La fragilidad del suelo quemado

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gea Grupo de Edafología Ambiental

UNIVERSITAS Miguel Hernández

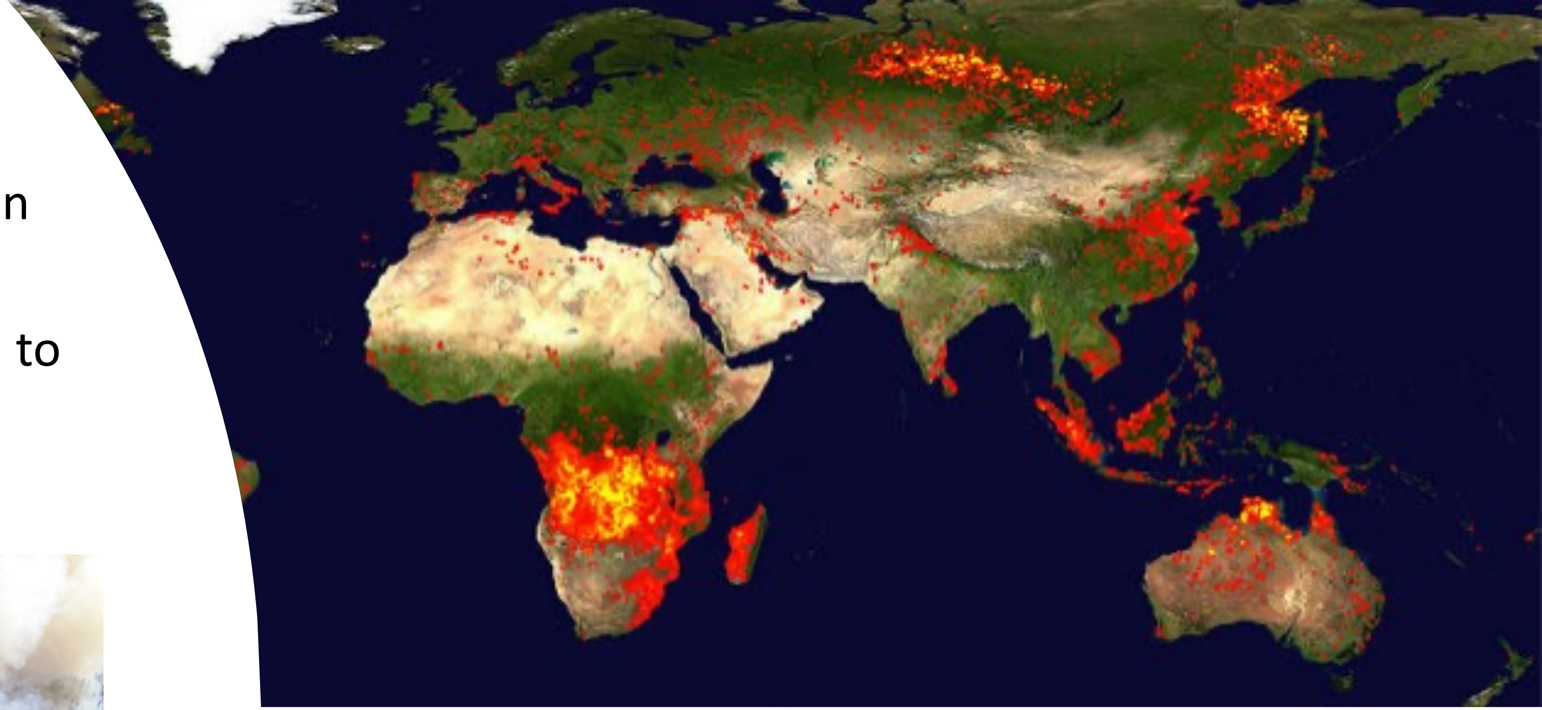
FUEGORED Red temática nacional Efectos de los Incendios Forestales sobre los Suelos

