RUNOFF AND SEDIMENT PRODUCTION IN A MEDITERRANEAN BASIN UNDER TWO DIFFERENT LAND USES AFTER FOREST MANAGEMENT

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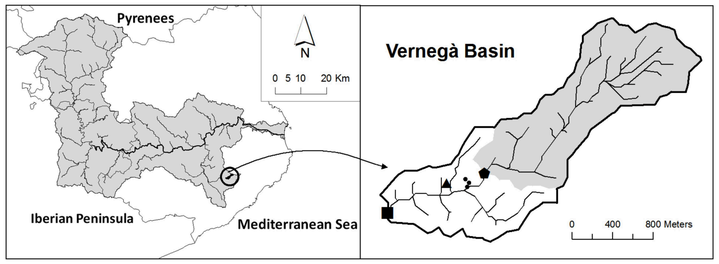
INTRODUCTION

This study analyses the influence of two different land uses (agriculture and Forest) and the forest management on the hydrology of the Vernegà experimental basin between the years 1993 and 2012. The basin is located in the Northeast of the Iberian Peninsula and it is influenced by a Mediterranean climate, with an average annual rainfall of 688 mm. The study of rainfall distribution shows that the majority occurs during autumn and spring, with a 34% and 25% of total annual rainfall respectively. Surface runoff flows from October to June. In this catchment, flash floods may represent 80% of the total water yield, though they only occur 6% of the time. It is important to emphasize that agricultural practices within the study area have been maintained, which is the contrary to the general trend in Mediterranean rural areas.



Legend

Campàs · Bosc · Wells · Meteorological Station · Campàs Area · BoscArea · Vernegá River

The total drainage area of the Vernegà basin is 2.57 km2 of which 0.97 km2 is Campàs (agriculture area) and 1.60 km2 is Bosc (forest area). Despite the topography smothness of the granite massif landforms, usually with gentle slopes, there are some steep slopes caused by fractures and younger orogenic uplifts. The forest management has been implemented initially after 2003-2005, therefore, has been divided into two periods: 1993-2005 and 2005-2012.

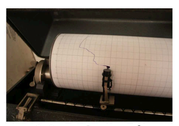
METHODS

Bosc Station

Campàs Station

Measuring equipment

Auto Sampler



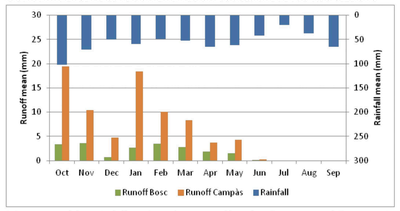
Limnigraph

Meteorological station

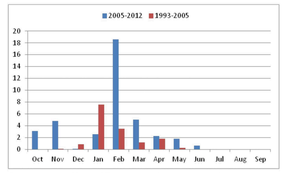
RESULTS

Period	Mean Surface Runoff		Mean Runoff coefficient	
	Bosc	Campàs	Bosc	Campàs
1993-2005	6.8	33.1	1.4	7.7
2005-2012	66.8	92.0	3.2	8.8
Total Mean	36.8	62.5	2.3	8.3

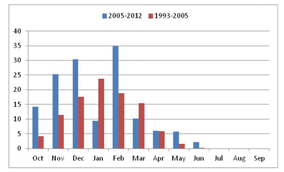
Mean annual surface runoff and runoff coefficient at the two stations



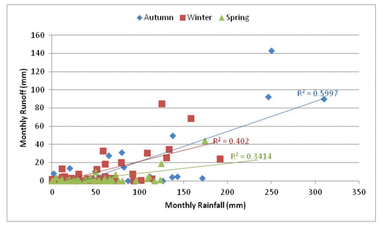
Mean monthly rainfall and surface runoff at the Campàs and Bosc station



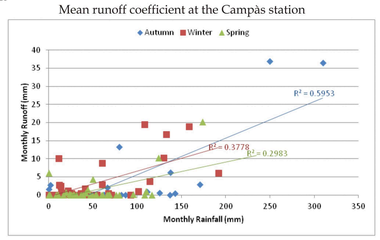
Mean runoff coefficient at the Bosc station



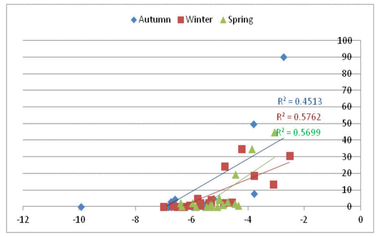
Mean runoff coefficient at the Campàs station



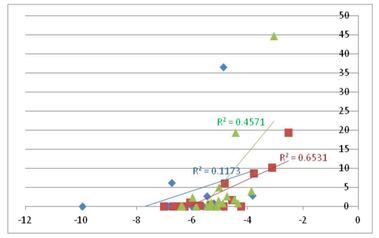
Relationship between monthly Runoff and Rainfall at the Campàs station



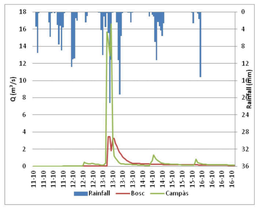
Relationship between monthly Runoff and Rainfall at the Bosc station



Relationship between monthly depth and surface runoff at the Campàs station



Relationship between monthly depth and surface runoff at the Bosc station



Big Flash flood in Octover 12 to 16 2005.

