Post-fire soil erosion mitigation in Portugal.

Sergio Prats & ESP team
DAO-CESAM

FCT Fundação para a Ciência e a Tecnologia
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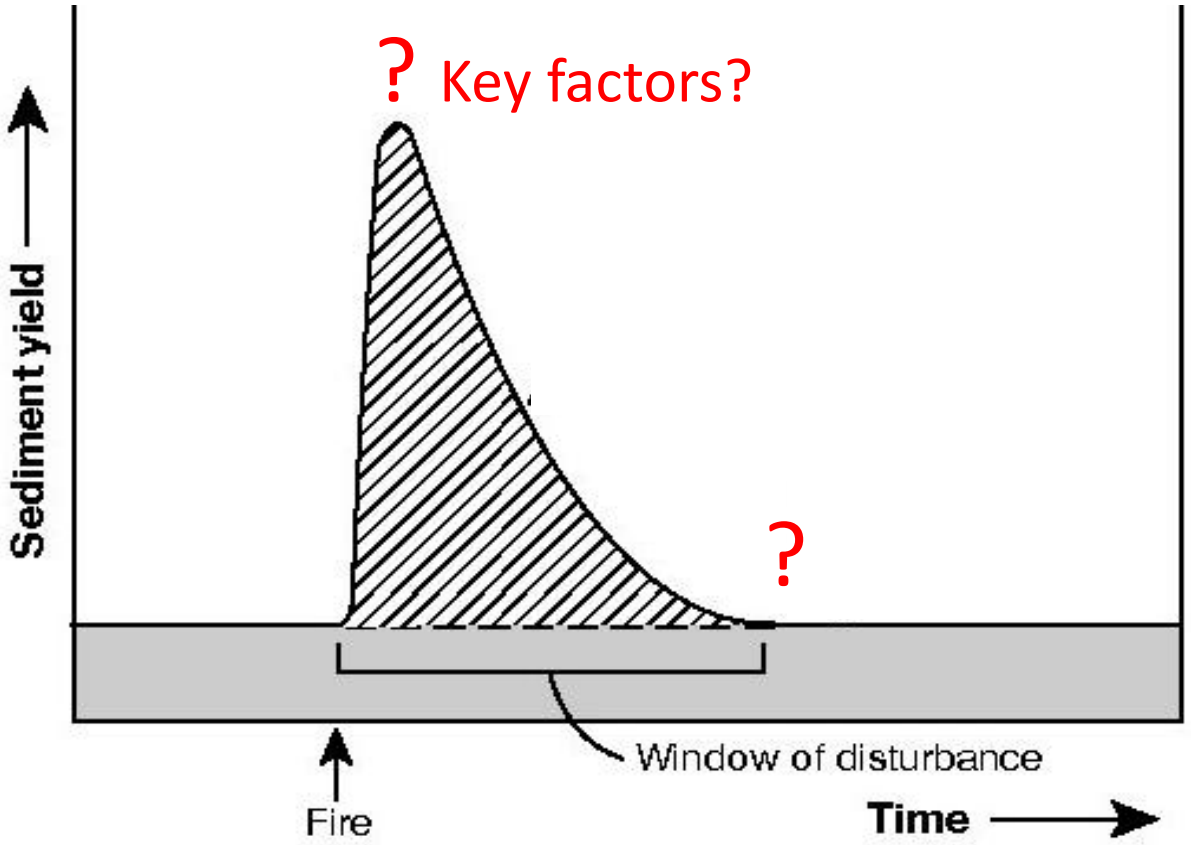
Wildfire effects on soils

Fire severity

Fire severity

Post-fire soil erosion window of disturbance




Eight years after
the Hayman wildfire, CO

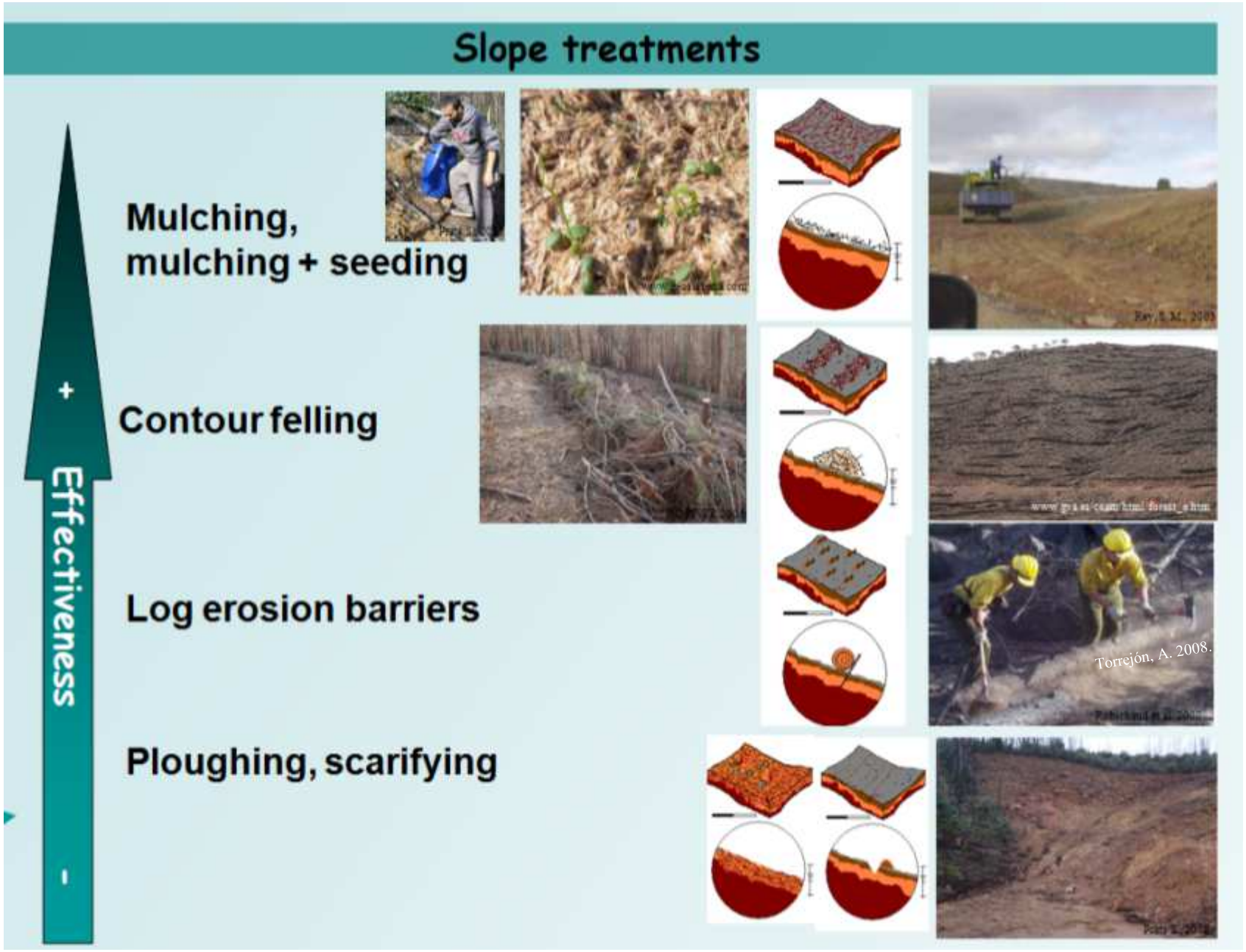
1. Soil erosion risk assessment

Monitoring programs:

-Set-up immediately after the wildfire
-Long term monitoring period (> year)
-Account with enough **control** replicates (>3)
-Account with enough **treated** replicates (>3)

© MacDonald (1994)