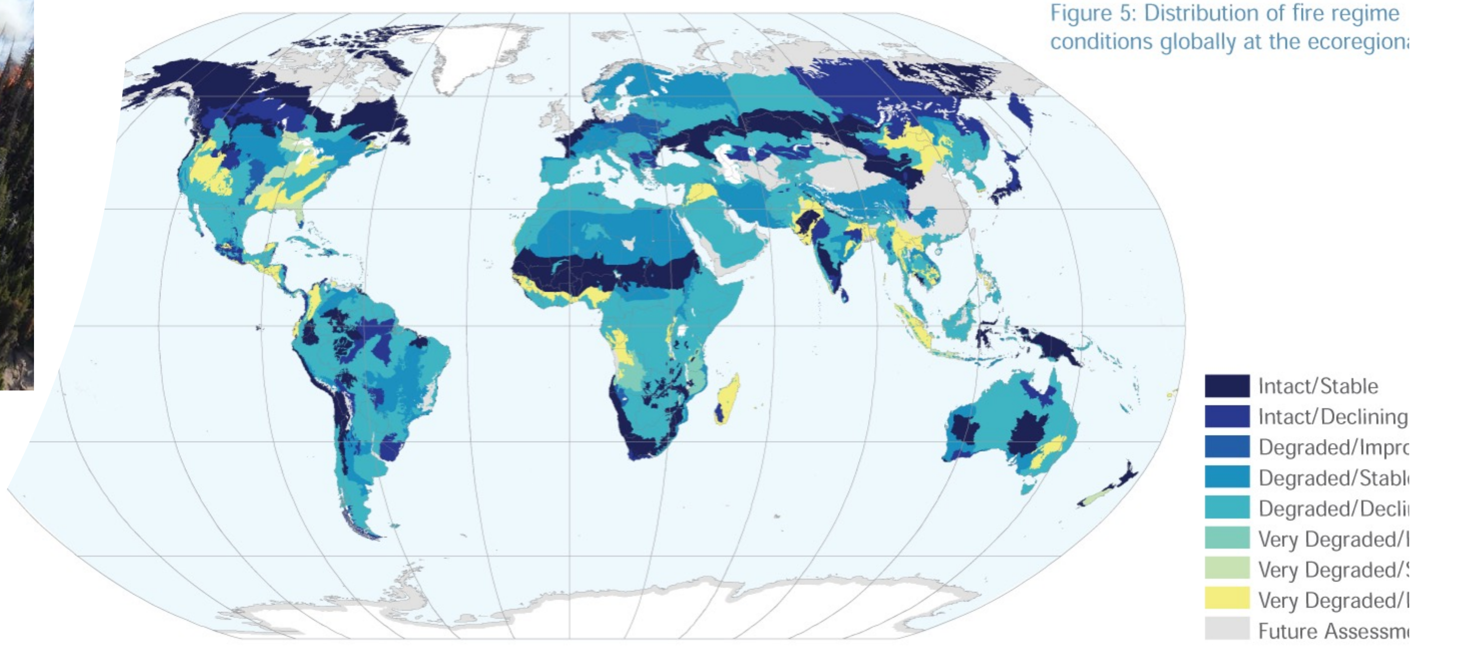
POSTFIRE_CARE

SECS SOCIEDAD ESPAÑOLA DE LA CIENCIA DEL SUELO 75 ANIVERSARIO 1947-2022

CICS 2022

- 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 (resilients) than others





Cambio climático

- Aumento de temperatura
- Aumento del periodo estival seco
- Mayor frecuencia de episodios de lluvias torrenciales

- Cambios en la vegetación
- Aumento del número de incendios
- Aumento de la intensidad de los fuegos
- Incendios en zonas que antes no eran frecuentes
- Aumento de procesos erosivos
- …..

Fire effects

Earth-Science Reviews 130 (2014) 103–127

Contents lists available at ScienceDirect

Earth-Science Reviews

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

Wildland fire ash: Production, composition and eco-hydro-geomorphic effects

Merche B. Bodí [a,b,*], Deborah A. Martin [c], Victoria N. Balfour [d], Cristina Santín [e], Stefan H. Doerr [e], Paulo Pereira [f], Artemi Cerdà [b], Jorge Mataix-Solera [g]

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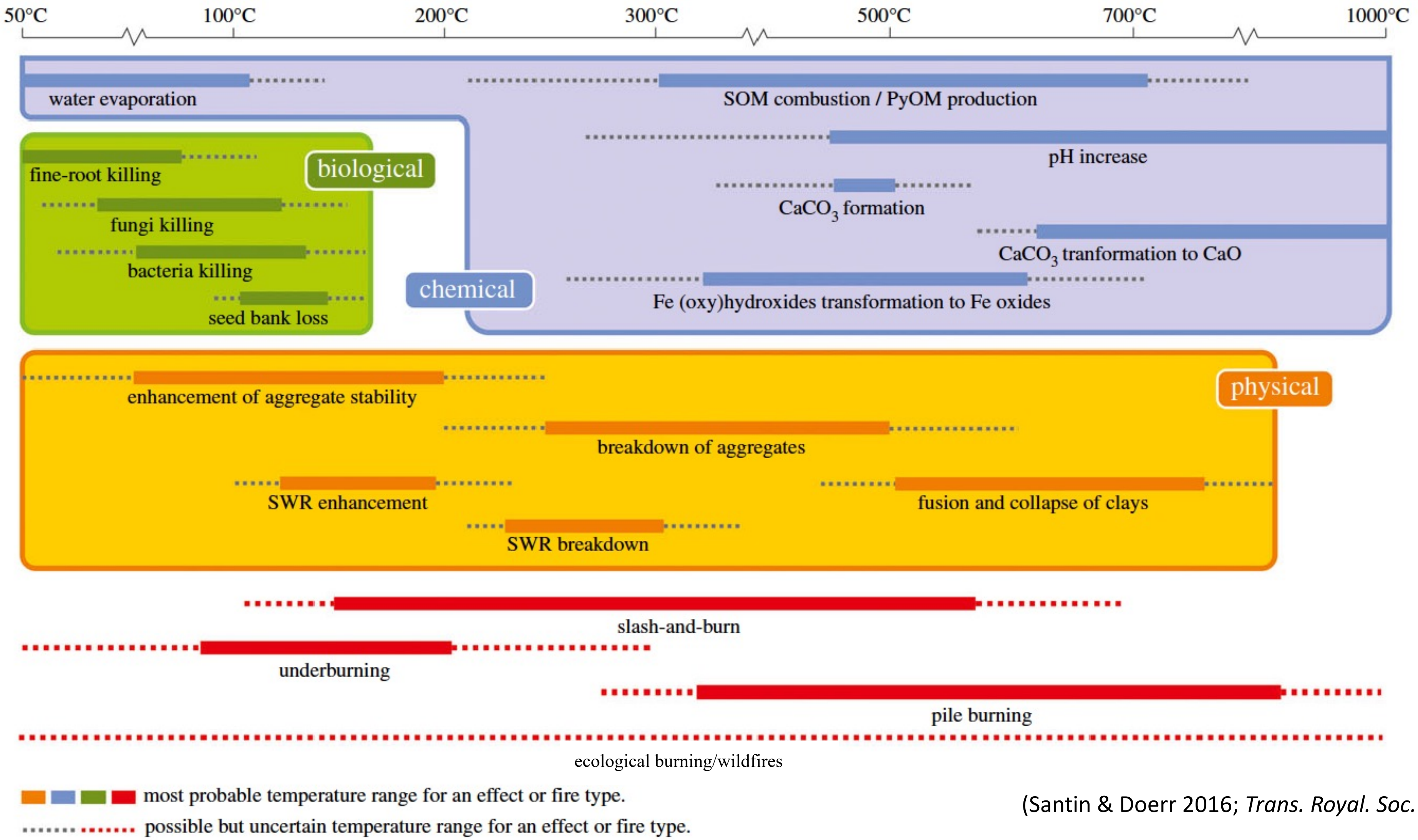
Factors controlling fire effects on soils

