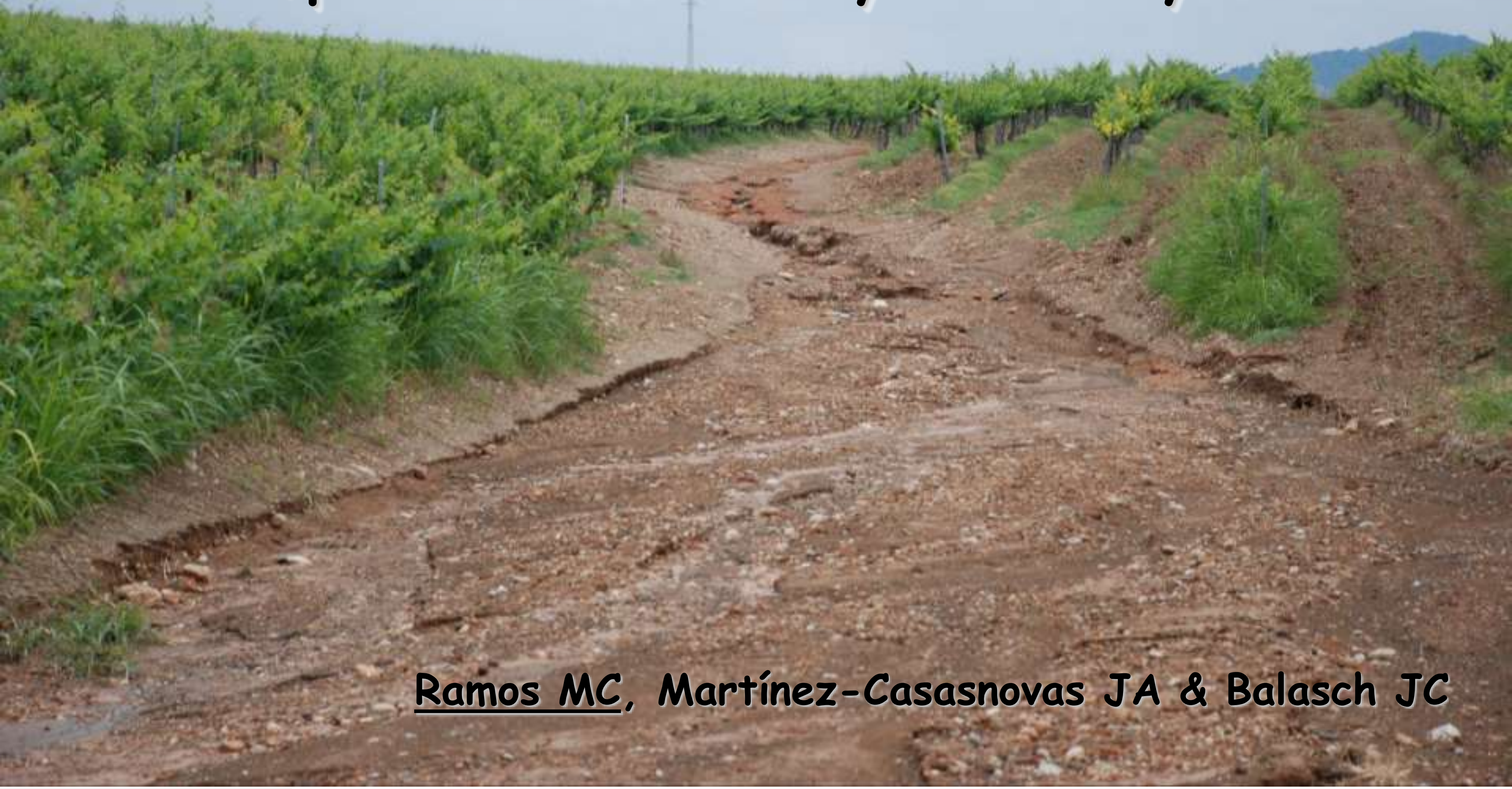
Runoff and soil loss prediction in a vineyard area at very detail scale using SWAT: comparison between dry and wet years