2. Post-fire soil erosion mitigation



2. Post-fire soil erosion mitigation

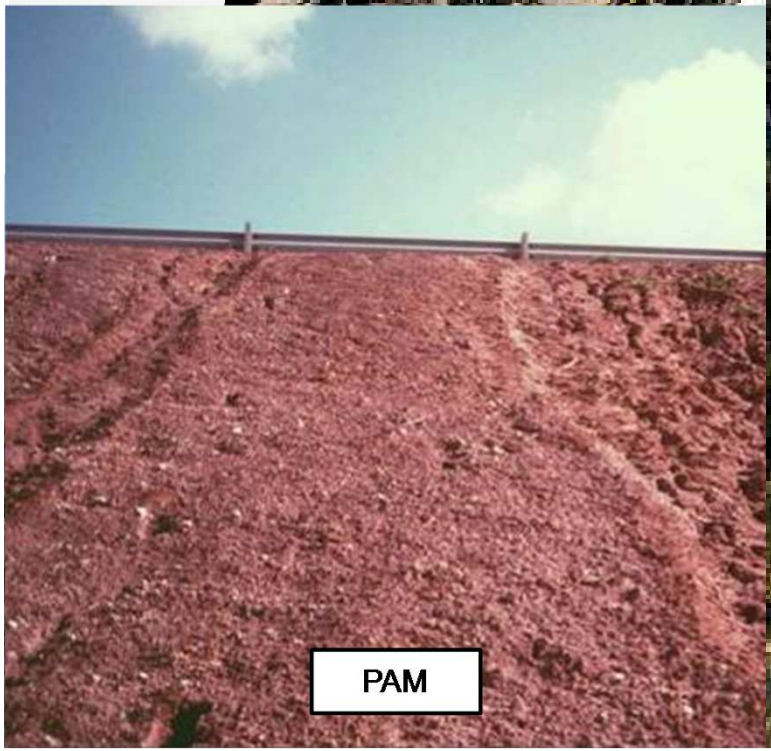
1919- Munns: Check dams

1920: Se

1950: ry

1960: dc

1989 Ta



Straw Mulch ----- Mulch de Palha

Objectives:

•to quantify soil losses in **burnt** plots at long temporal and spatial scales;

•to quantify soil losses in **treated** plots to test the effectiveness of:

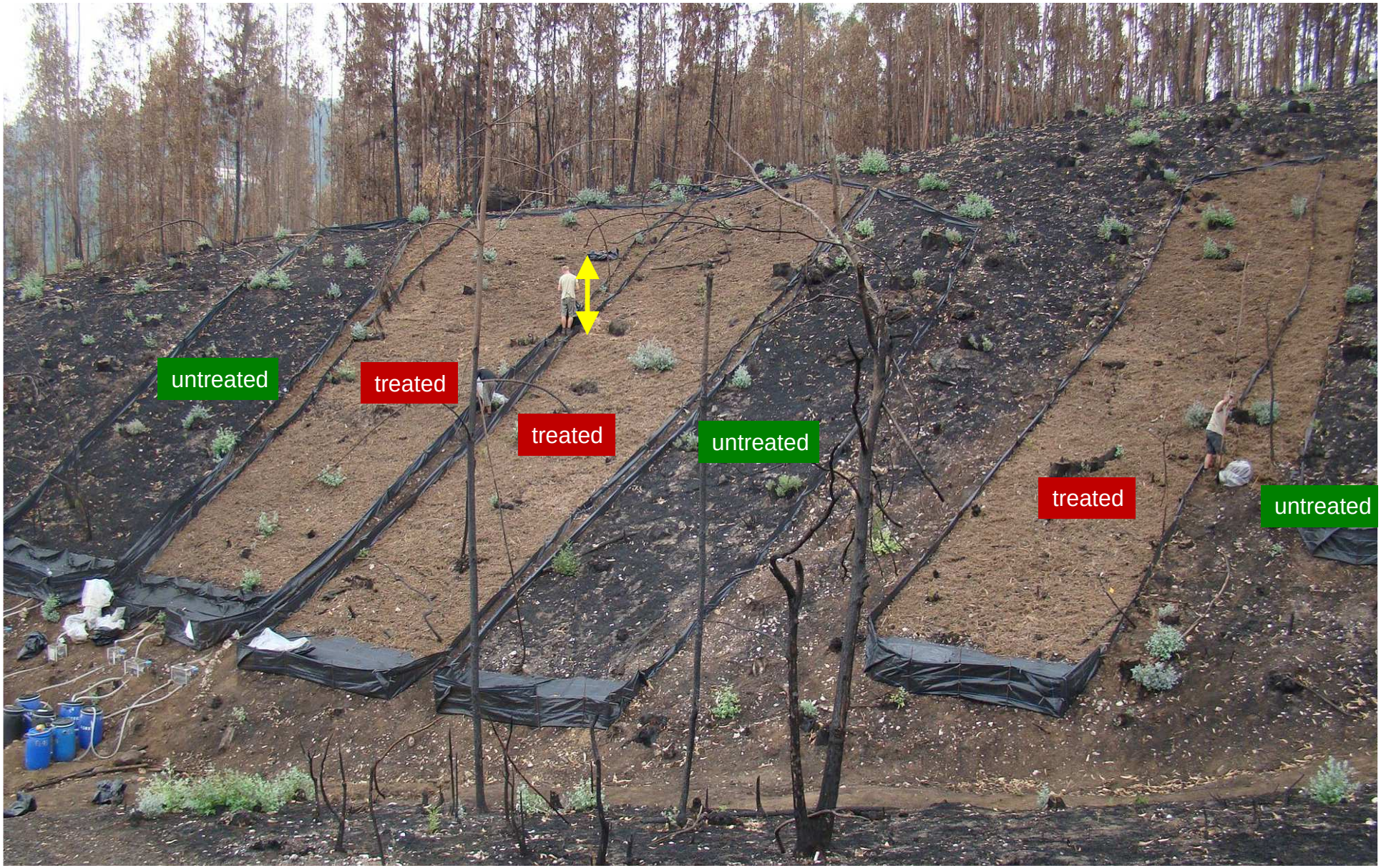
1. eucalypt chopped bark mulch;
2. eucalypt logging slash mulch;
3. dry polyacrylamide (PAM);
4. hydromulch;

•to identify **key factors** explaining post-fire runoff and erosion with and without treatments.

Material and Methods

Erosion plots

Erosion plots



Methods

-rainfall (mm; mm h^{-1})

-runoff (tanks)

-soil losses (105ºC, 24 h)

-OM % (550ºC, 4 h)

WEEKLY

-soil resitance (torvane + penetrometer)

-soil moisture sensors

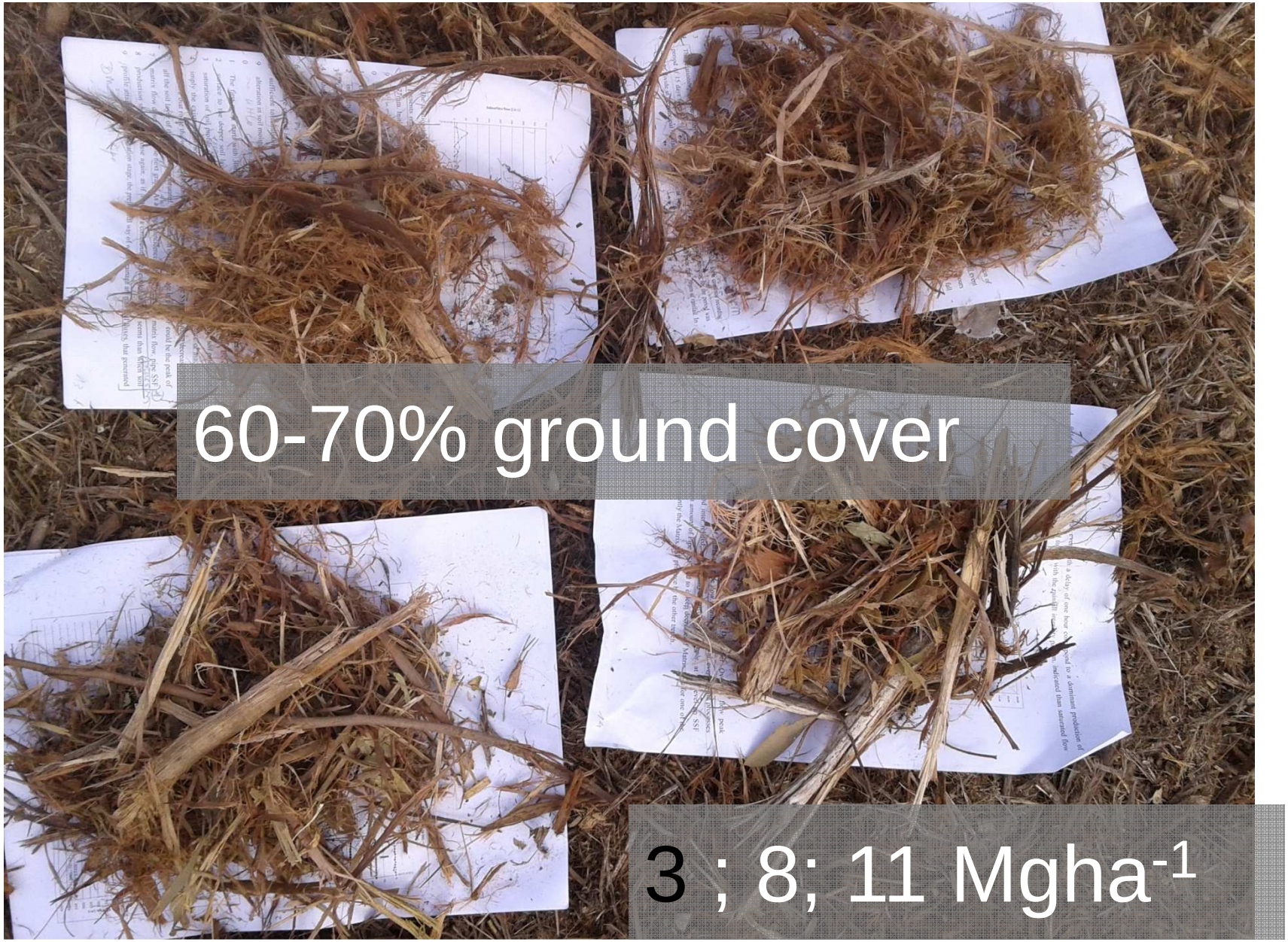
-soil water repellency (MED)

