FEDERAL UNIVERSITY OF SANTA MARIA
DEPARTMENT OF FOREST SCIENCES

Hydrosedimentological monitoring and modeling in paired watersheds in the Pampa biome

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INTRODUCTION

PRODUCTIVITY
x
SUSTAINABILITY

Naturally fragile areas used for forest production

- Fragile soils
- Soil tillage
- Extreme temperatures
- Water deficit

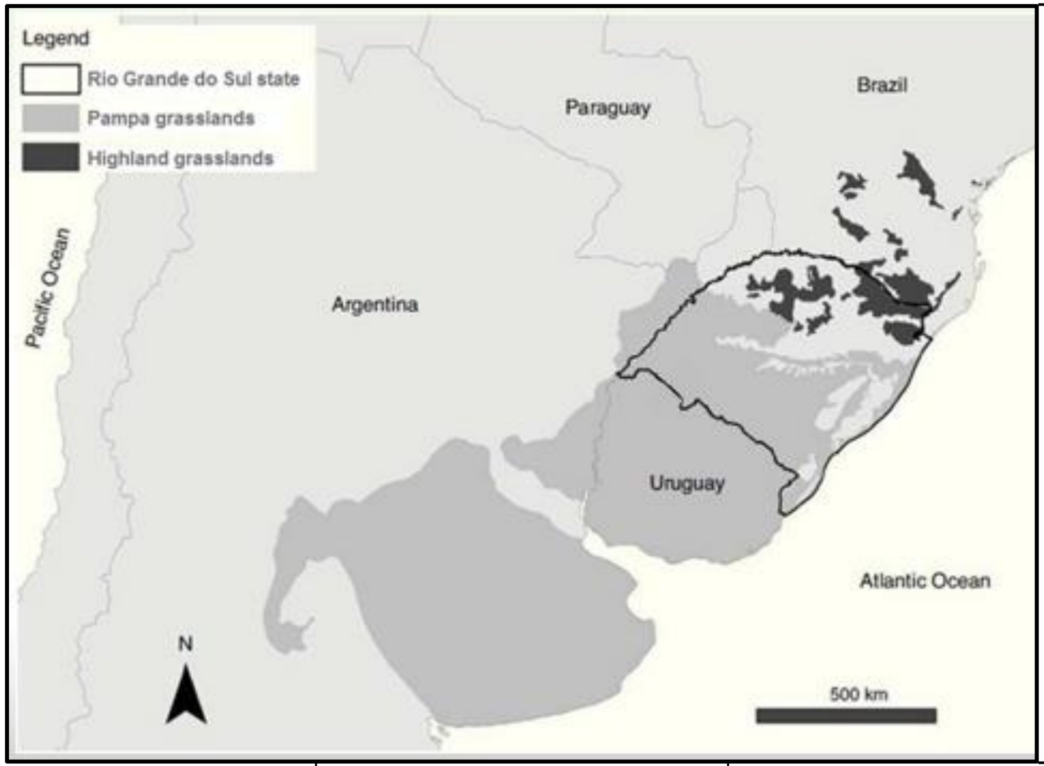
Sources: Research group collection

INTRODUCTION

Growth of *Eucalyptus* sp. in RS in the last decade:
184,2 thousand ha to **426,7 thousand ha** (AGEFLOR, 2017)

- Relevant insertion in the Pampa biome;

Pampa biome



Source: Oliveira et al., 2017

63% of RS territory

- Youngest Brazilian biome – 2004;
- Higher population density of grasses in the world (Oliveira et al., 2017);
- Environmentally fragile;

Replacement of native grassland by agricultural and forestry crops

INTRODUCTION

Sources: Research group collection

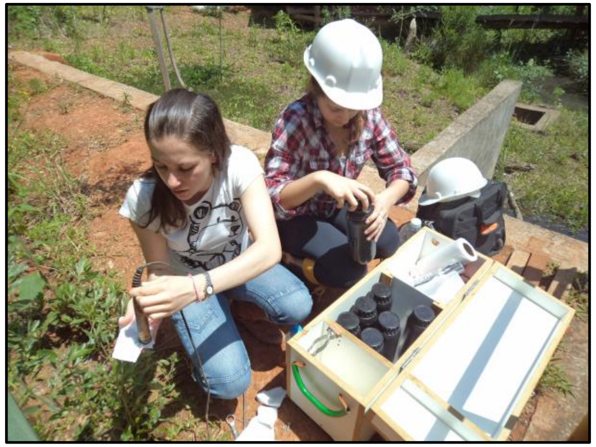
Unknown effect on environmental quality!

