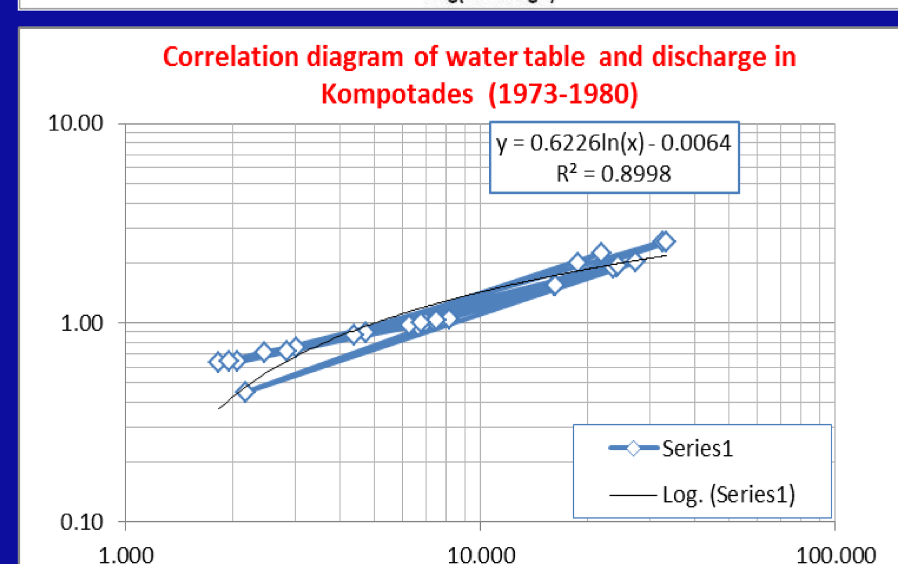


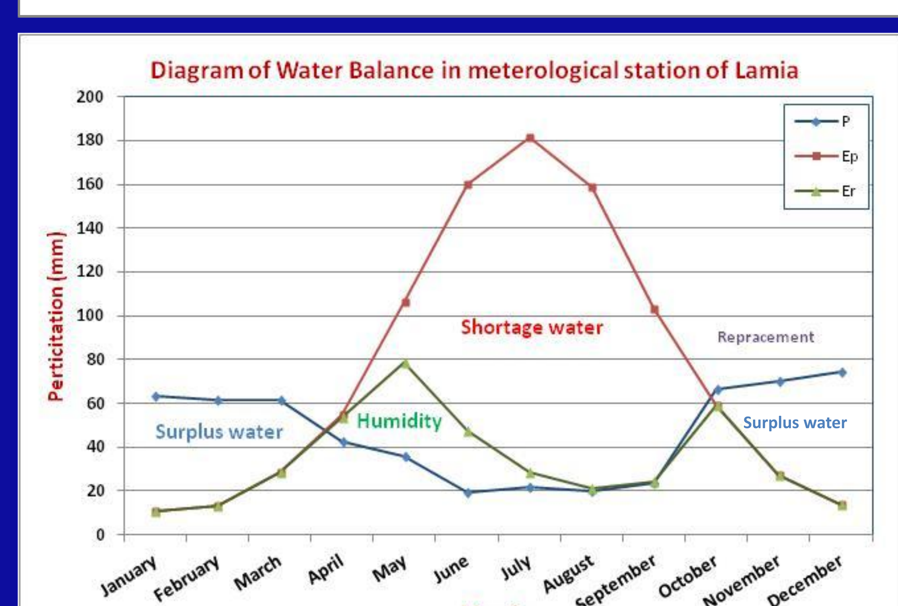
2. Hydrometeorological data

The climate ranges from dry to semi-humid. The average temperature is 16,8 °C in Lamia. The rainfall distribution at all stations is normal. The analysis of meteorological data showed decrease of rainfall (about 4 mm/yr) and run off (3 mm/yr).

The annual rain fall in the area, is about 893 mm/year. In Lamia meteorological station ,in the east coastal part of the area, the average precipitation is about 561 mm. The total amount of evaporation is high in about 72%, the infiltration and the surface run off is 28%. There is strong correlation between water table and discharge.