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Outlines

- Introduction
- Objective
- Material and methods
  - Study area
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  - Analysis
- Results and discussion
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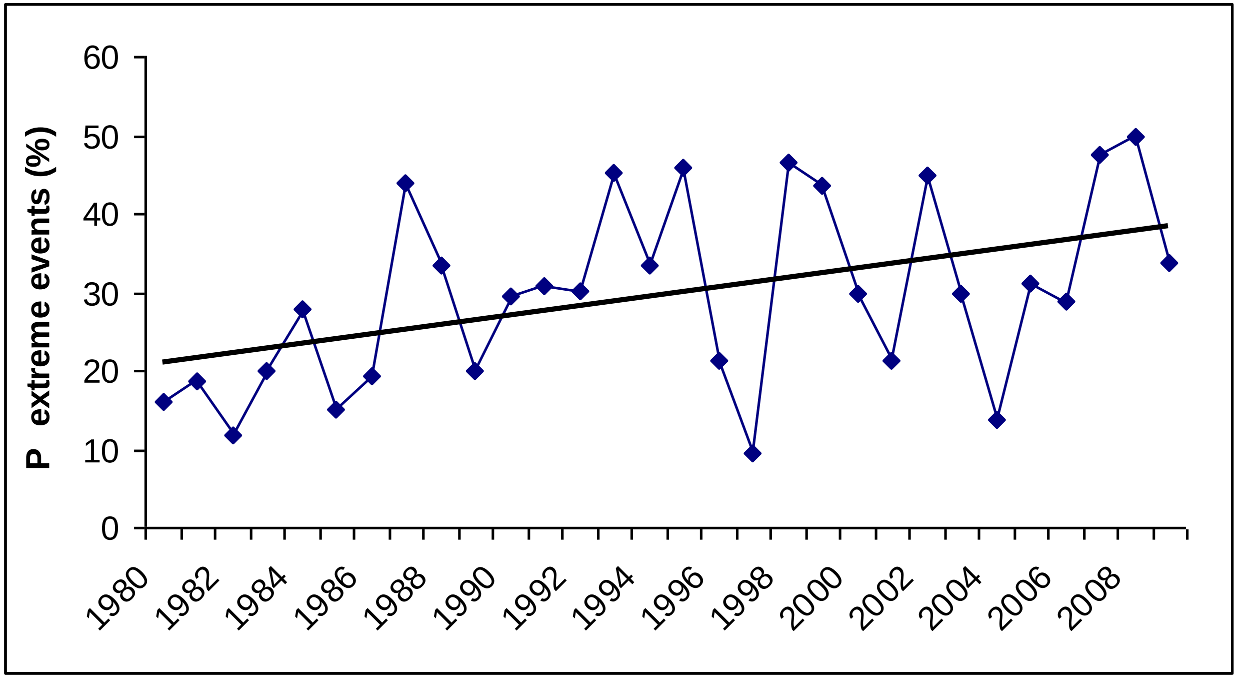
  - Effects of soil erosion
- Conclusions

Soil and nutrient losses by runoff at catchment scale

Soil and nutrient losses by runoff at catchment scale

Climate:

(increasing variability and extreme events)



Land use and management practices:

Land levelling and elimination of soil conservation measures

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Objective

The aim of this research was to analyse the impacts of rainfall amount and their distribution throughout the year on runoff and soil losses at watershed scale, in an area where vineyard is the main land use.

The analysis, using SWAT model at detail scale, compares the results of dry and wet years, including extreme events.

2011 SWAT

Study area

Soils
Typic Xerorthent
Fluventic Haploxerept
Typic Haploxeralfs,

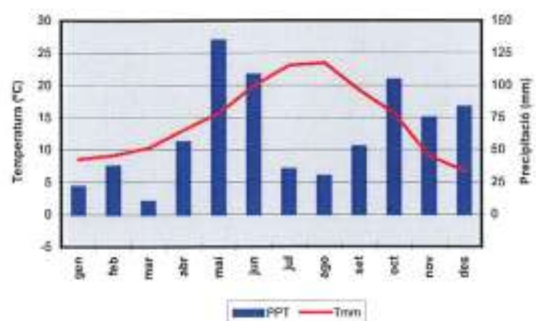
Climate:
Mediterranean – Maritime influence

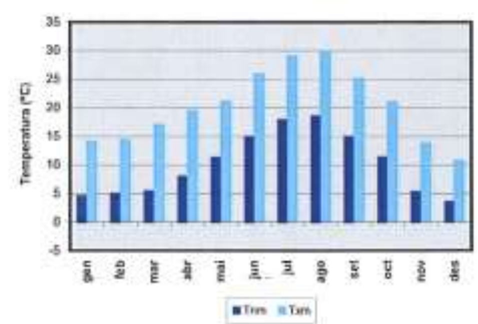
T m = 15°C (9-25°C)

Tmax = 20 °C (10.3-29.7°C)