- Deconfiguration of the natural landscape;
- Spatial and temporal changes in hydrological variables;

Studies in forest watersheds

1. Hydrosedimentological monitoring

- Measurement of environmental variables in forest areas, and in areas with land use and management change, such as:
  - Infiltration
  - Surface runoff
  - Erosion



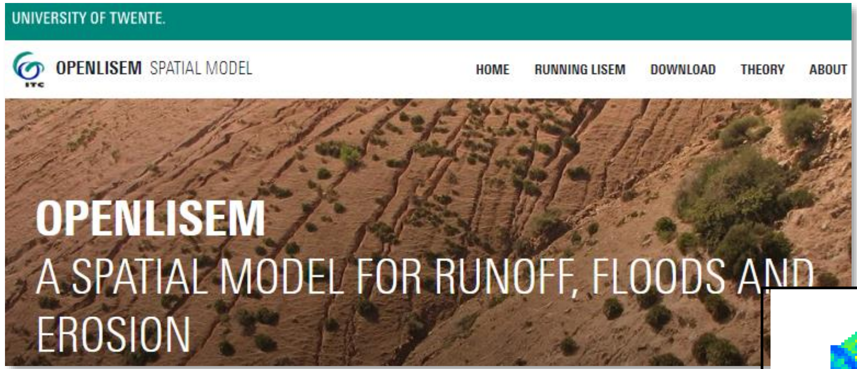
Sources: Research group collection

INTRODUCTION

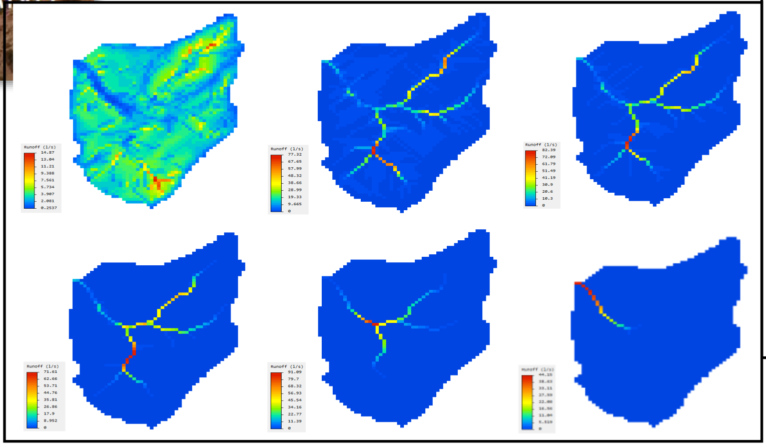
Studies in forest watersheds

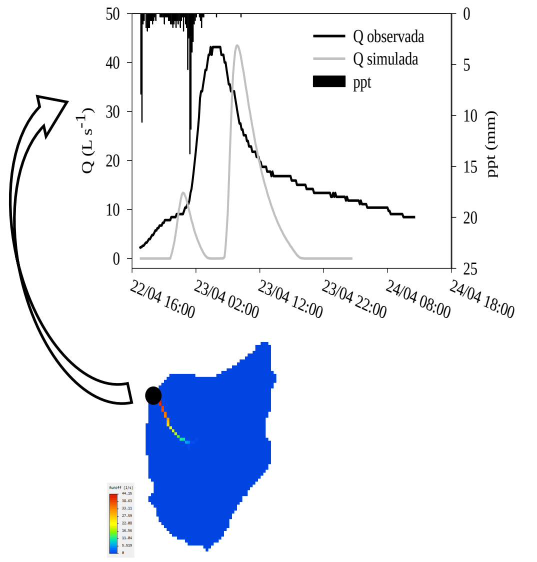
2. Use of mathematical models and scenarios simulation

- Identification of processes that negatively impact natural resources
- Identification of critical areas for the implementation of soil and water management practices



