EGU General Assembly 2020

Event runoff calibration with LISEM in a recently burned Mediterranean forest catchment

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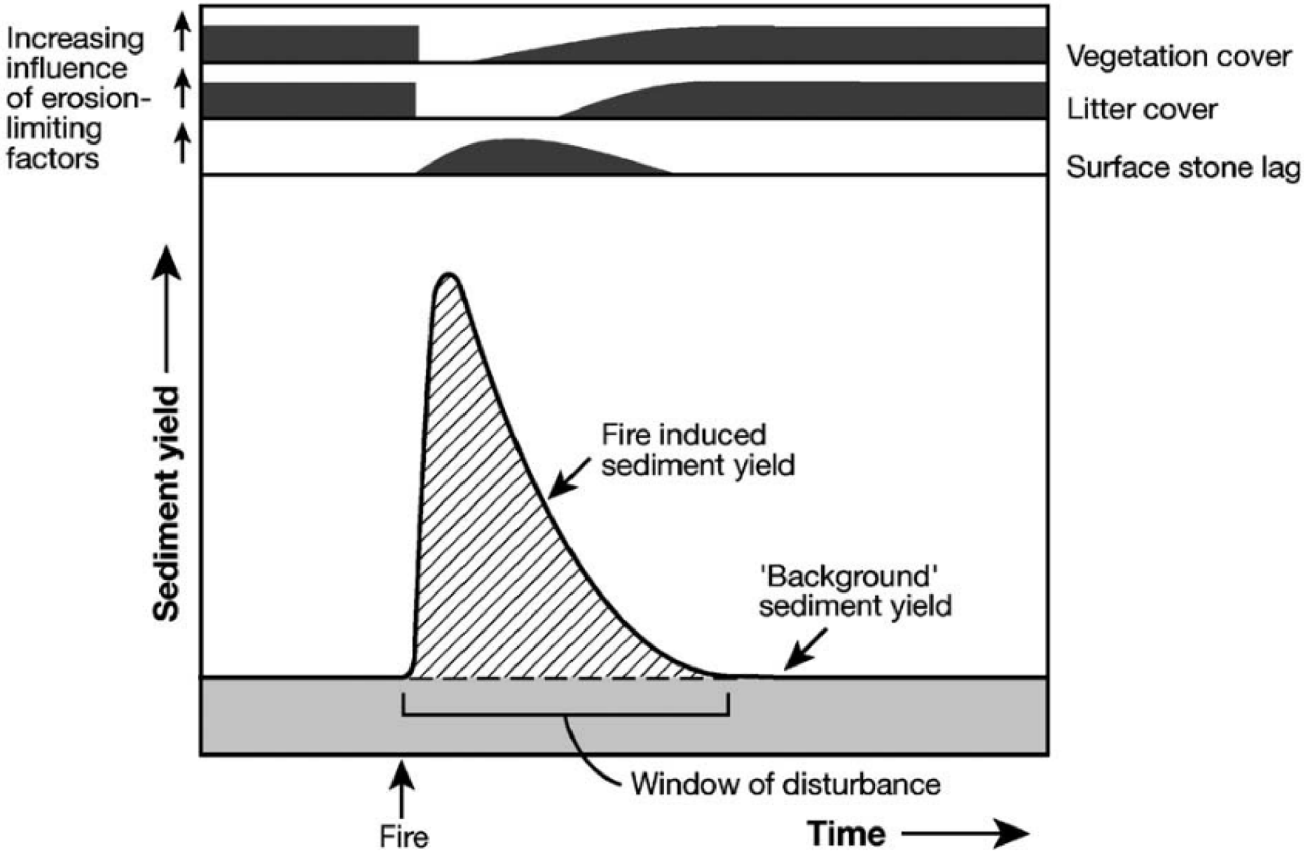
Introduction

Window of disturbance model

years

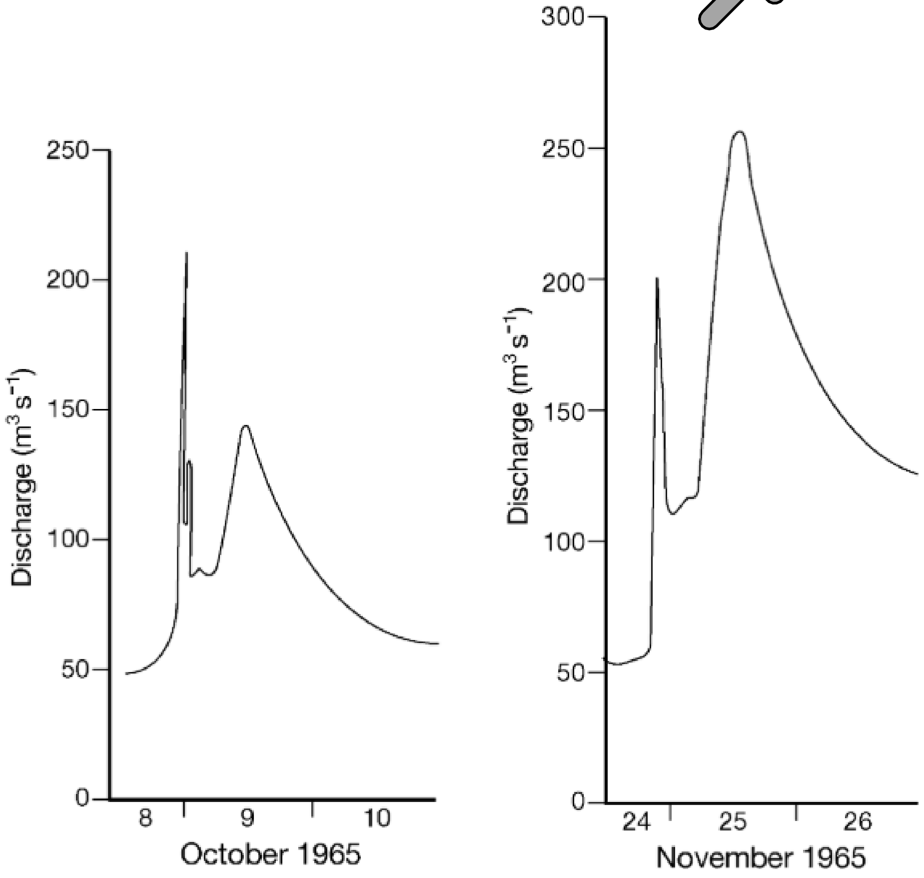
R.A. Shakesby, S.H. Doerr / Earth-Science Reviews 74 (2006) 269–307