-plot soil cover (grids)

Post-fire soil erosion mitigation treatments in Portugal

Forest residue Mulch
Eucalypt chopped bark mulch

Forest residue Mulch ----- Restos florestais triturados



Eucalypt slash logging mulch ----- Restos florestais sem triturar


Dry PAM ----- Poliacrilamidas
0,05 Mg ha-1

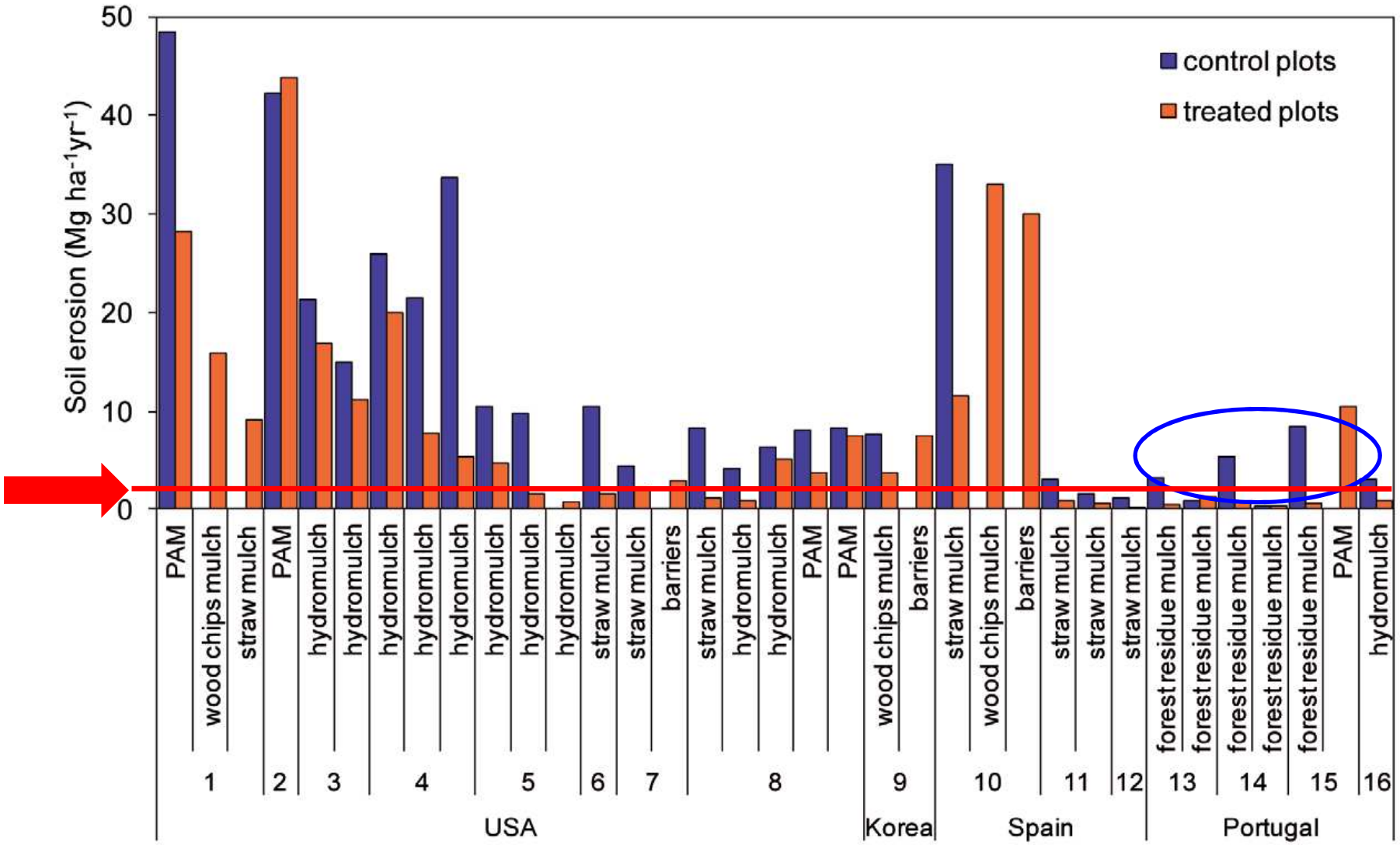
Hydromulch

4 Mg ha^{-1}

Results & Discussion

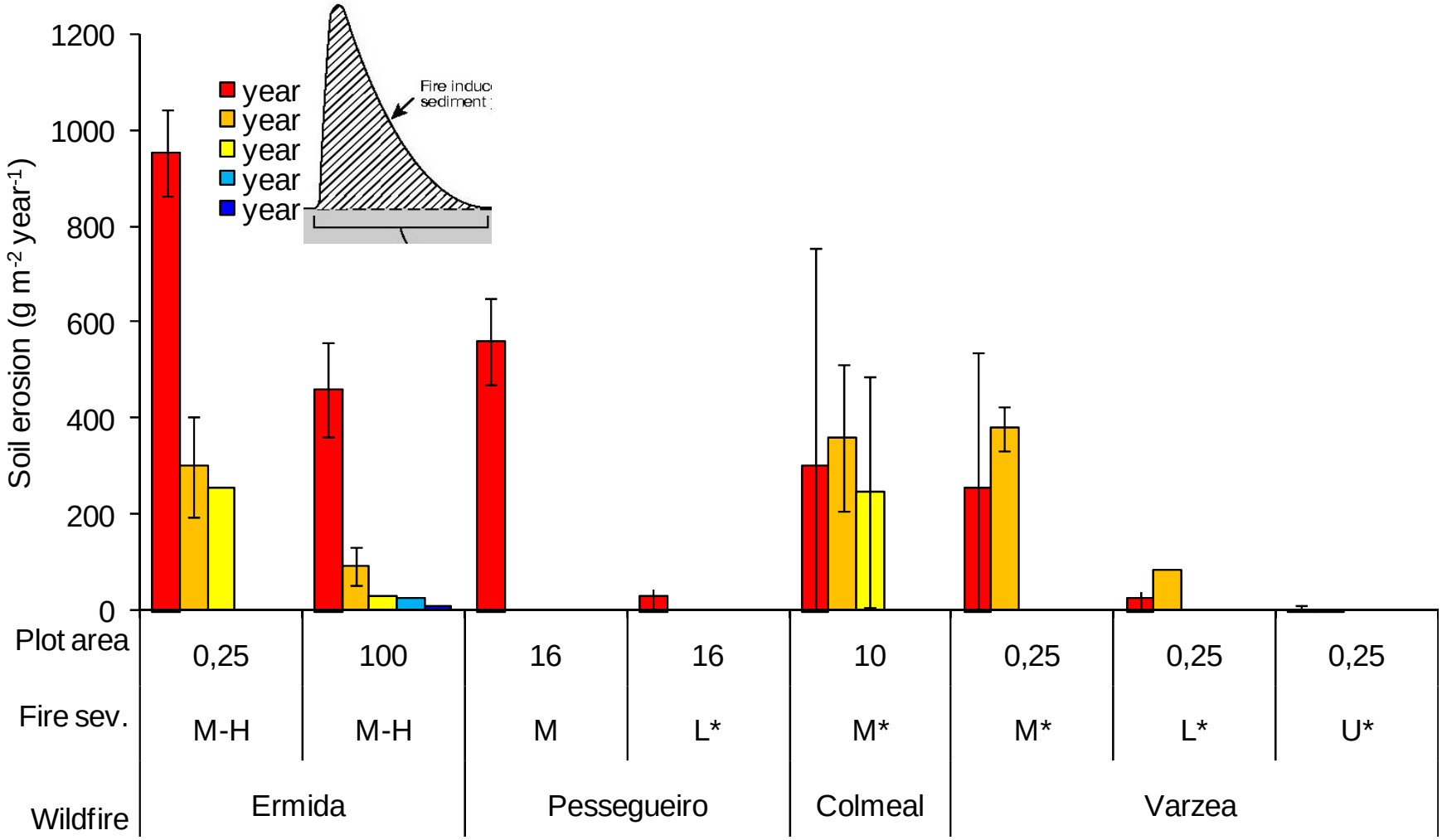
Soil erosion risk
Treatment effectiveness