Sources: De Roo et al., 1996
https://blog.utwente.nl/lisem/





$$PBIAS\ (\%) = \frac{Es - Em}{Em} 100$$

$$COE = 1 - \frac{\sum_{i=1}^{n}(Em - Es)^2}{\sum_{i=1}^{n}(Em - E)^2}$$

Sources: Research group collection

OBJECTIVES

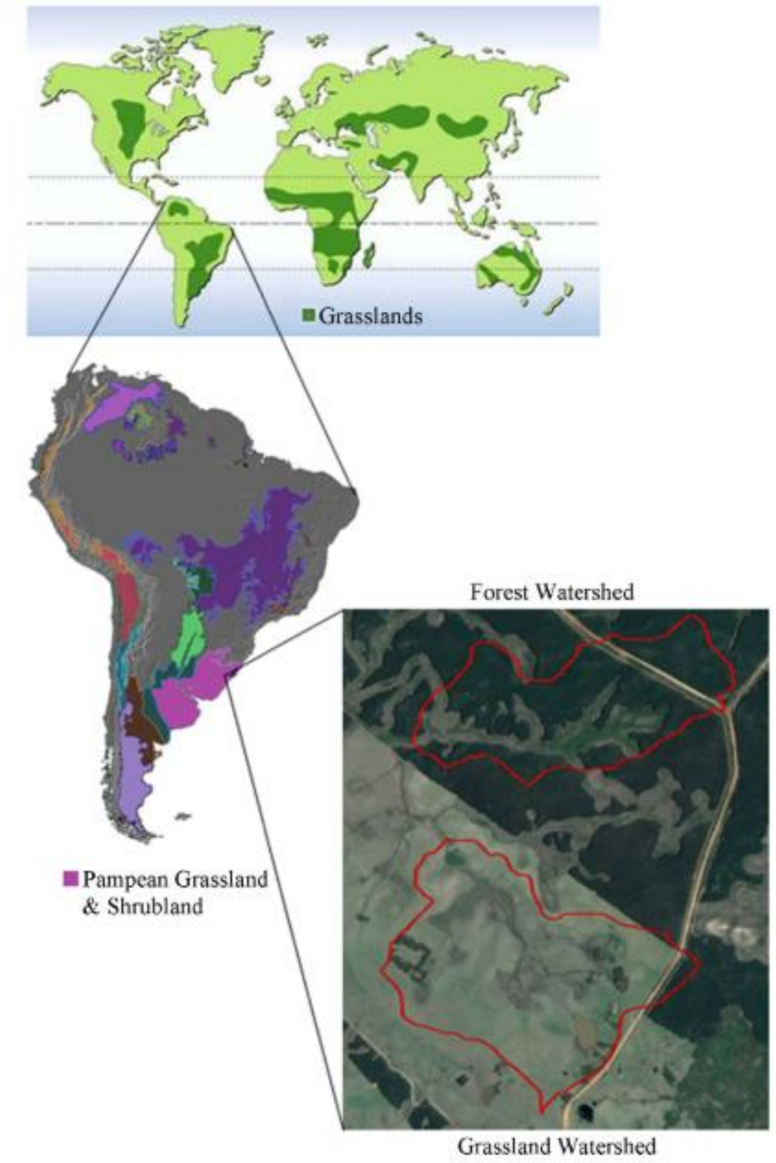
To represent the behavior and to understand the dynamics of hydrological and sedimentological processes by monitoring and modeling with the Limburg Soil Erosion Model (LISEM) two small paired rural watersheds.

MATERIAL AND METHODS

Study area

- Two paired watersheds:
  - Land use based in **eucalyptus plantation** (EW, 0.83 km²);
  - Land use based in **grassland** (GW, 1.10 km²);

- Average altitude: 273 m;
- Climate Cfa, subtropical humid (Álvares et al., 2013), average annual temperature of 18.6 °C, reaching 31 °C in the warmest month and 5 °C in the coolest months;
- Average annual rainfall of 1356 mm;
- Predominant soil classes: Alisols, Cambisols and Regosols (Curi; Marques, 2011);



Sources: Reichert et al., 2017

MATERIAL AND METHODS

Monitoring sections

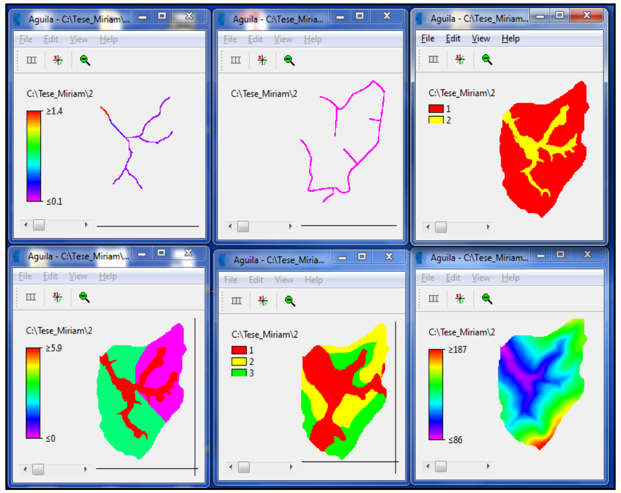
- Linigraphs;
- Turbidimeters (Validation);
- Pluviographs;

- Central datalogger and solar panel
- Temporal discretization: 10 min.

