Soil erosion modelling in an agro-forested catchment of NE Spain affected by gullying using SWAT

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OUTLINE

1. INTRODUCTION

Soil erosion is a widespread problem in Mediterranean areas and is recognized as the major cause of land degradation.

Factors such as land use changes and intensive agricultural practices have triggered the erosion processes.

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1. INTRODUCTION

One of the main crops in the Mediterranean region are the <u>vineyards</u>, whose lands have undergone major morphological changes to facilitate land mechanization.

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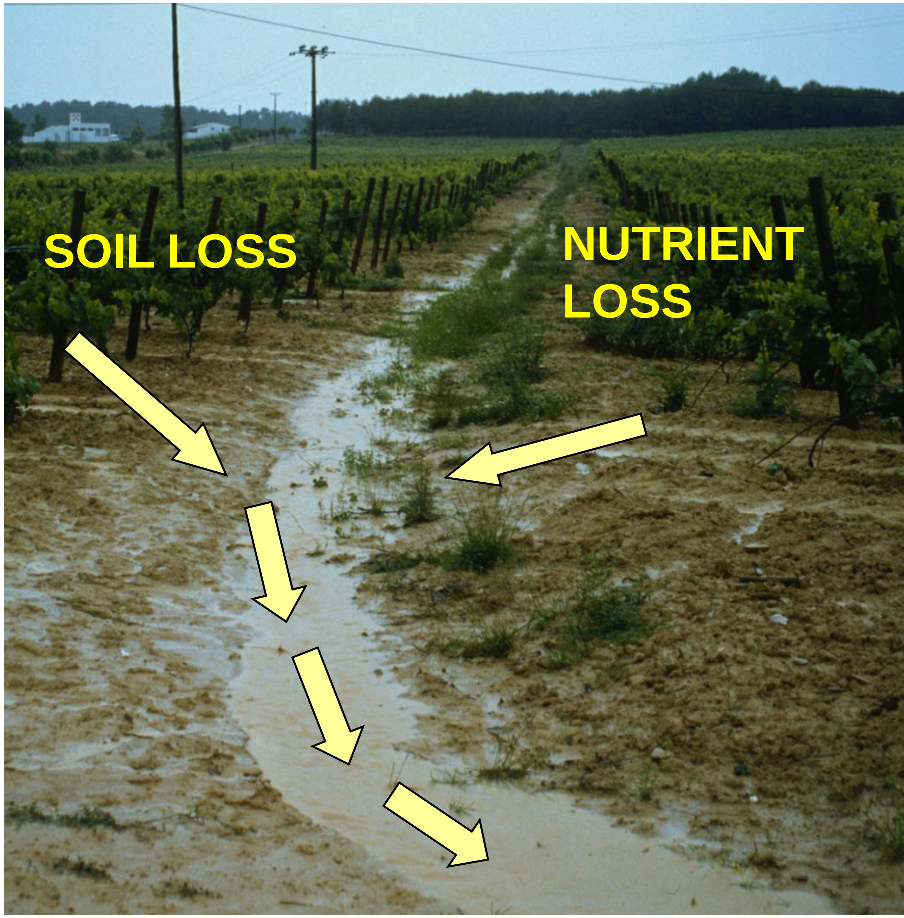
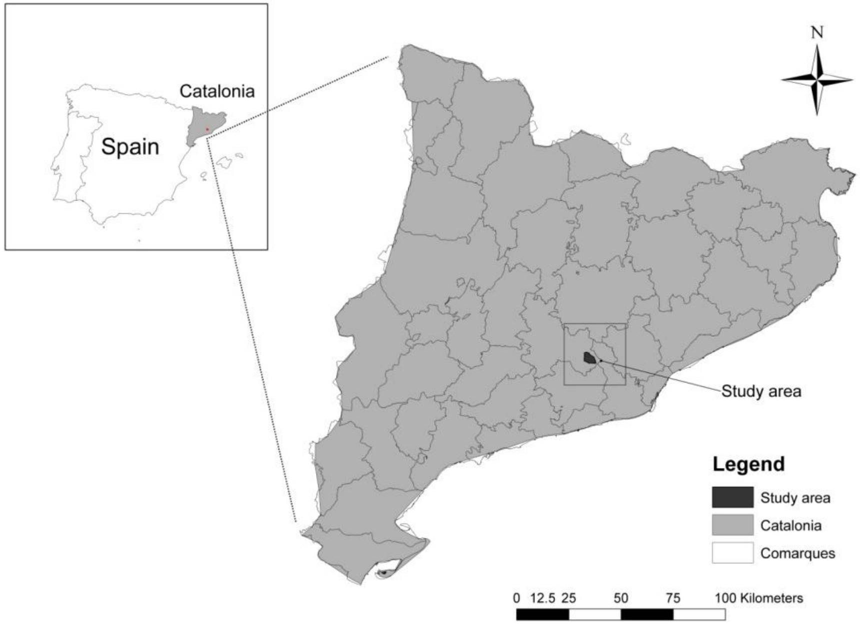
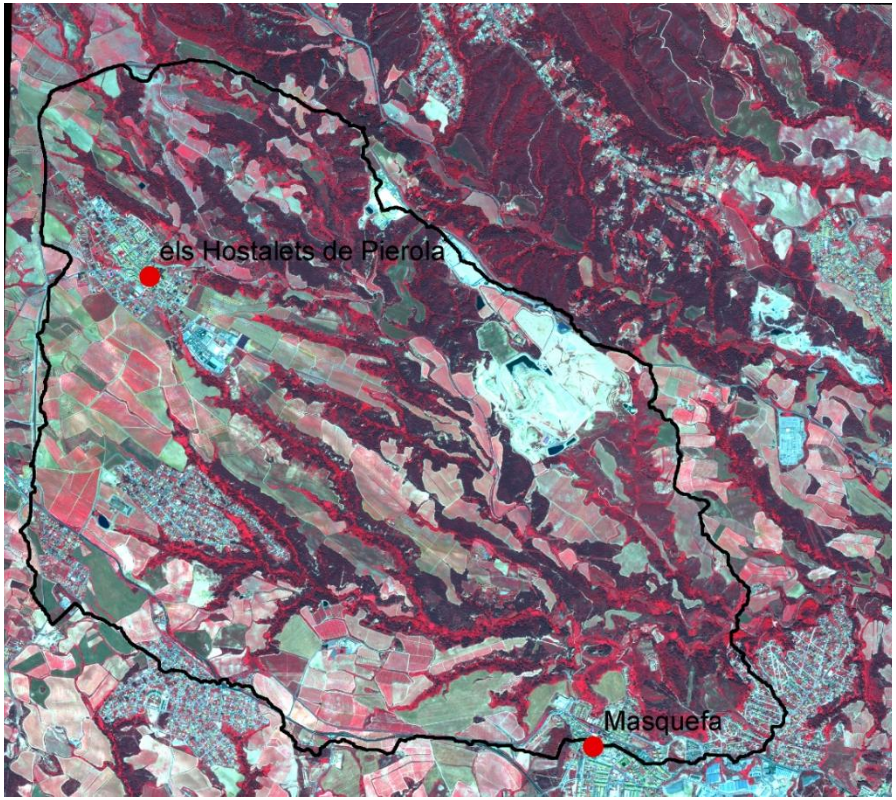
As a consequence, these land transformation operations have eliminated traditional soil conservation measures, increasing surface runoff and erosion.