Post-fire events

hours/days

modified from Brown, 1972



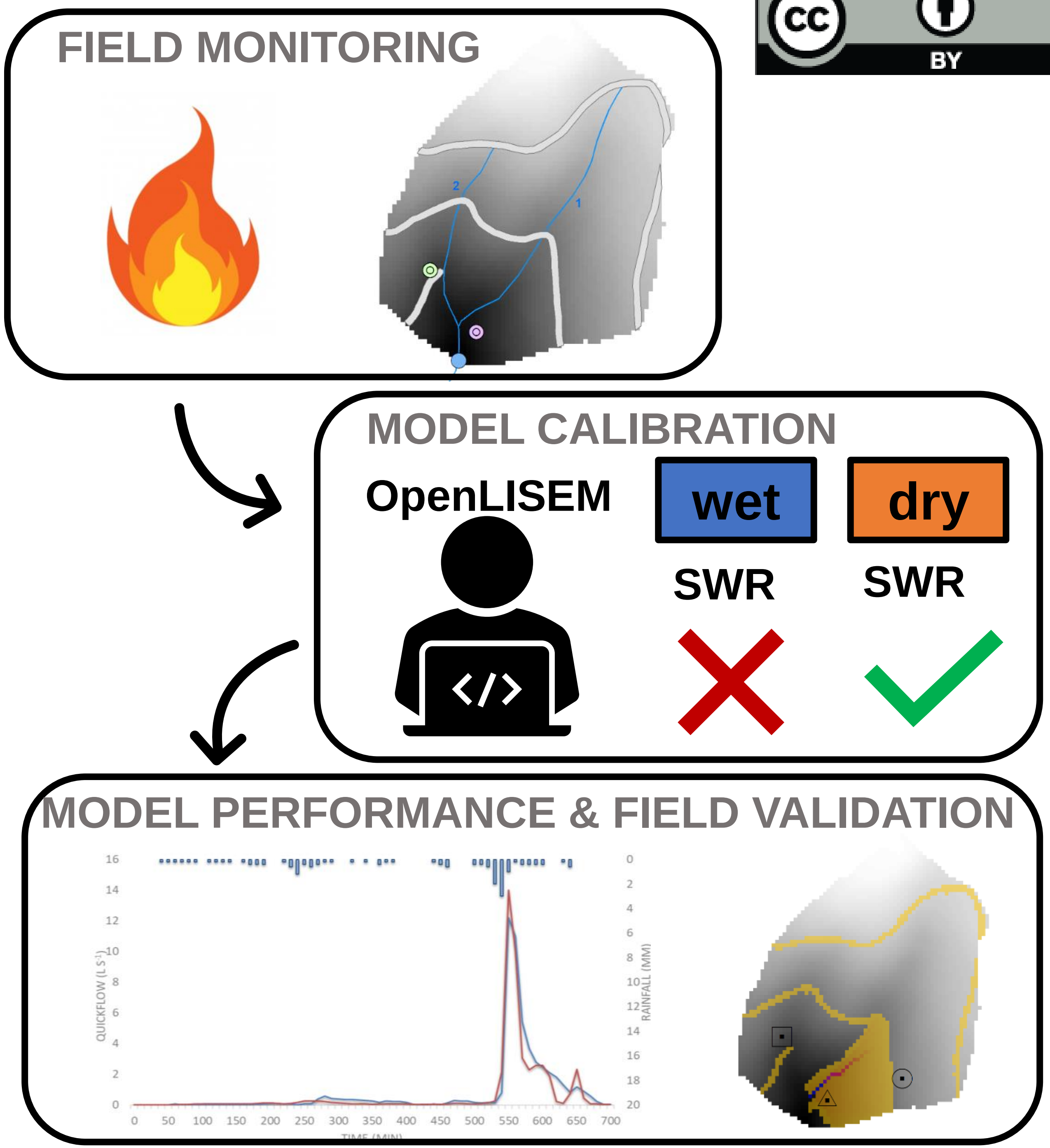
The size of the **post- fire increases** in hydrological response can be up to **several orders of magnitude** of difference, with increases in total flow being often considerably less than those in peak discharge.

