

La importancia del tipo de suelo en diferentes biomas en la respuesta al fuego y manejos post-incendio

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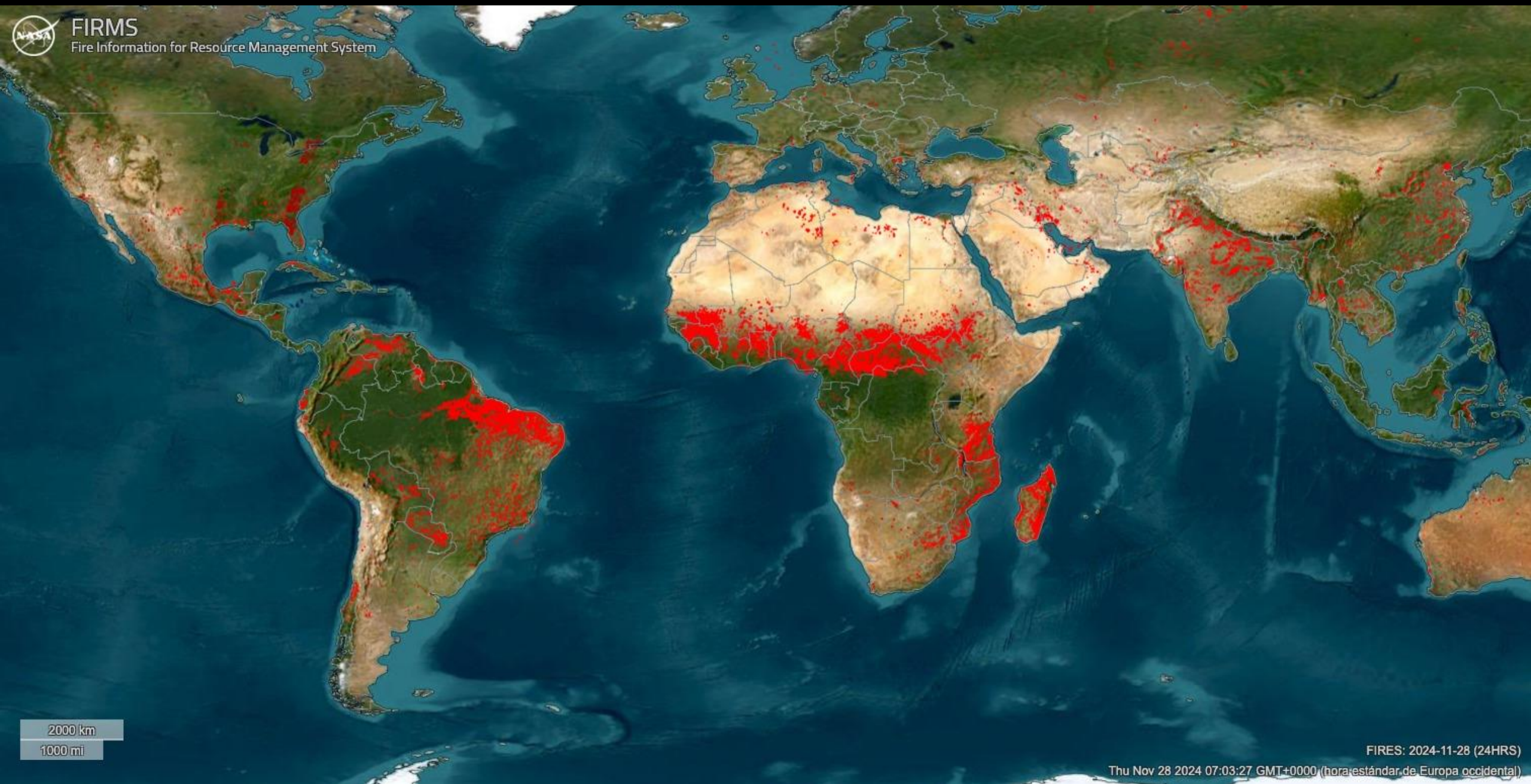
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FIRMS

Fire Information for Resource Management System



- Fire is a global phenomenon
- There is a distortion of fire regimes in many ecosystems of the world
- Some ecosystems are more adapted to fires than others (more resilient)
- Extreme fire events are more often
- Fire is now more present in non-adapted ecosystems

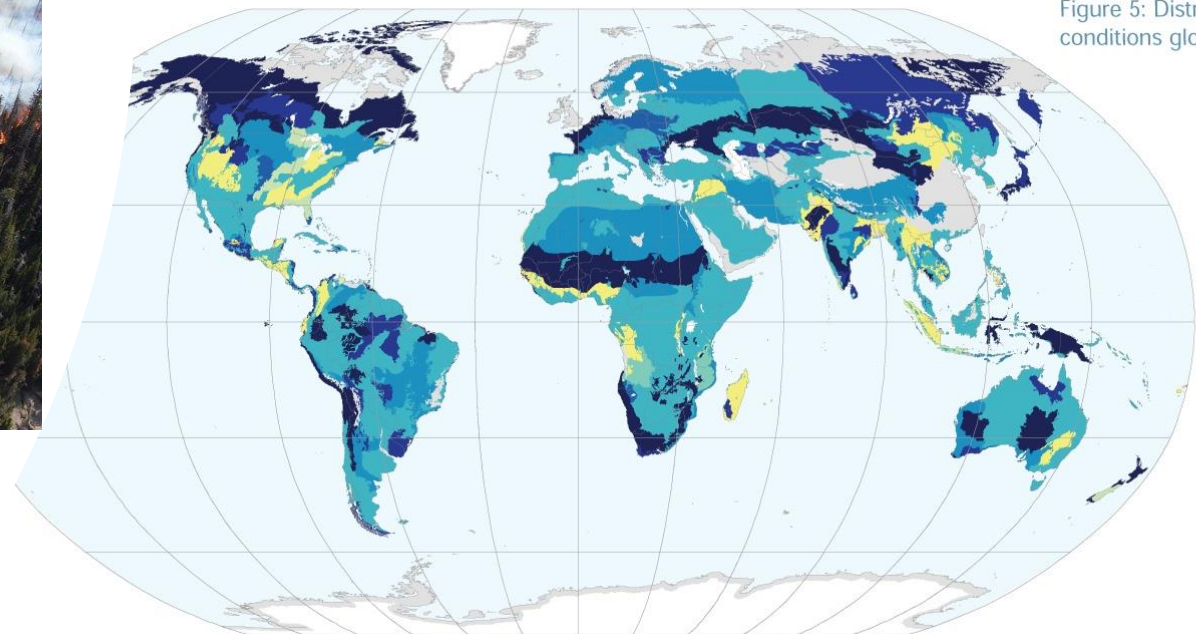
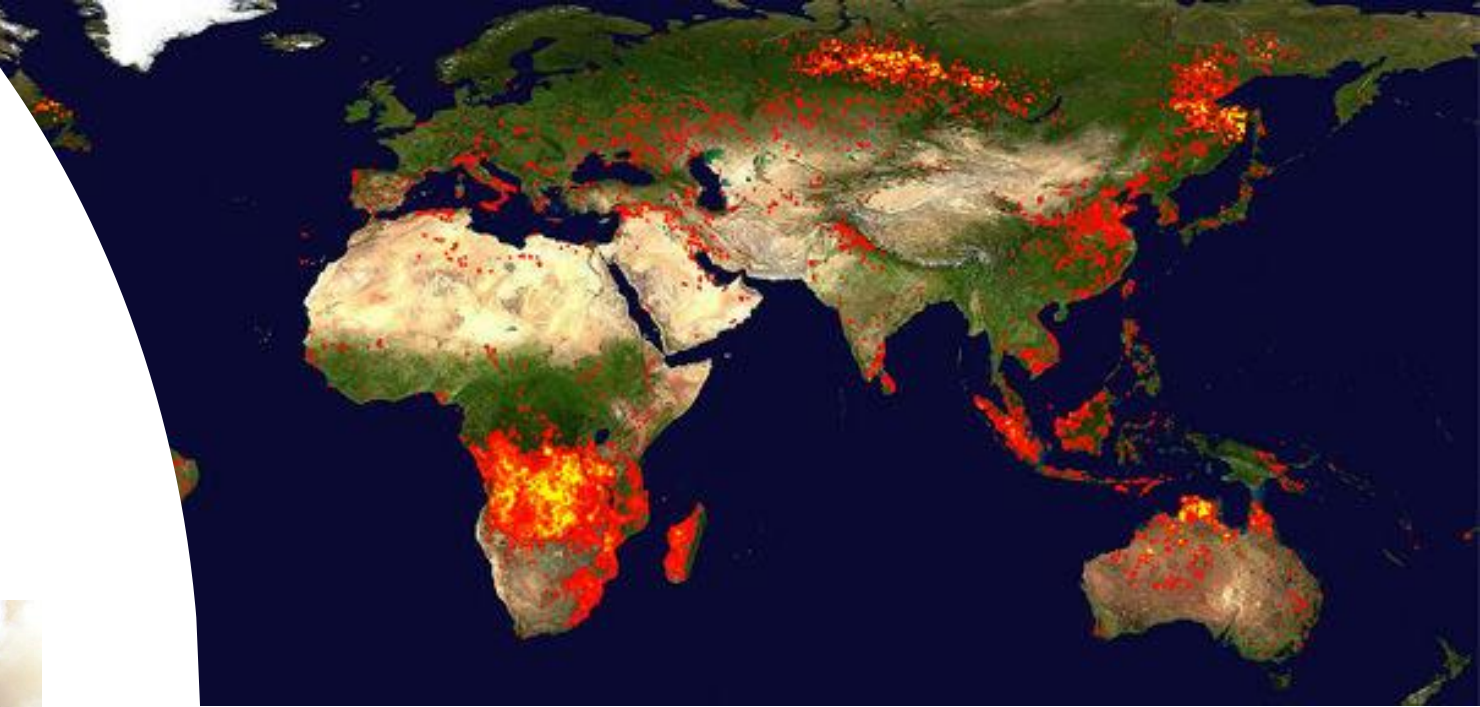


Figure 5: Distribution of fire regime conditions globally at the ecoregion:

- Intact/Stable
- Intact/Declining
- Degraded/Improving
- Degraded/Stable
- Degraded/Declining
- Very Degraded/Improving
- Very Degraded/Declining
- Very Degraded/Declining
- Future Assessment

Factors controlling fire effects on soils

Fire intensity and severity (fire behaviour)

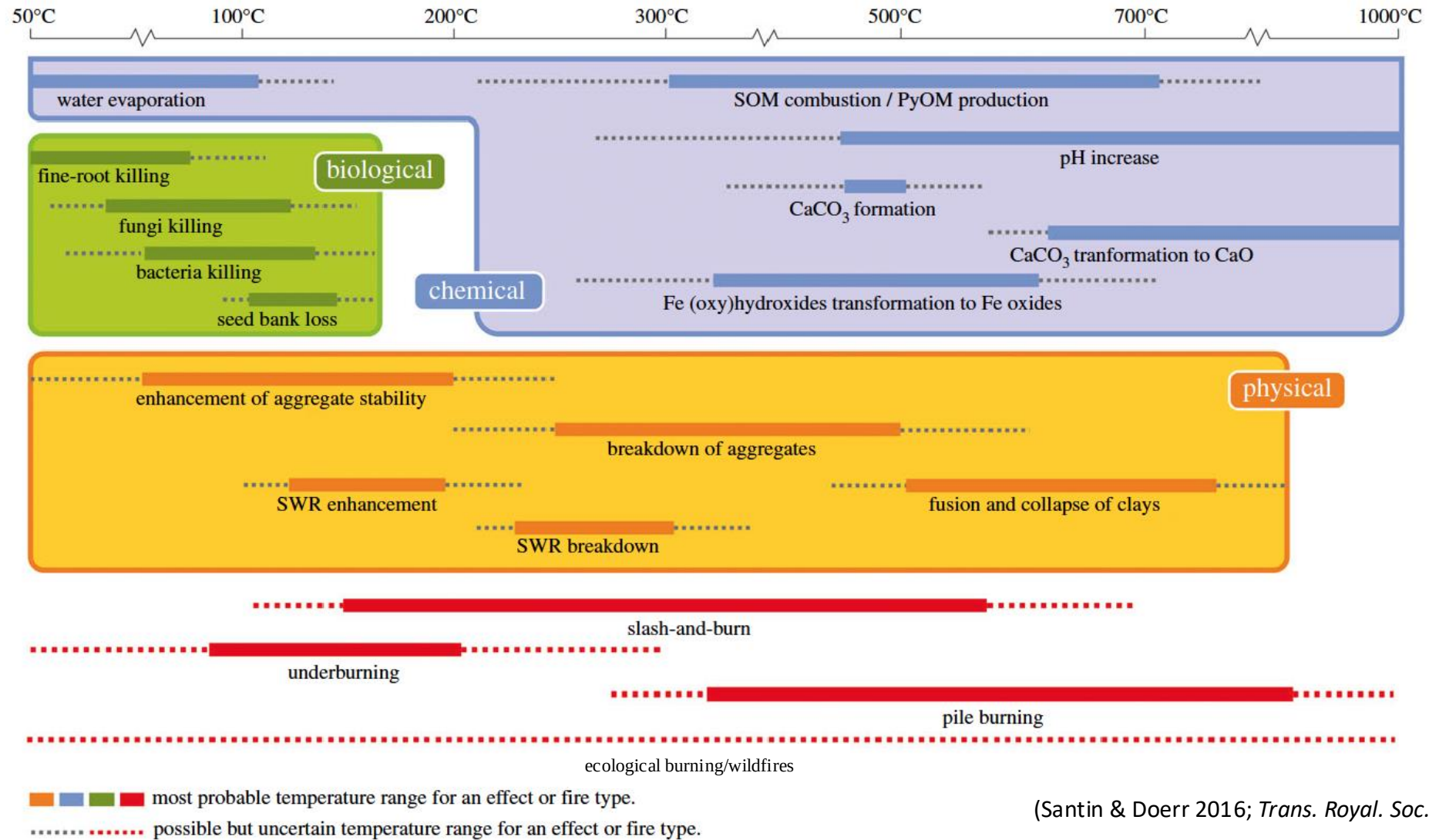
"Fire intensity describes the physical combustion process of energy release from organic matter"



"Fire severity is the degree of environmental change caused by fire"



Factors controlling fire effects on soils. Temperatures reached in soil



(Santin & Doerr 2016; *Trans. Royal. Soc. B*)

Temperature ranges and effects on soil for different types of fires (underburning, slash-and-burn, pile burning and ecological burning/wildfires)

Factors controlling fire effects on soils

- Topography (slopes angle and length; North face *vs* South face)
- Fire recurrence
- Post-fire meteorological conditions