Post-fire soil erosion worldwide

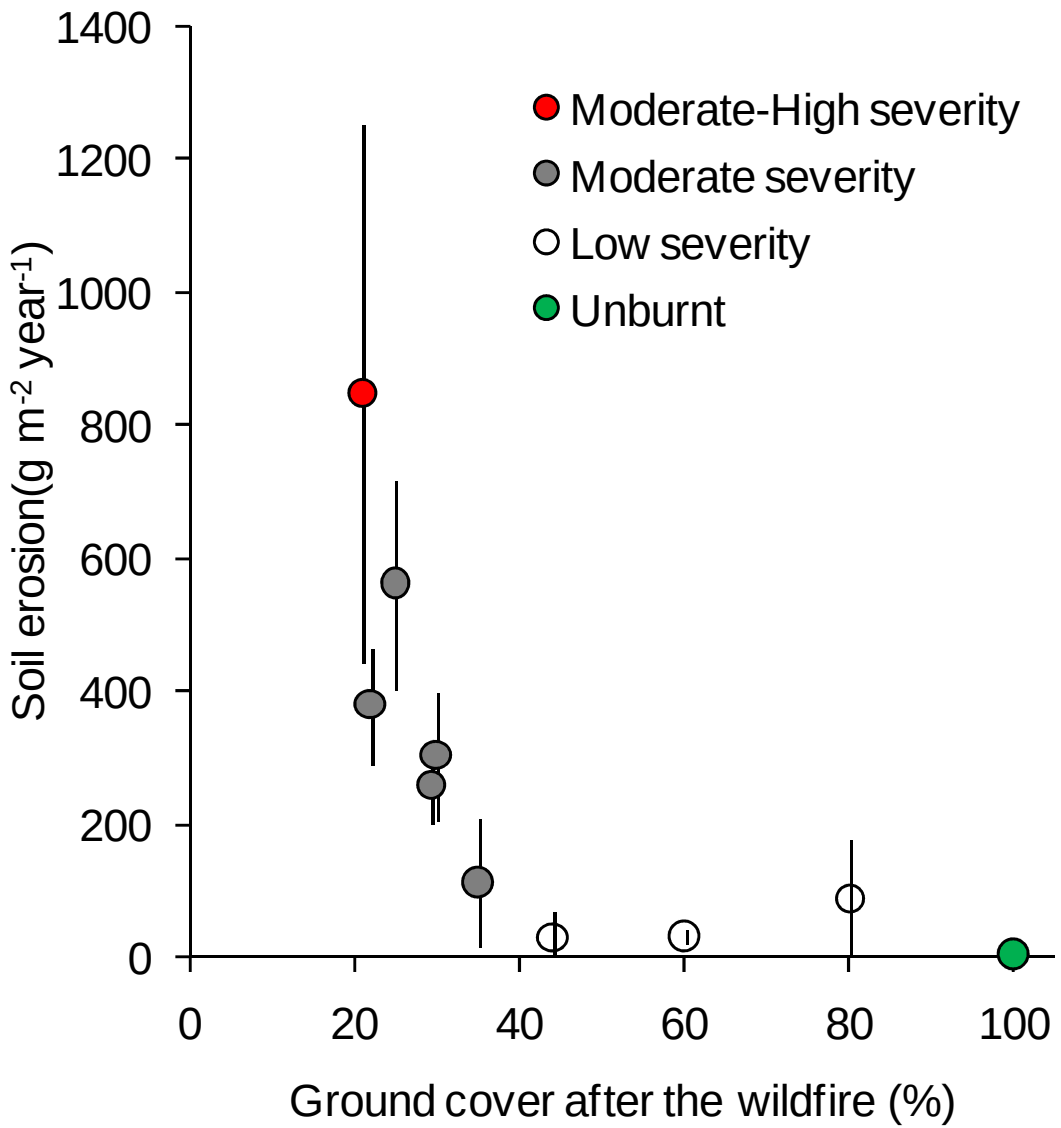


Low soil erosion in Mediterranean regions

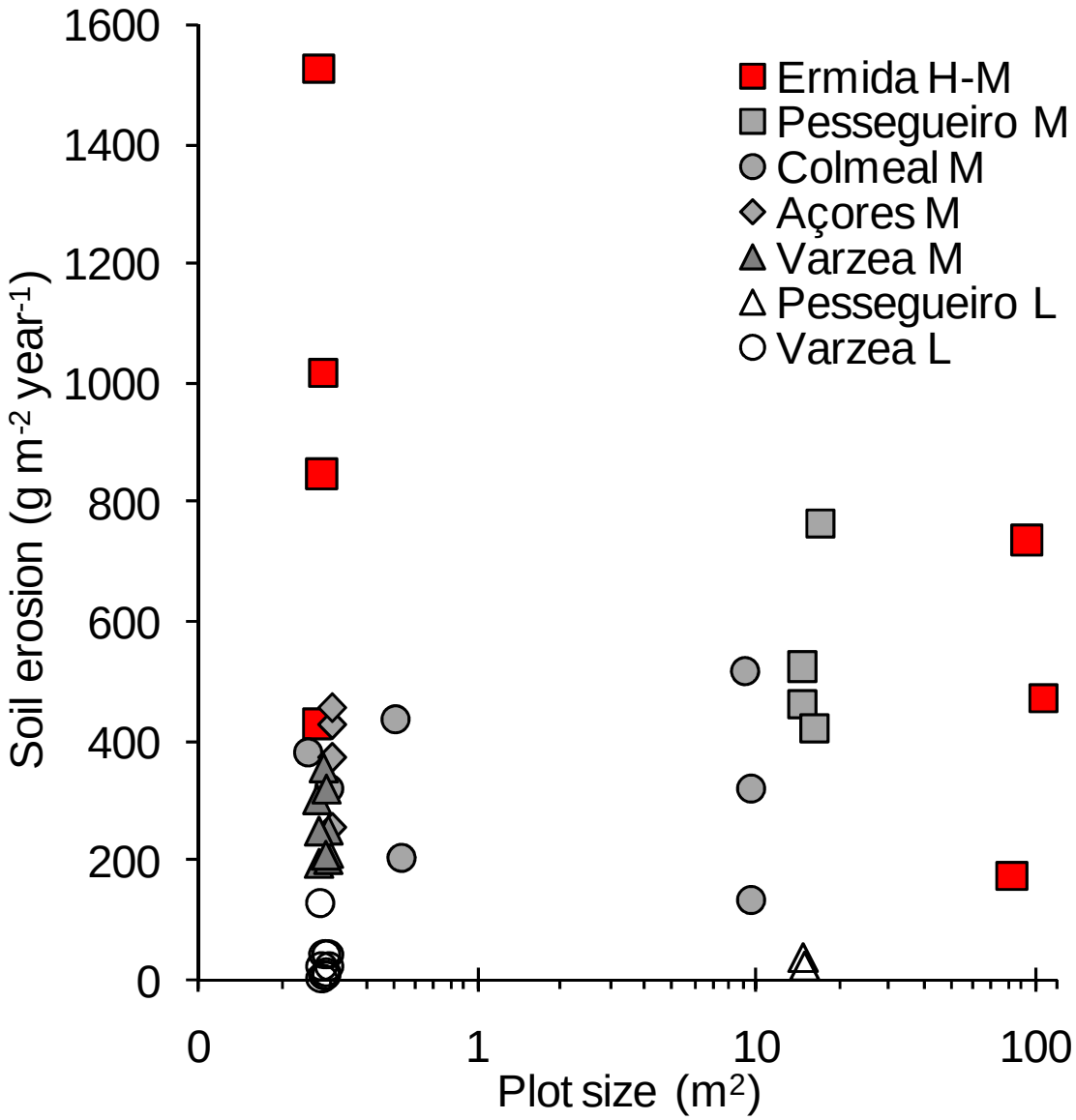
Post-fire soil erosion in Portugal



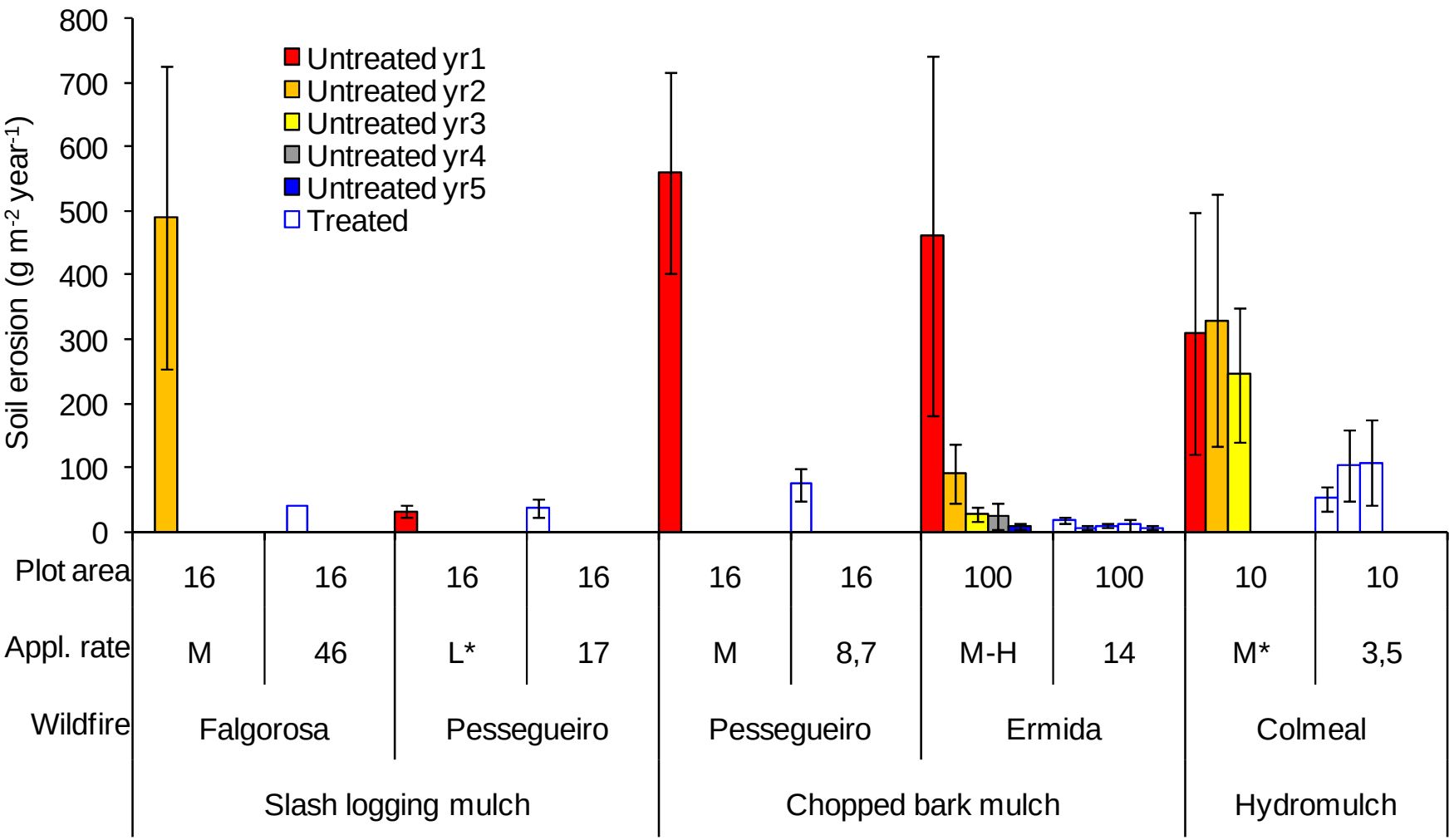
Wildfire severity



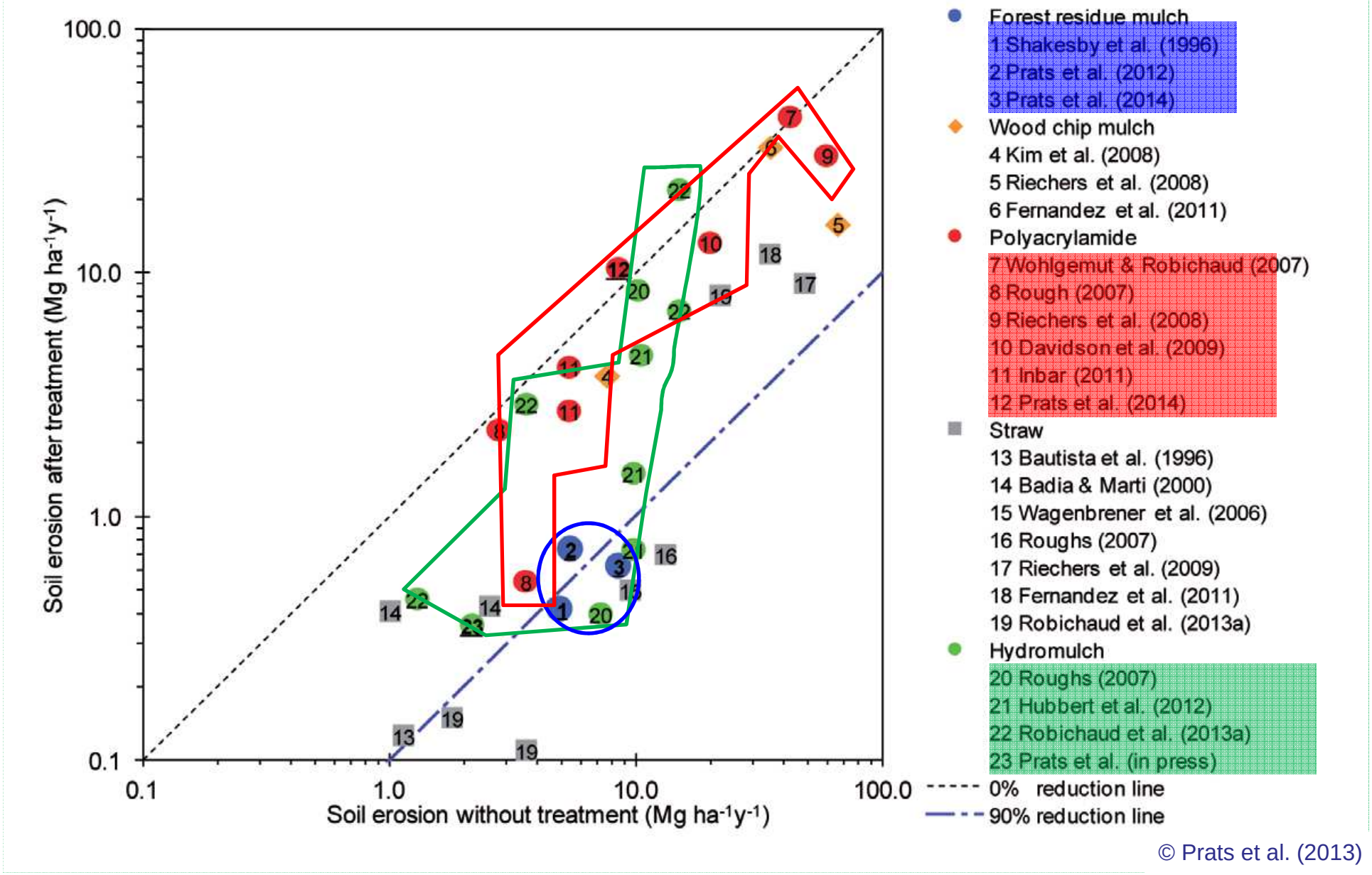
Scale effect