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

South-face

North-face

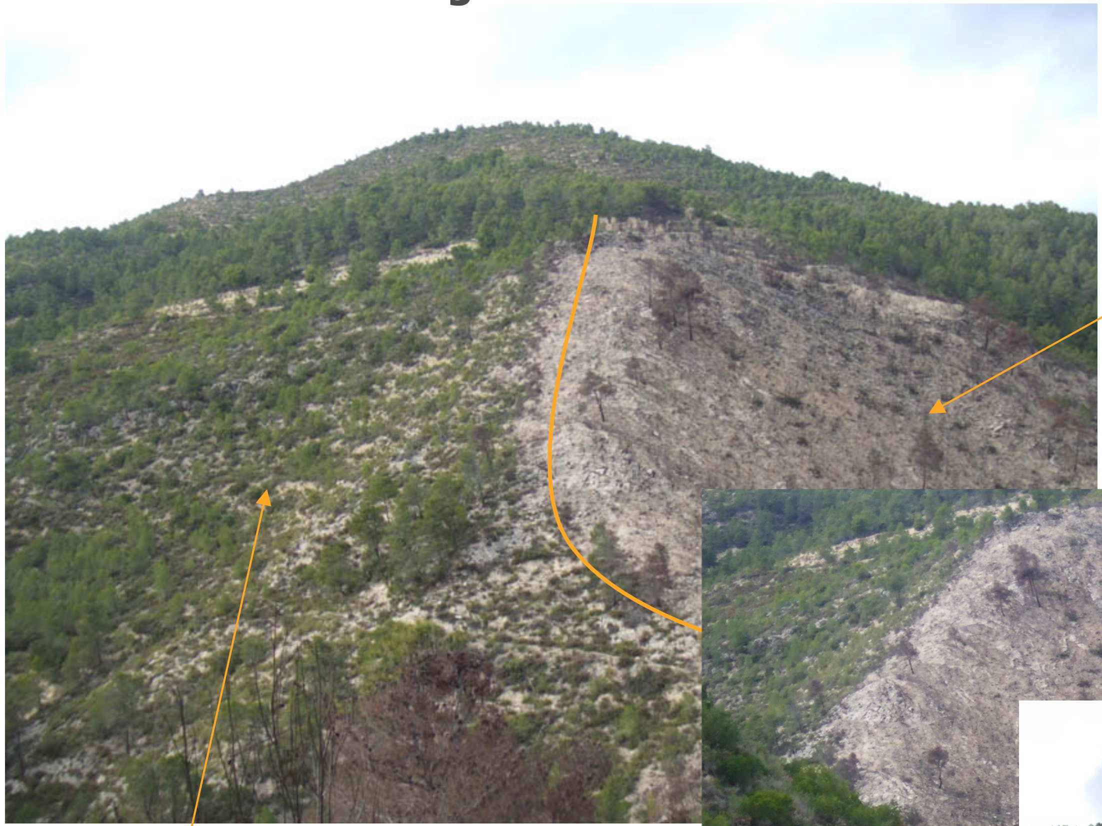
Torremanzanas Alicante
Fire Agosto 1987
Pictures Dic 2005
J. Mataix-Solera

¿Which one of these areas was affected by a forest fire?

Factors controlling fire effects on soils

Previous history of fires in affected area.