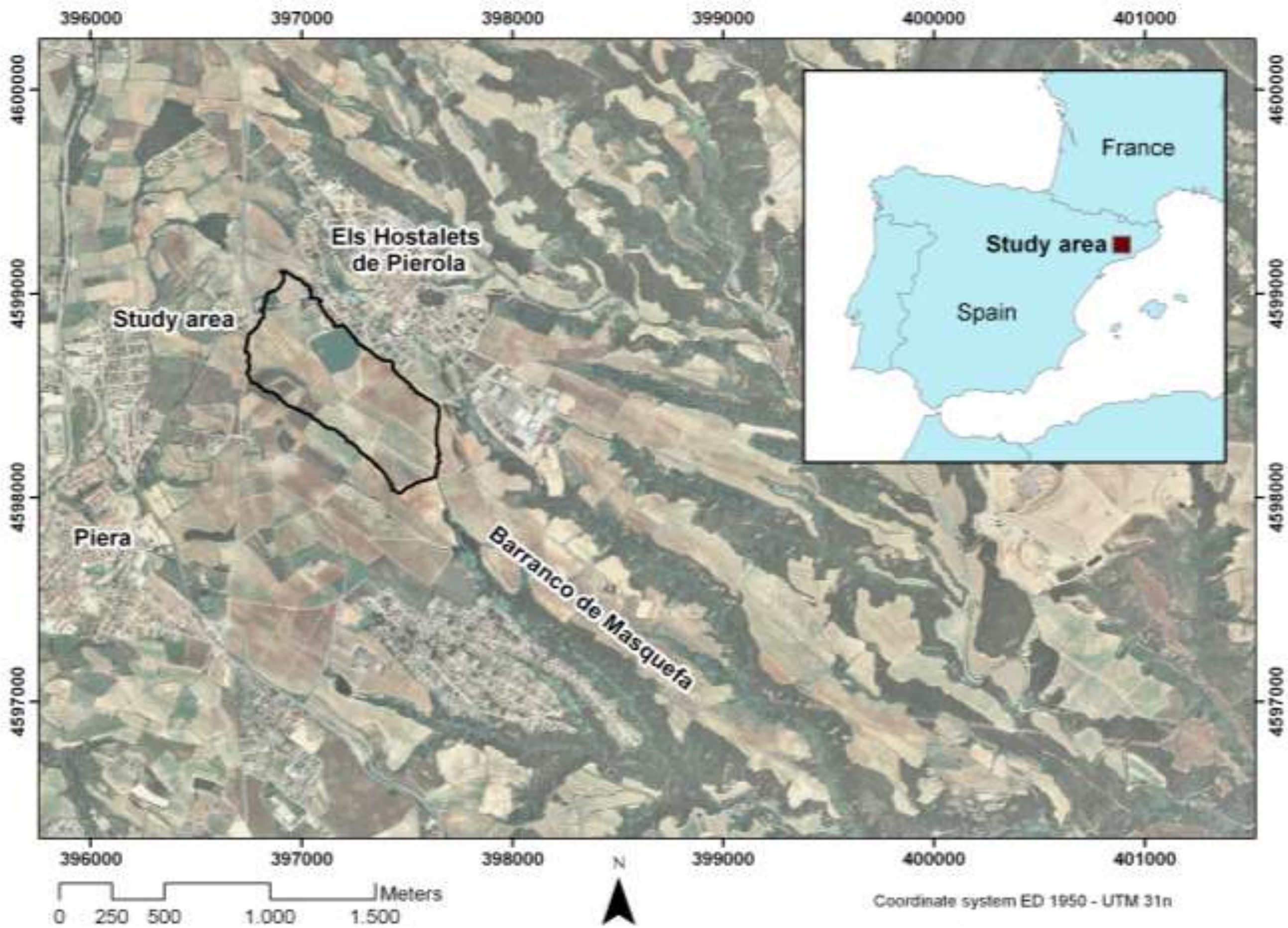
Tmin = 9° C (2.5-19.5 °C)

Pm = 520 mm





Runoff and soil loss prediction in a vineyard area at very detailed scale using SWAT model: comparison between dry and wet years



Basin: 0.46 km²

2011 SWAT

ArcSWAT 2009.93.5 daily time scale

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Input data

Soil data

Soil map (1:25,000) -Instituto Geológico de Cataluña
Soil survey: 23 additional points
- texture,
- bulk density,
- organic matter content,
- steady infiltration rate,
- available water capacity
- K-erodibility factor

A 1m-resolution digital elevation model:
altitude photogrammetric aerial survey (2010)→ slope

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Land Use:

Visual interpretation of very detail aereal photogrpahs

Climatic data

Els Hostalest de Pierola (1.809 E; 41.5328 N, 316 m.a.s.l.)
(Instituto Meteorológico de Cataluña)

15-year series (1996-2010) daily data:

- temperatures (maximum and minimum),
- precipitation,
- solar radiation,
- relative humidity
- wind velocity

Management practices

Farmer information

Model run

dry years:
- 2001: P= 447.8 mm
- 2005: P=365 mm

wet years
- 2008: P= 751.5 cm
- 2010: P= 729.4mm

Erosive rainfall events P> 9mm

Model validation

Soil moisture:

TFR probes (Decagon) at four depths:

10-30, 30-50, 50-70 and 70-90 cm

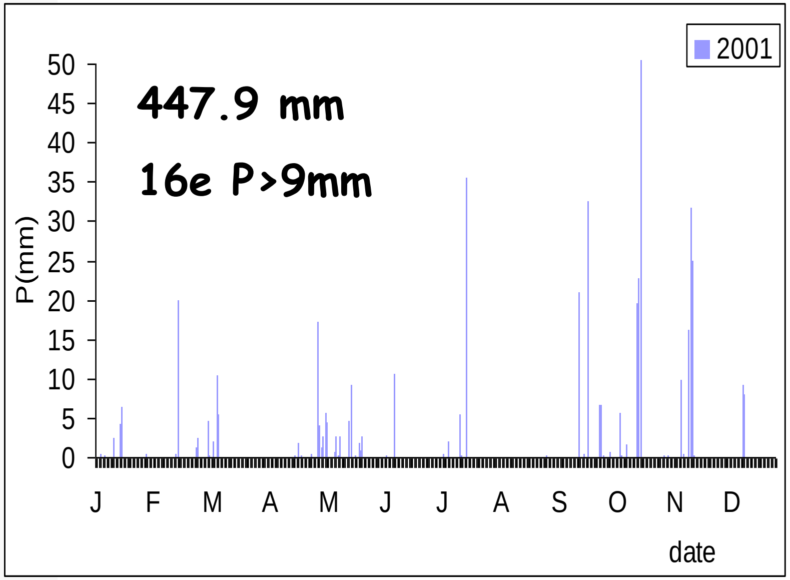
Sediment concentration in runoff in 3 HRU (vineyards)- 2010