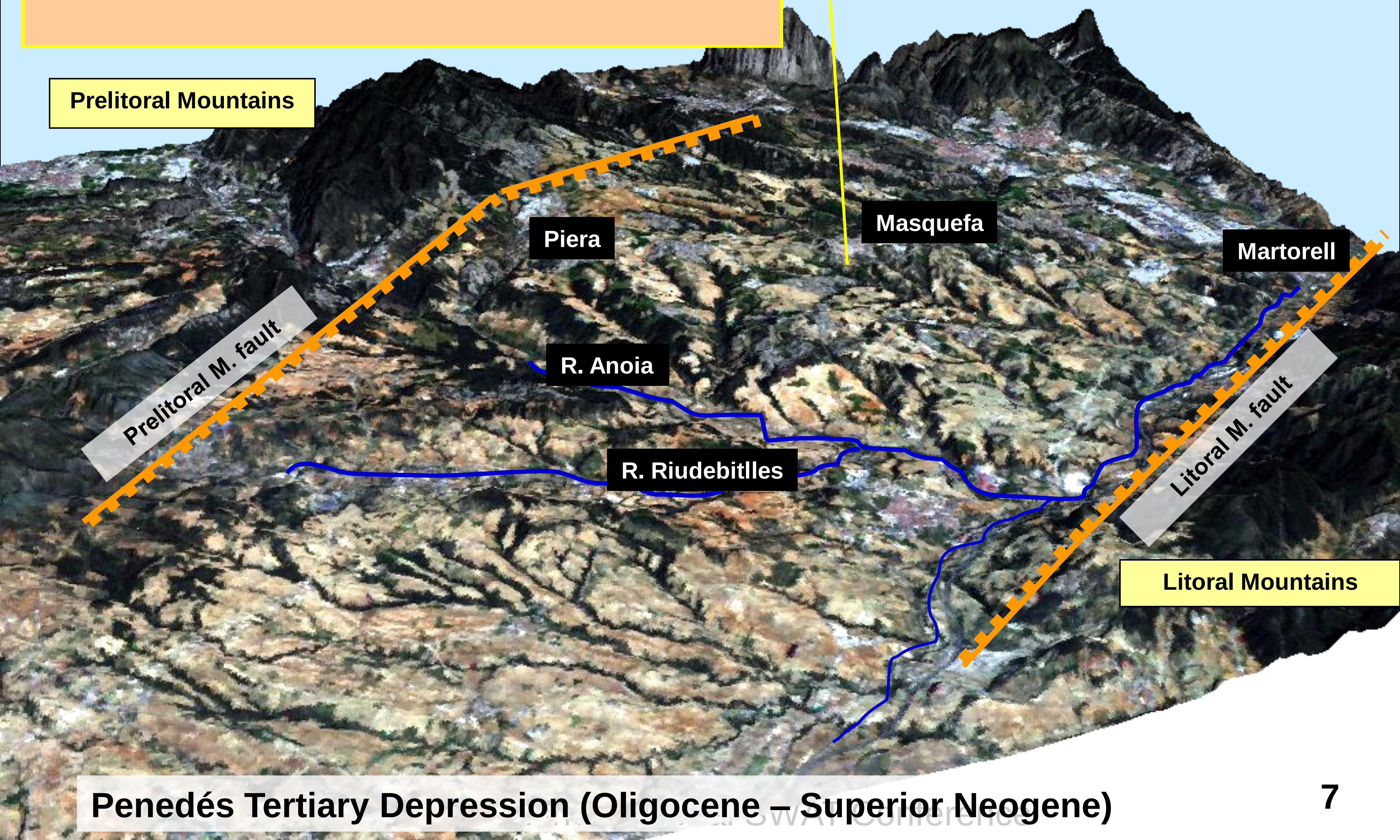
A particular example of these land characteristics and changes (that result in intensive erosion processes) is the region of Anoia-Penedès located in Catalonia (NE Spain).