Recurrence of fires



New fire in august 2005
Picture Dec 2005

Torremanzanas Alicante
Fire August 1987
Picture Dic 2005

October 2006

October 2018
J. Mataix-Solera

Factors controlling fire effects on soils

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

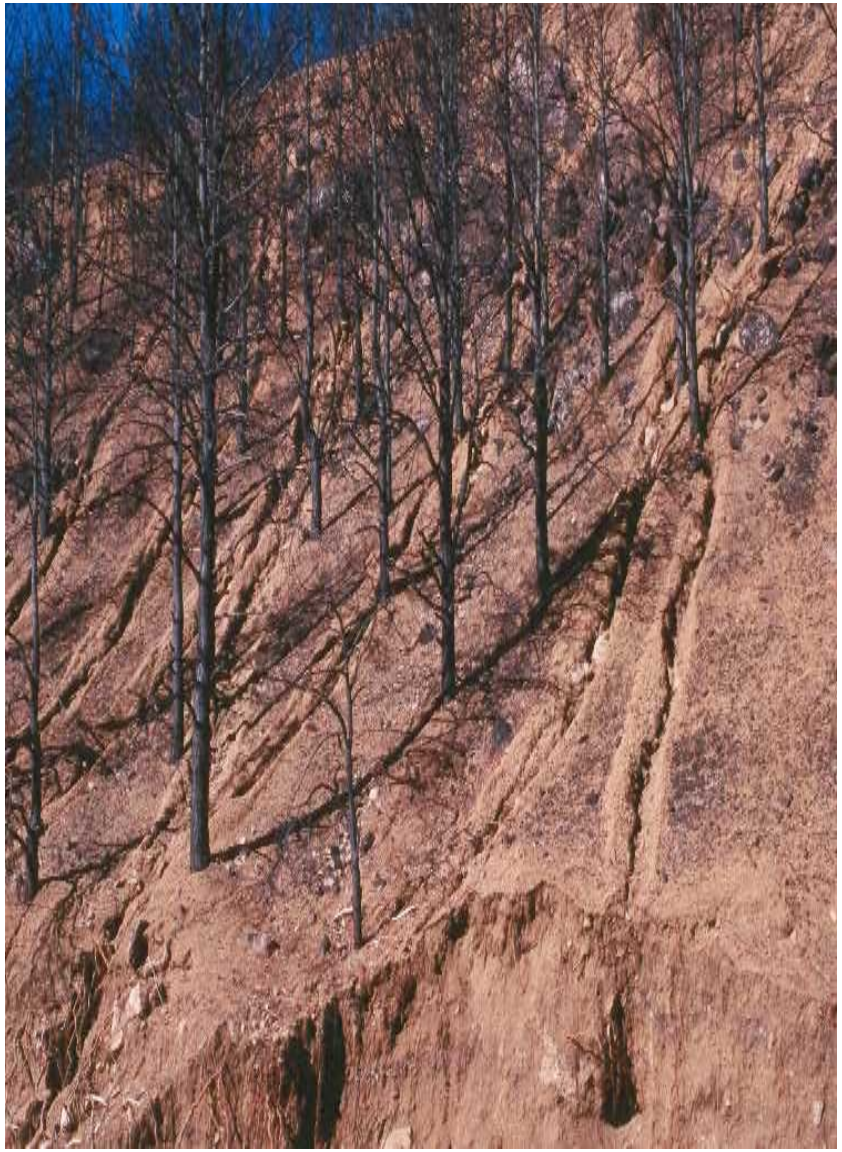
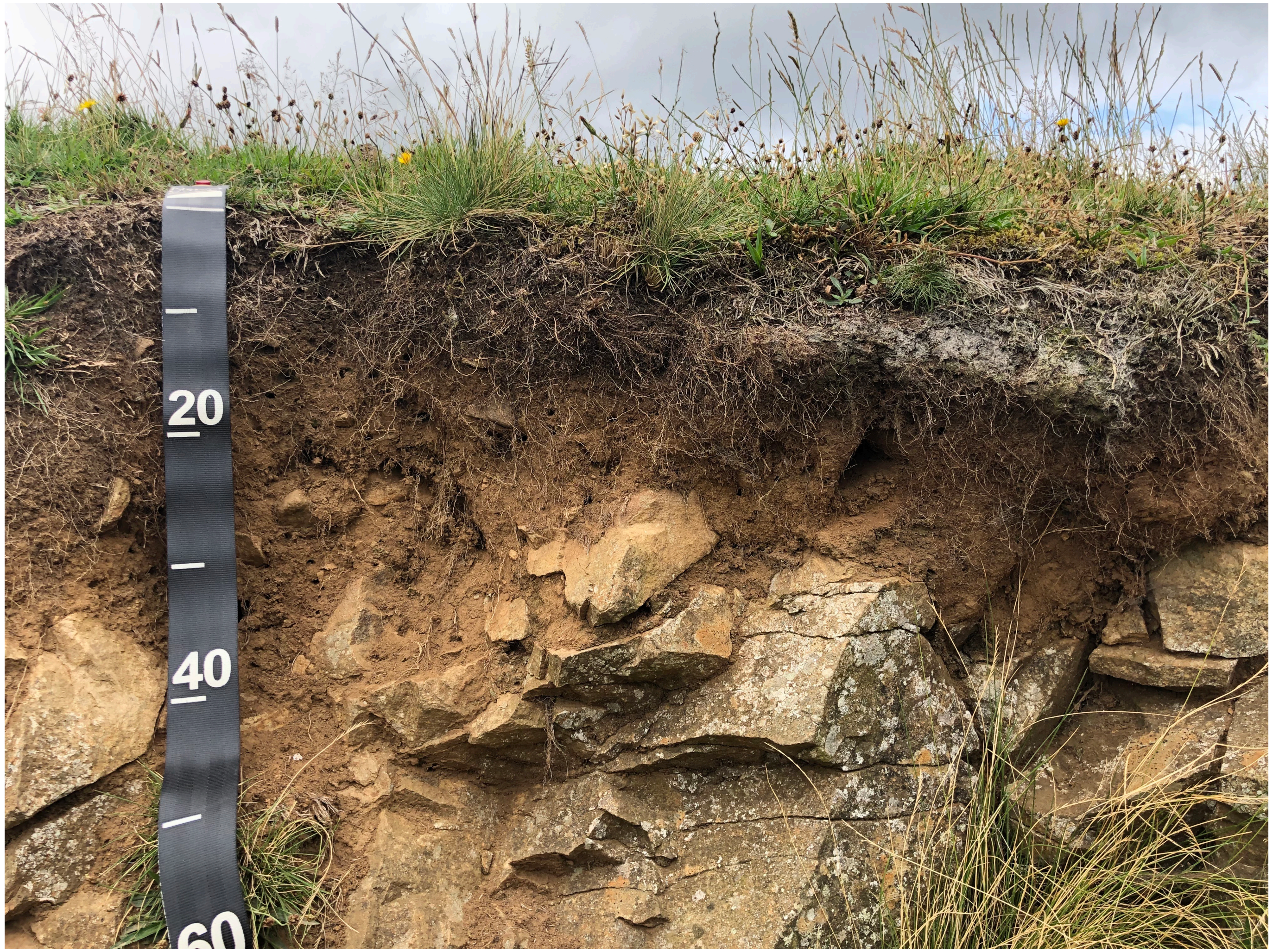