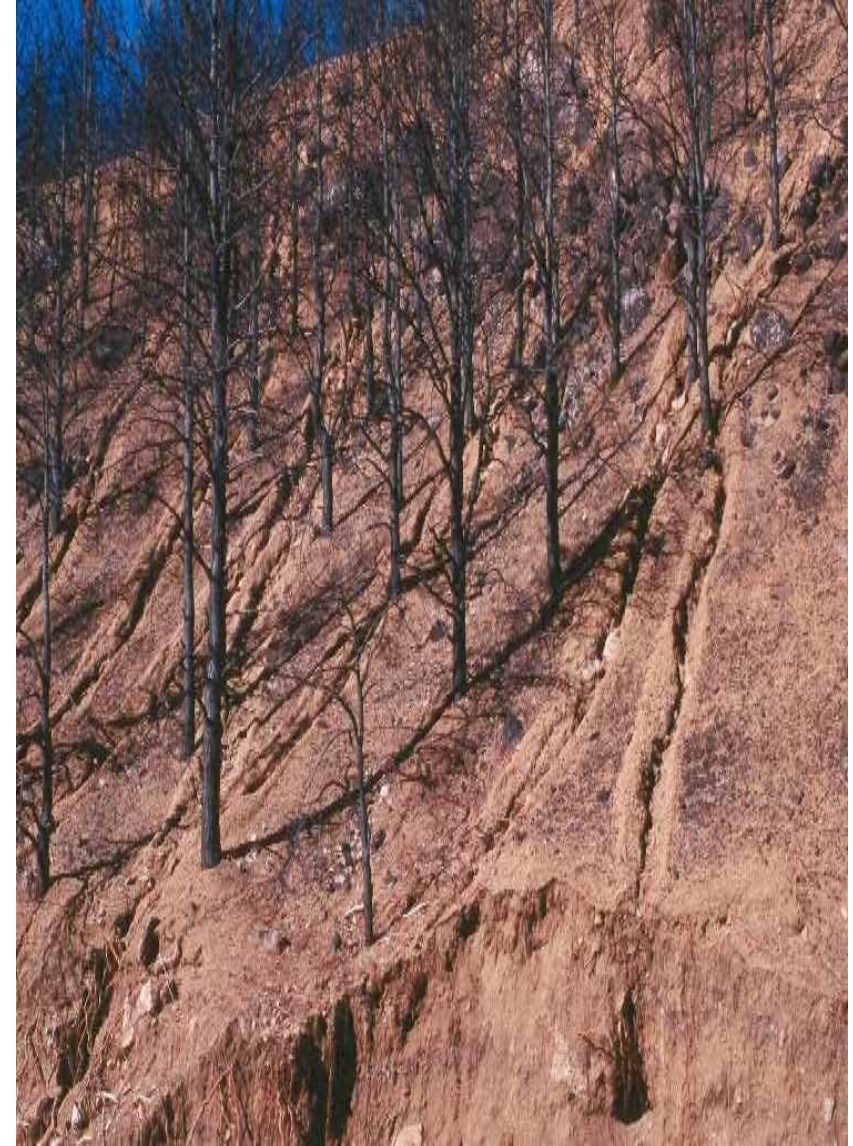


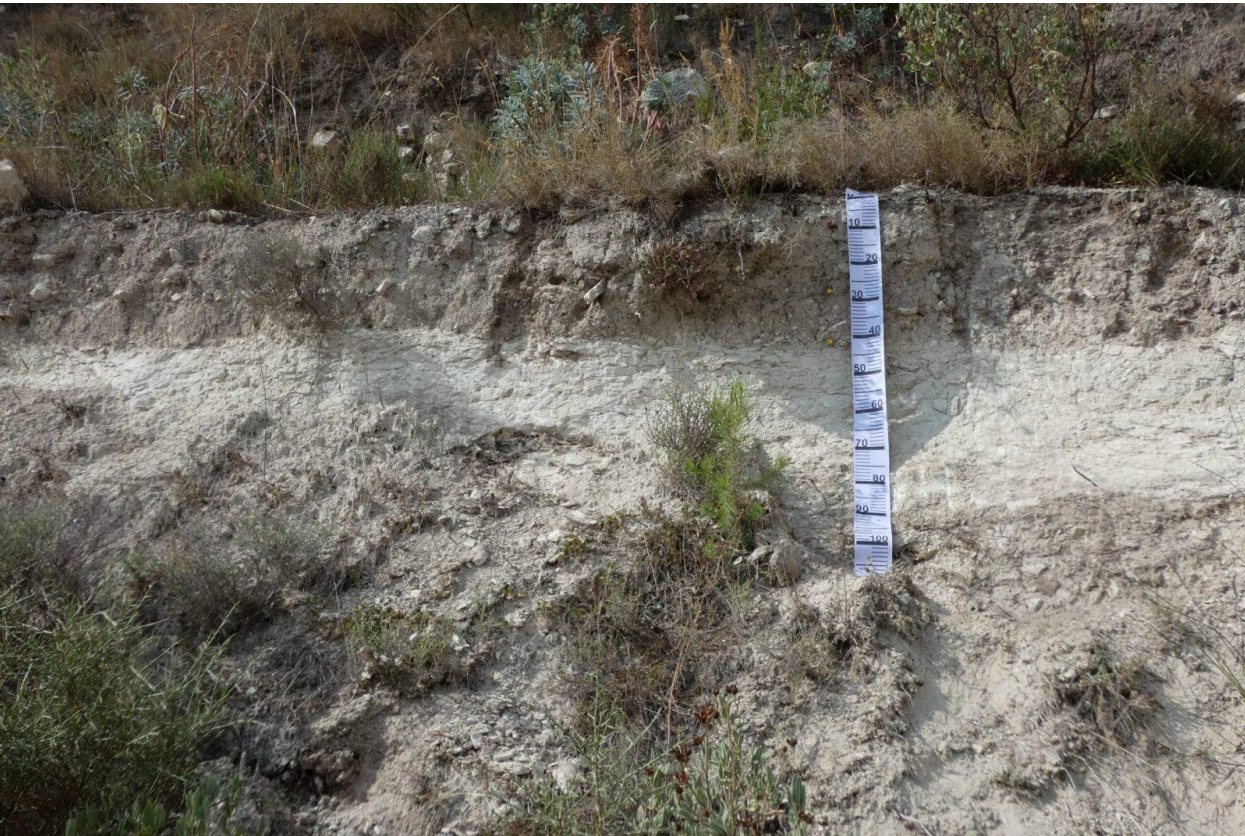
Photo: John A. Moody



Which is the role of soil type? “*The voice of soil*”

Soil Diversity

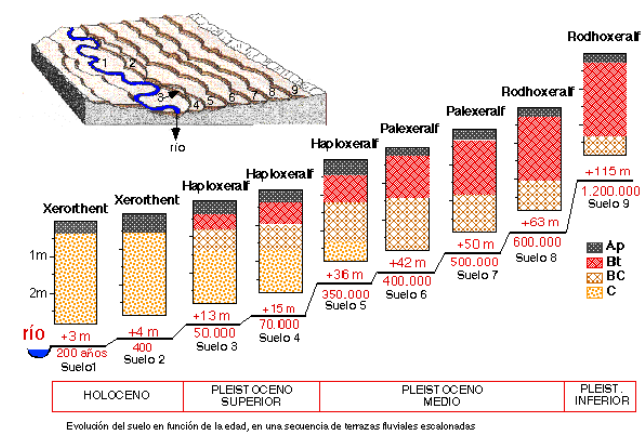




Typic Xerorthent. Sierra de Mariola, Alicante



Lithic Rodoxeralf. Liber, Alicante





Investigación

- Alcoi, Alicante
- Javea, Alicante
- Torres del Paine, Patagonia, Chile
- Arequipa, Perú
- Haifa, Israel



Soil water repellency (WR)



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Geoderma 118 (2004) 77–88

GEODERMA

www.elsevier.com/locate/geoderma

Hydrophobicity and aggregate stability in calcareous topsoils from fire-affected pine forests in southeastern Spain

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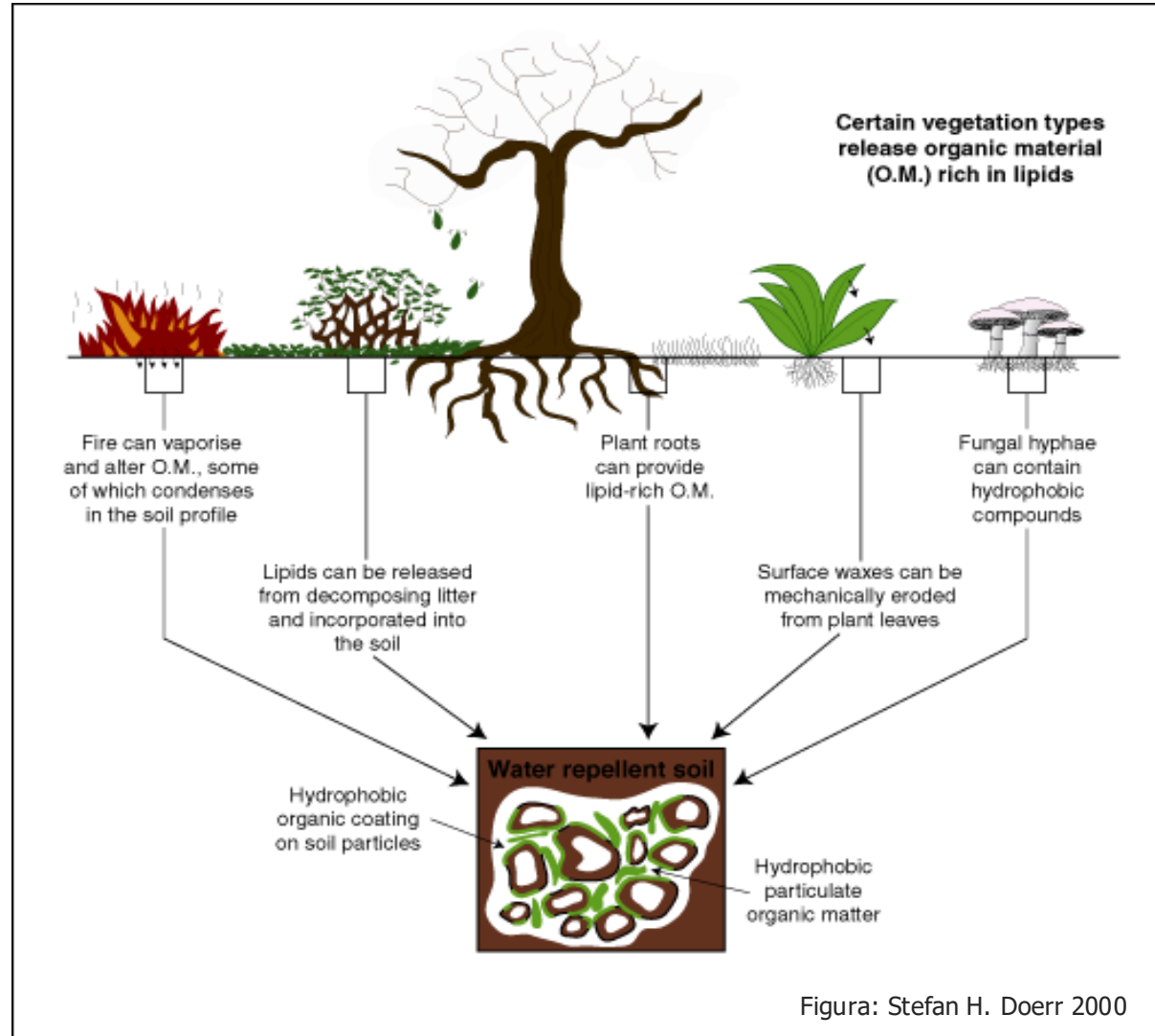
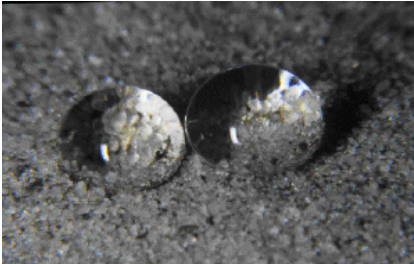
Photo: Ana Mateu



Photo: J. Mataix-Solera

Soil water repellency (WR)

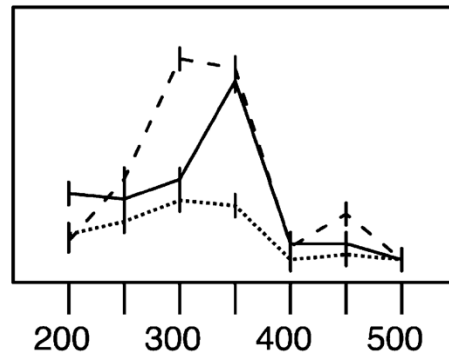
Causes of WR



Water repellency



Photo: J. Mataix-Solera



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Catena 74 (2008) 219–226

CATENA

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Immediate effects of wildfires on water repellency and aggregate stability in Mediterranean calcareous soils

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Received 24 July 2007; received in revised form 27 November 2007; accepted 20 December 2007

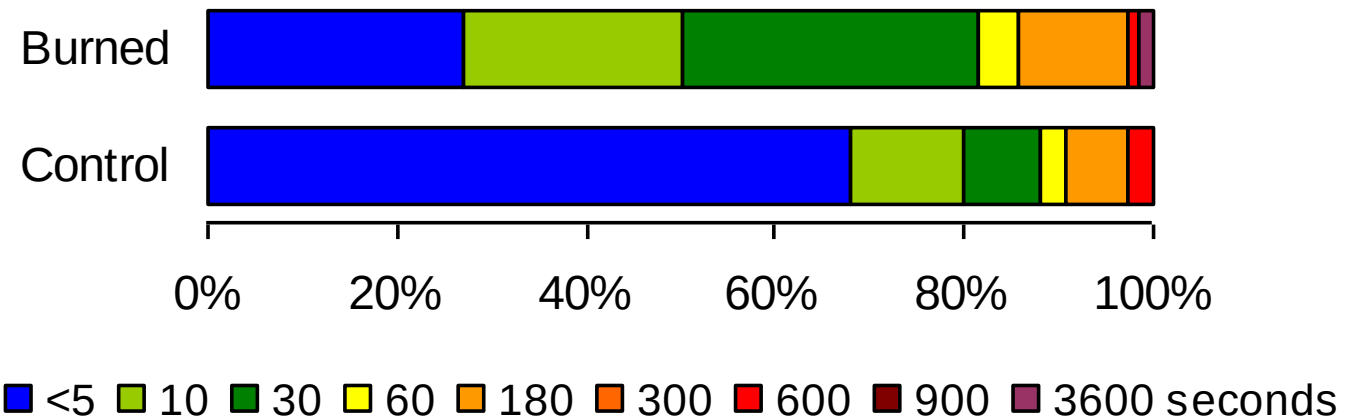


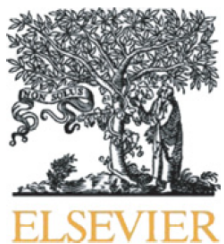
Figure 3. Relative frequency of water repellency classes (s) for burned samples from 10 wildfires occurred in summers 2003, 2004, 2005 and 2006 (pooled from all burned sites) and for all control samples ($n=200$).



Terra rossa. Benitatxel, Alicante.

Lithic Rhodoxeralf (Soil Taxonomy)

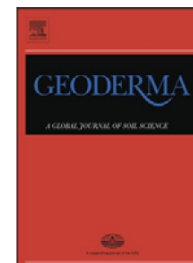
Chromic Luvisol (WRB Classification)



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Geoderma

journal homepage: www.elsevier.com/locate/geoderma



Can *terra rossa* become water repellent by burning? A laboratory approach

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Terra rossa. Benitatxel, Alicante.