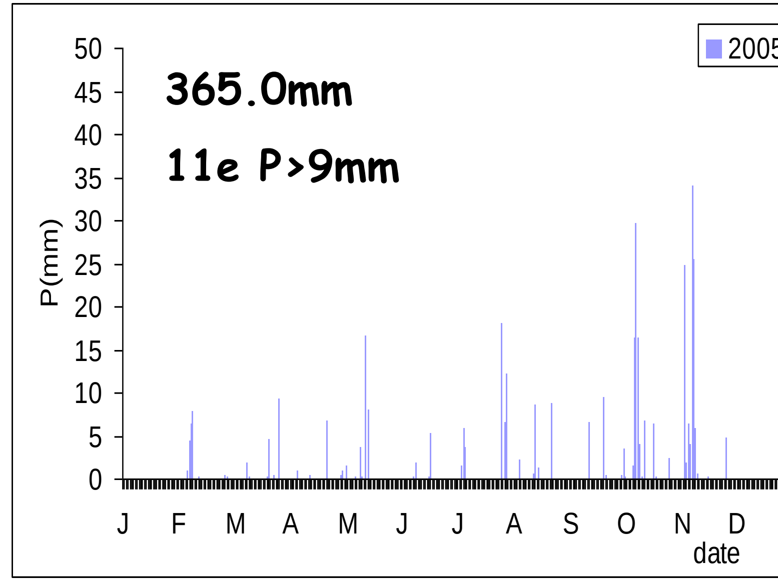
Soil characteristics

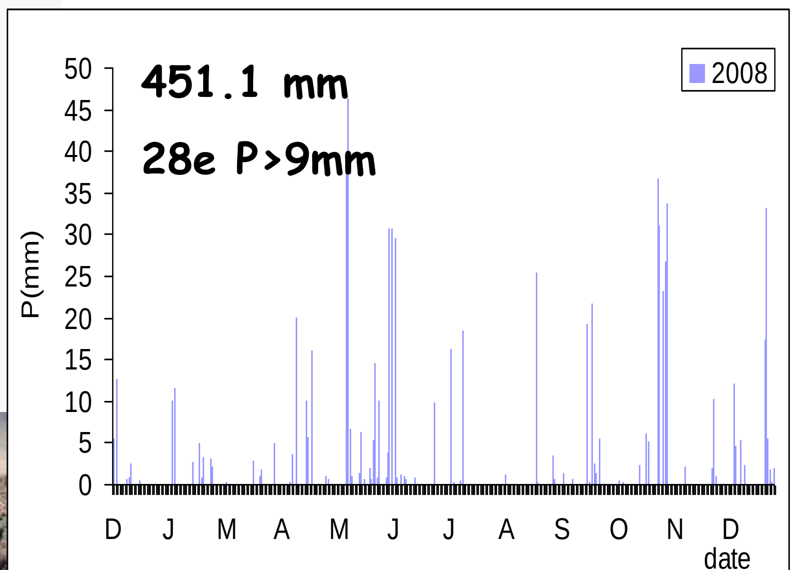
	O.M (%)	Clay (%)	Silt (%)	Sand (%)	Coarse elements (%)
Mean	1.48	19.23	32.34	48.14	20.35
Std	0.38	4.11	6.49	5.01	8.88
Max	2.34	27.40	45.00	65.40	28.43
Min	0.92	13.40	19.60	34.40	9.83

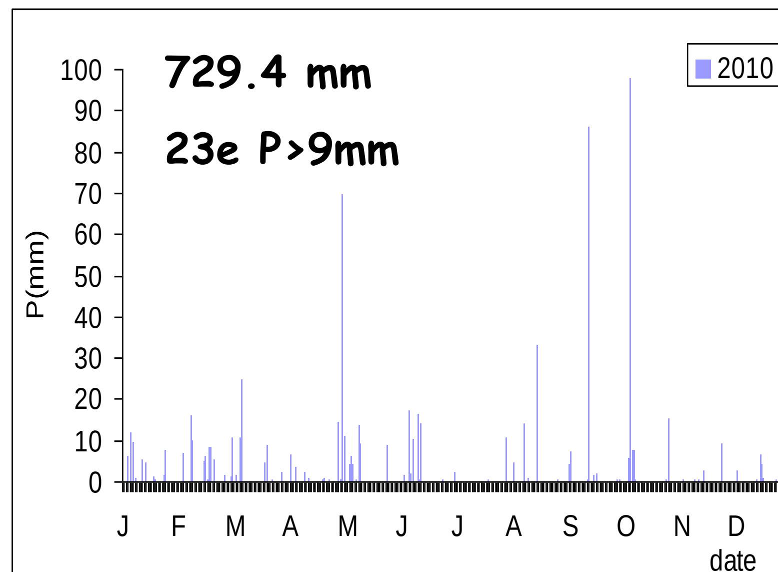
	BD (kg/m³)	AWC (mm)	CE (dS/m)	StIR (mm/h)	K -factor (Mg.h/MJmm)
Mean	1534	9.78	0.15	20.4	0.45
Std	248	1.51	0.02	8.3	0.15
Max	1879	12.22	0.19	29.5	0.65
Min	1258	7.68	0.13	8.0	0.25