Photo: John A. Moody


Which is the role of soil type? "*The voice of soil*"

Soil Diversity



Lithic Humic Dystrudept (Soil Taxonomy 2014) North England








Soil Organic Matter (SOM)

Fire can modify organic matter (quantity and quality)

- Losses or additions of OM depending on the severity of fire
- implications for many soil properties
  - soil structure
  - nutrients
  - etc

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Available online at www.sciencedirect.com

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Environment International 30 (2004) 855–870

ENVIRONMENT INTERNATIONAL

www.elsevier.com/locate/envint

Review article

The effect of fire on soil organic matter—a review

José A. González-Pérez[a,*], Francisco J. González-Vila[a], Gonzalo Almendros[b], Heike Knicker[c]

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nature geoscience

ARTICLES

https://doi.org/10.1038/s41561-019-0403-x

Global fire emissions buffered by the production of pyrogenic carbon

Matthew W. Jones[1,4*], Cristina Santín[1,2], Guido R. van der Werf[3] and Stefan H. Doerr[1]

Landscape fires burn 3–5 million km² of the Earth's surface annually. They emit 2.2 Pg of carbon per year to the atmosphere, but also convert a significant fraction of the burned vegetation biomass into pyrogenic carbon. Pyrogenic carbon can be stored in terrestrial and marine pools for centuries to millennia and therefore its production can be considered a mechanism for long-term carbon sequestration. Pyrogenic carbon stocks and dynamics are not considered in global carbon cycle models, which leads to systematic errors in carbon accounting. Here we present a comprehensive dataset of pyrogenic carbon production factors from field and experimental fires and merge this with the Global Fire Emissions Database to quantify the global pyrogenic carbon production flux. We found that 256 (uncertainty range: 196–340) Tg of biomass carbon was converted annually into pyrogenic carbon between 1997 and 2016. Our central estimate equates to 12% of the annual carbon emitted globally by landscape fires, which indicates that their emissions are buffered by pyrogenic carbon production. We further estimate that cumulative pyrogenic carbon production is 60 Pg since 1750, or 33–40% of the global biomass carbon lost through land use change in this period. Our results demonstrate that pyrogenic carbon production by landscape fires could be a significant, but overlooked, sink for atmospheric CO_2.