1. INTRODUCTION

The area is located in the Penedés Tertiary Depression where unconsolidated and highly erodible marls outcrop



Penedés Tertiary Depression (Oligocene – Superior Neogene)

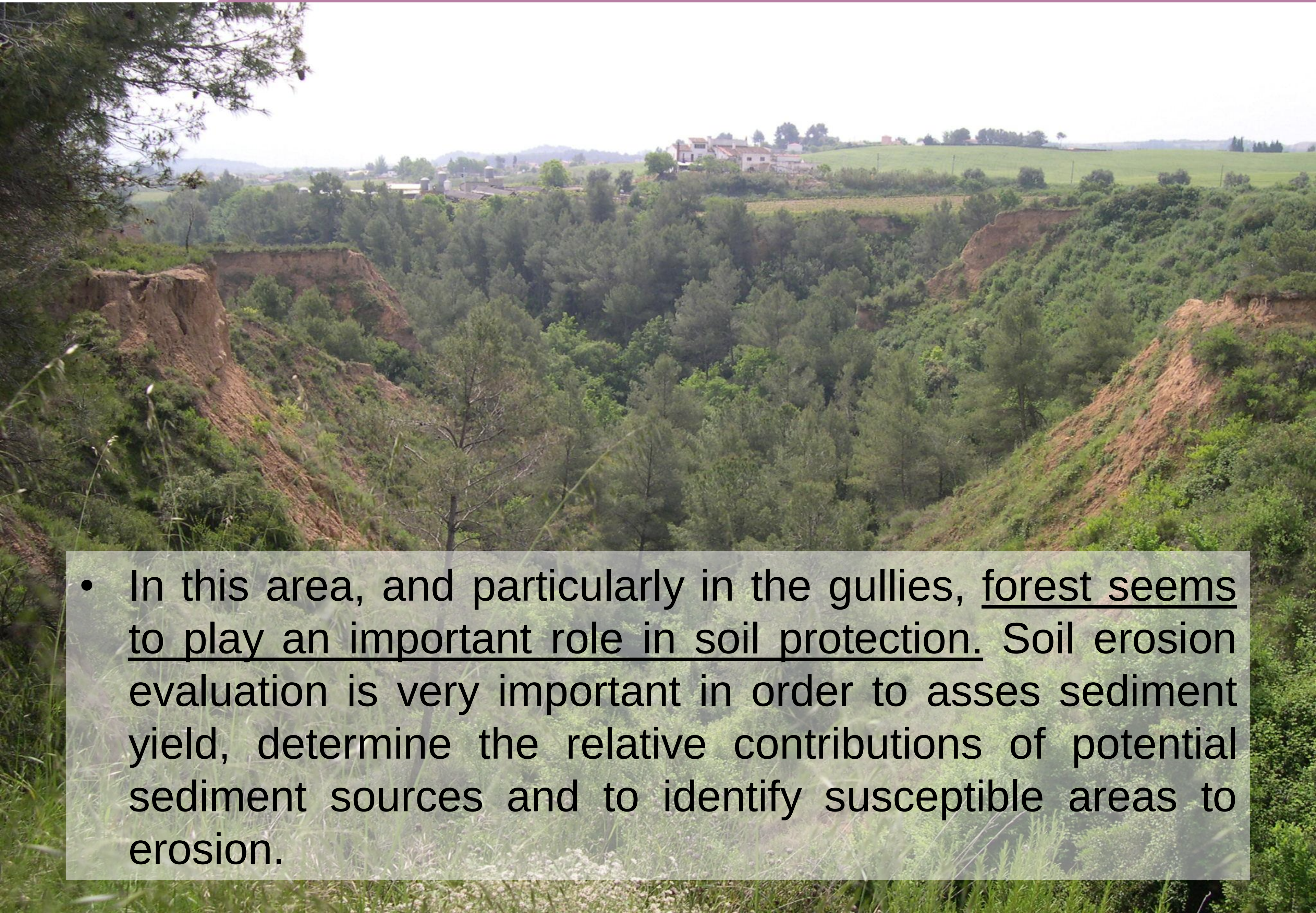
Problems in the study area:

- More extreme and frequent climatic events. The rainfall erosivity factor (R = kinetic energy x maximum intensity in 30-min period) ranges between 1049 and 1200 MJ mm ha^{-1} h^{-1} y^{-1} (Ramos 2002).

Problems in the study area:

- All these characteristics determine a high erosion, with the development of gullies and ravines that dissect the landscape.

1. INTRODUCTION



- In this area, and particularly in the gullies, forest seems to play an important role in soil protection. Soil erosion evaluation is very important in order to asses sediment yield, determine the relative contributions of potential sediment sources and to identify susceptible areas to erosion.

2. OBJECTIVE

- The aim of this work is to estimate soil erosion in an agro forested catchment using SWAT.

- In addition, the present work is a contribution to the application of SWAT in agro-forested areas at detailed scale, in a region where the development of gullies (mainly covered by forest) is an important erosion process.

- Here we present the first results of the study: Estimation of runoff and sediment yield of the different climatic years in the Penedès study area using SWAT.