Climatic characteristics

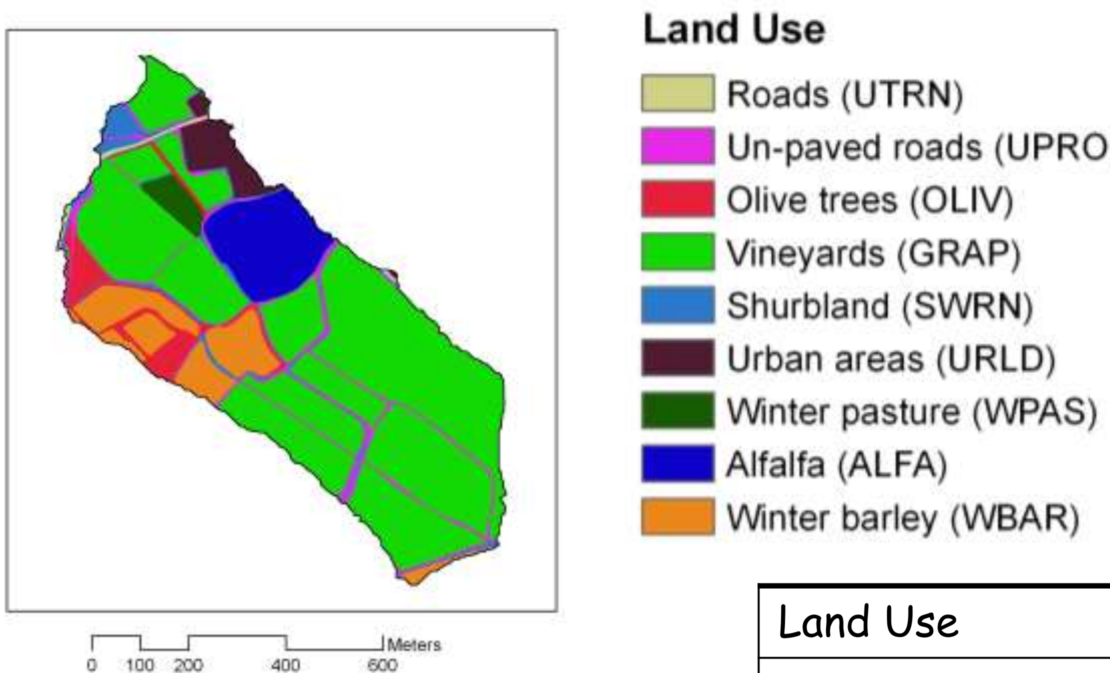








Land Use:



Land Use	%
vineyards	62.81
olive trees	4.70
alfalfa	8.47
winter barley	9.45
winter pasture	1.49
ranges	3.50

Sub-basins	34
HRU	1182
slope	< 1-15%

Runoff and soil loss prediction

year	P	Runoff		Perc	Soil loss
	(mm)	(mm)	%	(mm)	(Mg/ha)
2001	447.8	59.9	10.3	68.8	4.25
2005	365.0	37.9	13.3	44.2	1.54
2008	751.1	173.0	23.0	271.0	17.66
2010	729.4	143.8	20.0	139.7	25.53

Runoff and soil loss prediction

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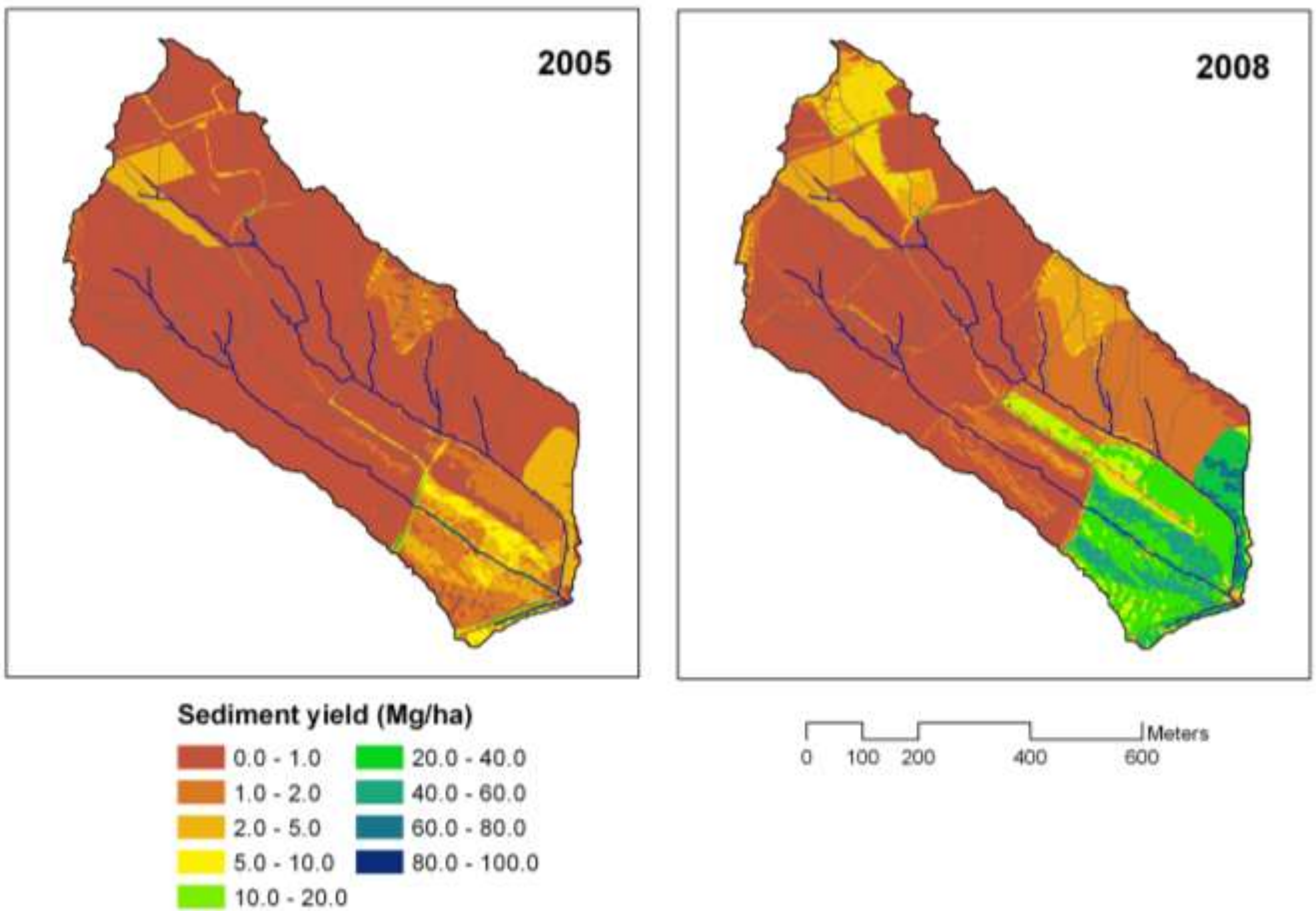