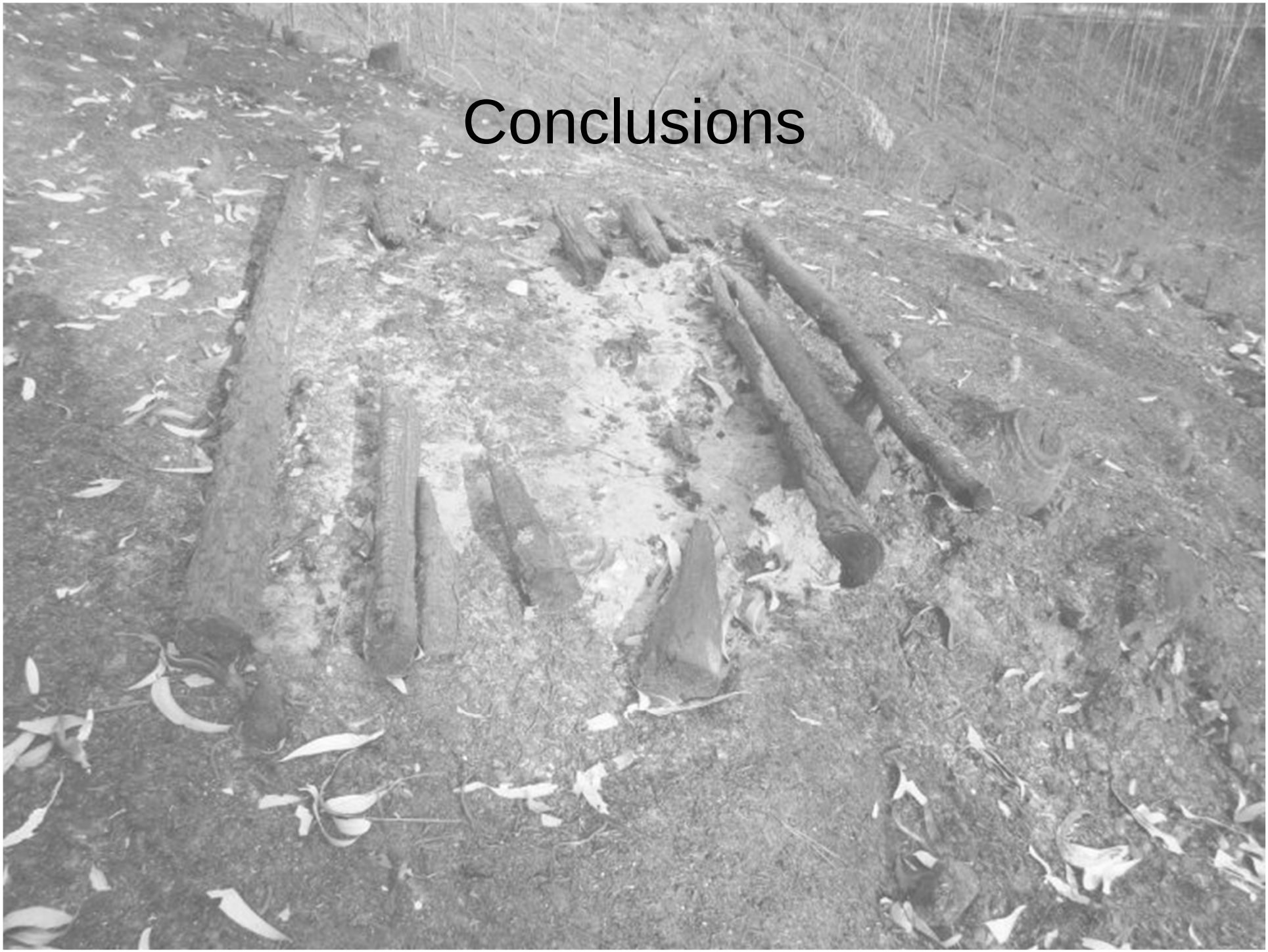
Mulch effectiveness



Treatment effectiveness: overall



Conclusions



Conclusions

1. Post-fire soil losses are low, but still higher than soil formation rates estimates.

2. Some field indicators (20º slope, 10-5% ground cover, grey-red ashes) are useful for indentifying risky areas.