Lithic Rhodoxeralf (Soil Taxonomy)

Chromic Luvisol (WRB Classification)

Photo: J. Mataix-Solera

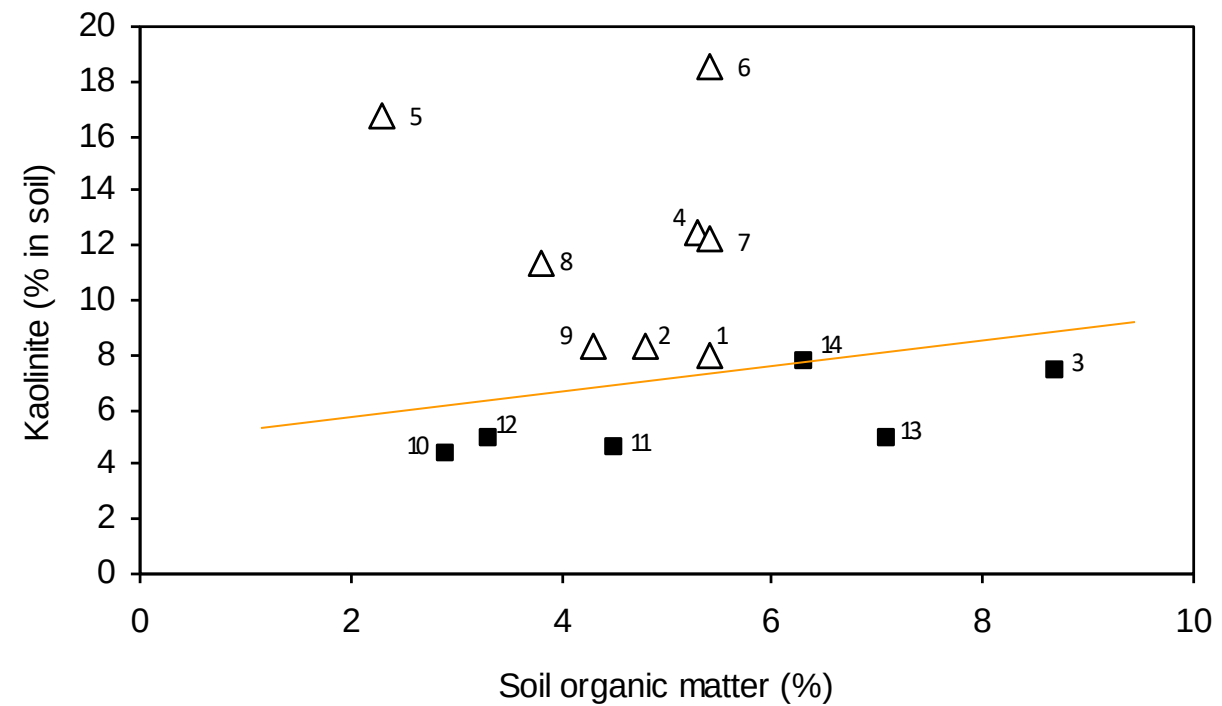
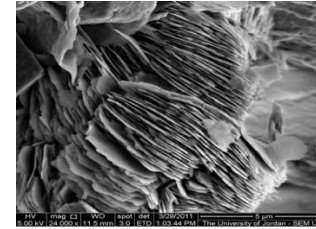


Terra rossa. Javea, Alicante. Photo: J. Mataix-Solera 2008
Lithic Rhodoxeralf (Soil Taxonomy)
Chromic Luvisol (WRB Classification)

Susceptibility of soils to develop WR by burning is quite variable

Soil factors controlling:

- SOM content
- Texture
- Mineralogy of clay fraction



△ wettables ■ potentially water repellents

Mataix-Solera et al., 2008. Geoderma



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Earth-Science Reviews

journal homepage: www.elsevier.com/locate/earscirev



Fire effects on soil aggregation: A review

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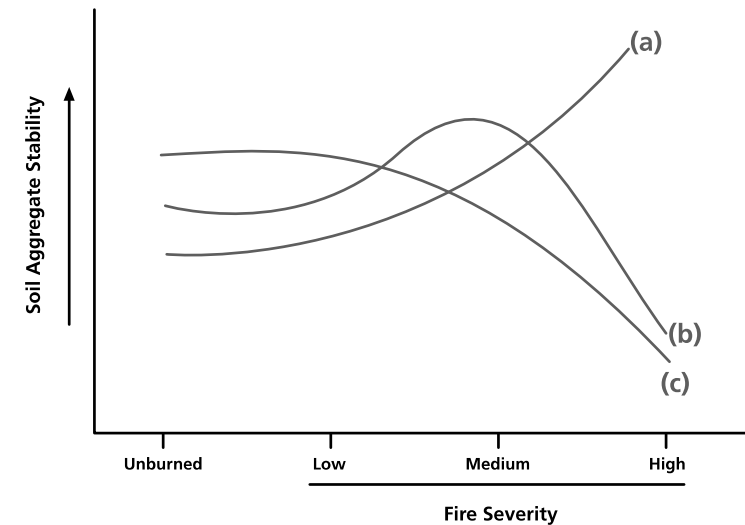
^b SEDER (Soil Erosion and Degradation Research Group). Departamento de Geografía, Universitat de València, Avenida de Blasco Ibáñez, 28, 46010 València, Spain

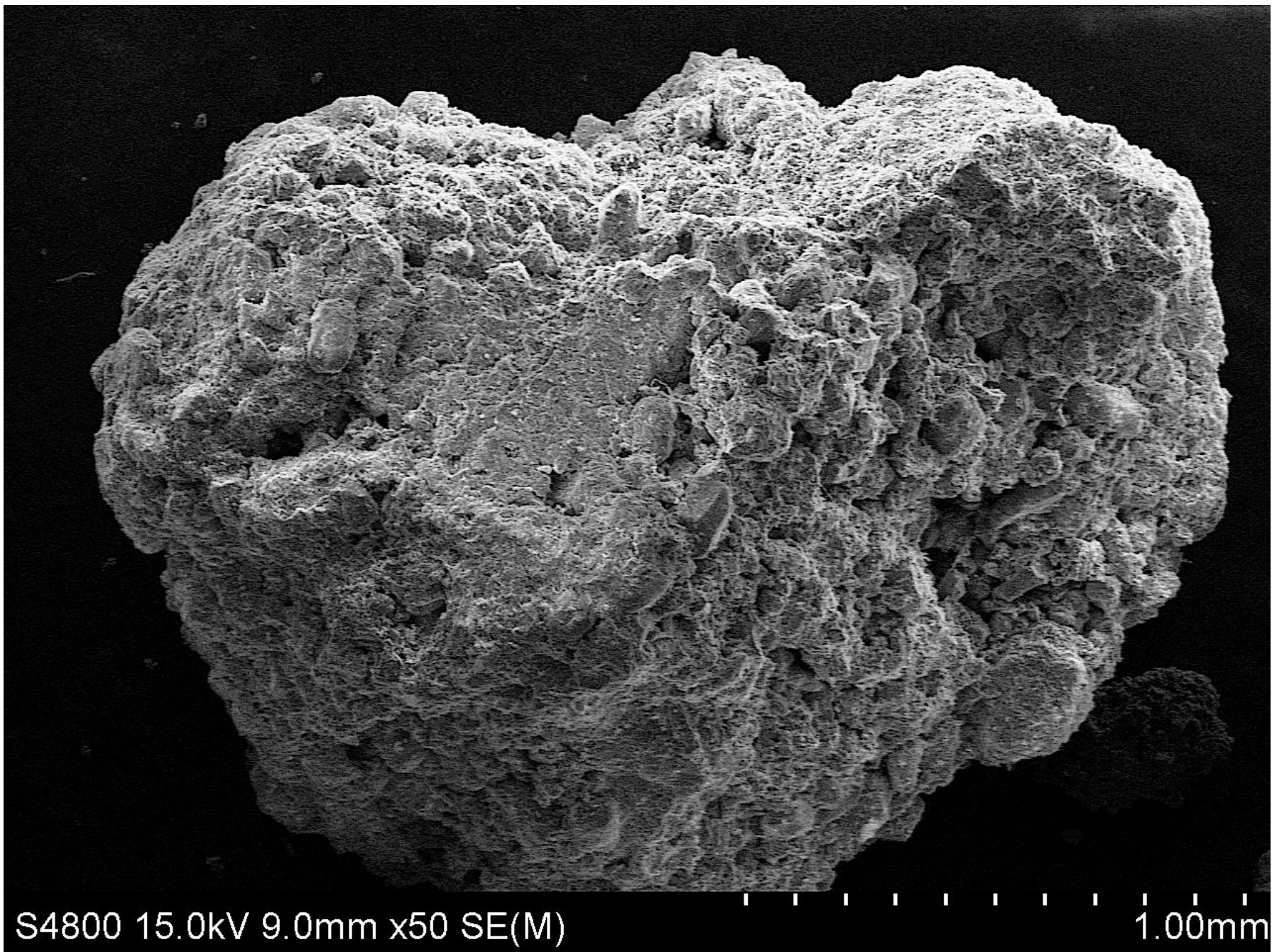
^c MED_Soil Research Group. Departamento de Cristalografía, Mineralogía y Química Agrícola, Facultad de Química. Universidad de Sevilla, C/Profesor García González, 1, 41012, Sevilla, Spain

J. Mataix-Solera et al. / Earth-Science Reviews 109 (2011) 44–60



Photos: J. Mataix-Solera and Stefan H. Doerr





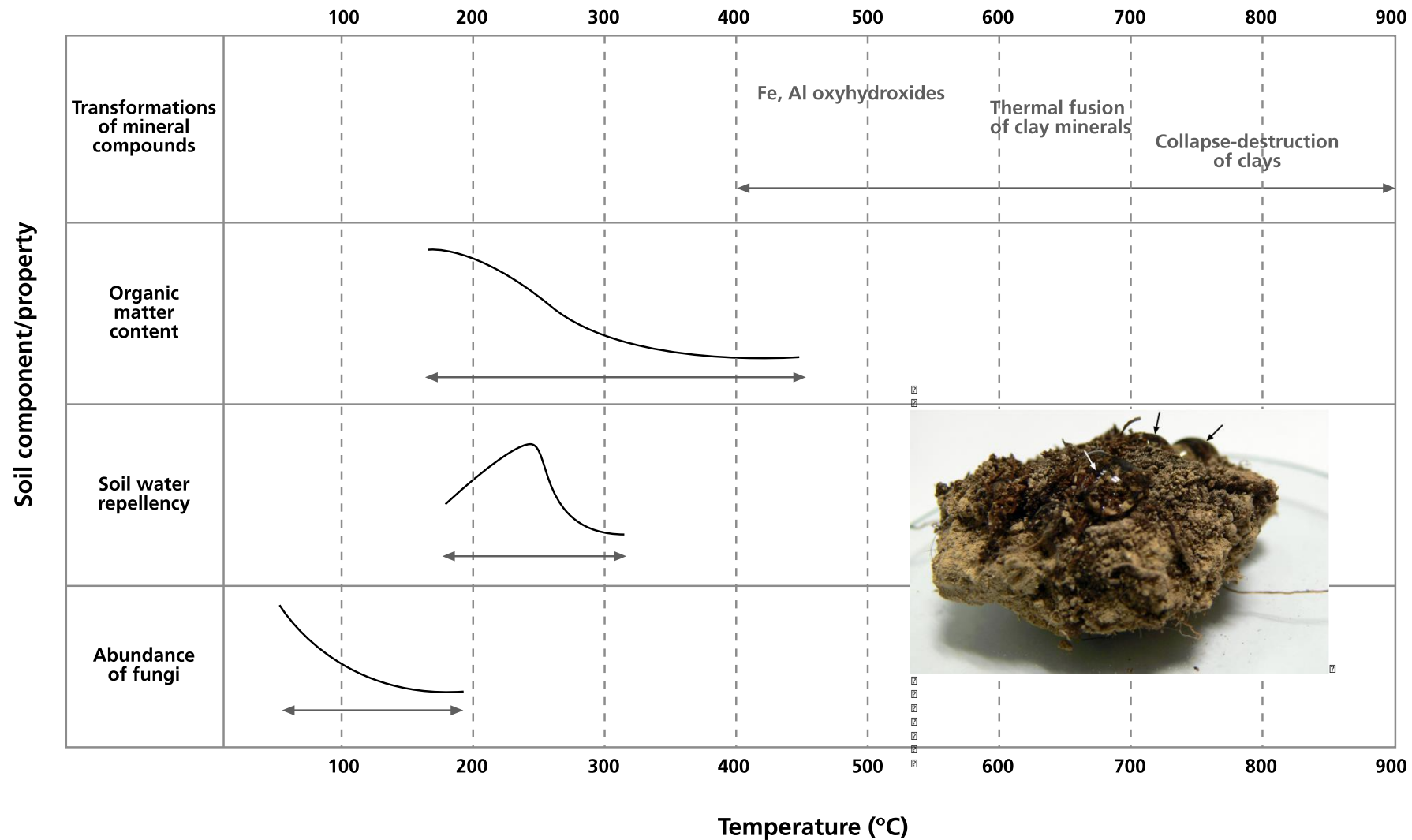


Fig. 3. The main soil components or properties relevant to aggregation and their changes at different temperatures. Horizontal lines indicate the approximate range of temperatures at ones which each property changes. The curves represent the magnitude and trend of the changes induced by fire at particular temperatures. These ranges can vary depending on the type of soil and also on the duration of a given temperature. Based in different studies (e.g.: DeBano et al., 1976; Giovannini et al., 1988; Soto et al., 1991; Neary et al., 1999; Ketterings et al, 2000; Arcenegui et al., 2007).

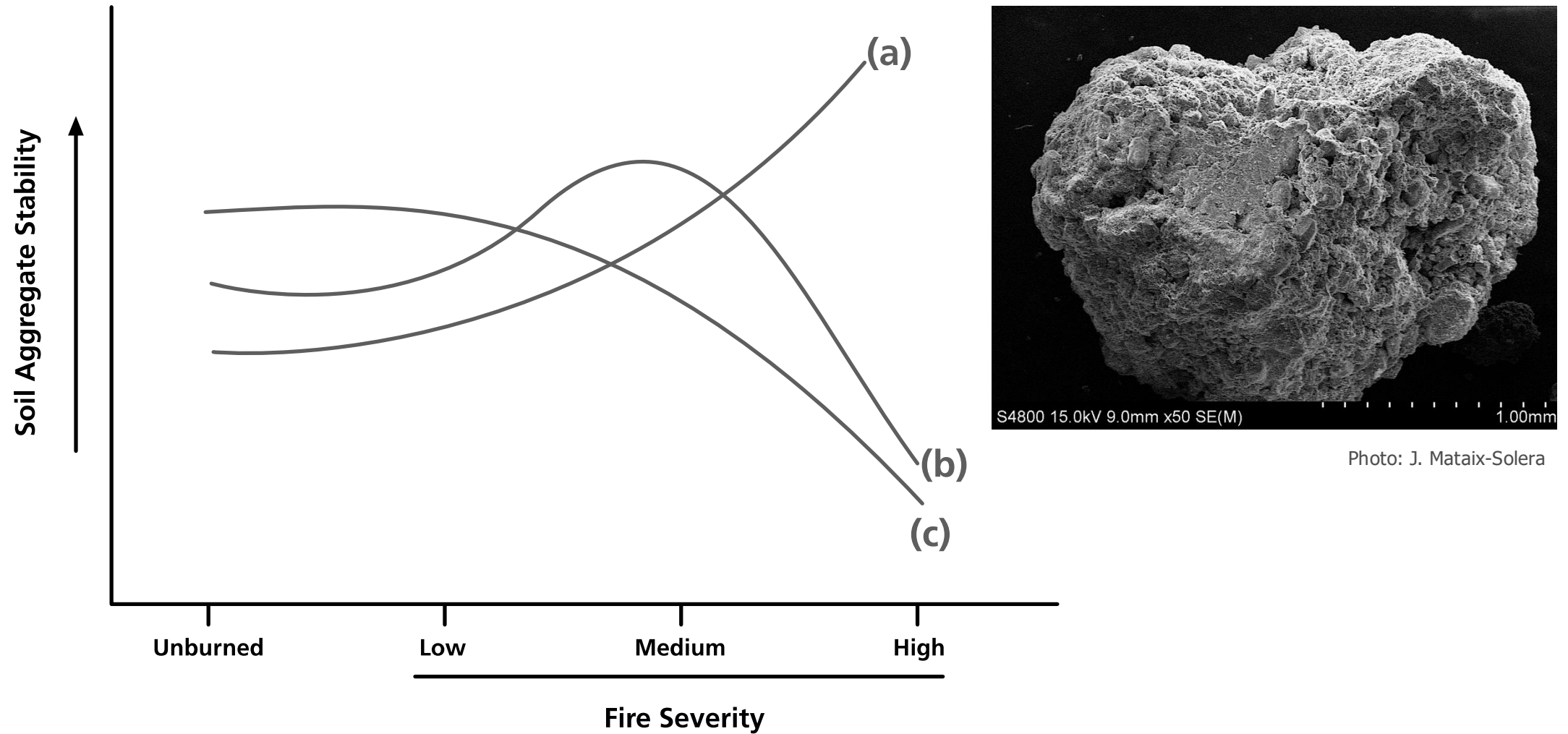


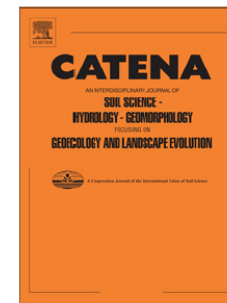
Fig. 6. Three different patterns of aggregate stability changes in relation to fire severity: a) soil with a more clay content, calcium carbonate, Fe and Al oxides as principal cementing substances; b) soil with organic matter as the principal binding agent and originally hydrophilic or with low water repellency; and c) a sandy soil which is water-repellent and has organic matter as the principal binding agent.