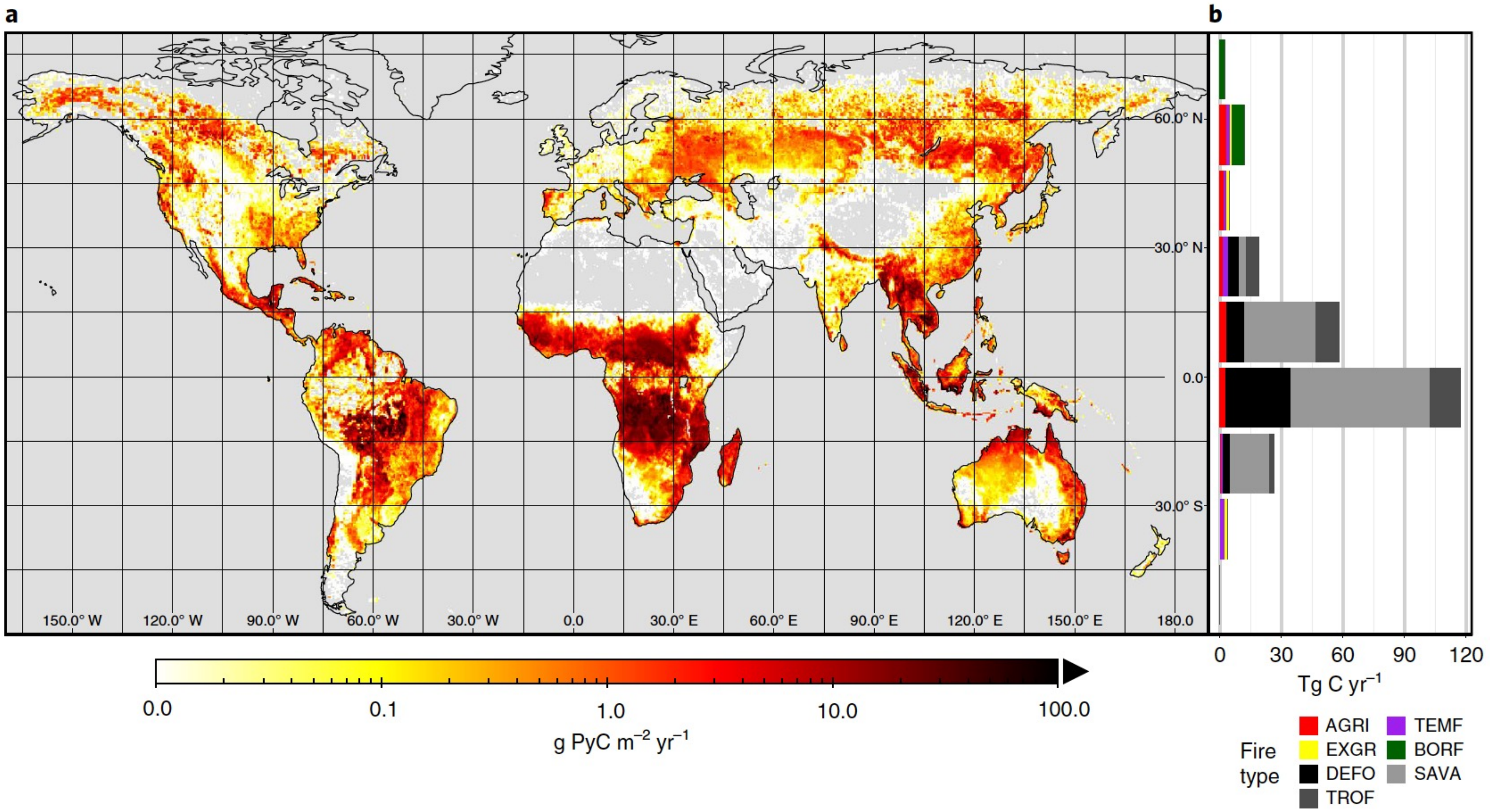

Fig. 4 | Annual average PyC production rates for the period 1997–2016 from GFED4s+PyC, based on central production factors (Fig. 2). a, The average global distribution of PyC production (g C m^{-2} yr^{-1}; note the log scale). **b**, The total production of PyC (Tg C yr^{-1}) in 15° latitudinal bands segregated according to the fire type, which includes savannah fires (SAVA), non-deforestation tropical forest fires (TROF), tropical deforestation fires (DEFO), agricultural fires (AGRI), temperate forest fires (TEMF), extratropical grassland fires (EXGR) and boreal forest fires (BORF).

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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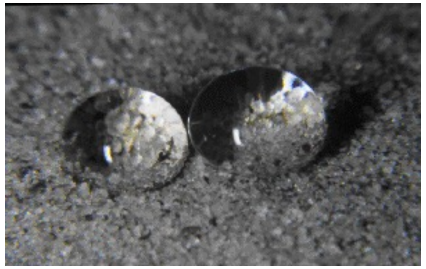
Received 10 October 2002; accepted 25 April 2003

Photo: Ana Mateu

Photo: J. Mataix-Solera

Soil water repellency (WR)

Causes of WR



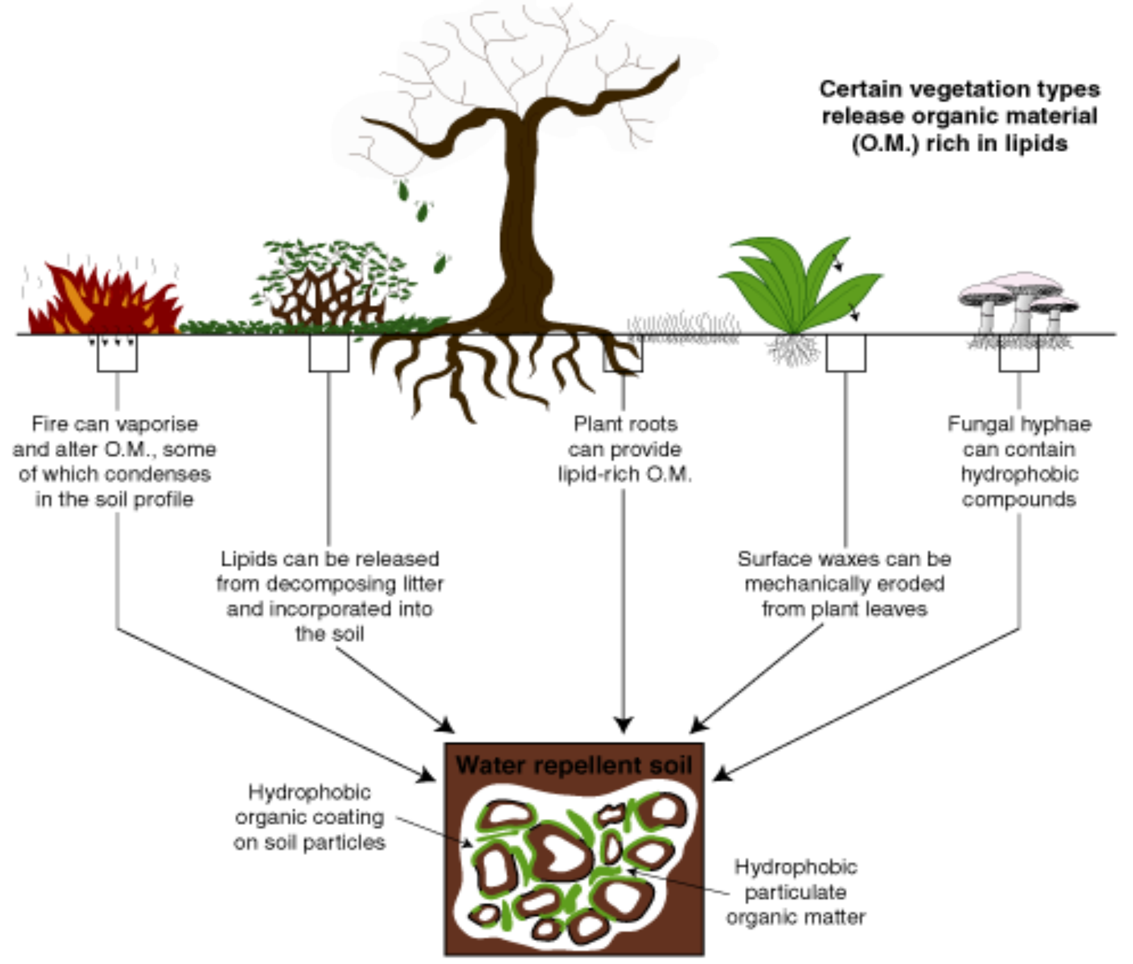
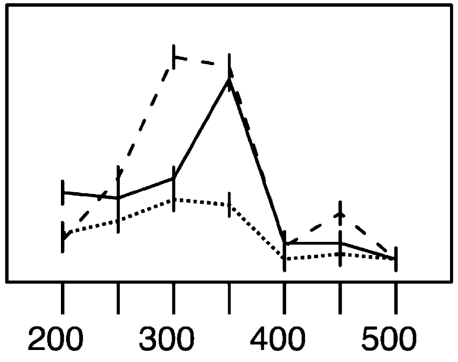