Research question & approach

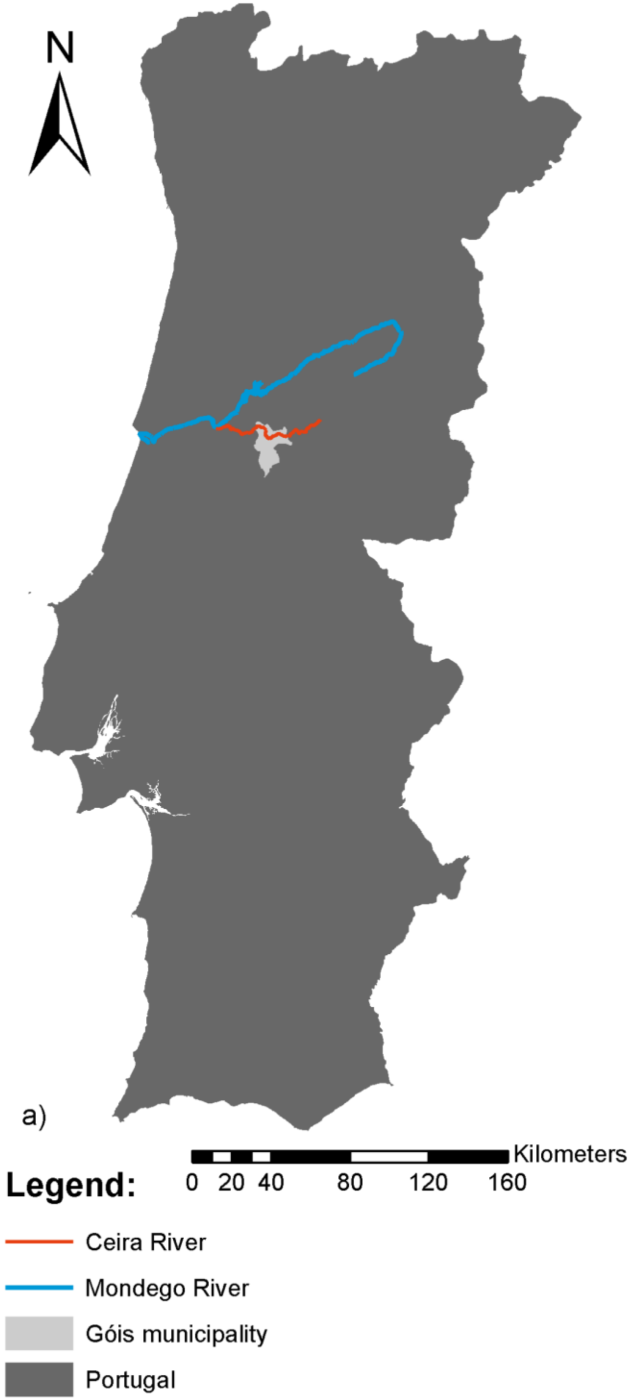
Objective

Improve the understanding of the hydrological response of recently burnt catchments and the role of soil water repellency (SWR).

1. Can OpenLISEM simulate the quickflow of events with contrasting initial soil moisture content (SMC), presumed SWR conditions?
2. Can OpenLISEM be optimized by adjusting infiltration capacity as a simple function of initial SMC?
3. How do runoff predictions fit with field observations?