3. Chopped bark mulching is the most effective (similar to straw), reducing around 90% soil erosion (Gcover 70%);

4. Dry PAM did not reduce soil erosion;

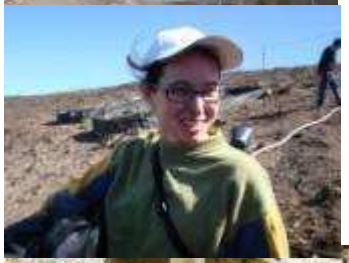
5. Hydromulch was effective but expensive.













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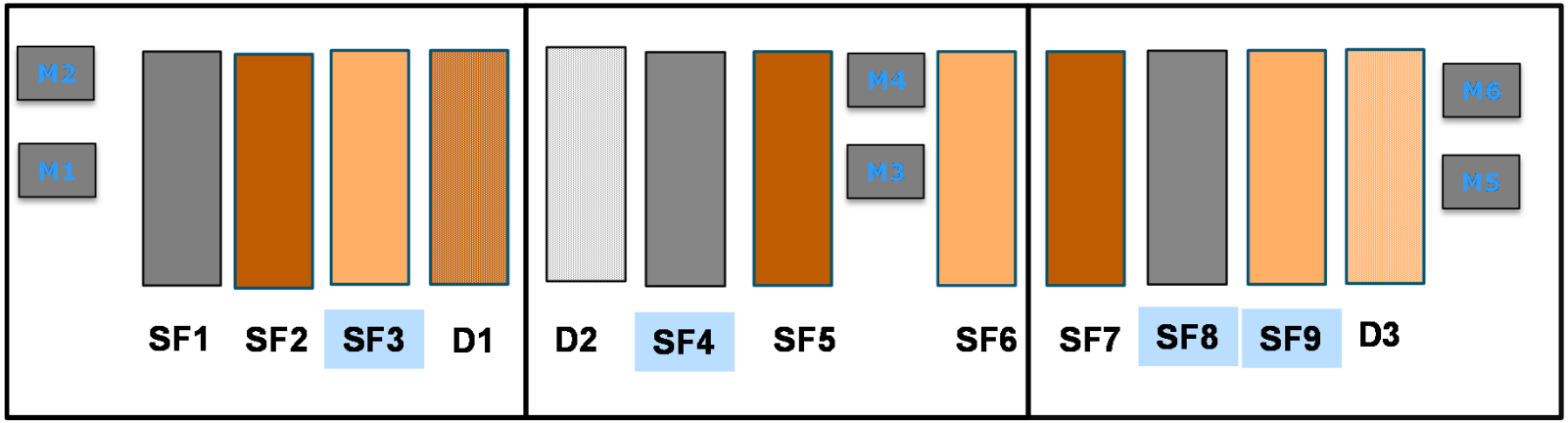
Muito obrigado