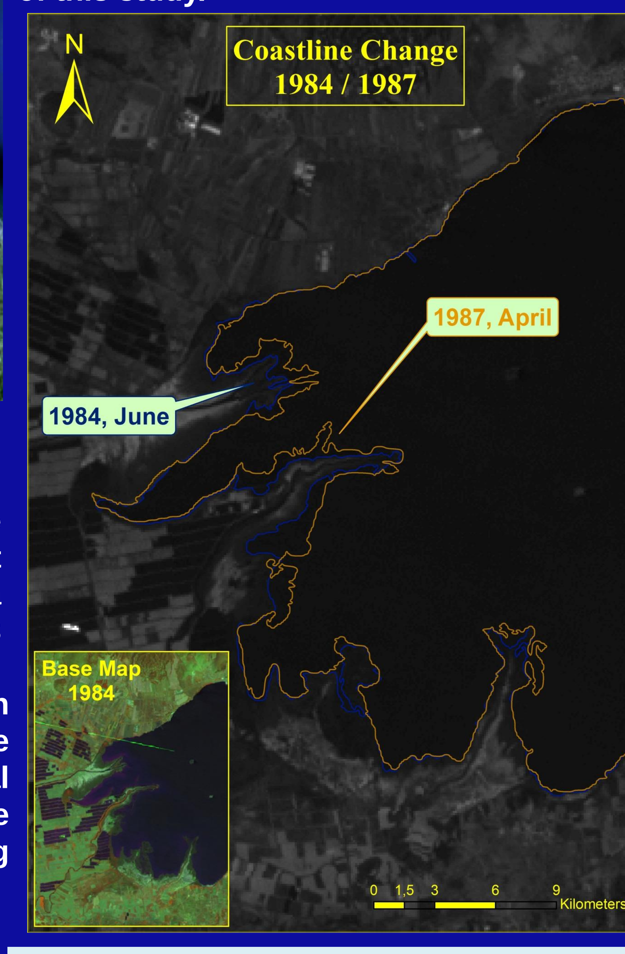


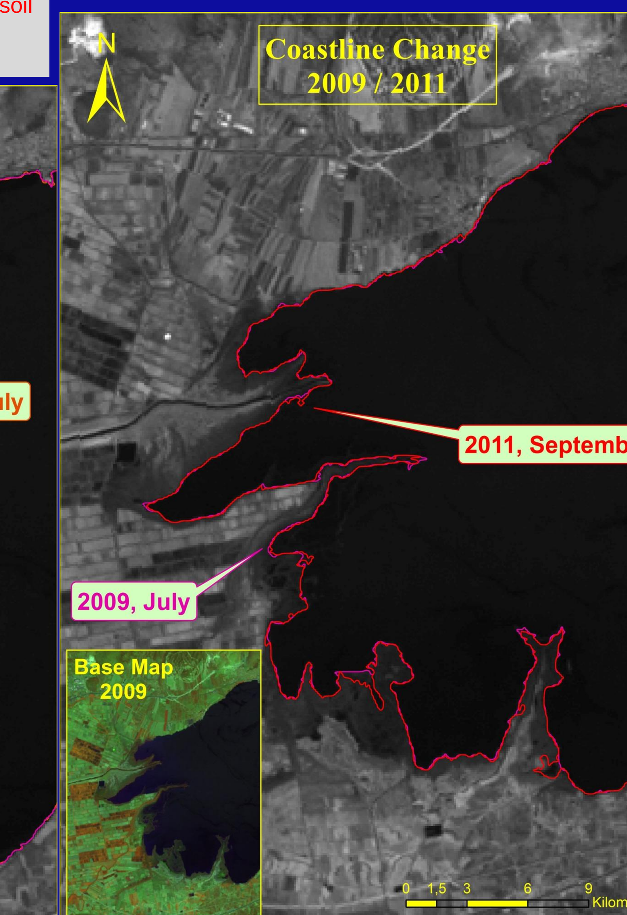


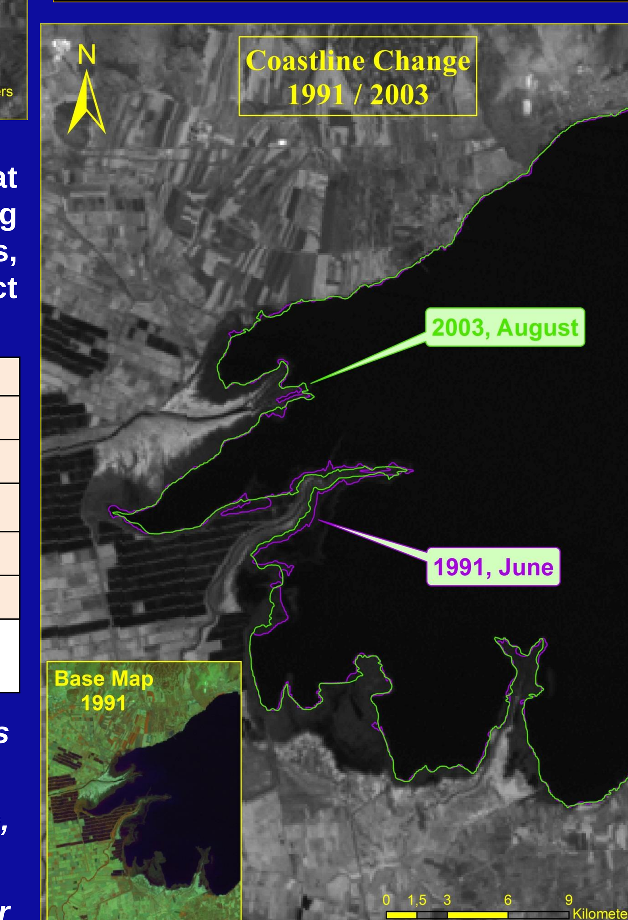
3. Remote sensing data

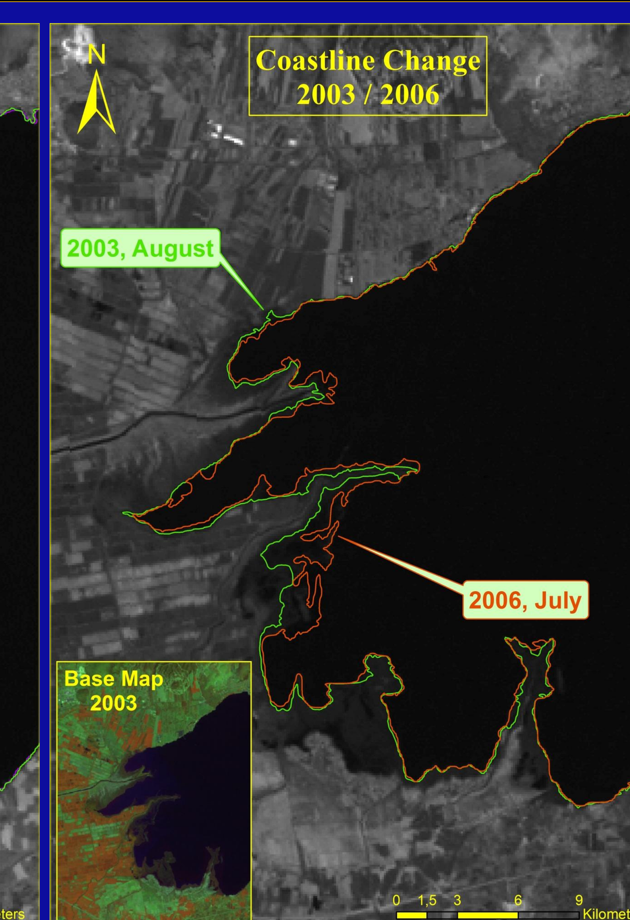
Remotely sensed data are widely used for land cover and/or coastline change detections. In this study, multitemporal Landsat images were the main source of information. A 30 year time series of the Landsat images from past archives were obtained and interpreted. Classification of the various land cover types within the area of interest and the subsequent delineation of the coastline was performed using unsupervised classification techniques. High resolution (approximately 0.5m) ortho-photos available through the WMS service of the Greek Cadastral Agency have been also used to acquire information and verify the results obtained from the analysis of Landsat data. The available ortho-photos were linked with a GIS system, acting as basemaps on which several data were overlaid in order to identify changes. The results were proved satisfactory in terms of effectively projecting and evaluating relevant observed coastline and land cover changes and trends. The analysis and interpration of satellite images was performed using a combination of channels 4-5-3 by the professional version of TNT mips editor. Coastline and land cover changes was the main subject of this study.