Study site



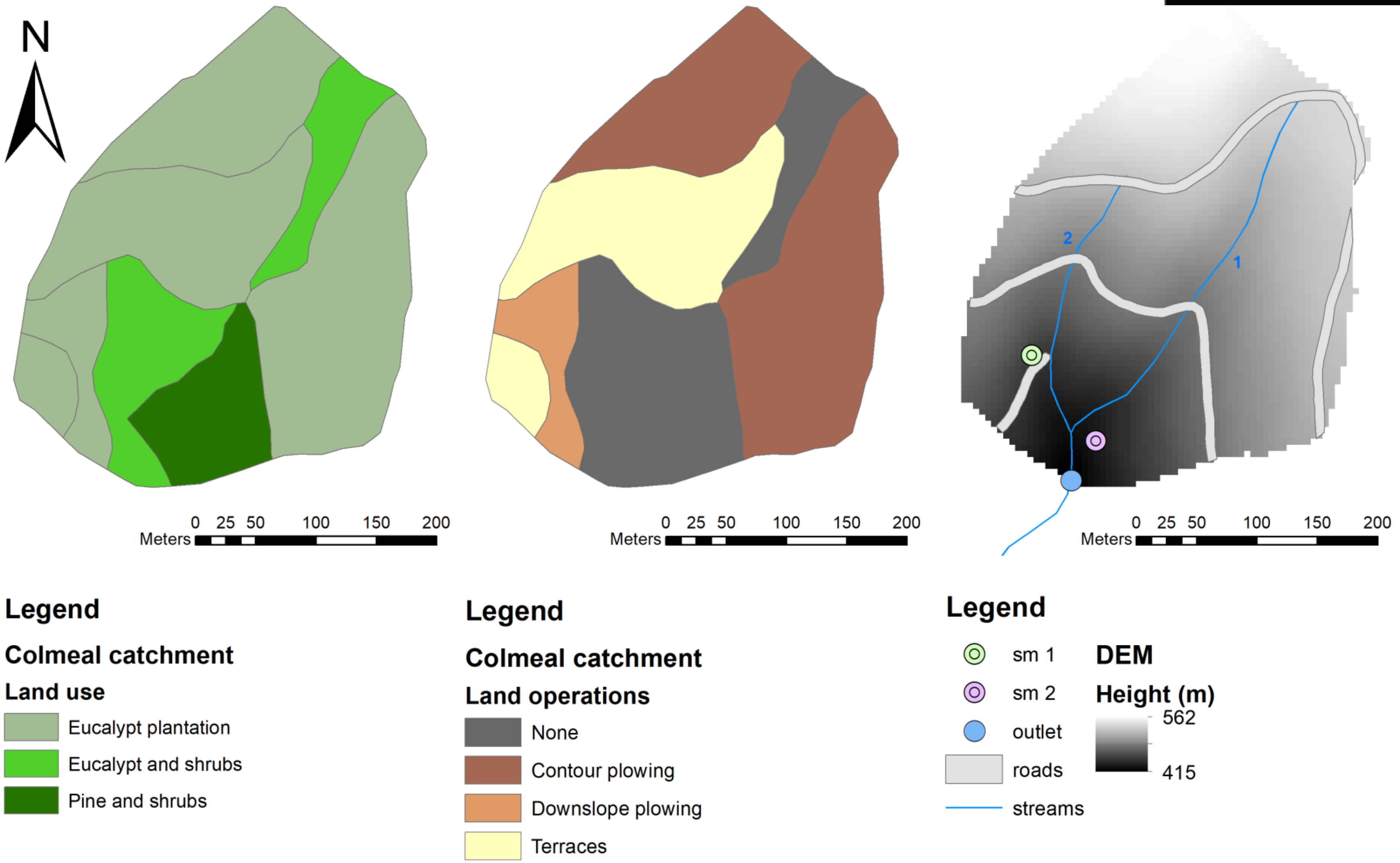
Climate

- humid meso-thermal
- mean temperature 12°
- mean rainfall 1133 mm

Study site

Overall

- catchment of 10 ha;
- maritime pine stands and eucalypt forest plantations;
- distinct land operations;
- low-to-moderate burn severity



Monitoring

- hydraulic channel at the outlet;
- discharge measured w/ ultrasonic sensor (5 min);
- SMC registered continuously (sm1, sm2, outlet);
- monthly SWR measurement