Nutrient loss prediction

year	N-Nitrate loss	N-Org loss	P-Dis loss	P-Org loss
	kg/ha			
2001	17.58	13.65	0.19	2.5
2005	17.58	5.91	0.18	1.32
2008	58.79	44.94	0.49	7.39
2010	43.17	54.19	0.10	7.13

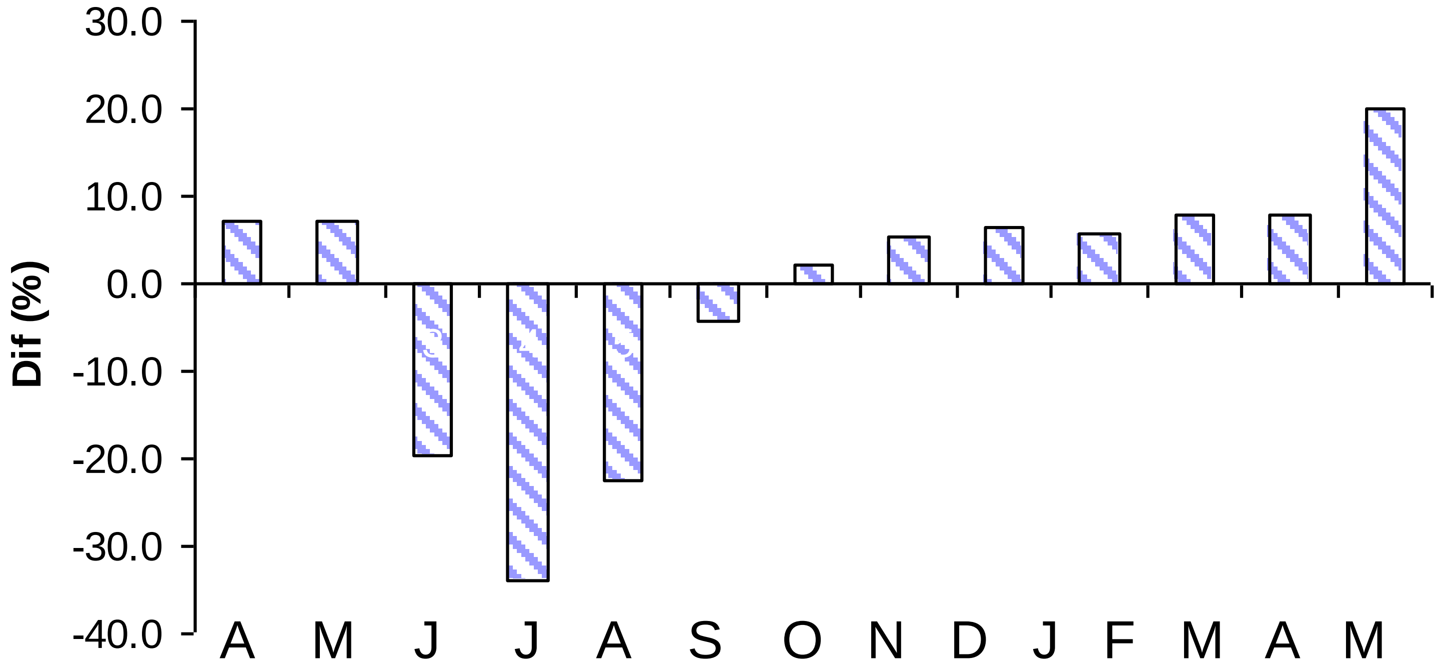
Soil loss in vineyards in one event in 2010