Sources: Research group collection

MATERIAL AND METHODS

Mathematical modeling



Basic maps: soil, DEM, basin area, roads, drainage.

Sources: Research group collection

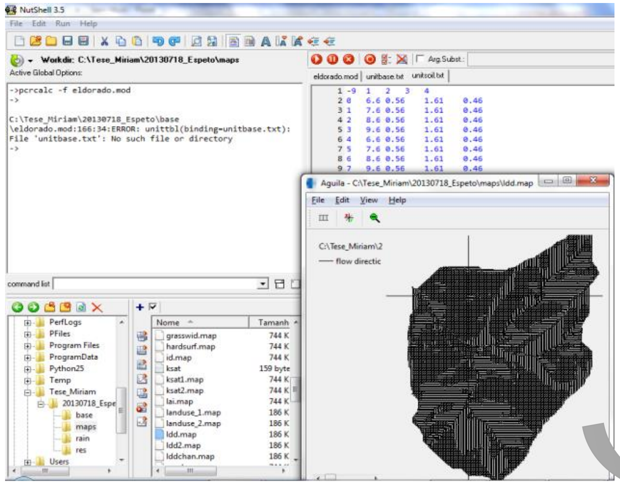
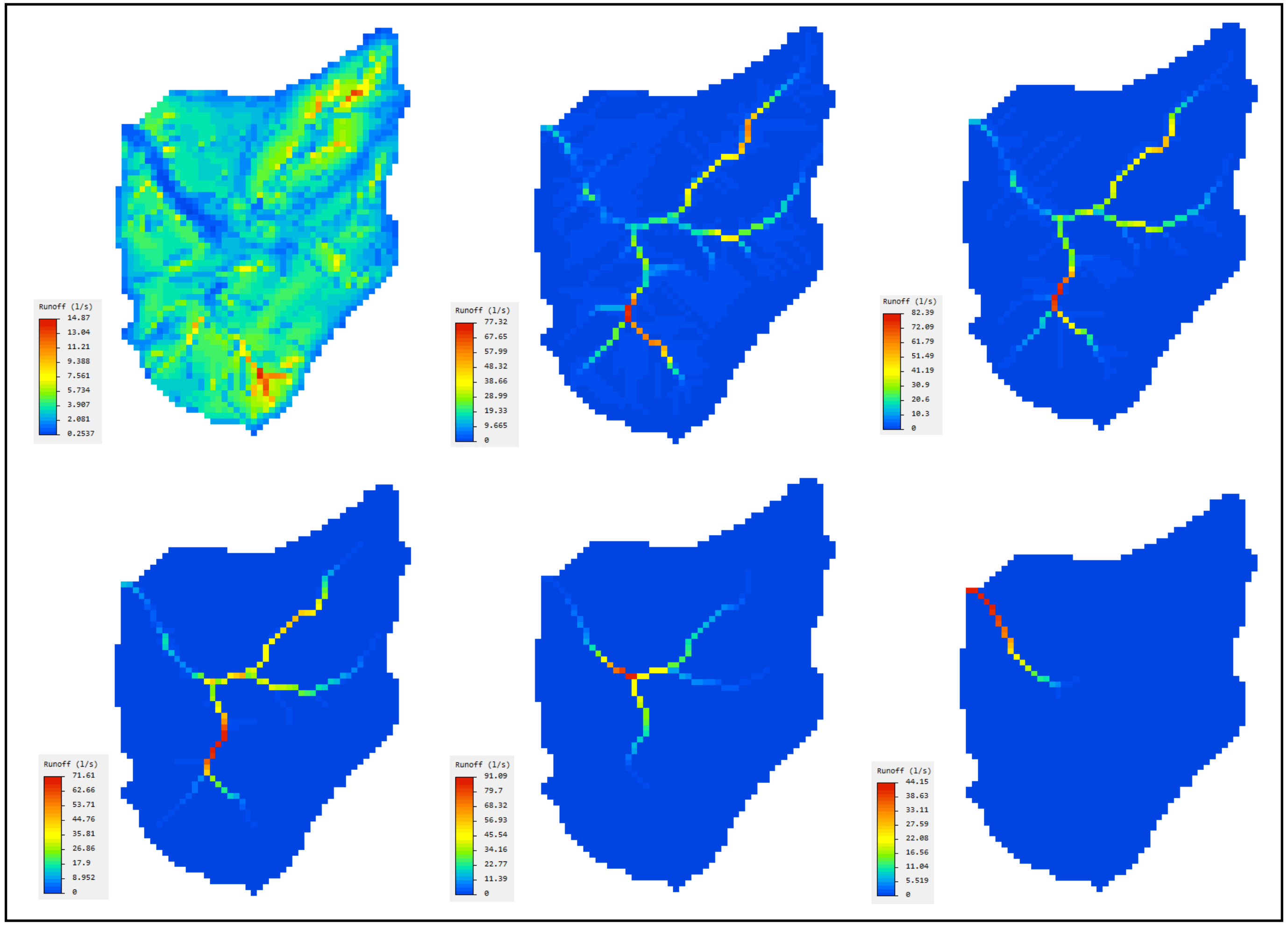