Figura: Stefan H. Doerr 2000

Water repellency

Photo: J. Mataix-Solera



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Catena 74 (2008) 219–226

CATENA

www.elsevier.com/locate/catena

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

V. Arcenegui *, J. Mataix-Solera, C. Guerrero, R. Zornoza, J. Mataix-Beneyto, F. García-Orenes

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

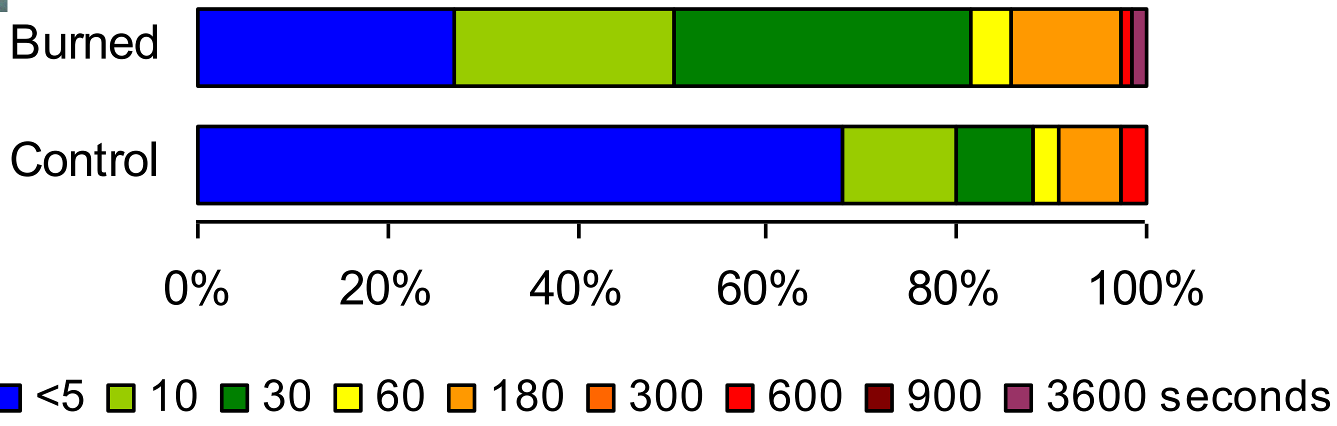

Figure 3. Relative frequency of water repellency classes (s) for burned samples from 10 wildfires occurred in summers 2003, 2004, 2005 and 2006 (pooled from all burned sites) and for all control samples (*n*=200).

Geoderma 147 (2008) 178–184

Contents lists available at ScienceDirect

Geoderma

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

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

J. Mataix-Solera [a,*], V. Arcenegui [a], C. Guerrero [a], M.M. Jordán [a], P. Dlapa [b], N. Tessler [c], L. Wittenberg [c]

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Terra rossa. Benitatxel, Alicante.