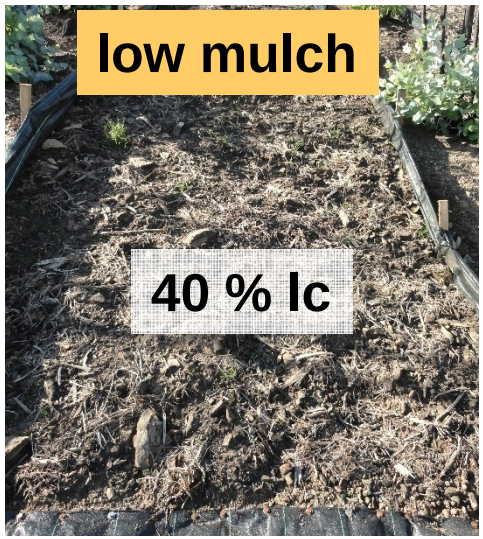
Comments are welcome

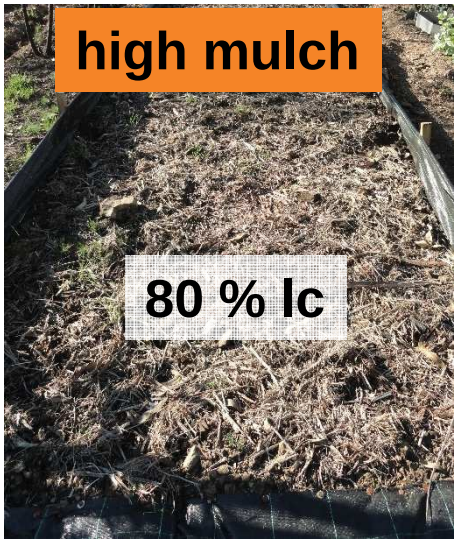
Ongoing research

1. Laboratory testing: Lowest-but-effective application rate. FCTU Coimbra

2. Field testing: Semide wildfire (2015)







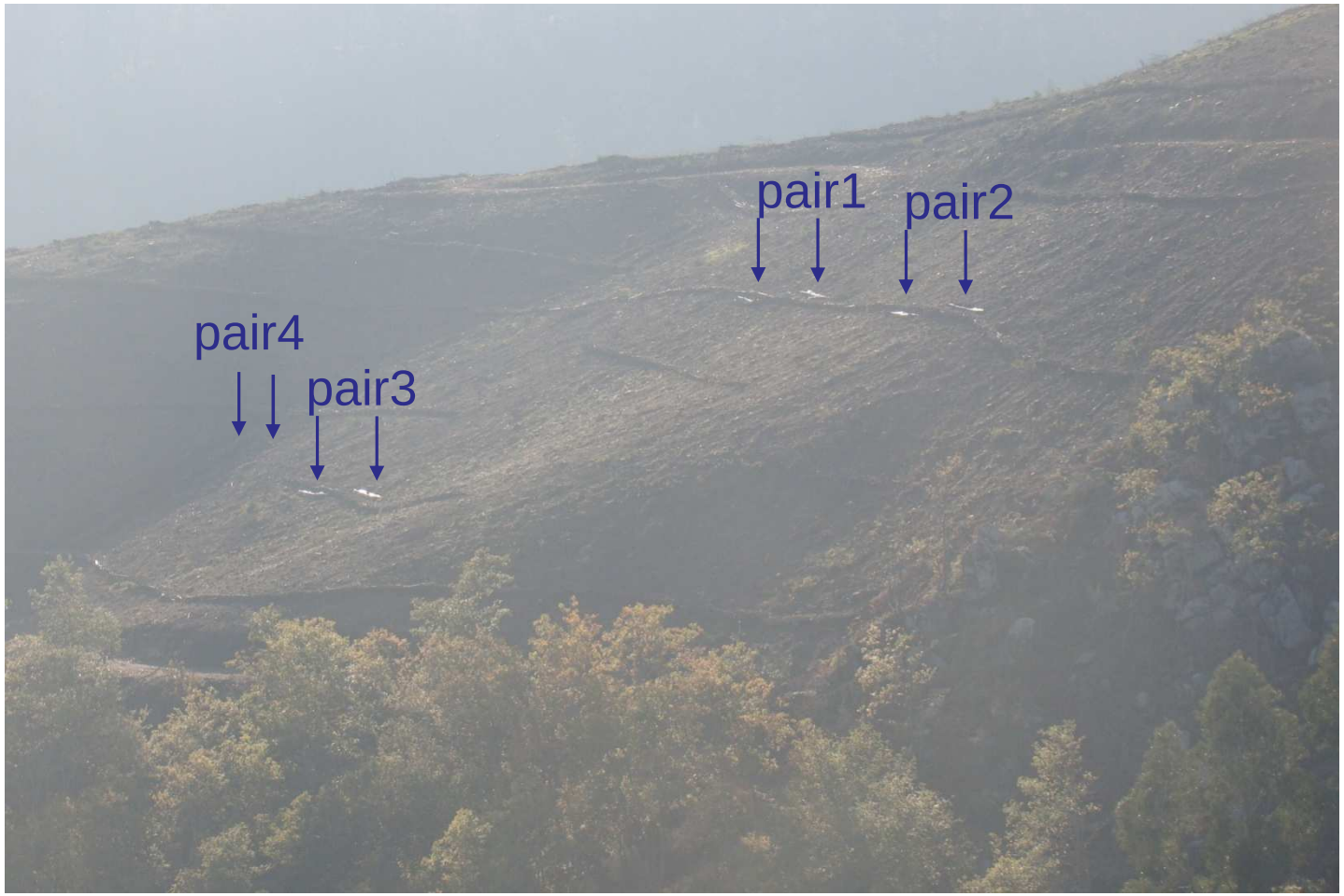
SF1 SF2 SF3 SF4 SF5 SF6 SF7 SF8 SF9

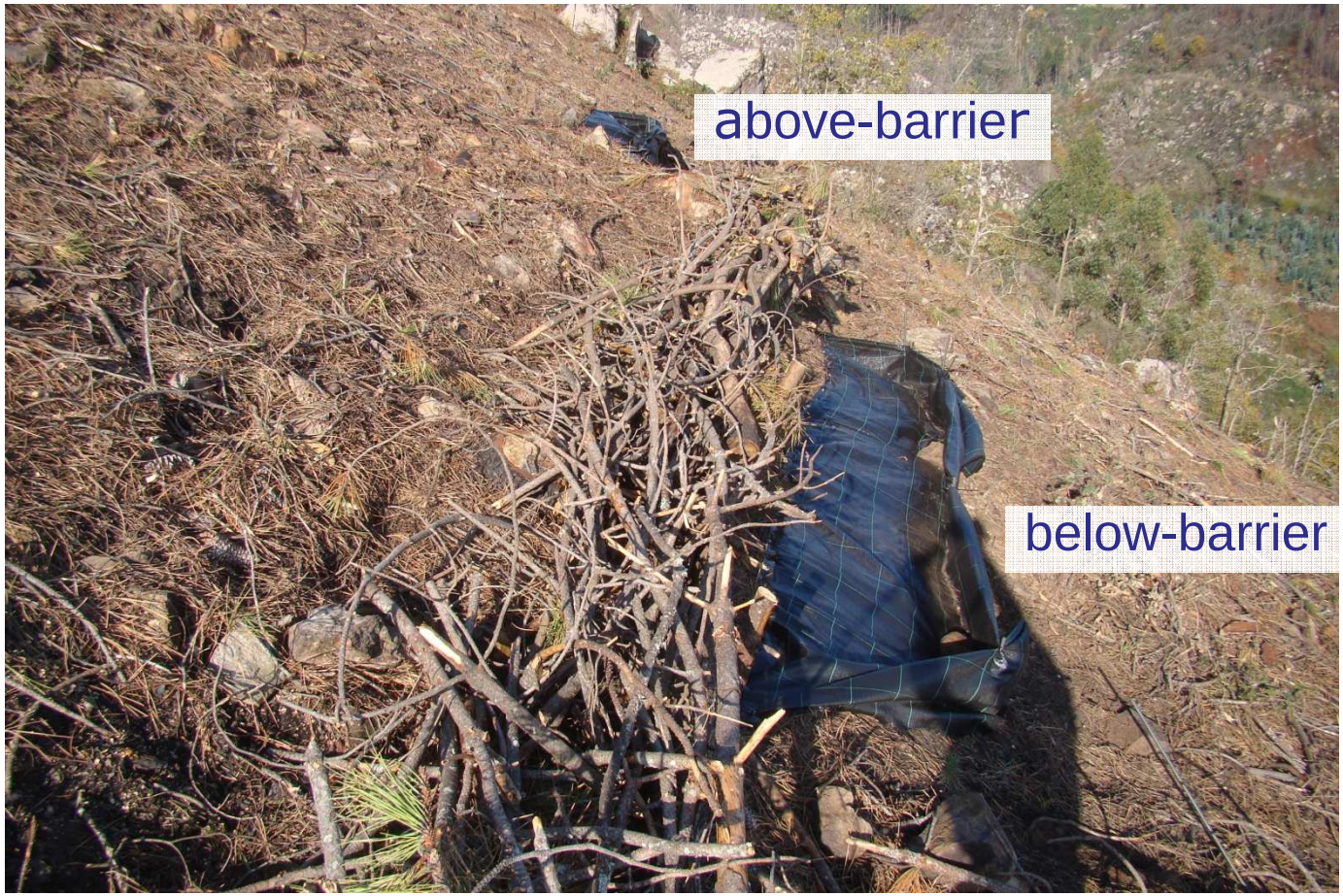
no mulch

high mulch

low mulch

3. PRODER funded measures: Shrub erosion barriers


pair1
pair2
pair4
pair3


above-barrier
below-barrier

We want to acknowledge:

FCT and co-financed by FEDER POCI2010 founded Projects:
RECOVER PTCD/AGR-AAM/73350/2006
EROSFIRE POCI/AGR/60354/2004
EROSFIRE-II PTDC/AGR-CFL/70968/2006
FIRECNUTS PTDC/AGRCFL/104559/2008
CASCADE (EU-FP7 – ENV.2011.2.1.4-2/283068)
RECARE (EU-FP7 ENV.2013.6.2-4 no. 603498)

Portuguese Government IFADAP/INGA-founded Project :
R.A.A.“Recuperação Areas Ardidas” (no. 2004 09 002629 7).

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Post-fire soil erosion mitigation research in Portugal

1. Fire severity & FR mulching
   Shakesby et al. 1996
   Prats et al. 2012
   Hosseini et al. 2016

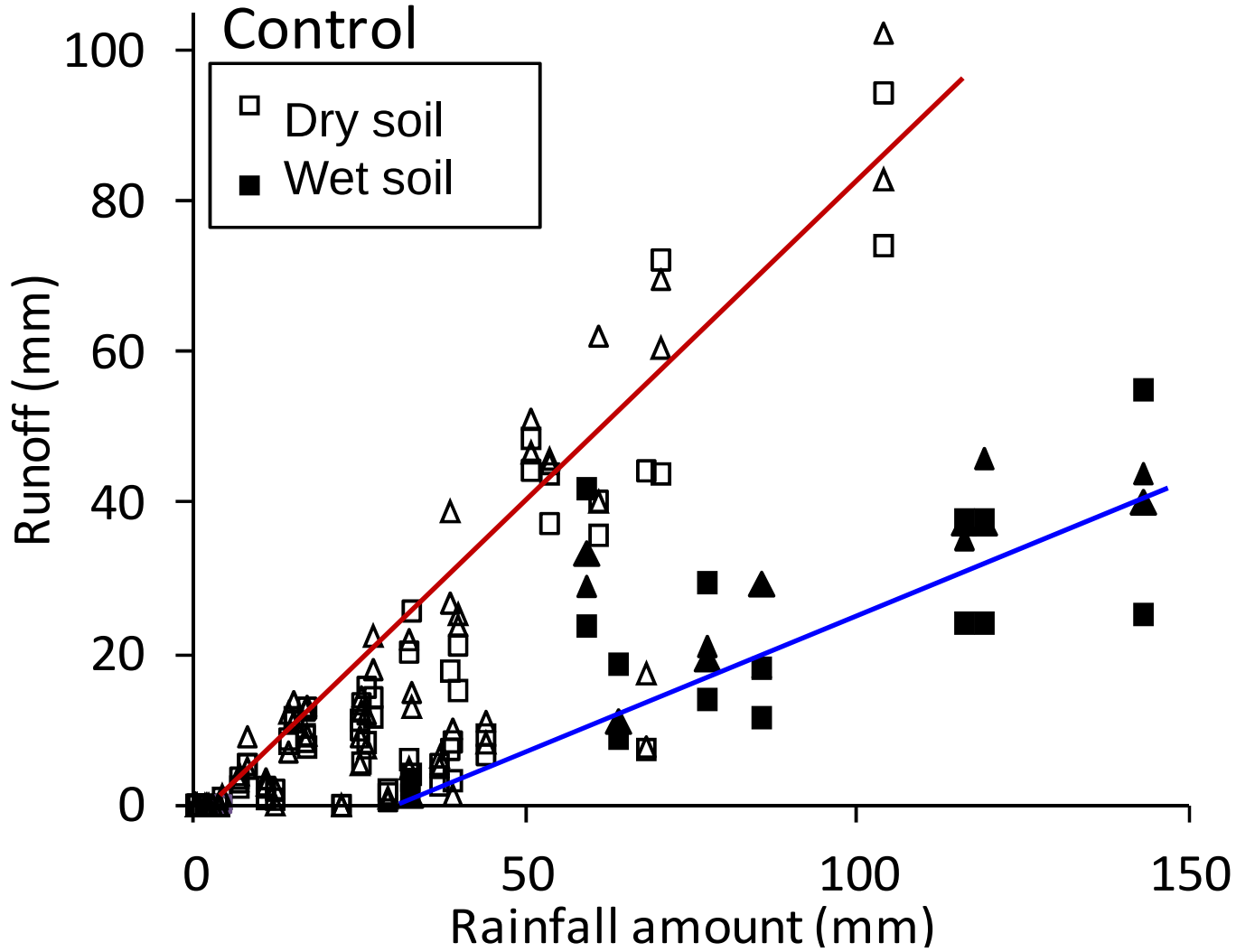
2. Micro-plot position & PAM vs. FR mulching
   Prats et al. 2014a

3. Upscaling & Hydromulching
   Prats et al. 2016a

4. Upscaling & FR mulching
   Prats et al. 2016b
   Prats et al. 2016c

5. Review
   Ferreira et al. 2014
   Prats et al. 2014b
   Prats et al. (submitted)

Other factors: Soil water repellence



OM losses & gains

Table 4
Estimated soil organic matter (OM) content, OM losses in the eroded sediment, soil OM gains, and OM net change as a percentage of the original soil OM ($g\ m^{-2}$) for various studies. OM contents calculated from organic C contents (OCC) using the van Belemen factor (OM = OCC × 1.724; Pribyl, 2010) for the OM pool in the upper 2 cm of the soil.

Fire severity	Study design		Soil properties (0-2 cm depth)				Soil loss by water erosion			Gains by mulch		Net change in soil OM	Reference
	Time period	Plot surface	Bulk density	Stone content > 2 mm	OM content		Reported soil loss	Sediment OM content	OM loss in sediment	Mulch OM content			
	Years	m^2	$g\ cm^{-3}$	% vol	%	$g\ m^{-2}$	$g\ m^{-2}$	%	$g\ m^{-2}$	%	$g\ m^{-2}$	%	
Unburnt	2	16	0.9	55	20	1597	2	57	1			−0.1	Thomas et al. (1999)
Low	2	4238	0.8	16	9	1212	86	40	34			−2.8	Shakesby et al. (2013)
Low	1	16	1.2	65	9.9	827	38	52	20			−2.4	Prats et al. (2012)
Low	1	16	1.2	65	9.9	827	38	52	20	88	1540	183.8	Prats et al. (2012)-mulch
Moderate	2	0.28	0.8	57	11	757	930	56	521			−68.8	Malvar et al. (in press-b)
Moderate	2	2620	0.8	16	9	1212	155	40	61			−5.1	Shakesby et al. (2013)
Moderate	2	16	1	55	20	1720	610	34	207			−12	Thomas et al. (1999)
Moderate	2	192	1.1	55	19	1839	131	41	58			−3.2	Faria et al. (2015)
Moderate	0.5	100	1.1	40	10	1980	410	40	164			−8.3	Gimeno-García et al. (2000)
Moderate	1	16	1.0	51	12.2	1224	562	45	258			−21.1	Prats et al. (2012)
Moderate	1	16	1.0	51	12.2	1224	562	45	258	88	766	41.5	Prats et al. (2012)-mulch
Moderate–high	2	100	1.1	55	10	990	616	37	224			−22.6	This study SF-untreated
Moderate–high	2	100	1.1	55	10	990	55	33	8	88	1197	123.9	This study SF-mulch

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-60%

+120%