Table: soil properties, channel, road, and vegetation.



Simulation of hydrological events occurred using the LISEM model.

RESULTS

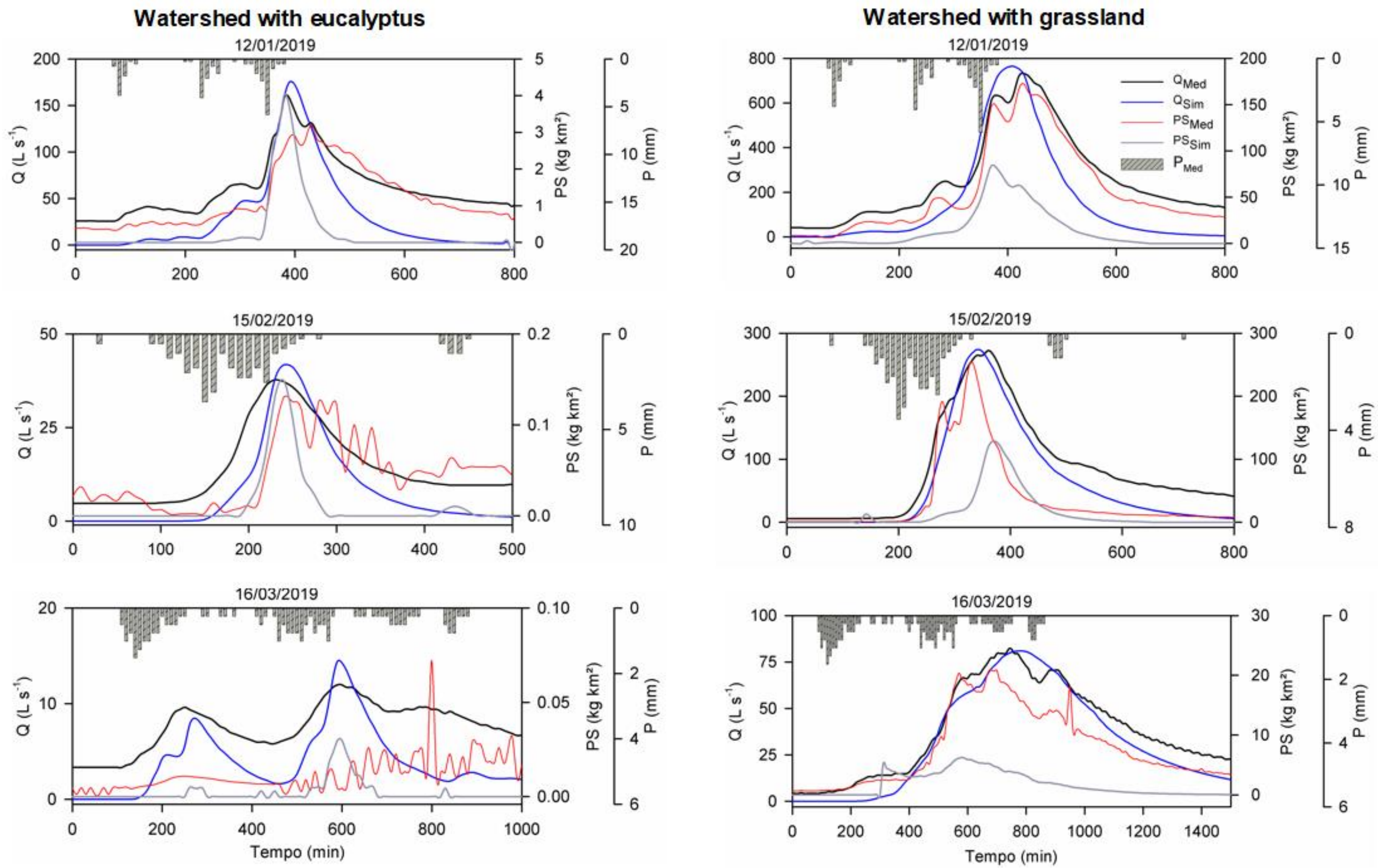
Table 1: Hydrological variables measured (Mea) and simulated (Sim) for the two basins during the three simulated rain events.