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Advances in the knowledge of how heating can affect aggregate stability in Mediterranean soils: a XDR and SEM-EDX approach



Patricia Jiménez-Pinilla ^{a,b,*}, Jorge Mataix-Solera ^{a,b}, Victoria Arcenegui ^{a,b}, Rafael Delgado ^c, Juan Manuel Martín-García ^c, Elena Lozano ^{a,b}, Lorena Martínez-Zavala ^b, Antonio Jordán ^b

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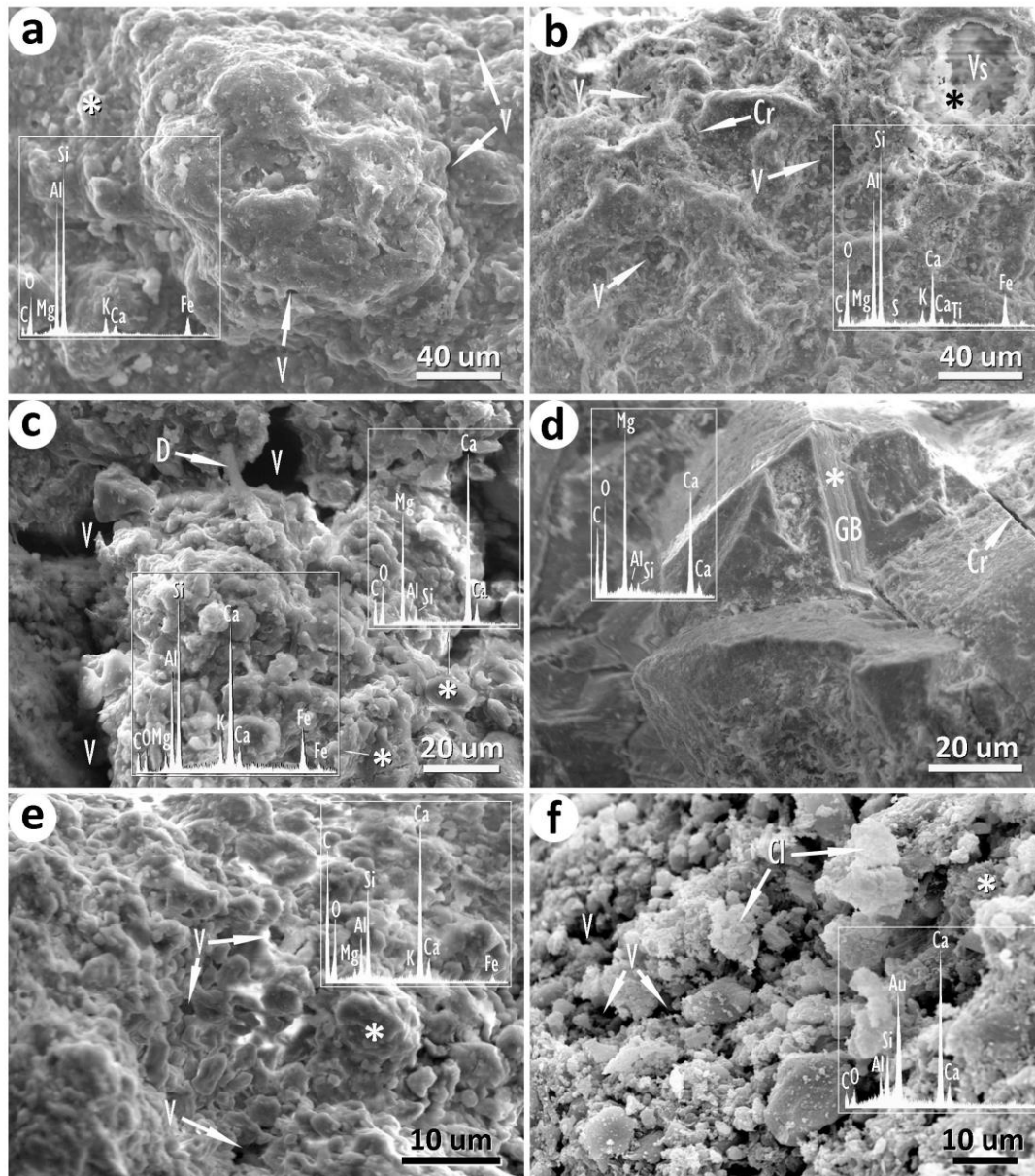
Advances in the knowledge of how heating can affect aggregate stability in Mediterranean soils: a XDR and SEM-EDX approach

Patricia Jiménez-Pinilla ^{a,b,*}, Jorge Mataix-Solera ^{a,b}, Victoria Arcenegui ^{a,b}, Rafael Delgado ^c, Juan Manuel Martín-García ^c, Elena Lozano ^{a,b}, Lorena Martínez-Zavala ^b, Antonio Jordán ^b

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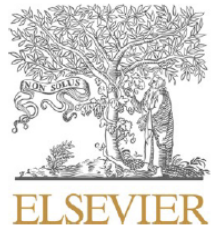
^c Departamento de Edafología y Química Agrícola, Facultad de Farmacia, Universidad de Granada, Campus Cartuja, 18071 Granada, Spain





Aggregates from fire affected area in Vall d'Ebó, Alicante, Spain 2022

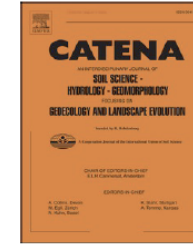




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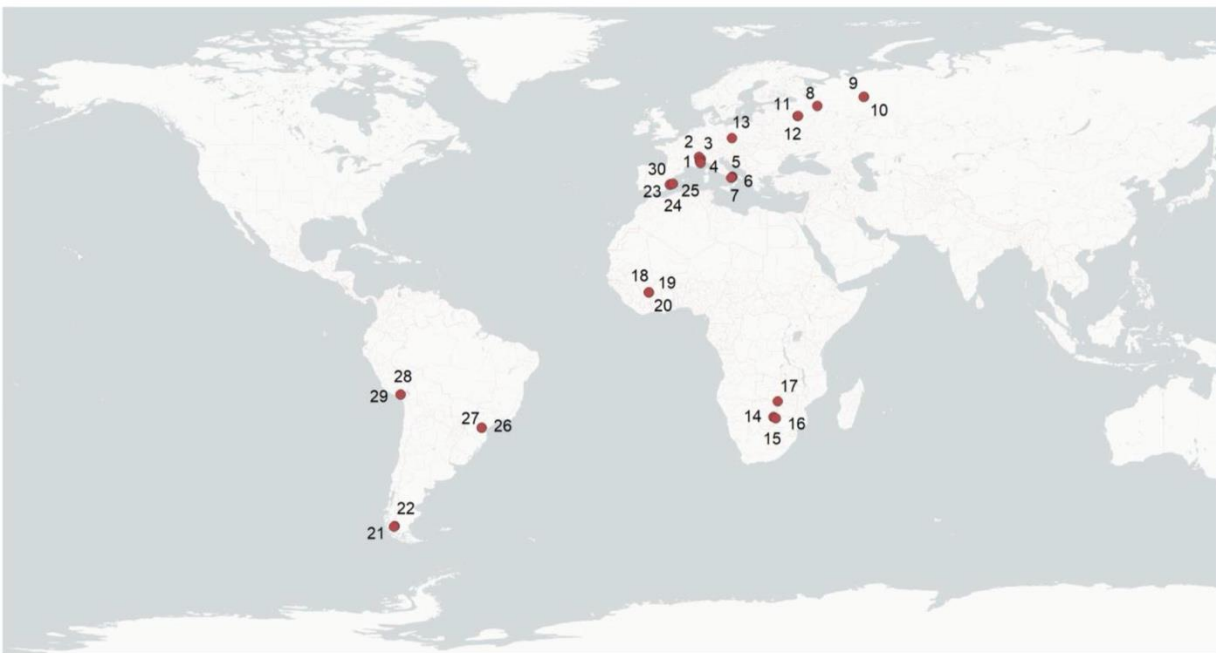


Extreme water repellency and loss of aggregate stability in heat-affected soils around the globe: Driving factors and their relationships

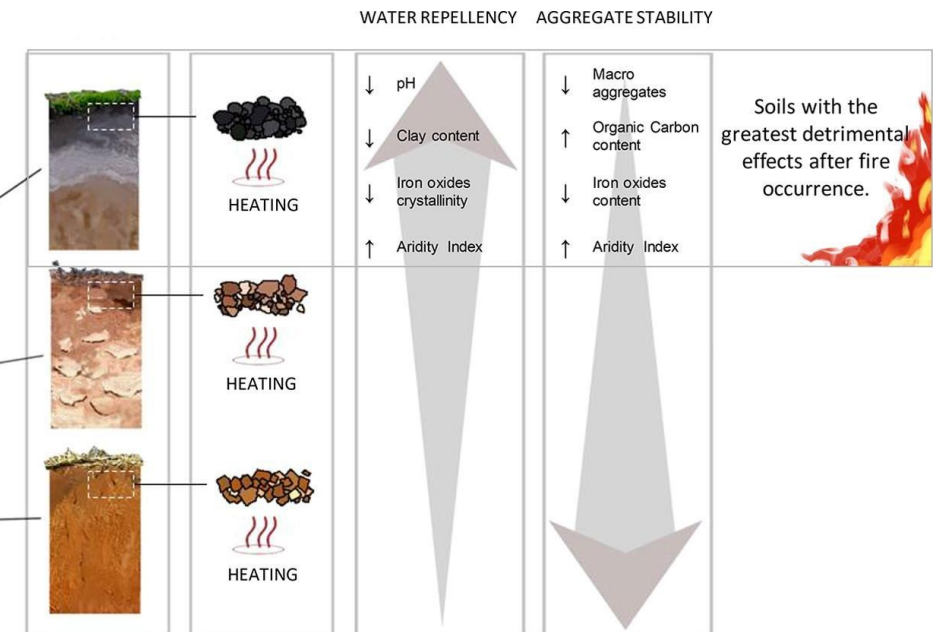
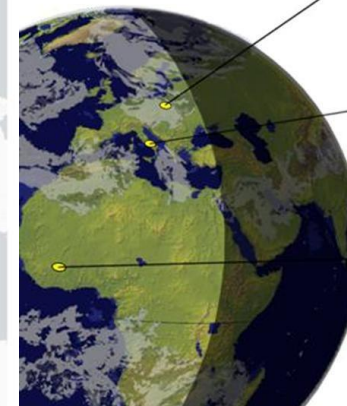
S. Negri^{a,*}, V. Arcenegui^b, J. Mataix-Solera^b, E. Bonifacio^a

^a University of Torino, Department of Agricultural, Forest and Food Sciences, Largo Braccini 2, 10095 Grugliasco, Italy

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Thirty topsoils across the globe.



Soil vulnerability indicators to degradation by wildfires in Torres del Paine National Park (Patagonia, Chile)

J. Mataix-Solera (1), J.E. Jaña (2), E. Arellano (2), L. Olivares (3), J. Guardiola (1), V. Arcenegui, (1), N. García-Franco (4), M. García-Carmona (1), P. Valenzuela

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POSTFIRE_CARE
Estrategias de gestión forestal y manejo
postincendio orientadas a la conservación
y mejora de la calidad del suelo



Soil Vulnerability Indicators to Degradation by Wildfires in Torres del Paine National Park (Patagonia, Chile)

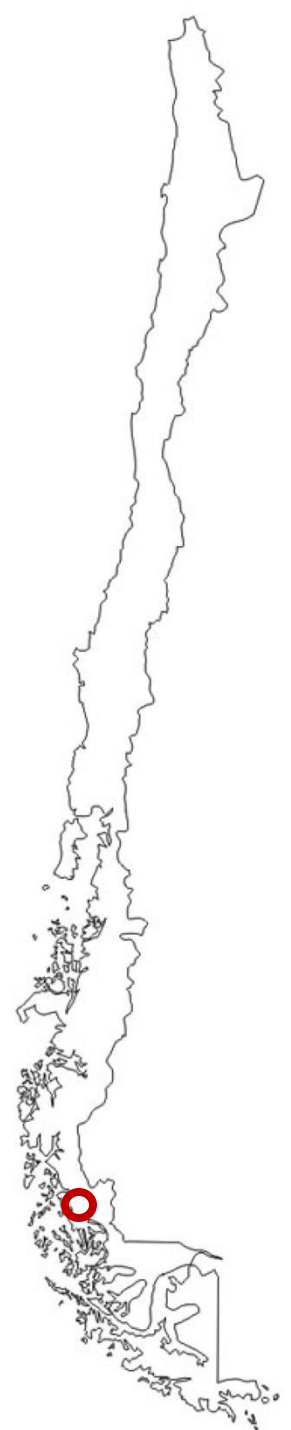
Jorge Mataix-Solera^{1*}, Eduardo C. Arellano^{2,3}, Jorge E. Jaña^{2,3}, Luis Olivares⁴, José Guardiola¹, Victoria Arcenegui¹, Minerva García-Carmona¹, Noelia García-Franco⁵ and Patricio Valenzuela⁶

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Study area

- **Torres del Paine National Park.** Patagonia, Region de Magallanes y la Antártica Chilena
- The study area is in a temperate cold rainy climate zone without dry season. The park is located in the transitional forest-steppe zone whose annual **rainfall varies between 300 mm and 1500 mm.**
- Plant communities goes from **Patagonian steppe, pre-Andean scrub to Magallanic forest.**
- The soils of the region vary from **Cryorthents and Udorthents to Haplocryolls** (Soil Survey Staff, 2014), most of them with scarce development.
- **Forest fire** in 2011 affecting 17,666 ha
- Based on vegetation coverage, **five** areas of the park were sampled in 2019 following the transects where a vegetation recovery study has been monitored in order to know the status of the ecosystem and how fire and post-fire conditions affected.