Red (TM 4): Due to strong absorption by chlorophyll, green vegetation appears darker than in the other visible light bands. The strength of this absorption can be used to differentiate different plant types. The red band is important in determining soil color, and for identifying reddish, iron-stained rocks that are often associated with ore deposits. **Green (TM 5): Includes the peak visible light reflectance of green vegetation, thus helps assess plant vigor and differentiate green and yellowed vegetation.** **Blue (TM 3):** Provides maximum penetration of shallow water bodies. The brightness of the bare fields varies widely with moisture content.









4. Sediment load estimation

Sediment yield estimations are achieved mainly from simple empirical models that relate mean annual sediment yield (Sy in t/km^2) to catchment properties, including drainage area, topography, climate and vegetation characteristics. In some cases, catchment area (A in km^2) seems to be the only explanatory variable used to predict sediment yield. The relation between Sy and A is presented to table 1.

Literature	Equation	Sperchios
1.Dendy and Bolton (1976)	$Sy = 674A^{-0,16}$	1.Sy=197,96 tn/km^2
2.Avendano Salas et.al (1997)	$Sy = 4139A^{-0,43}$	2.Sy=153,79 tn/km^2
3.Webb and Griffiths (2001)	$Qs = 193A^{1,04}$	3.Qs=554745,26tn/yr
4.Lu et.al (2003)	$Sy = 849{,}15A^{-0,0785}$	4.Sy=465,51 tn/km^2
		5.Qs=24,22 tn/yr
5.Moulder and Syvitski (1996)	$\log(Qs) = 0{,}406\log(A) + 1{,}279\log(H\max) - 3{,}679$	

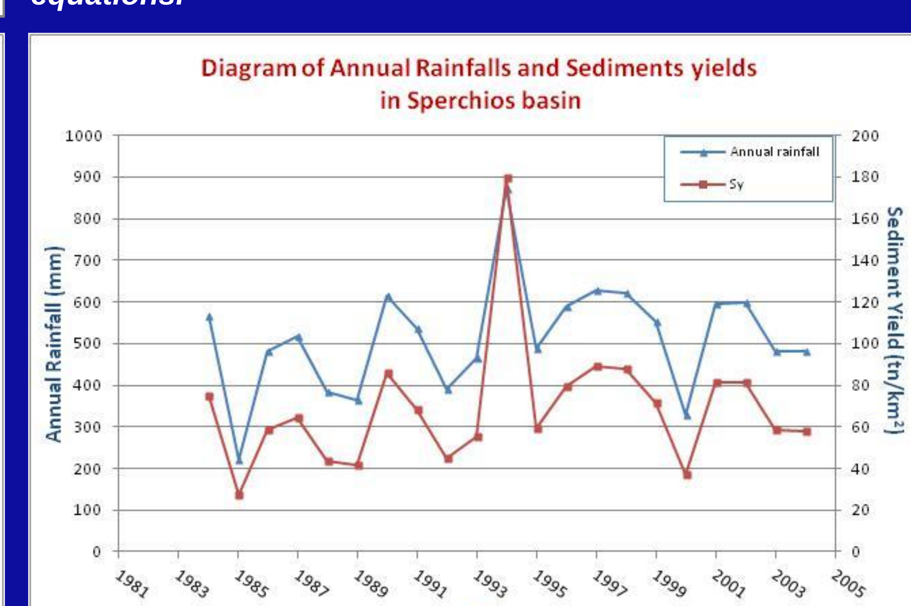
Different equations were applied due to estimate the sediment yield of Sperchios River basin. The results of these empirical models are:

Many are the factors , which influence the sediment load in this area: a)Surface, b)Lithology, c)Rainfall, d)Vegetation, e)Erosion due to climatic conditions