Date		Watershed with eucalyptus			Watershed with grassland		
		12/01/19	15/02/19	16/03/19	12/01/19	15/02/19	16/03/19
P	(mm)	28,956	31,496	29,464	29,0	31,8	29,5
$I_{max\ 1h}$	(mm)	12,9	11,7	11,7	11,7	14,0	6,6
Q_{peak} (L s^{-1})	Mea	157,7	37,8	12,0	732,4	272,5	81,9
	Sim	175,365	41,778	14,427	765,3	274,1	81,0
T_{peak} (min)	Mea	380	230	590	430	570	740
	Sim	390	240	590	410	200	790
SR (L)	Mea	555.727,3	139.799,5	52.628,8	4.064.796,8	1.786.839,5	1.041.003,4
	Sim	655.854,9	113.478,3	56.109,0	3.769.525,2	1.745.114,4	1.130.840,1
SSC_{Max} (mg L^{-1})	Mea	59,4	13,3	15,4	372,5	1.649,3	480,8
	Sim	51,0	8,0	5,0	210,0	3.241,0	542,0
SP_{Total} (Mg)	Mea	0,1175	0,0030	0,0016	4,41	2,77	1,15
	Sim	0,0288	0,0008	0,0003	1,06	1,25	0,25
PBIAS SR	Q_{peak}	11,2	10,6	20,5	4,5	0,6	-1,1
	T_{peak}	2,6	4,3	0,0	-4,7	-64,9	6,8
	SR_{Total}	18,0	-18,8	6,6	-7,3	-2,3	8,6
PBIAS SSC	Max	-14,16	-39,94	-67,56	-43,63	96,51	12,74
	T_{peak}	-25,49	-29,41	-26,25	-34,55	-50,00	-45,61
PBIAS SP_{Total}	(kg)	-75,5	-74,9	-83,0	-75,9	-55,0	-78,3
	(kg km²)	-75,5	-74,9	-83,0	-76,3	-59,0	-78,7
	T_{peak}	-11,6	0,0	-26,3	-14,0	12,1	-14,7
NSE	Hid	0,54	0,65	-0,42	0,66	0,96	0,93
	SSC	-10,60	-2,93	-2,19	-79,15	-2,37	-15,45
	SP	-1,14	-0,75	-1,70	-0,21	0,19	-0,52
	$SP_{Specific}$	-1,14	-0,75	-1,70	-0,21	0,18	-0,52
r^2	$Q_{sim/obs}$	0,55	0,47	-0,27	0,67	0,96	0,94

Where: Precipitation (P); Maximum intensity of rain in one hour ($I_{max\ 1h}$); Peak flow (Q_{peak}); Peak time (T_{peak}), Surface runoff (SR); Suspended sediment concentration (SSC), Sediment production (SP).

RESULTS

Figure 1: Precipitation, hydrograph and sedimentogram measured and simulated during the three monitored rain events for the basins with eucalyptus and grassland.



CONCLUSION

- LISEM satisfactorily represented the runoff in rainfall events of different intensities for both basins, supported by the Nash and Sutcliffe coefficients (> 0.50) and PBIAS or ERROR (< 25% for runoff and < 55% for the production of sediments).
- The model was unable to represent sediment production satisfactorily (< 0.50). This may be associated with spatial variability of the soil and the characteristics of the model used, which simulates the surface flow promoted by individual rainfall events in watersheds.

Our studies are in the early stages, continued monitoring is necessary to evaluate events of different magnitudes, and to identify a model capable of adequately representing the predominant subsurface runoff in forest areas.

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