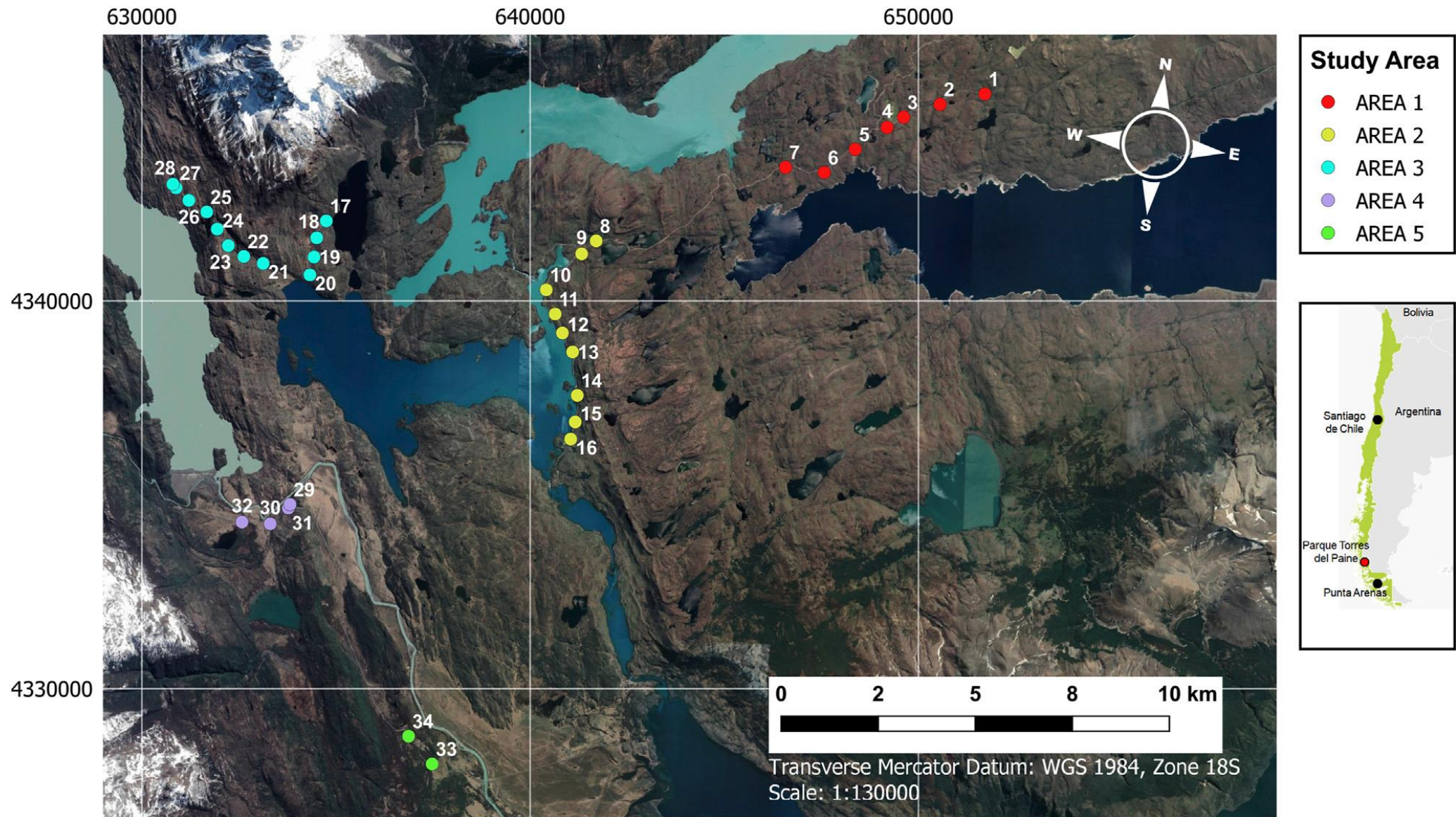


FIGURE 1 | Geographical location of Torres del Paine National Park in Chile and Google earth image of the study areas and points of soil samplings.



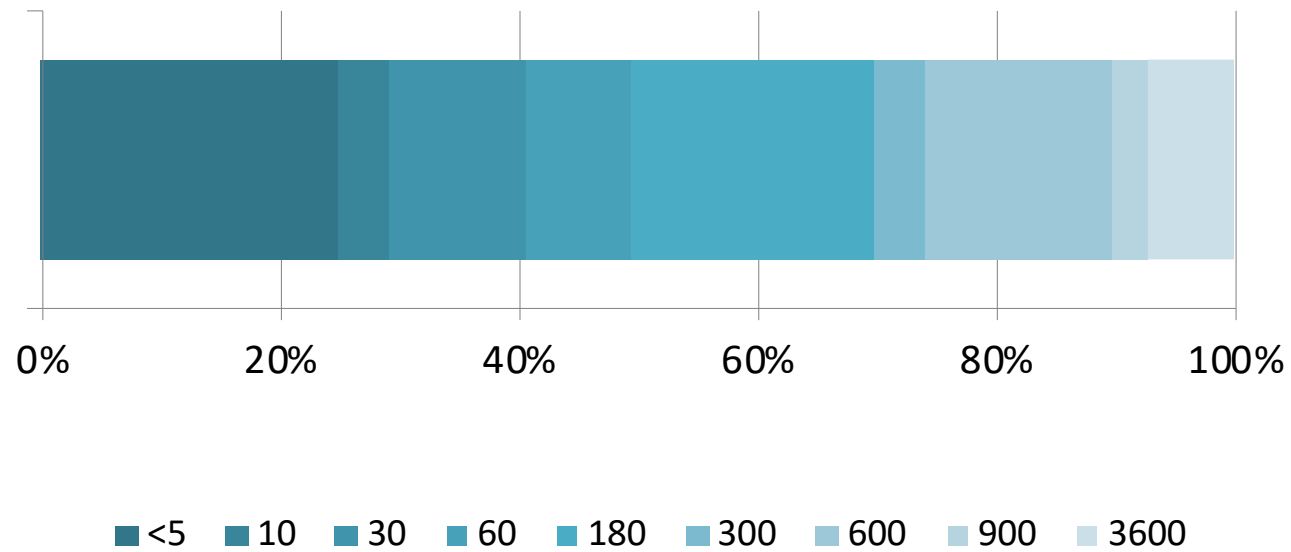


Figure 3. Frequency of distribution of Water Repellency (WDPT (s))

A 75% of samples showed WR from slight to severe

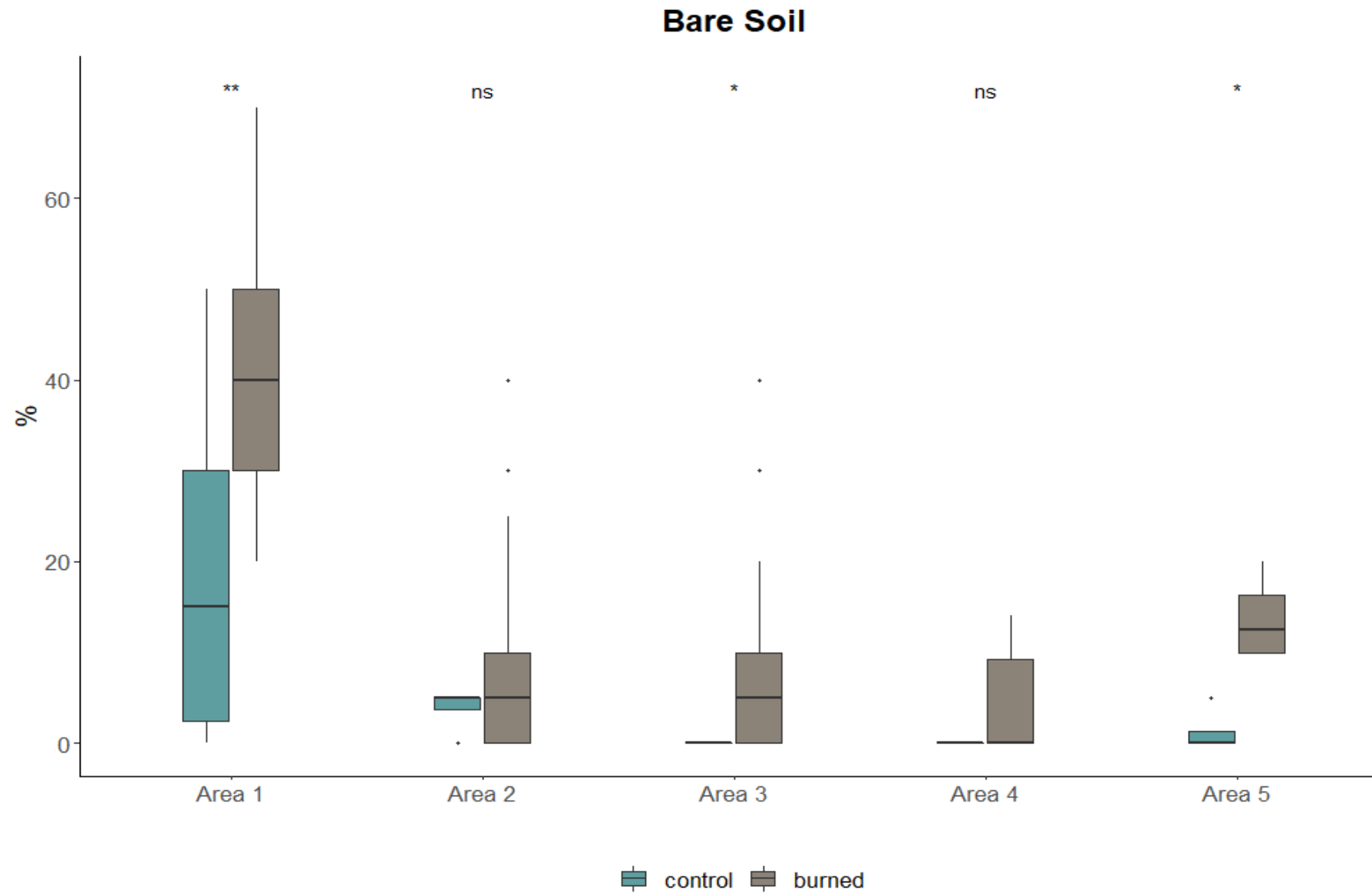


Figure 1. Box-plot of bare soil (%) per study area comparing burned soils vs controls. **, *: significant level for $P < 0.01$ and $P < 0.05$ respectively; ns: not significant at $P > 0.05$

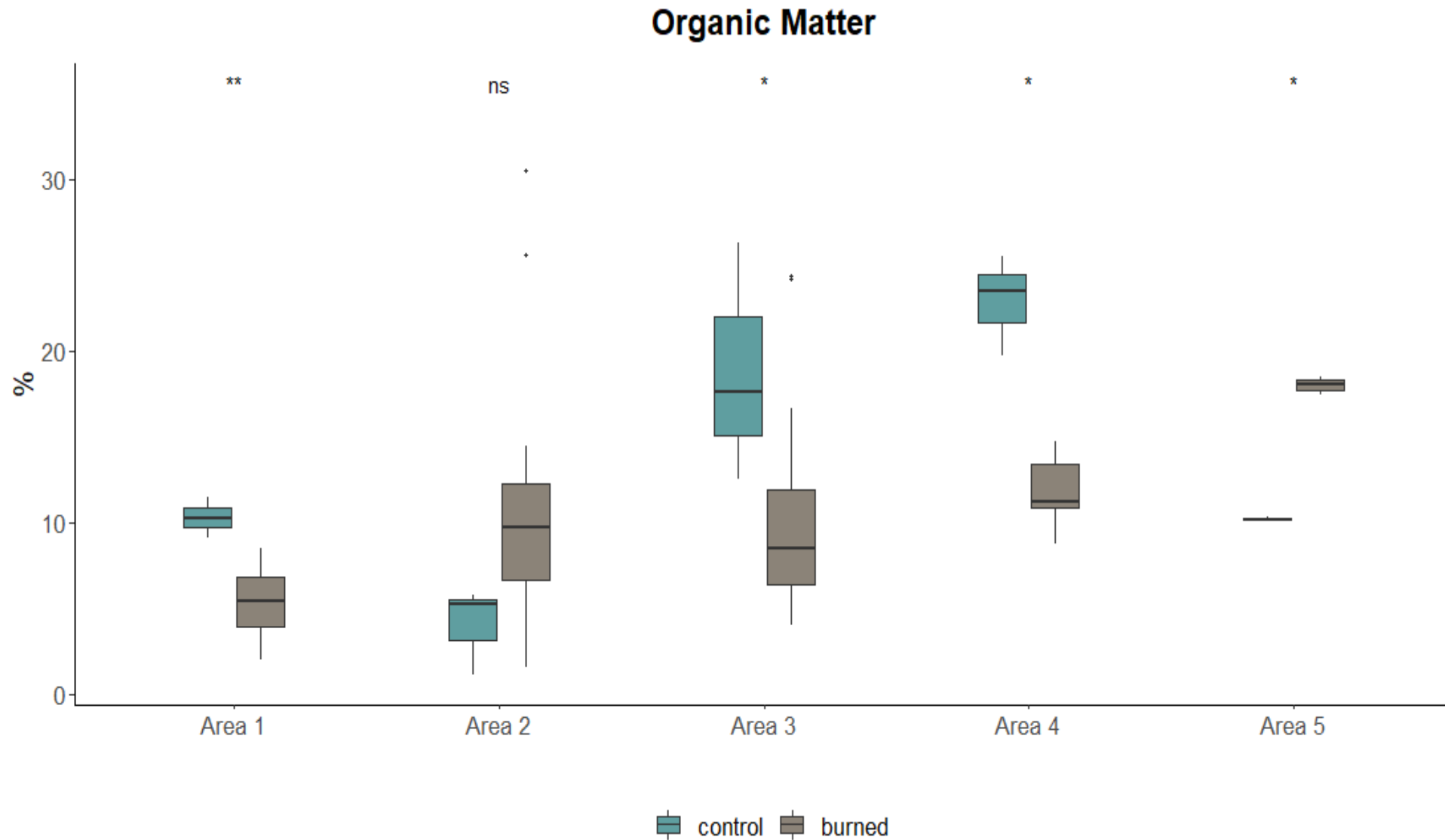


Figure 2. Box-plot of organic matter content (%) per study area comparing burned soils vs controls. **, *: significant level for $P < 0.01$ and $P < 0.05$ respectively; ns: not significant at $P > 0.05$

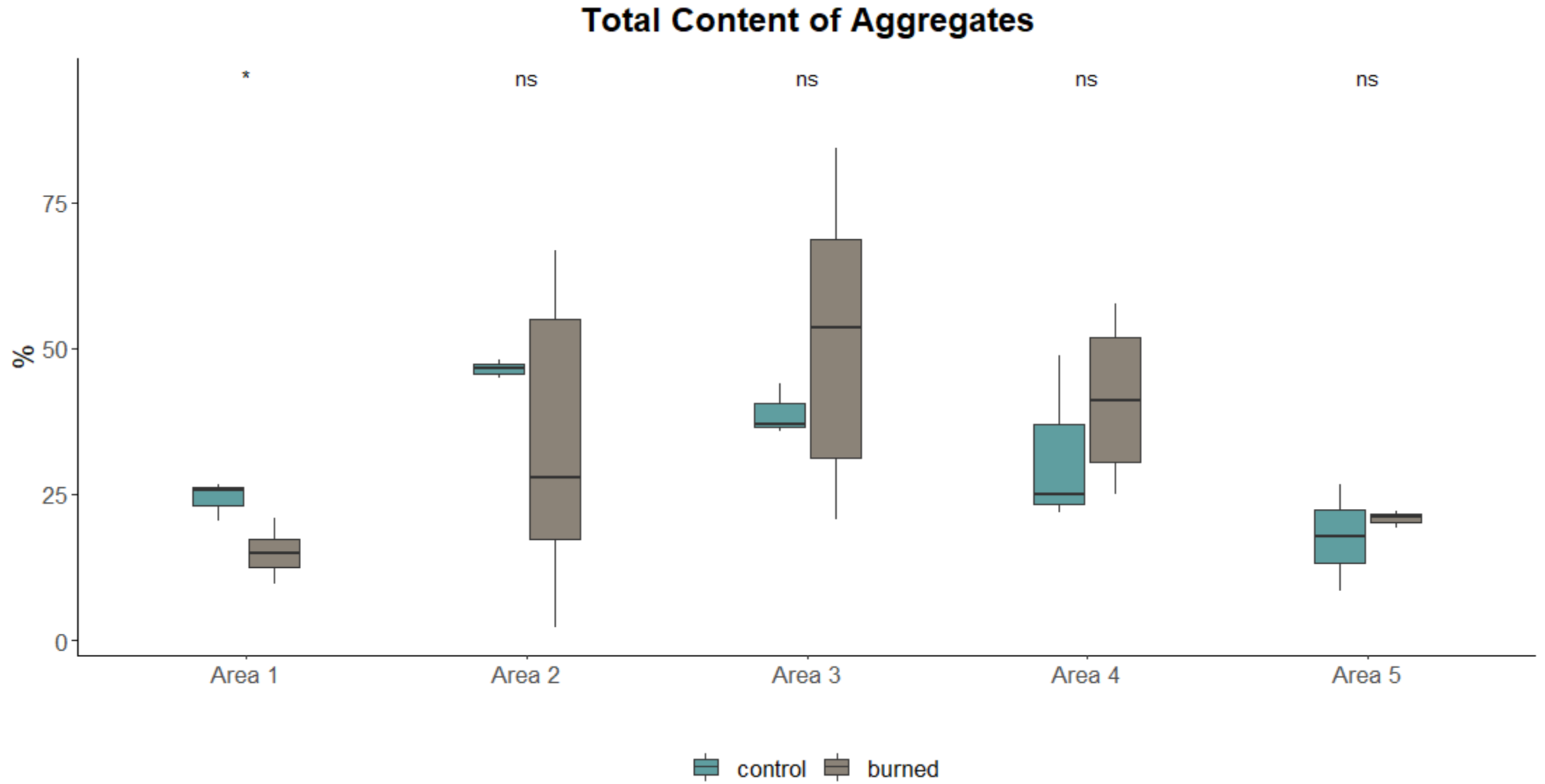


Figure 7. Box-plot of total content of aggregates (TCA %) per study area comparing burned soils vs controls. **, *: significant level for $P < 0.01$ and $P < 0.05$ respectively; ns: not significant at $P > 0.05$