	2005-2006						2006-2007					
	Bosc			Campàs			Bosc			Campàs		
	Suspended Load (kg)	Dissolved Load (kg)	Total Yield Tkm⁻²yr⁻¹	Suspended Load (kg)	Dissolved Load (kg)	Total Yield Tkm⁻²yr⁻¹	Suspended Load (kg)	Dissolved Load (kg)	Total Yield Tkm⁻²yr⁻¹	Suspended Load (kg)	Dissolved Load (kg)	Total Yield Tkm⁻²yr⁻¹
October	5049.72	3945.09	5.62	10597.11	7160.21	6.91	2344.51	263.51	1.63	1217.06	1294.67	0.98
November	1064.29	682.92	1.09	17896.48	7781.08	9.99	0.00	0.00	0.00	0.00	0.00	0.00
December	76.88	28.19	0.07	47.29	47.29	0.04	0.00	0.00	0.00	0.00	0.00	0.00
January	2711.29	1810.56	2.83	4417.18	4717.54	3.55	0.00	0.00	0.00	0.00	0.00	0.00
February	226.55	267.07	0.31	425.35	371.34	0.31	35.83	303.18	0.21	7.45	635.47	0.25
March	2.82	28.18	0.02	0.06	0.06	0.00	5.25	46.02	0.03	4.83	172.04	0.07
April	0.59	1.18	0.00	0.01	0.01	0.00	111.73	2011.21	1.33	2137.22	4970.54	2.77
May	0.00	0.00	0.00	0.00	0.00	0.00	0.57	31.07	0.02	0.71	235.13	0.09
June	0.00	0.00	0.00	0.00	0.00	0.00	1.83	84.50	0.05	34.66	389.54	0.17
July	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
August	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
September	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**9132.13**	**6763.19**	**9.93**	**33383.46**	**20077.52**	**20.80**	**2499.72**	**2737.49**	**3.27**	**3401.93**	**7697.37**	**4.32**
	2007-2008						2008-2009					
	Bosc			Campàs			Bosc			Campàs		
	Suspended Load (kg)	Dissolved Load (kg)	Total Yield Tkm⁻²yr⁻¹	Suspended Load (kg)	Dissolved Load (kg)	Total Yield Tkm⁻²yr⁻¹	Suspended Load (kg)	Dissolved Load (kg)	Total Yield Tkm⁻²yr⁻¹	Suspended Load (kg)	Dissolved Load (kg)	Total Yield Tkm⁻²yr⁻¹
October	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
November	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
December	0.00	0.00	0.00	0.00	0.00	0.00	12.38	39.86	0.03	65.55	729.03	0.31
January	0.00	0.00	0.00	0.00	0.00	0.00	5.94	256.40	0.16	492.00	3208.06	1.44
February	0.00	0.00	0.00	2.10	41.94	0.02	126.04	4489.31	2.88	73.99	4545.86	1.80
March	0.00	0.00	0.00	1.32	26.42	0.01	0.04	0.75	0.00	24.20	483.90	0.20
April	0.30	5.95	0.00	7.55	150.63	0.06	1.71	730.66	0.46	978.91	3819.56	1.87
May	59.68	784.06	0.53	103.23	1722.78	0.71	0.00	0.00	0.00	15.08	0.00	0.01
June	1.37	117.12	0.07	6.27	93.13	0.04	0.00	0.00	0.00	0.00	0.00	0.00
July	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
August	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
September	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	**61.35**	**907.13**	**0.61**	**120.47**	**2034.89**	**0.84**	**146.10**	**5516.99**	**3.54**	**1649.73**	**12786.42**	**5.62**

CONCLUSIONS

The introduction of forest management practices between 2003 and 2005 has resulted in important hydrological changes in the watershed: Between 2005 and 2012 an increase of the runoff coefficient has been detected. In Bosc the increase represents 38% while in Campàs is 12% in relation with the 1993-2005 period. Campàs yields are greater than total runoff in Bosc as a consequence of a greater catchment surface, greater agricultural surface and the existence of forest roads and forest management practices. Part of this phenomenon may be due to the decrease of interception of rainfall and plant biomass in the forested area of the basin. In relation to the sediment yield, the charge is higher in "Campàs" compared to "Bosc" and it is concentrated during floods, there is an increase of available sediment after extraordinary events, as it is the case of October 2005 flood, where the total sediment yield was 7 Tkm^{-2}yr^{-1} and in November 2005 it was 10 Tkm^{-2}yr^{-1}.

In all periods there are runoff from October to June, reflecting a low-flow runoff, with an average of 1 ls-1 in Bosc area and 5 ls-1 in Campàs. And despite this, due to seasonality those values can go up to 3.5 m3s-1 in Bosc and 16.6 m3s-1 in Campàs station, providing a wide variability in the basin. The total volume of water intercepted in the two monitoring stations is greater in Campàs. According to total yield, Forest station has increased over 100% the suspended sediment yield production and about 64% the dissolved load, while Agriculture station has increased over 100% both sediment yields since studies undertaken in the basin during late 1990's. Suspended sediment concentrations were greater at Forest than Agriculture, as a consequence of new and more active sediment sources developed upstream, while the traditional agricultural fields downstream.

The involvement of forest roads and forest management practices in the watershed.

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ACKNOWLEDGMENTS

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