Study area characteristics

- Total area: 2050 hectares
- Mean annual temperature: 15ºC
- Mean annual rainfall: 550 mm.
- Main land uses: Vineyards, cereals (winter barley) and gully areas covered by *Pinus halepensis*

3. METHODOLOGY

- We used the ArcSWAT 2009.93.5 version compatible with ArcGIS 9.3.

- Two selected years:
  - 2005 (dry year)

    365 mm: Precipitation below the average

  - 2010 (wet year)

  729,4 mm. Precipitation above the average

Input data:

- 5 m resolution Digital elevation model (DEM).
  - Provide slope information.

- Two land use/land cover maps (2005 and 2010).
  - 2005 map: adapted from Land Cover Map of Catalonia.
  - 2010 map: Hybrid process of visual interpretation and supervised classification.

Input data:

- Climatic data from Hostalets de Pierola Station
  - Data: Daily precipitation, min and max temperatures, solar radiation, wind speed and relative air humidity.
- Detailed Soil Map of Catalonia 1:25 000.
  - Musle K factor calculated according Wischmeier et al. (1971).
- C minimal factors
- Management operations
  - According to local practices in the study area

4. RESULTS

Table 1. Annual average surface runoff and sediment yield for the study years.

Variable	Year	
	2005	2010
Precipitation (mm)	365.00	729.40
Surface runoff (mm)	32.15	112.04
Sediment yield (t/ha)	2.92	40.65

- Months with more precipitation: May, september and october.
- 4 (2005) and 5 (2010) extreme rainfall events were the responsible for more than 80% of the total surface runoff and sediment yield.

Table 2. Average annual runoff (mm) and sediment yield (t/ha) according land use

Land use	2005		2010	
	Surface runoff (mm)	**Sediment yield (t/ha)**	**Surface runoff (mm)**	**Sediment yield (t/ha)**
Pine forest	18.44	< 0.01	88.65	1.98
Mixed forest	17.47	< 0.01	57.51	0.99
Pine regeneration	20.78	< 0.01	77.10	10.02
Scrubland	35.40	0.12	116.30	29.07
Riparian vegetation	30.15	0.01	116.23	15.60
Vineyard	30.46	0.70	114.25	43.66
Olive trees	35.72	< 0.01	147.95	3.55
Fruit trees	35.80	< 0.01	135.79	12.10
Cereals	44.24	2.25	164.50	24.55
Grasslands	42.77	8.73	160.44	172.47
Bare soil	100.13	17.44	290.37	221.97
Bare soil in gullies	109.31	38.00	307.76	315.19

4. RESULTS

- Sediment yield of gully walls represent 99 % (2005) and 85 % (2010) of the total sediment yield in gully zones

Table3. Sum of average annual surface runoff and sediment yield by land use type: agricultural land versus forest and gully walls

Land use type	2005		2010	
	Surface runoff (mm)	**Sed yield (t/ha)**	**Surface runoff (mm)**	**Sed yield (t/ha)**
Agricul land	289.12	29.14	1013.3	478.30
Forest and gully walls	231.55	38.16	763.55	372.85