Soil degradation by fire in the “*Pichu Pichu*” ecosystem scrubland area of the Andean region of Arequipa (Perú)

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X International Conference FUEGORED 2022. Évora, Portugal



Study area



- **Arequipa** (Perú): 2335 m a.s.l.
- Climate: BWk (Pm = 96.5 mm; Tm = 14.5 °C)



- Volcanic mountains:
- Misti: 5820 m a.s.l.
- Chachani: 6057 m a.s.l.
- **Pichu Pichu**: 5665 m a.s.l. Study area at: 3700 m a.s.l., ★ Pm increase to 385 mm concentrated only between January-March. The mean annual temperature is 10°C ranging from 4 to 18°C.

Scrubland landscape





No vegetation > 5000 m a.s.l.



Yareta (*Azorella compacta*) > 4500 m a.s.l.



Queñua (*Polylepis*), between 3500-4500 m a.s.l.

Scrubland landscape





History

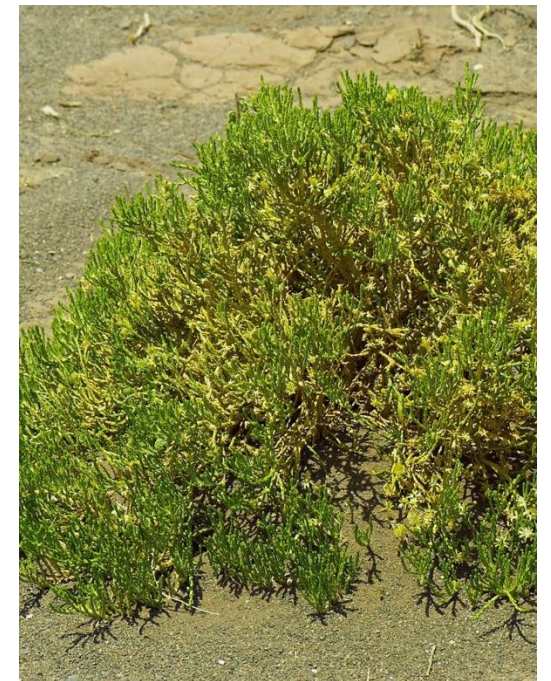
- **2018 Wildfire** affecting 1992 ha
- 2019 visit the affected area
- 2020 Project to study soil and vegetation recovery
- **2021 first sampling**
- **2022 second sampling**



Soil: Torripsamment (Soil Taxonomy 2014)
developed over volcaniclastic sandstone



Berberis lutea



Parastrephia quadrangularis

40 soil samples comparing Burned vs unburned area and per plant species



Lab analysis:

A set of chemical, physical, and microbial soil properties such as: **organic carbon content (OC)**, **pH**, **EC**, **water repellency (WR)**, **total content of macroaggregates (TCA)**, **aggregate stability (AS)**, **bulk density (BD)**, **microbial biomass carbon (C_{mic})**, **basal soil respiration (BSR)**, and **enzymatic activities**, among others were analysed in the labs of UNSA (Arequipa, Peru) and UMH (Elche, Spain).



Soils have an acidic pH, coarse texture with a high content of sand, Water repellency under natural conditions and low values of aggregation.

Results 2021

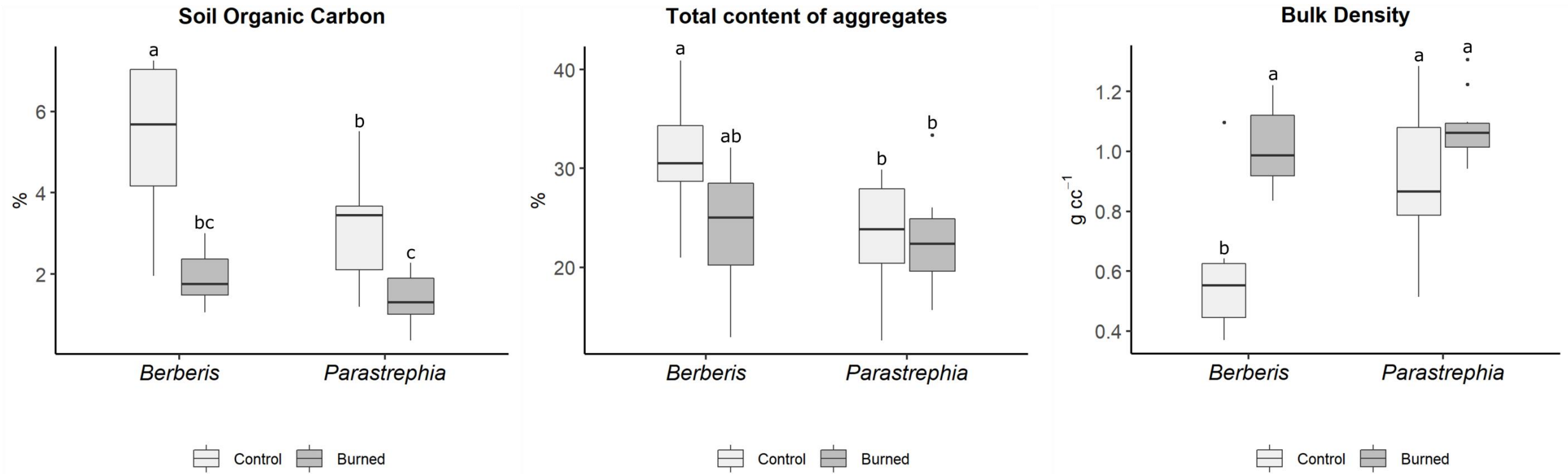


Figure 1. Box-plots of Soil OC (%), TCA, and BD per plant species comparing burned soils vs controls. Different letters indicate statistical differences at $P < 0.05$

Results 2021

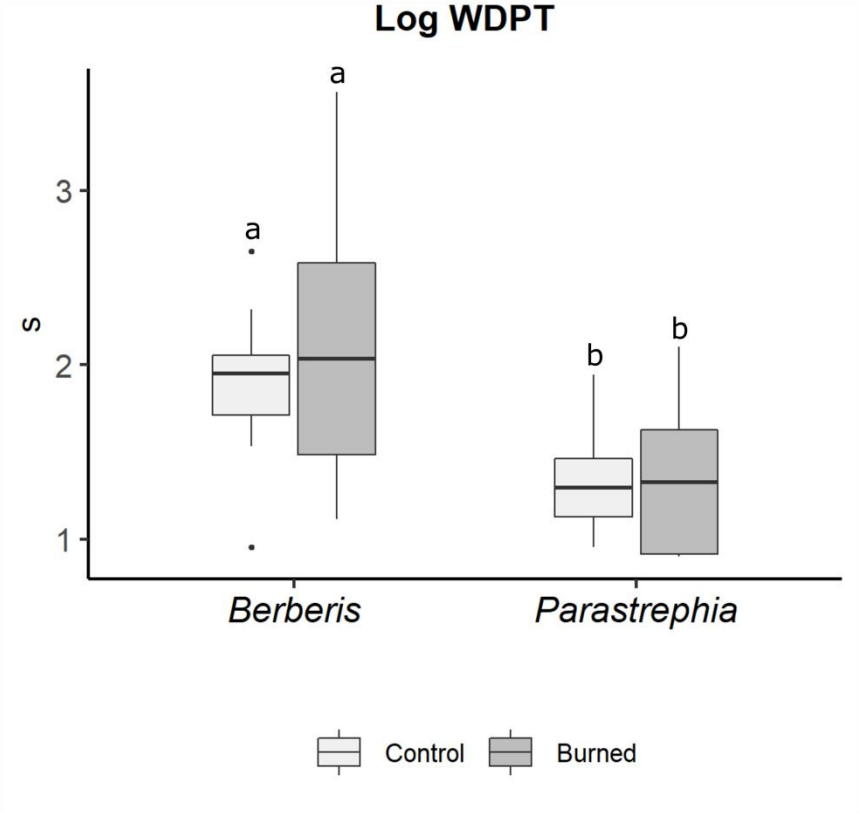


Figure 2. Box-plots of WR (LogWDPT (s)) per plant species comparing burned soils vs controls. Different letters indicate statistical differences at P <0.05

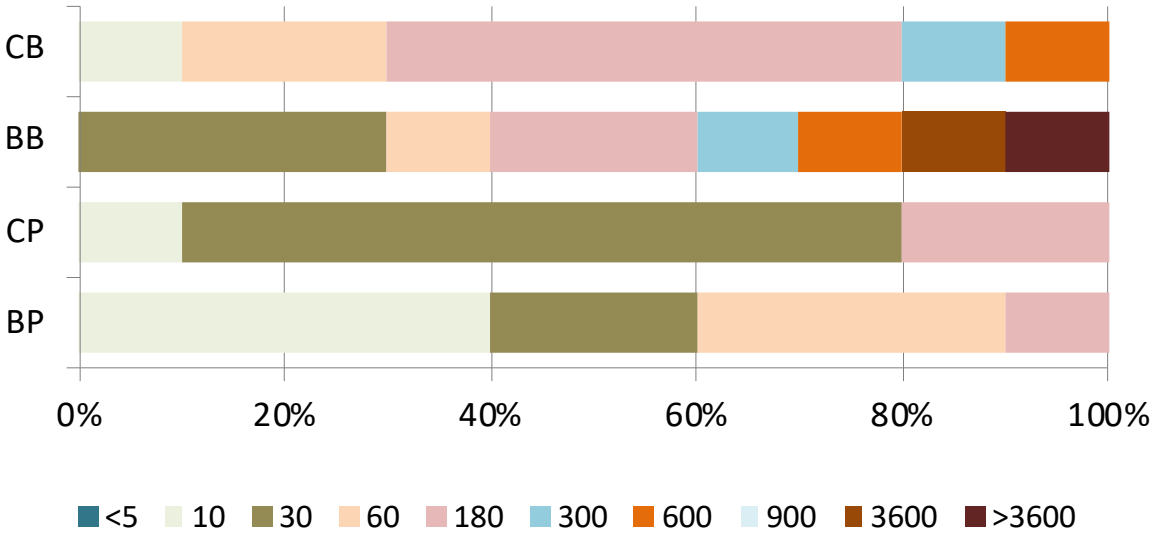


Figure 3. Frequency of distribution of Water Repellency (WDPT (s)). C: Control, B: Burned; B: *Berberis*; P: *Parastrephia*

100% of samples showed WR from slight to extreme

Results 2021

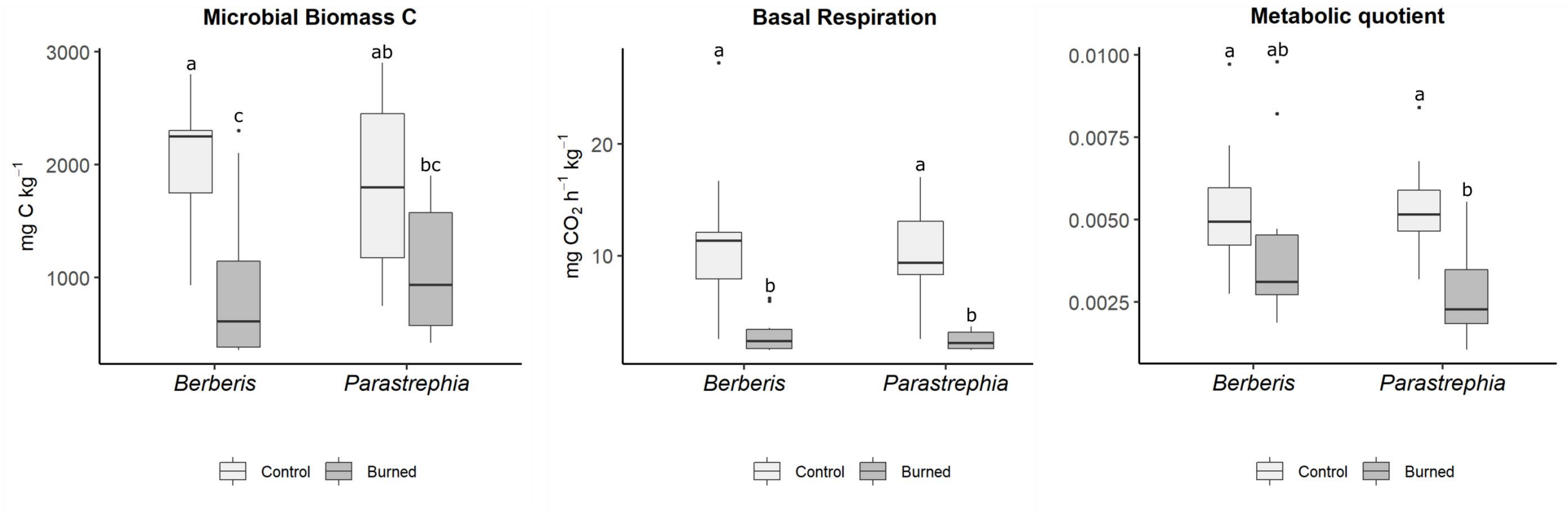


Figure 4. Box-plots of Microbial Biomas C (%) BR, and Metabolic quotient qCO₂ per plant species comparing burned soils vs controls. Different letters indicate statistical differences at P <0.05