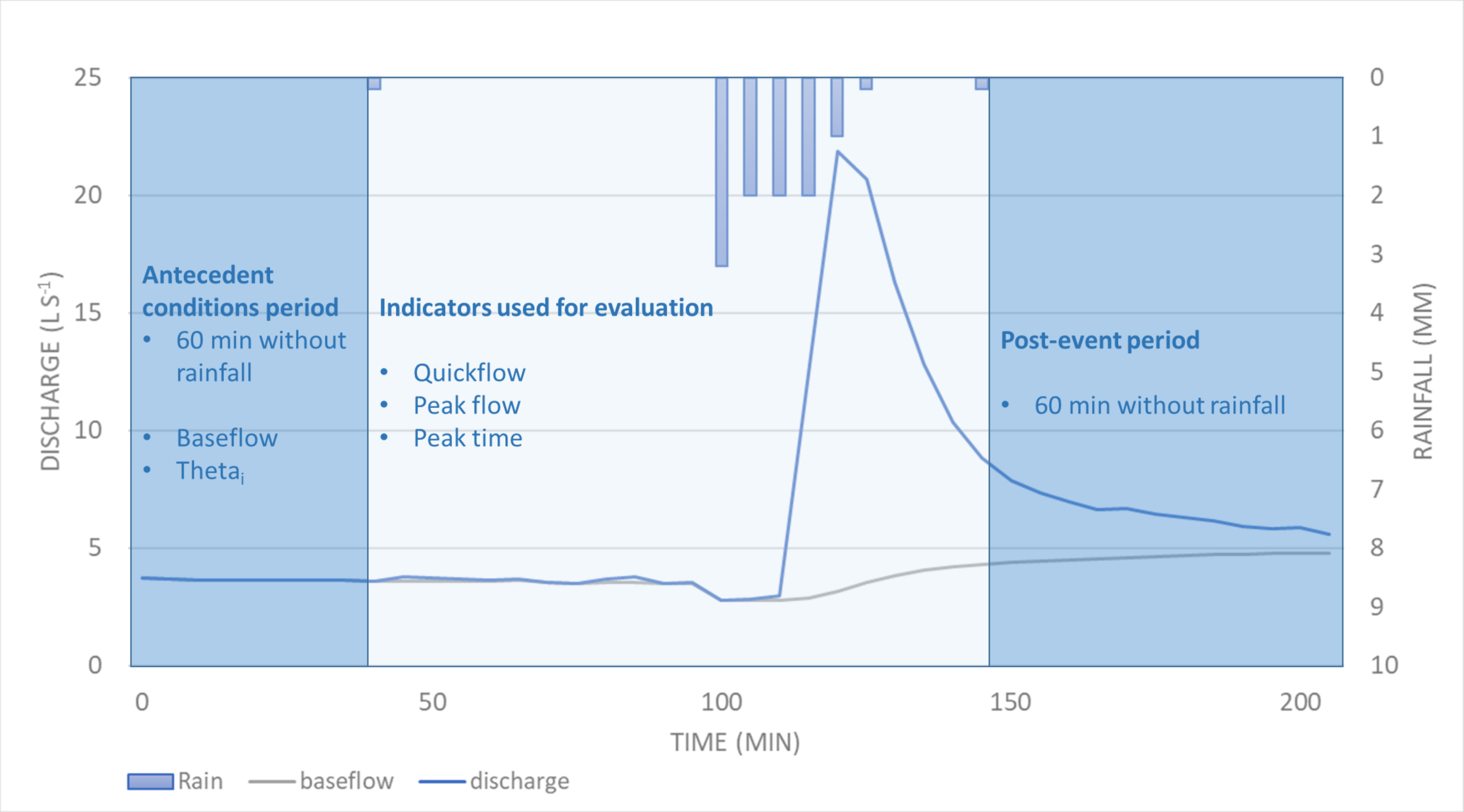
Event selection & data

Selection
- 16 events

Classification
Mean catchment $theta_i$
dry < 17% vol. < wet