4. RESULTS

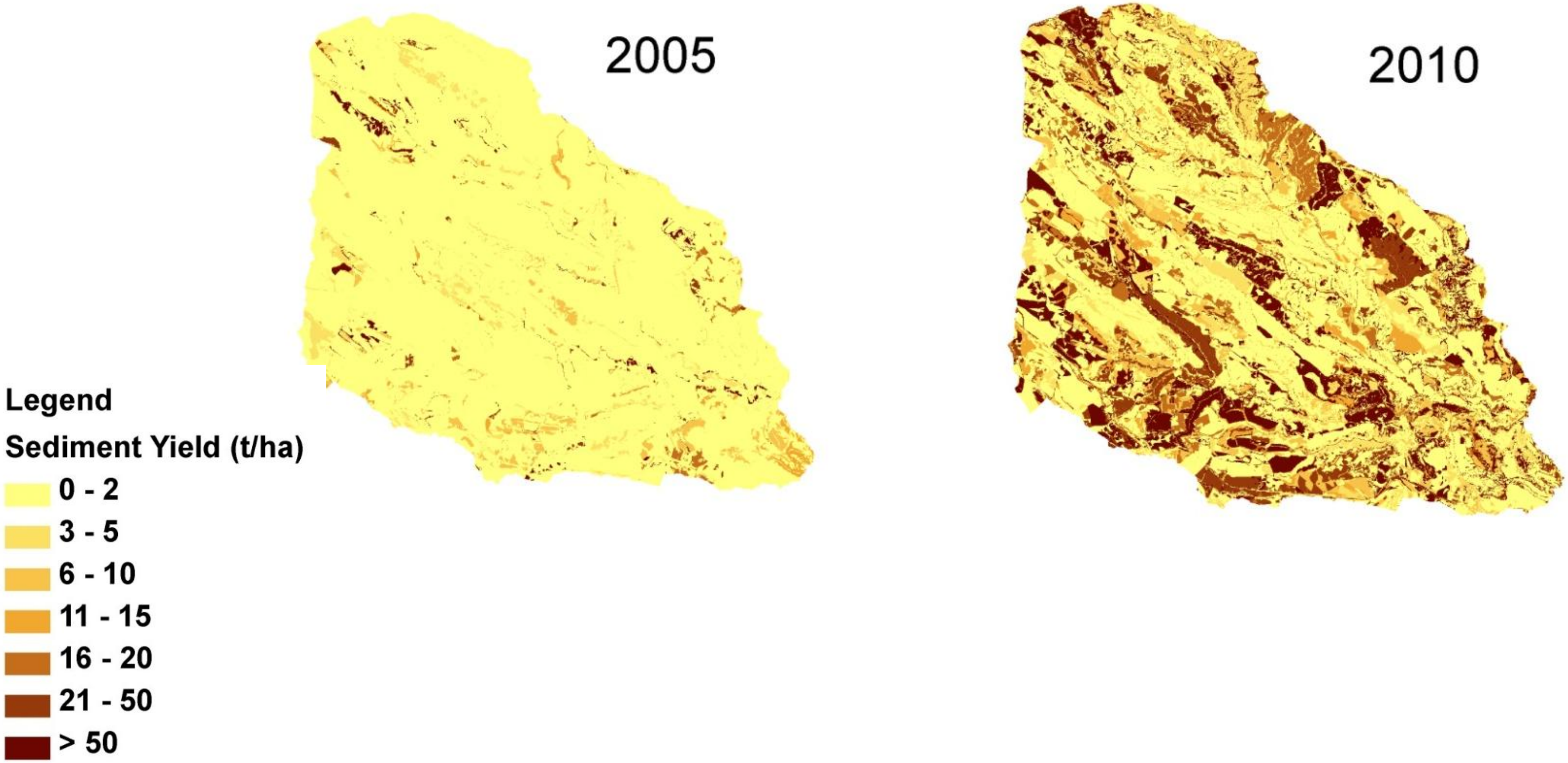


Figure 1. Distribution of mean annual sediment yield in the study area

5. DISCUSSION & CONCLUSIONS

- There is a great difference in sediment yield between vineyards, olive trees and other fruit trees because the first are on higher degree slopes.

- Forested areas (in gullies) contribute less to sediment yield than agricultural areas. However, the existence of bare gully walls produces high sediment yield in gullies. This is particularly relevant in wet years.

- Even though MUSLE integrated in SWAT does not specifically model gully erosion, the results in the gully areas are consistent with previous research addressed to measure sediment yield due to mass movements (Martínez-Casasnovas et al. 2004).

5. DISCUSSION & CONCLUSIONS

Example of mass movement produced by an extreme event in 2004

5. DISCUSSION & CONCLUSIONS

- This is because bare gully sidewalls have very high slope degree and highly erodible lithological materials (unconsolidated marls), which made them very prone to sheet and rill erosion.

- Other processes, such as the ones that produce gully wall failure, suppose the displacement and preparation of materials, but these are washed out of the wall and/or the gully by surface runoff processes.

- Finally, the wet selected year represents an example of the situations that more and more frequently are being recorded in the area under the climate change scenario.

Thanks for your attention