Results 2021

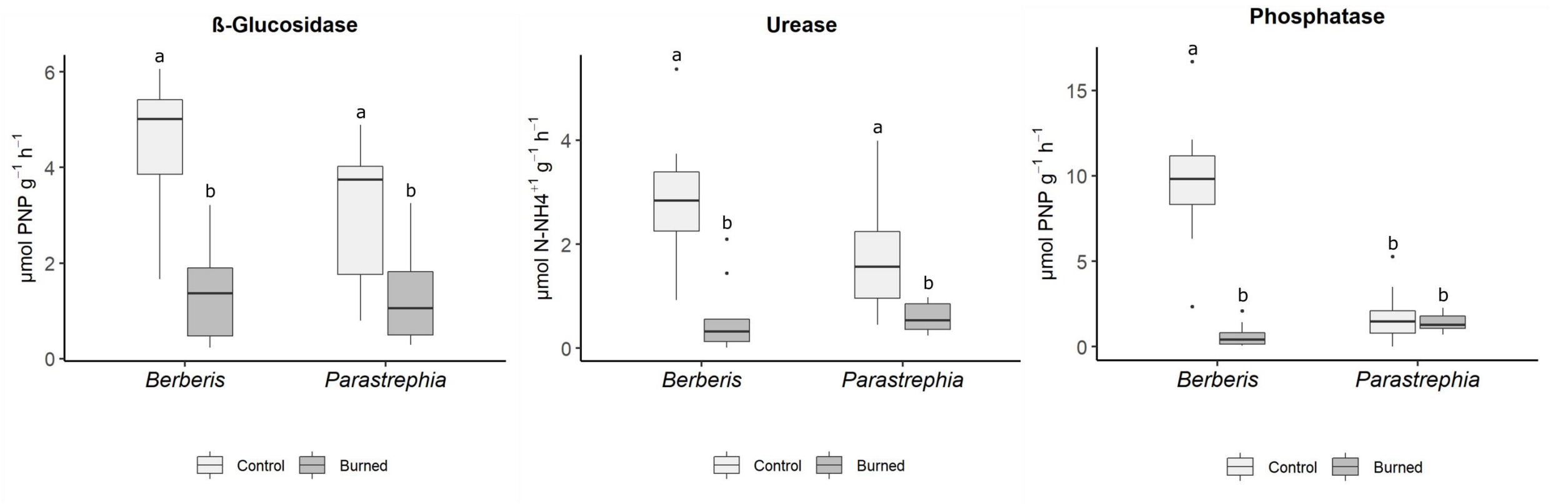


Figure 5. Box-plots of three enzymatic activities per plant species comparing burned soils vs controls. Different letters indicate statistical differences at $P < 0.05$

Results

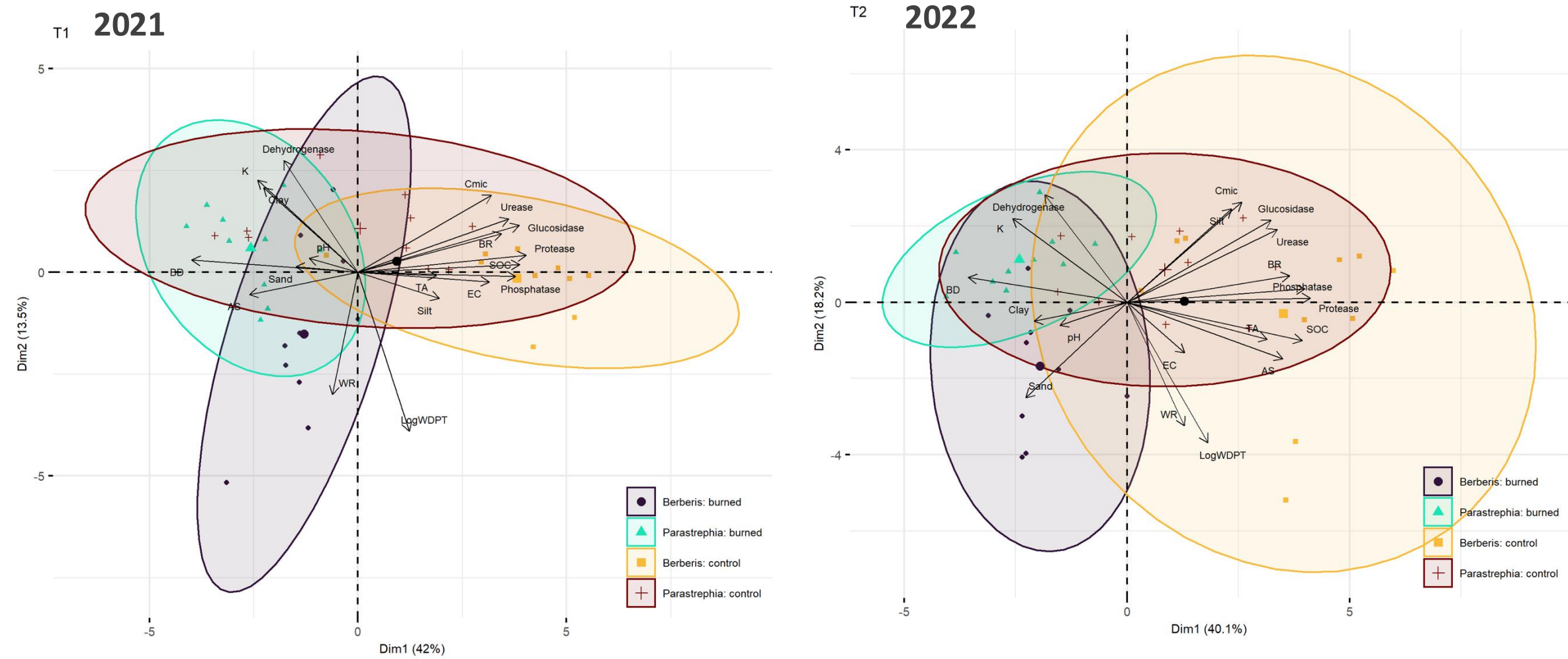


Figure 6. Scores and loadings for PCA performed with results of all soil samples per study area (burned and unburned and between plant species). C: Control, B: Burned; *B*: *Berberis*; *P*: *Parastrephia*



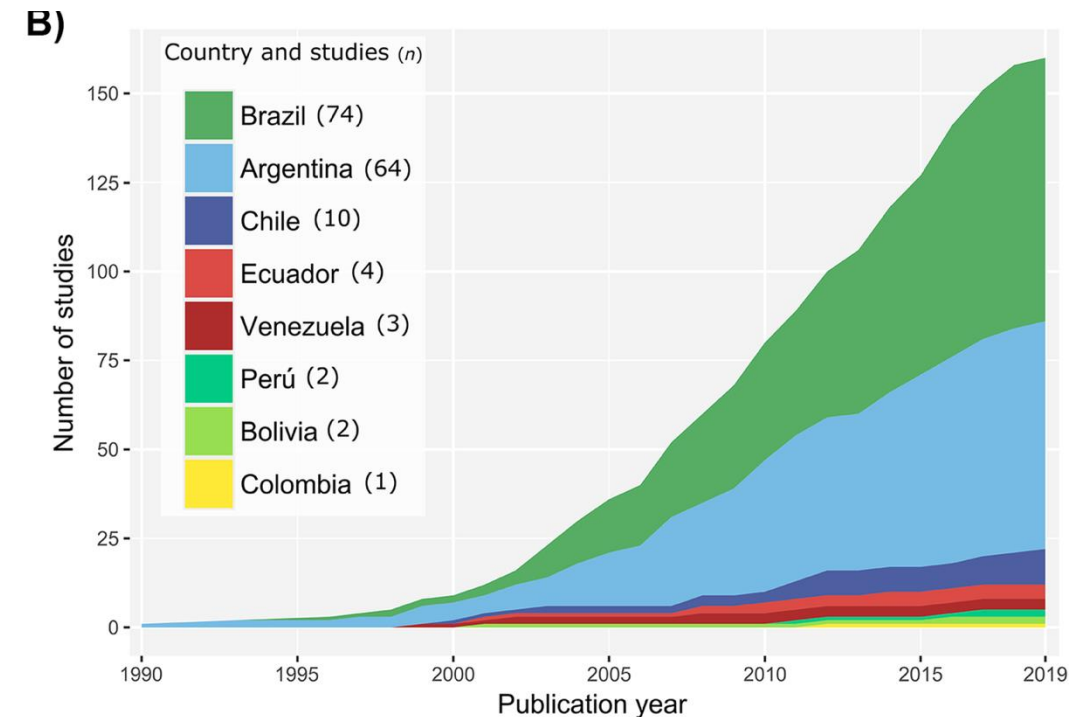
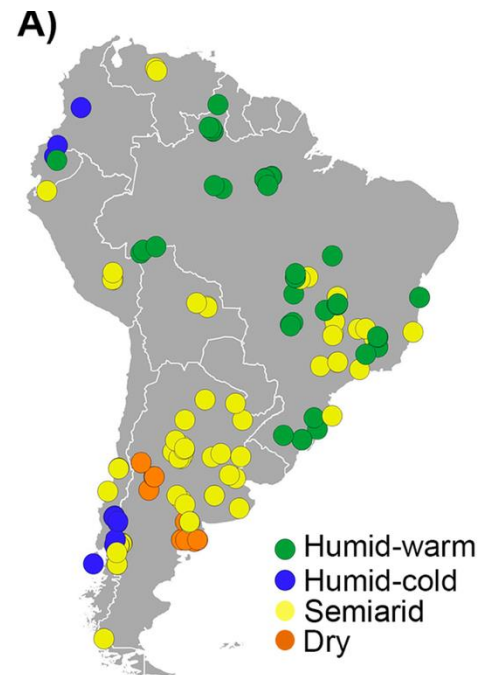
REVIEW

Open Access

A review of fire effects across South American ecosystems: the role of climate and time since fire



Melisa A. Giorgis^{1,2*} , Sebastian R. Zeballos¹, Lucas Carbone¹, Heike Zimmermann³, Henrik von Wehrden⁴, Ramiro Aguilar¹, Ana E. Ferreras¹, Paula A. Tecco^{1,2}, Esteban Kowaljow^{1,2}, Fernando Barri⁵, Diego E. Gurvich^{1,2}, Pablo Villagra^{6,7} and Pedro Jaureguiberry¹



Bolivia nov 2024



Bolivia nov 2024



Salvage logging impact in a Mediterranean soil affected by fire

- Sierra de Mariola. Alcoi, Alicante, Spain
- Wildfire in July 2012. more than 500 has affected
- In some areas, soil: Xerorthent developed from marls
- Treatment: salvage logging in Feb 2013

















Effect of salvage logging treatments on soil properties. Sierra de Mariola, Alicante. Sep2013





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journal homepage: www.elsevier.com/locate/scitotenv



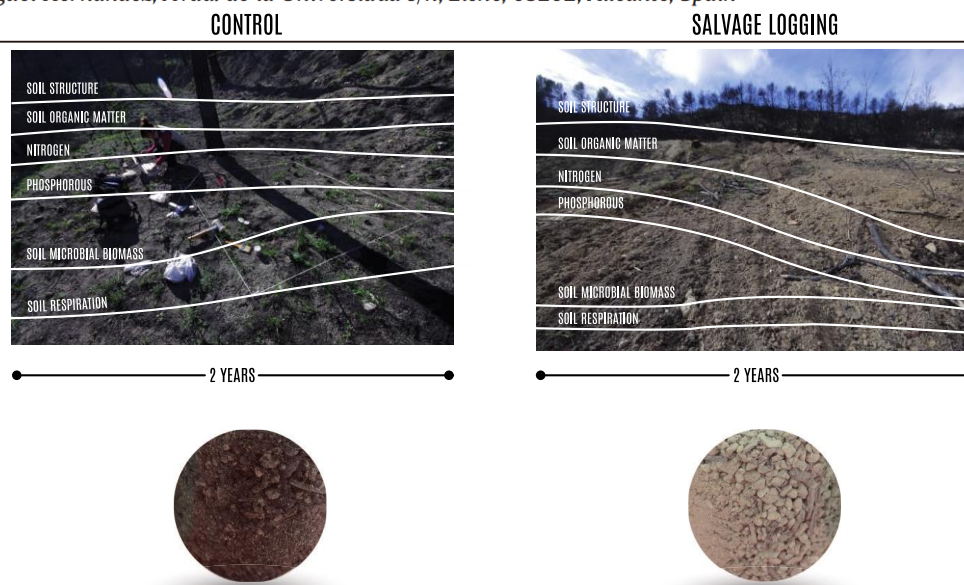
Effects of salvage logging on soil properties and vegetation recovery in a fire-affected Mediterranean forest: A two year monitoring research



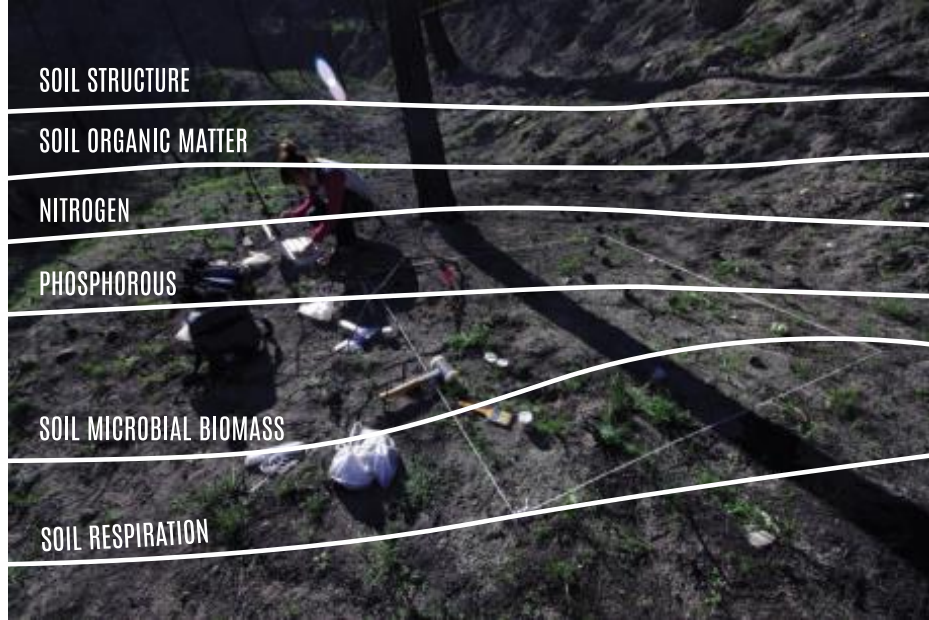
F. García-Orenes^a, V. Arcenegui^a, K. Chrenková^a, J. Mataix-Solera^{a,*}, J. Moltó^a, A.B. Jara-Navarro^a, M.P. Torres^b

^a GEA, Department of Agrochemistry and Environment, University Miguel Hernández, Avda. de la Universidad s/n, Elche, 03202, Alicante, Spain

^b Department of Applied Biology, University Miguel Hernández, Avda. de la Universidad s/n, Elche, 03202, Alicante, Spain



CONTROL



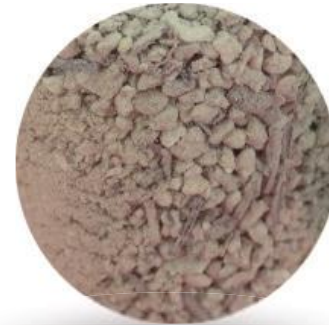
2 YEARS



SALVAGE LOGGING



2 YEARS





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The impact of post-fire salvage logging on microbial nitrogen cyclers in Mediterranean forest soil

Lily Pereg^{a,*}, Jorge Mataix-Solera^b, Mary McMillan^a, Fuensanta García-Orenes^b

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Applied Soil Ecology

journal homepage: www.elsevier.com/locate/apsoil



Salvage logging alters microbial community structure and functioning after a wildfire in a Mediterranean forest

Minerva García-Carmona^{a,*}, Fuensanta García-Orenes^a, Jorge Mataix-Solera^a, Antonio Roldán^b, Lily Pereg^c, Fuensanta Caravaca^b

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Research article

The role of mosses in soil stability, fertility and microbiology six years after a post-fire salvage logging management

Minerva García-Carmona^{*}, Victoria Arcenegui, Fuensanta García-Orenes, Jorge Mataix-Solera

GEA (Grupo de Edafología Ambiental), Department of Agrochemistry and Environment, University Miguel Hernández, Avda. de La Universidad s/n, Elche, 03202, Alicante, Spain