- 7 events dry
- 9 events wet

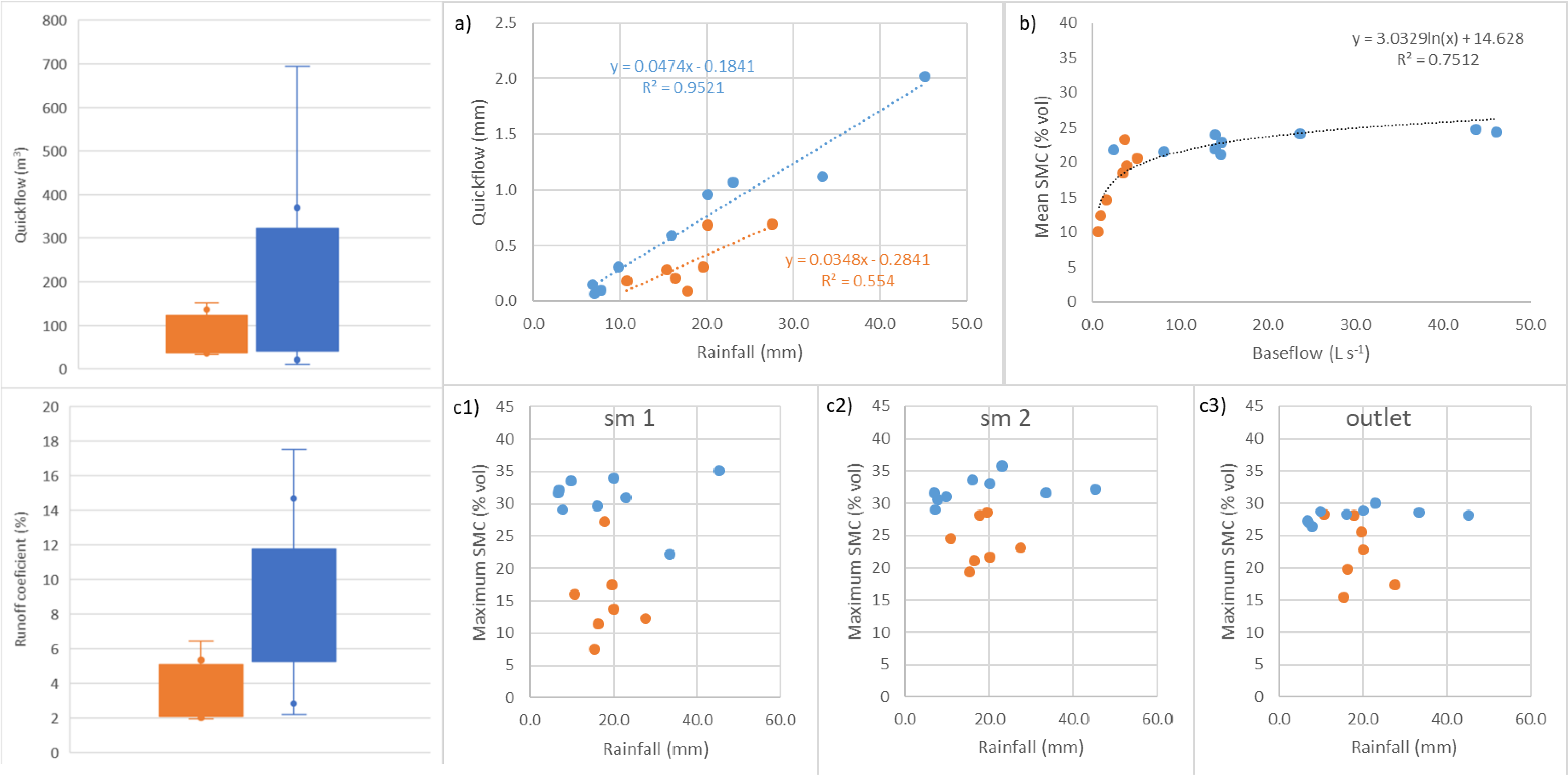
Data
Baseflow separation, since OpenLISEM does not simulate baseflow.