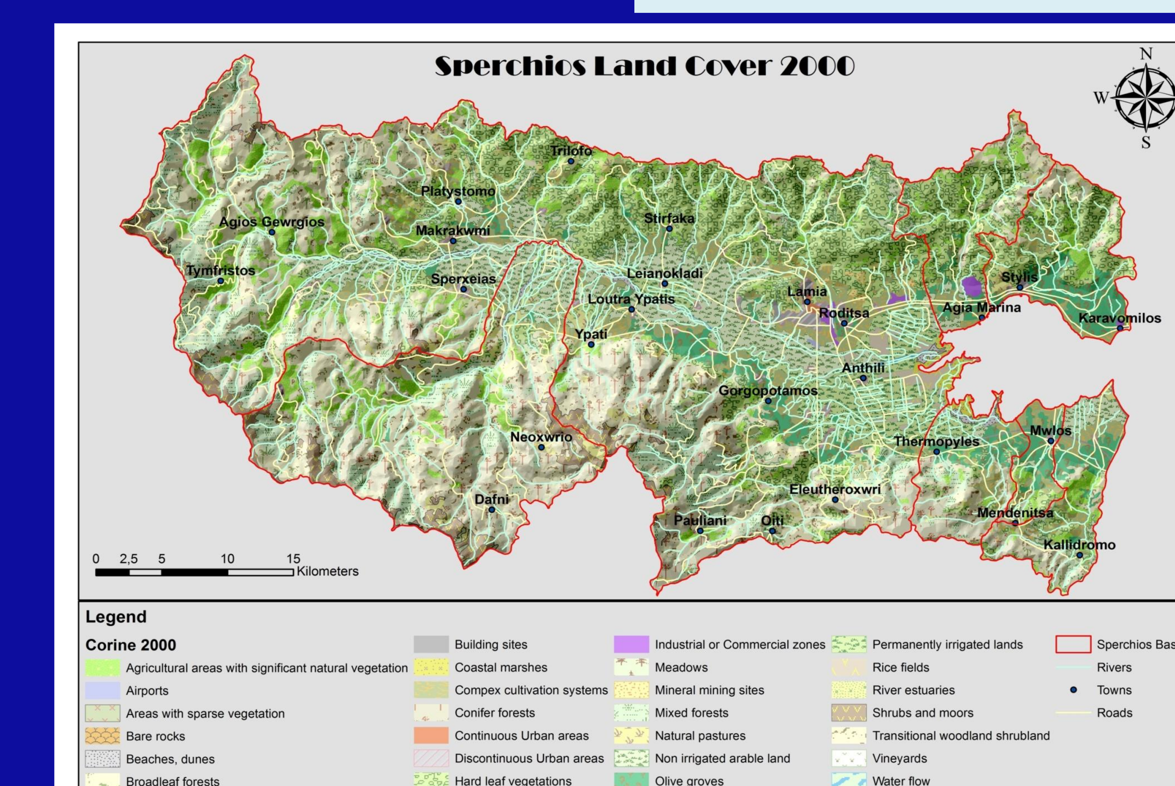
Koutsogiannis (et.al. 2003), has proposed two additional empirical equations, for estimating the sediment yield, considering all these factors.

$G=15*y*e^{3P}$	$G=14{,}4*e^{2,9P/1000}$

In the diagram below, it showed the fluctuation of annual rainfall and the sediment yield, regarding these two equations.



5. Land Cover data (Corine 2000-2006)



6. Conclusions

- *The coastline part in the area of the old riverbed , in deltaic part, in September of 2011 has moved towards inland, in comparison with June of 1984*
- *The coastline part in the area of the new diverted riverbed, in deltaic part, shows a small change, small accession towards sea, in September of 2011June of 1984.*
- *The coastline part, between the two riverbeds depicts a significant accession in September of 2011 compared to June of 1984.*
- *There are not metric stations in the area, for having a secure estimation for the sediment yield. The estimations are empirical.*
- *Remote sensing methods can help to evaluate this phenomenon and correlate all the parameters , which participate in this processing.*
- *All the hydrological parameters (run off, water table, discharge, meteorological data), are necessary for define the changes in the coastline and the changes in land use along the riverbed of Srerchios River.*

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