P= 97.7 mm

Imax h = 49 mm/h

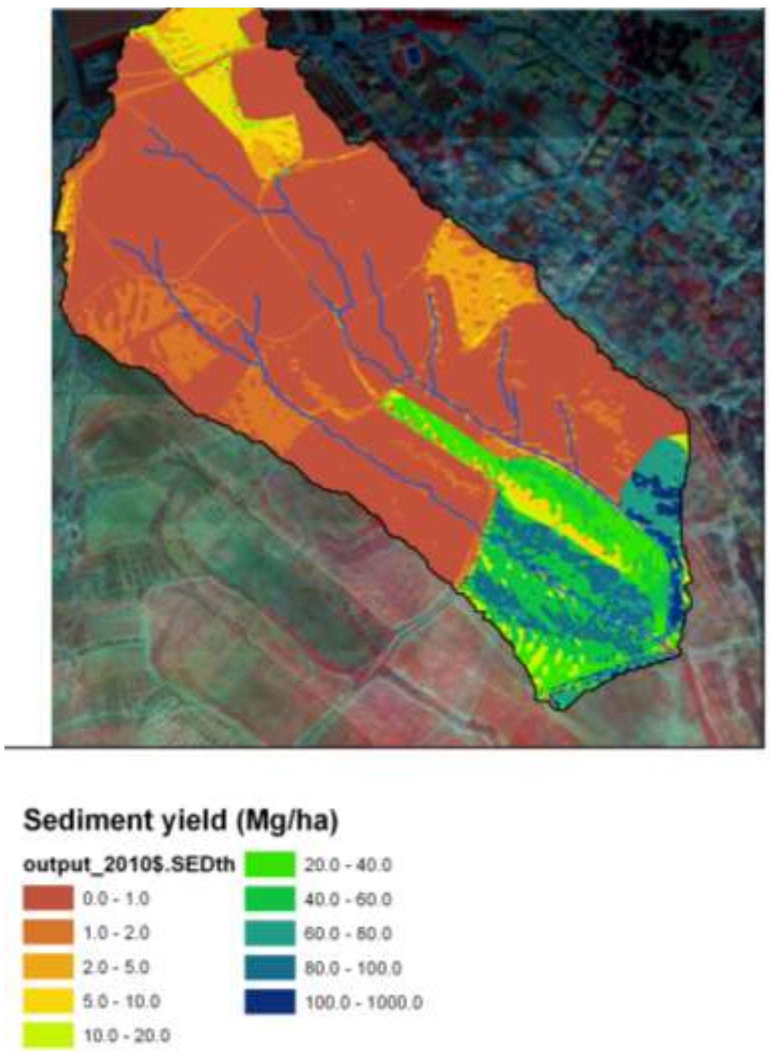
Soil loss in vineyards at the catchment outlet in one event in 2010

Differences in SW in a reference subbasin



Annual dif: -10.9 %

Impact of soil erosion on vine development



Impact of soil erosion on vine development
NDVI

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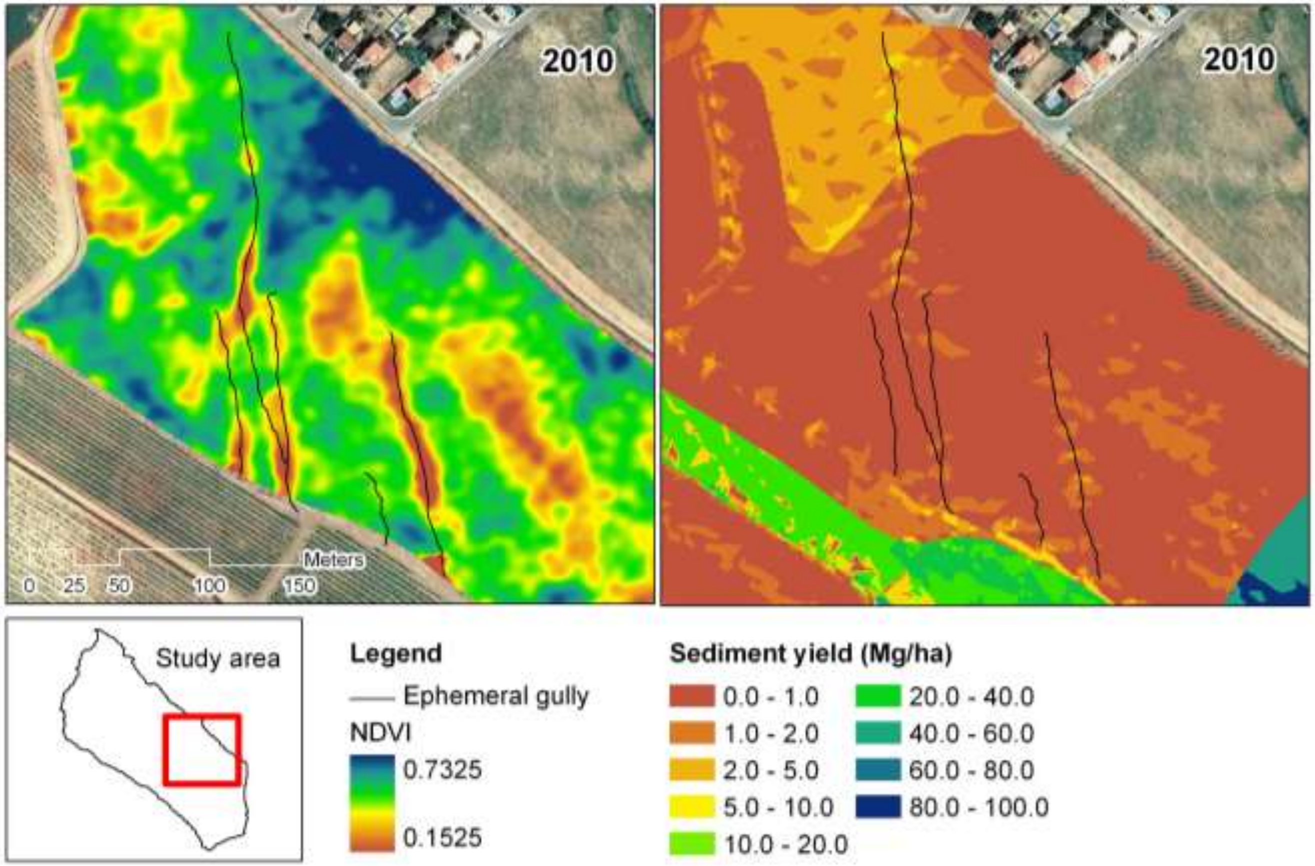

Conclusions

SWAT model simulations for years with different rainfall characteristics showed the influence of rainfall distribution and intensity on soil and nutrient losses, which may be particularly high in some areas of the basin near the outlet.