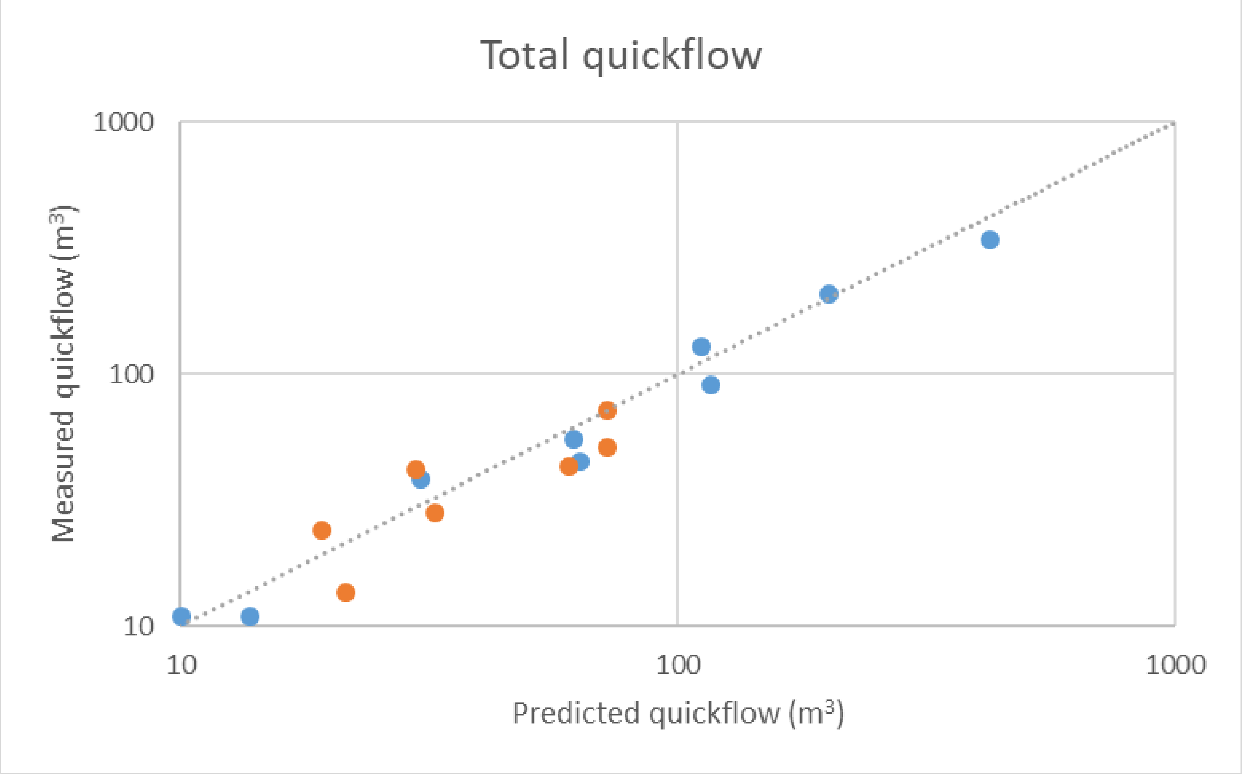
Results - Event classification

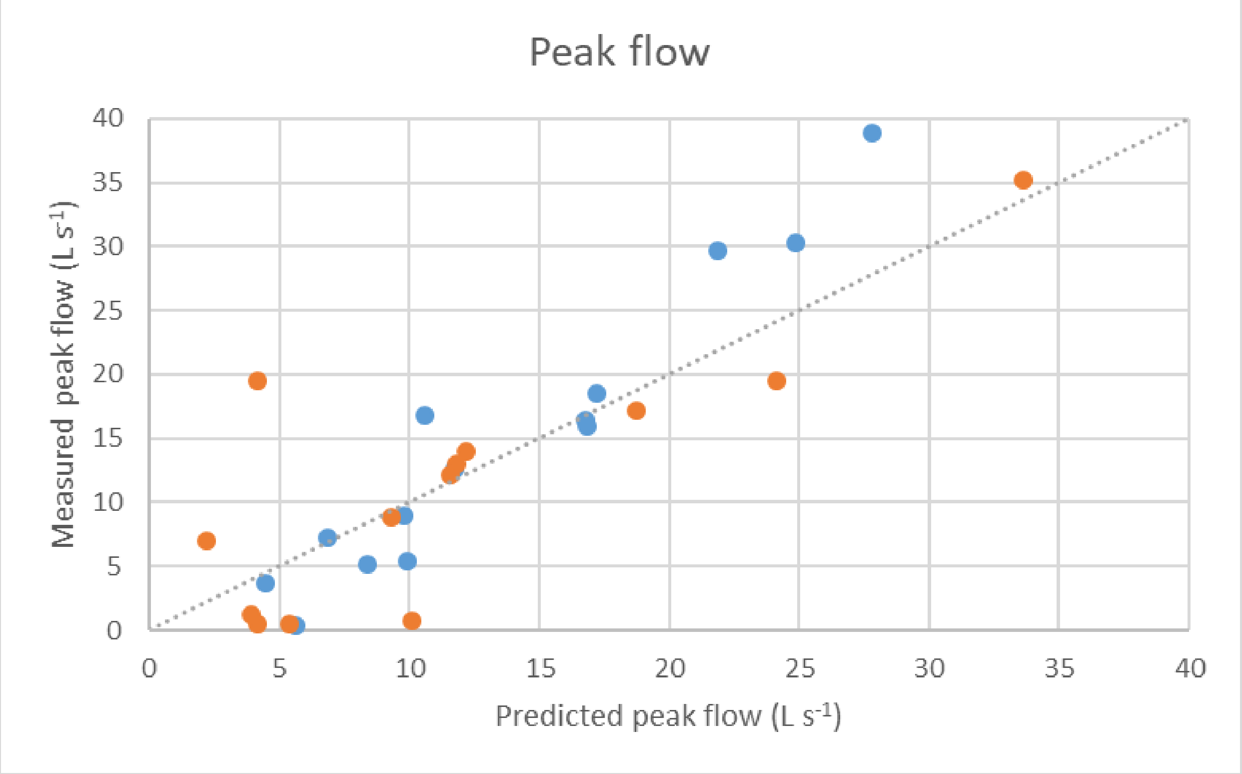
wet

dry



Results – Model performance (manual cal.)





Efficiency assessment	Indices	Total discharge	Peak discharge	Time peak
Overall	NSE	0.95	0.68	1.00
	R2	0.97	0.88	1.00
	PBIAS	-10.01	7.14	0.66
Dry	NSE	0.71	0.58	1.00
	R2	0.87	0.72	1.00
	PBIAS	-10.85	-10.76	1.58
Wet	NSE	0.94	0.54	1.00
	R2	0.99	0.96	1.00
	PBIAS	-9.76	19.22	-0.50

Results – Parameterization sets

A statistical parameterization set was built relating manual calibration with:

- antecedent precipitation index (API, -)
- baseflow (L s^{-1}) event duration (min)
- initial soil moisture content ($theta_i$, cm^3 cm^{-3})
- maximum rainfall intensity (Imax, mm s^{-1})
- total rain (mm)

Calibration procedure		Adjusted R-squared	p-value	OpenLISEM performance predicting total discharge		
				NSE	R^2	PBIAS
overall	$all = 0.084 + 0.0004\,duration + 0.0026\,rain + 2.1419\,theta_i$	0.77	<0.0001	**0.58**	0.67	11.60
combined	$wet = 0.3344 + 0.0003\,duration + 0.0026\,rain + 1.1691\,theta_i$	0.97	<0.001	**0.86**	0.87	-6.40
	$dry = -0.5687 - 0.0863\,baseflow + 0.0015\,duration + 0.0053\,Imax - 0.024\,rain + 7.5182\,theta_i$	0.95	<0.5			
manual calibration		-	-	**0.95**	0.68	-10.01