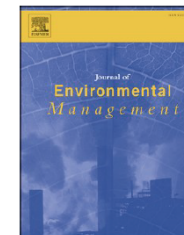




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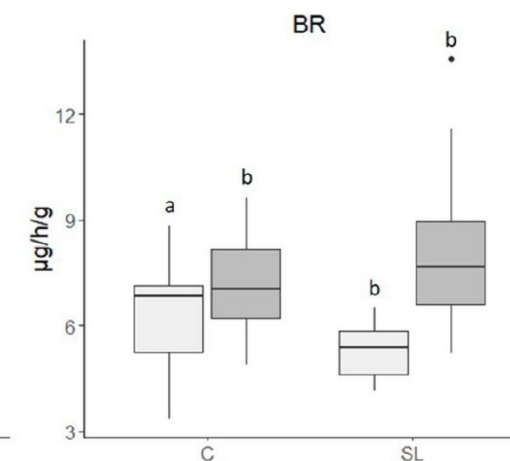
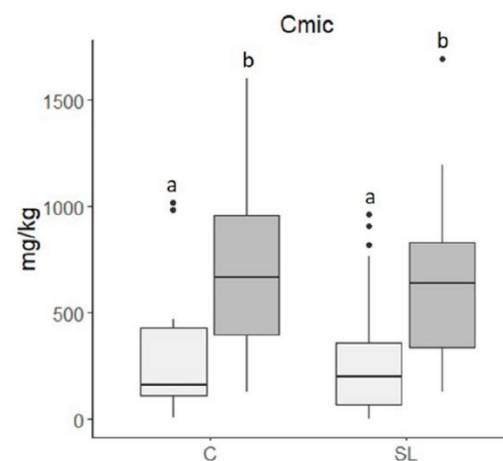
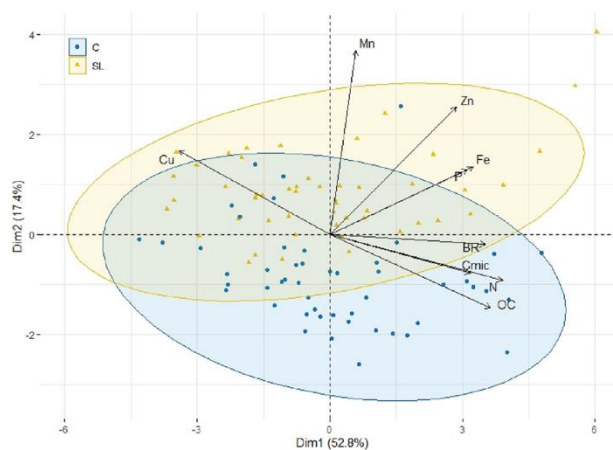
Research article

The role of mosses in soil stability, fertility and microbiology six years after a post-fire salvage logging management



Minerva García-Carmona^{*}, Victoria Arcenegui, Fuensanta García-Orenes, Jorge Mataix-Solera

GEA (Grupo de Edafología Ambiental), Department of Agrochemistry and Environment, University Miguel Hernández, Avda. de La Universidad s/n, Elche, 03202, Alicante, Spain



☐ BareSoil ☐ Moss

☐ BareSoil ☐ Moss



FIGURE 1 | Patch of moss biocrust emerged after a wildfire stabilizing soils surrounded by bare soils exhibiting erosion symptoms.

The Recovery of Mediterranean Soils After Post-Fire Management: The Role of Biocrusts and Soil Microbial Communities

Minerva García-Carmona, Fuensanta García-Orenes, Victoria Arcenegui and Jorge Mataix-Solera*

GETECMA- Soil Science and Environmental Technologies Group, Department of Agrochemistry and Environment, Miguel Hernández University, Elche, Spain



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Earth-Science Reviews

journal homepage: www.elsevier.com/locate/earscirev



Review Article

Effectiveness of post-fire soil erosion mitigation treatments: A systematic review and meta-analysis

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Peter R. Robichaud^c, J. Jacob Keizer^a

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ARTICLE INFO

Keywords:

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Runoff
Sediment losses
Erosion control
Mulch

ABSTRACT

Wildfires are known to be one of the main causes of soil erosion and land degradation, and their impacts on ecosystems and society are expected to increase in the future due to changes in climate and land use. It is therefore vital to mitigate the increased hydrological and erosive response after wildfires to maintain the sustainability of ecosystems and protect the values at risk downstream from the fire-affected areas. Soil erosion mitigation treatments have been widely applied after wildfires but assessment of their effectiveness has been limited to local and regional-scale studies, whose conclusions may depend heavily on site-specific conditions. To overcome this limitation, a meta-analysis approach was applied to investigations of post-wildfire soil erosion mitigation treatments published in peer-reviewed journals.

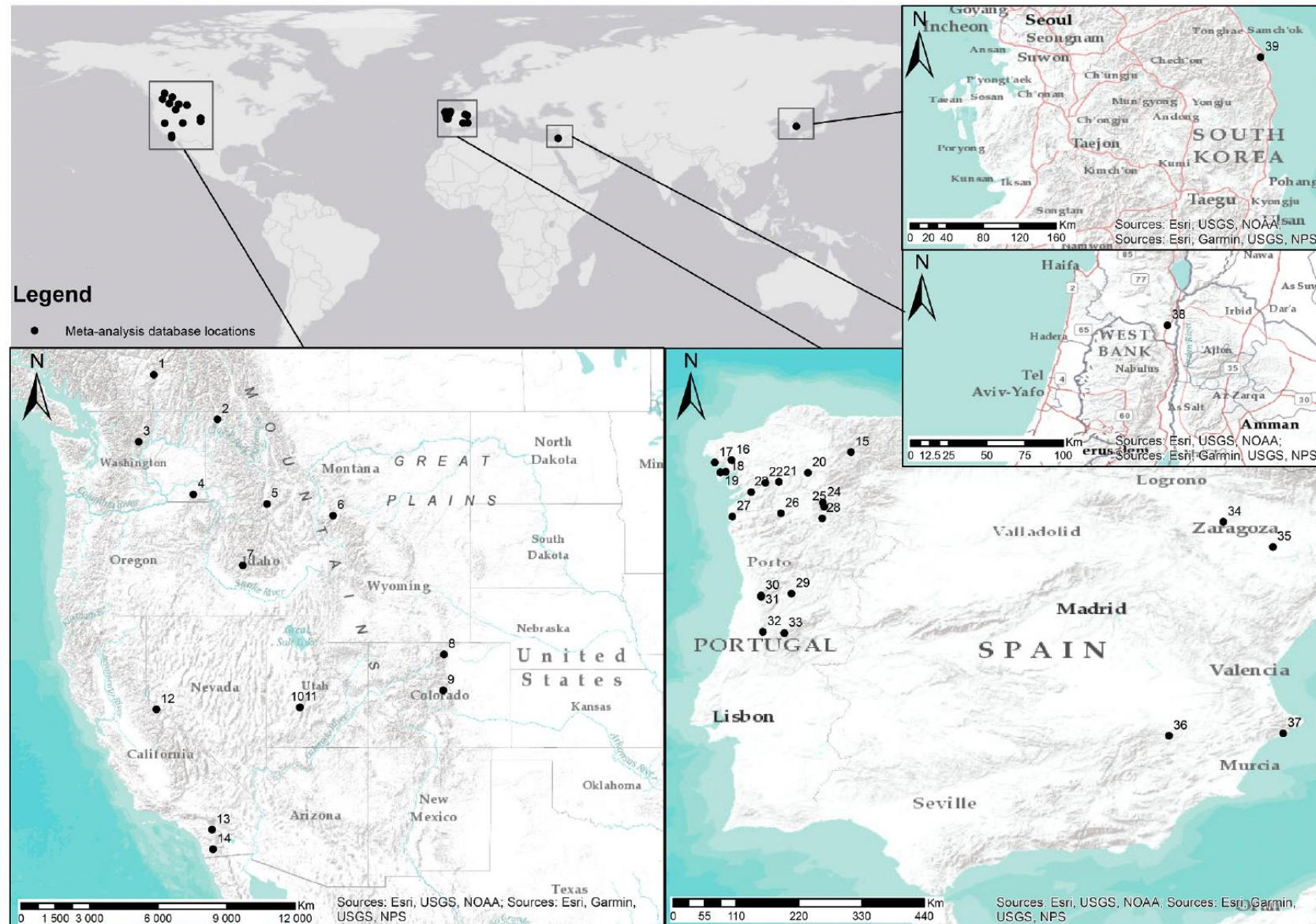


Fig. 2. Location of the study sites identified across the publications included in the meta-analysis. Numbers correspond to the study site reference provided in Table 1.



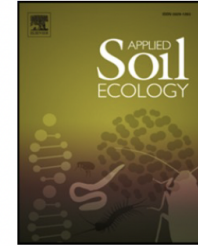
Fig. 5. Photographs of common ground cover and barrier treatments included in the meta-analysis: a) straw bale transport by helicopter (2005 School Fire, Washington, USA); b) helimulching dropping (2015, Navia de Suarna, Lugo, Spain); c) aerial hydromulch application (2002 Hayman Fire, Colorado, USA); d) wood shred mulching ground cover frame (2012 Waldo Canyon Fire, Colorado, USA); e) wood strand mulch study plot (2002 Hayman Fire, Colorado, USA); f) wood chips mulch (2006, Soutelo de Montes, Pontevedra, Spain); g) bark strand mulch (2010, Fial das Corzas, Pontevedra, Spain); h) straw bale check dams in an ephemeral channel (2010 Twitchell Canyon Fire, Utah, USA); i) log barriers (2002 Canyon Fire, California, USA); j) straw wattle barrier (2000 Bitterroot Complex Fire, Montana, USA); k) barriers made with shrubs (2006, Soutelo de Montes, Pontevedra, Spain); l) log dam (2015, Cinco Villas, Orés, Spain).



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Applied Soil Ecology

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Post-fire wood mulch negatively affects the moss biocrust cover and its positive effects on microbial diversity in a semi-arid Mediterranean forest

Minerva García-Carmona^{a,*}, Clémentine Lepinay^b, Jorge Mataix-Solera^a, Petr Baldrian^b, Victoria Arcenegui^a, Tomáš Cajthaml^b, Fuensanta García-Orenes^a

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^b Institute of Microbiology of the Czech Academy of Sciences, Videnska 1083, 14220 Praha 4, Czech Republic

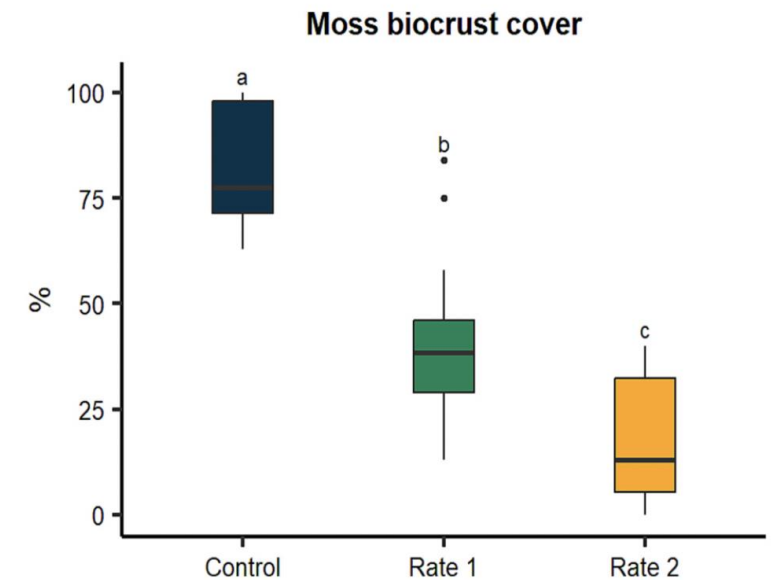


Fig. 1. Moss cover in soils after one year of mulch application. Different lowercase letters indicate significant differences among treatments (p-value < 0.05, Tukey test).





GABOPHOTOGRAPHY.COM

13-març DIA DE L'ARBRE 2016

Serelles

LLOC I HORA DE CONCENTRACIÓ:
davant de la Creu Roja, a les 3.30 del matí

Col·locació de substrat d'estelles per a
recobrir les zones més sensibles, on el sòl
està nuet, per tal d'ajudar els arbres a
poder continuar creixent.

Hi haurà esmorzar popular.

Cal portar calçat còmode.

US HI ESPEREM!!!



Organitza:



Col·labora:



Mariola, día del árbol. 12 marzo 2017





FUEGODIA

Sábado 18 mayo 2024- Serelles, Sierra de Mariola, Alcoi

Trekking didáctico impartido por estudiantes de 4º de Ciencias Ambientales de la Universidad Miguel Hernández sobre distintos aspectos de los incendios forestales

Ecología del fuego, impacto en el ecosistema, gestión pre- y post-incendio, etc...



Los Incendios forestales: recuperación, cuidado y gestión de áreas quemadas

EL FUEGO.

Es un factor ecológico natural que ha contribuido al desarrollo del ecosistema Mediterráneo. Hasta tal punto es importante, que es necesario para la multiplicación de muchas especies y la regeneración de sus formaciones vegetales. Existen multitud de ejemplos de adaptación a este factor. Un ejemplo es el Pino carrasco (*Pinus halepensis*).



PROBLEMÁTICA.

El problema reside cuando este factor ecológico se ve modificado por la acción antrópica, la cual altera el régimen natural de los incendios afectando tanto a la frecuencia como a la intensidad, y por tanto a las características del fuego tales como su severidad o extensión. Estos cambios pueden arrebatar al fuego su carácter renovador, creando incendios más destructivos.



SUELO.

Tras el paso de un incendio, la cubierta vegetal desaparece temporalmente, el suelo pierde la protección que ésta le proporcionaba y se vuelve más sensible ante agentes externos como la lluvia o el viento. Las lluvias intensas o las ventiscas podrían afectar erosionando la parte superficial del suelo llevándose las cenizas que son vitales para su buena recuperación.



POST-INCENDIO.

Debido a esta fragilidad del suelo, es necesario que las medidas que se tomen a corto plazo, eviten que puedan degradarlo o condicionar su recuperación. Es por ello que la extracción de madera quemada con la utilización de maquinaria pesada puede afectar de manera grave a la recuperación de los suelos, especialmente los desarrollados sobre litologías como las margas, que son rocas fácilmente erosionables. Los estudios realizados en esta zona así lo confirman.



MULCH.

Realizar acciones que protejan el suelo durante este periodo de vulnerabilidad son aconsejables. Como cubrirlo con acolchados (de astilla, paja o acículas de pino, etc.) que lo protejan del impacto de las gotas de lluvia, frenen las escorrentías y preserven más y durante más tiempo la humedad del suelo.



LOS MUSGOS.

Los musgos ayudan a los ecosistemas afectados por incendios, mejoran la fertilidad del suelo y la fijación de nutrientes, forman una biocostra en la superficie del suelo que lo protege de la erosión y la desecación, facilitando así al crecimiento microbiano y los procesos bioquímicos.



In summary (1/2)

- Fire is not the problem, the problem is changing its natural regime
- The effects on the soil are highly variable and partly controlled by the type of soil
- Decisions on post-fire management must be done after evaluation of the affected area. Possibilities on not intervention, act with some emergency treatment to protect soil (e.g., mulch) or to improve soil conditions to accelerate the recovery (e.g.: organic amendment) must be decided at local scale.



In summary (2/2)

- Improper post-fire management can cause more damage than fire
- Short, medium and long-term post-fire strategies should be planned by multidisciplinary teams (Forestry, Ecology, Botany, Geography, Sociology...) , and must include Soil Scientists
- Post-fire management must take care of the soils and take advantage of the circumstance to achieve future forests that will be more resilient to fire
- Disseminate what we know is as important as research it





Obrigado



POSTFIRE_CARE

Estrategias de gestión forestal y manejo postincendio orientadas a la conservación y mejora de la calidad del suelo