The simulation for one of the wettest years of the last decade, which recorded high erosive rainfall events, is an example of the potential risk that this type of events, associated with climate change, can cause in the case study region.

Runoff rates, ranged between 10 and 23% of rainfall in the analysed years, which should be taken into account in terms of water availability, due to the fact that rainfall is the only water resource in the area for agriculture

2011 SWAT

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The research also highlighted the relation between soil losses and crop development measured by the NDVI at grape veraison. This is particularly relevant in the hydrological response units (HRU) in which gullies are developed within the vineyard fields.

Further research is needed to get best fitting between observed and modeled results, particularly related to the evaporative demand and the effects of high intensity events on water availability for typical crops in the region.

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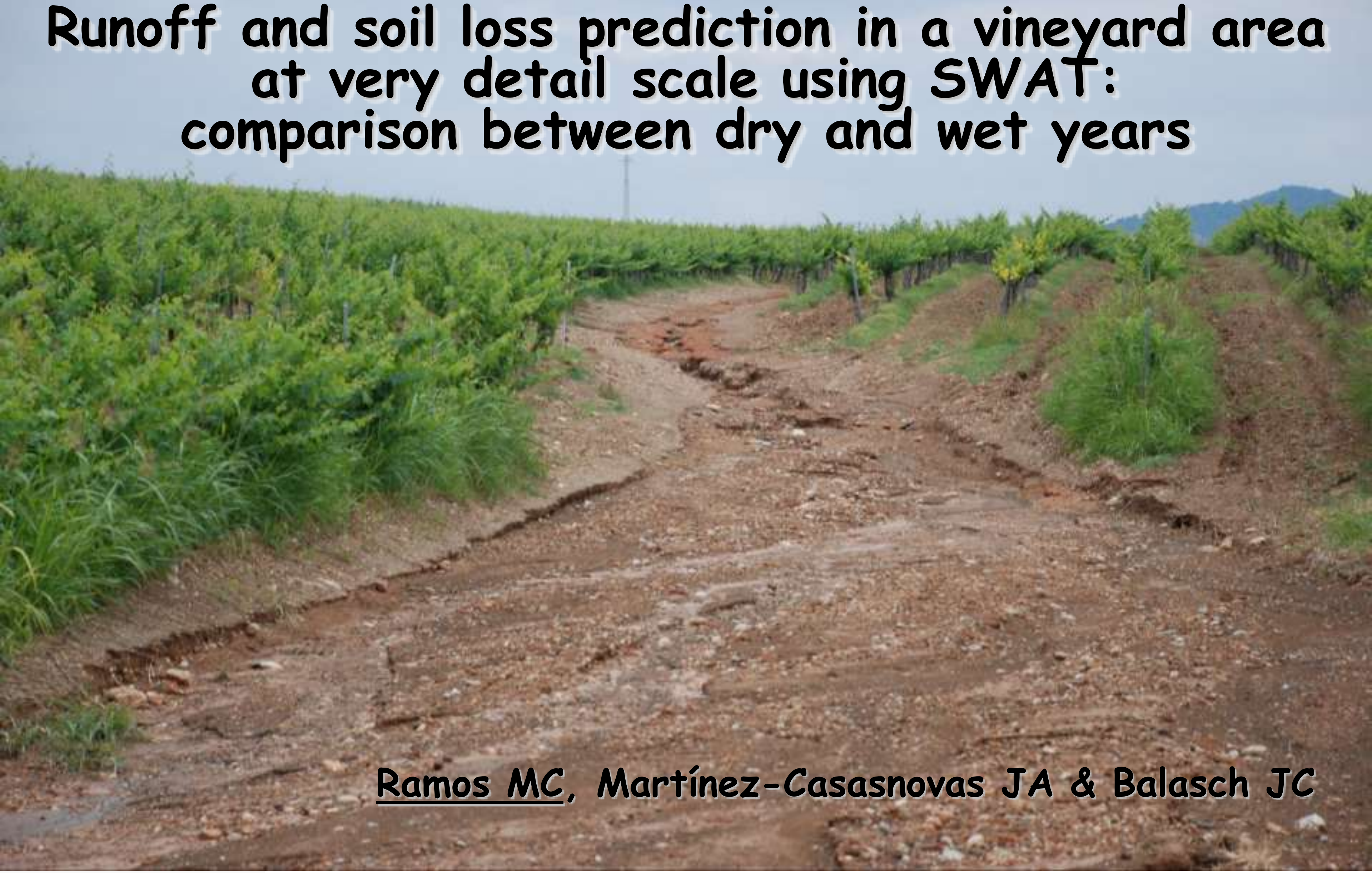

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