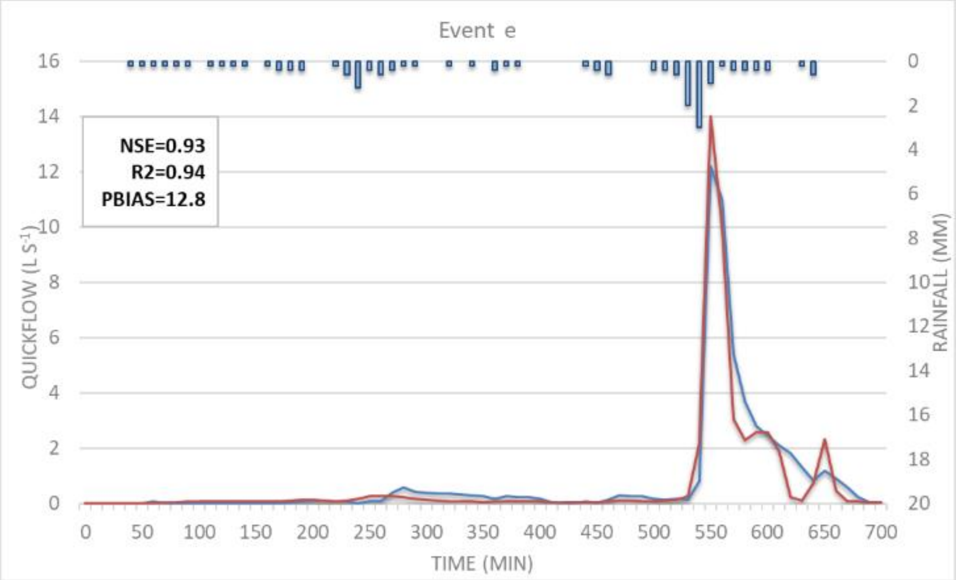
Results – Model simulations

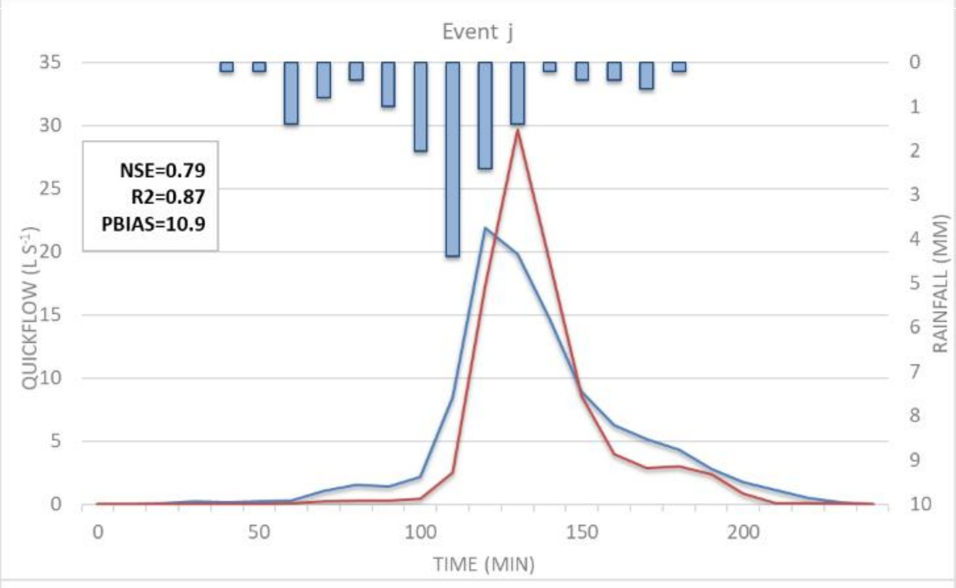
Outlet

- Model simulations agree with quickflow measurements

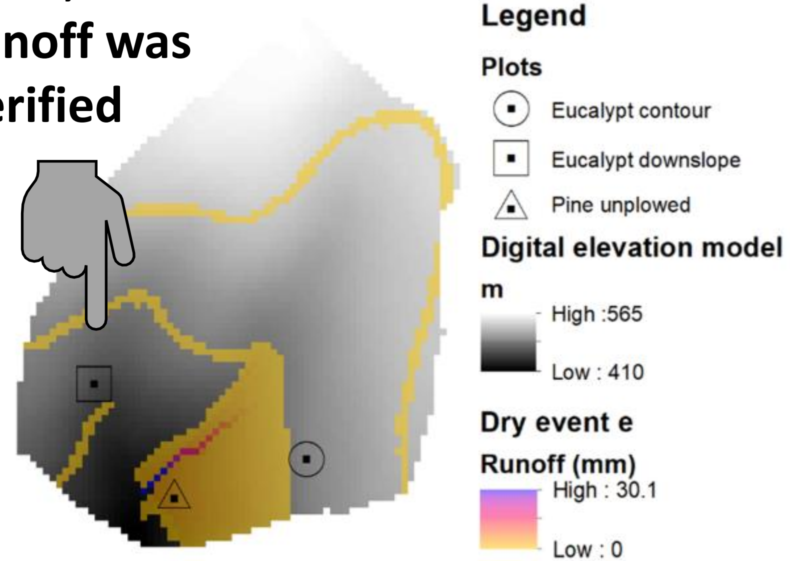
Spatial predictions

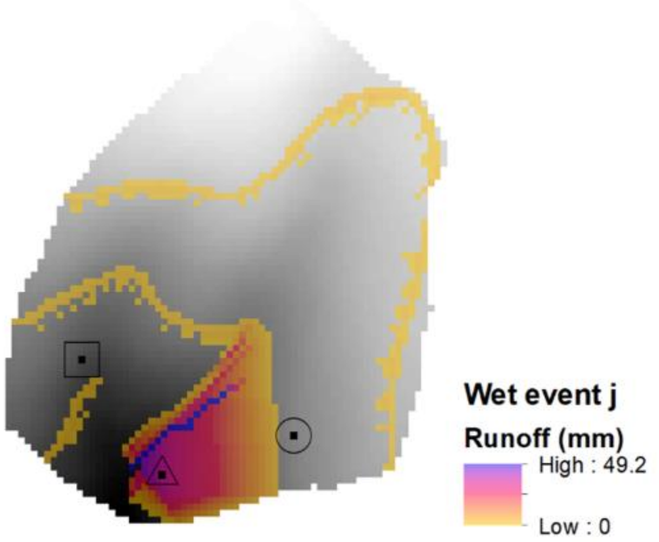
- Low agreement between simulations and runoff plots





No runoff was simulated in 2/3 monitored plots, where runoff was verified





Discussion

Fragilities

- Model calibration for two distinct initial soil moisture conditions:
    - Wet or dry classification → inconsistencies with field data
    - SMC is the main predictor of SWR → other variables affect model calibration (rainfall amounts and storm duration)
    - Spatial predictions have a poor agreement with field runoff measurements

Strengths

- Model calibration approach:
    - OpenLISEM can be calibrated by limiting water storage capacity of soil
    - Statistical models can provide alternative inputs sets

Conclusion

This modelling exercise revealed that OpenLISEM has a **strong potential** to simulate post-fire hydrological response, especially if SWR component can be considered in the simulations, and if more detailed information is provided to the model, namely high resolution of **SWR measurements** and **spatially distributed SMC**.

Thanks for your attention!

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post-fire erosion risk modelling tool

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Acknowledgements

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