Lithic Rhodoxeralf (Soil Taxonomy)

Chromic Luvisol (WRB Classification)

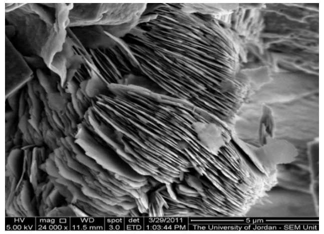
Photo: J. Mataix-Solera

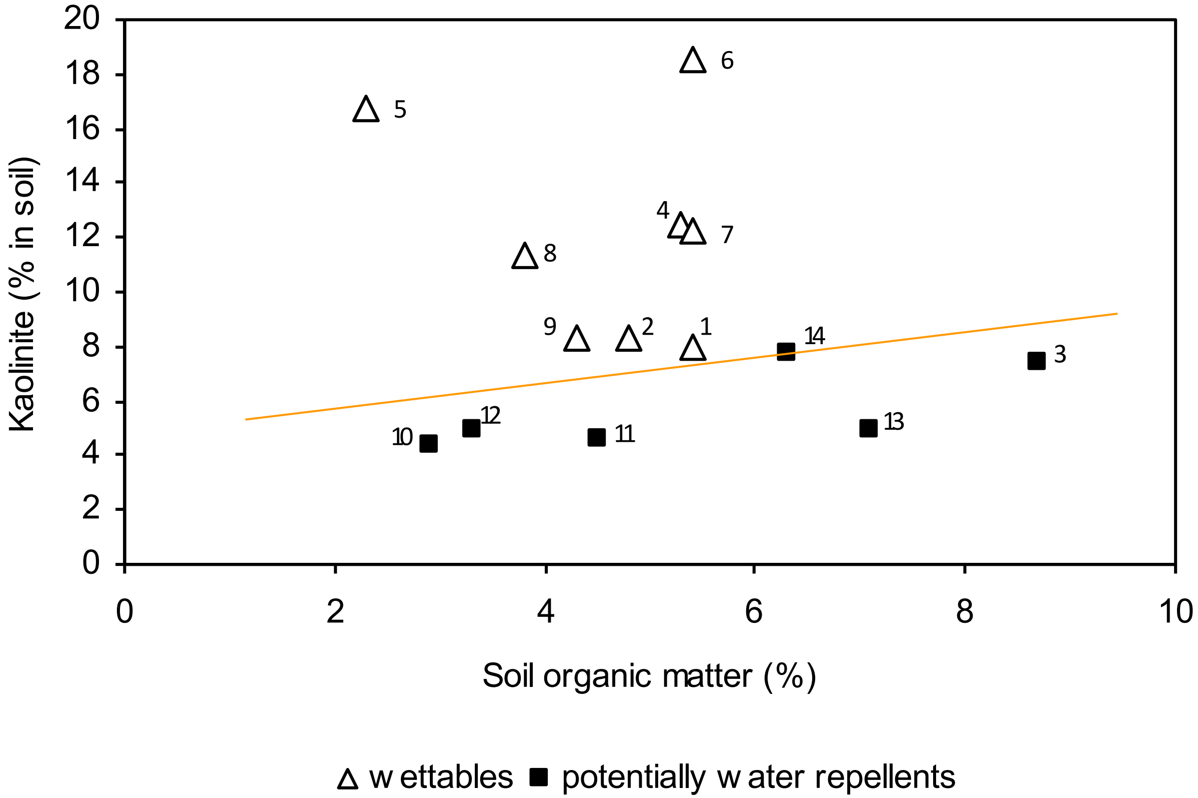
Terra rossa. Javea, Alicante. Photo: J. Mataix-Solera 2008
Lithic Rhodoxeralf (Soil Taxonomy)
Chromic Luvisol (WRB Classification)

Susceptibility of soils to develop WR by burning is quite variable

Soil factors controlling:

- SOM content
- Texture
- Mineralogy of clay fraction





Mataix-Solera et al., 2008. Geoderma

Small differences in some soil properties can control the occurrence and persistence of soil WR developed by burning.

Texture, **mineralogy of clay**, **SOM quantity and quality**

Foto: Ana Mateu

The high spatial variability of soil WR found in field in burned areas, which has been mainly attributed to the expected differences in temperature reached in burned soils -as a consequence of fuel distribution and fire behaviour-, can also be a consequence of the spatial variability of soil properties, because small differences in some soil properties affect the fire-induced changes in soil WR

Mataix-Solera et al., 2013. Spanish Journal of Soil Science

Earth-Science Reviews 109 (2011) 44–60

Contents lists available at SciVerse ScienceDirect

Earth-Science Reviews

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

Fire effects on soil aggregation: A review

J. Mataix-Solera [a,c,*], A. Cerdà [b,c], V. Arcenegui [a,c], A. Jordán [c], L.M. Zavala [c]

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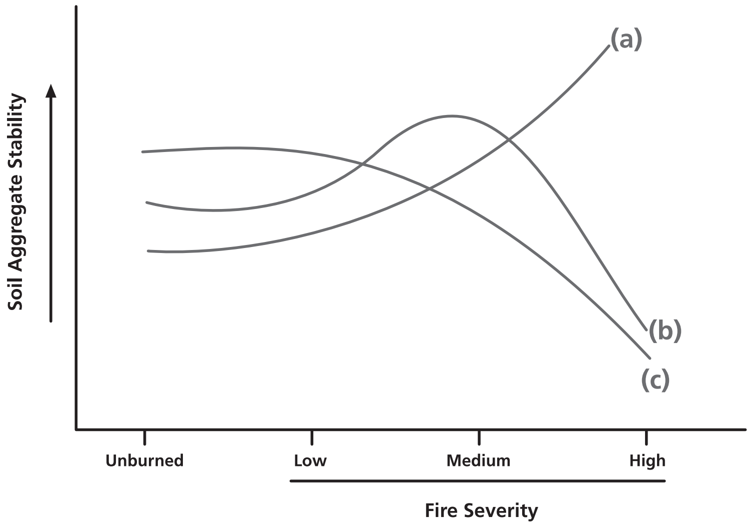
Photos: J. Mataix-Solera and Stefan H. Doerr



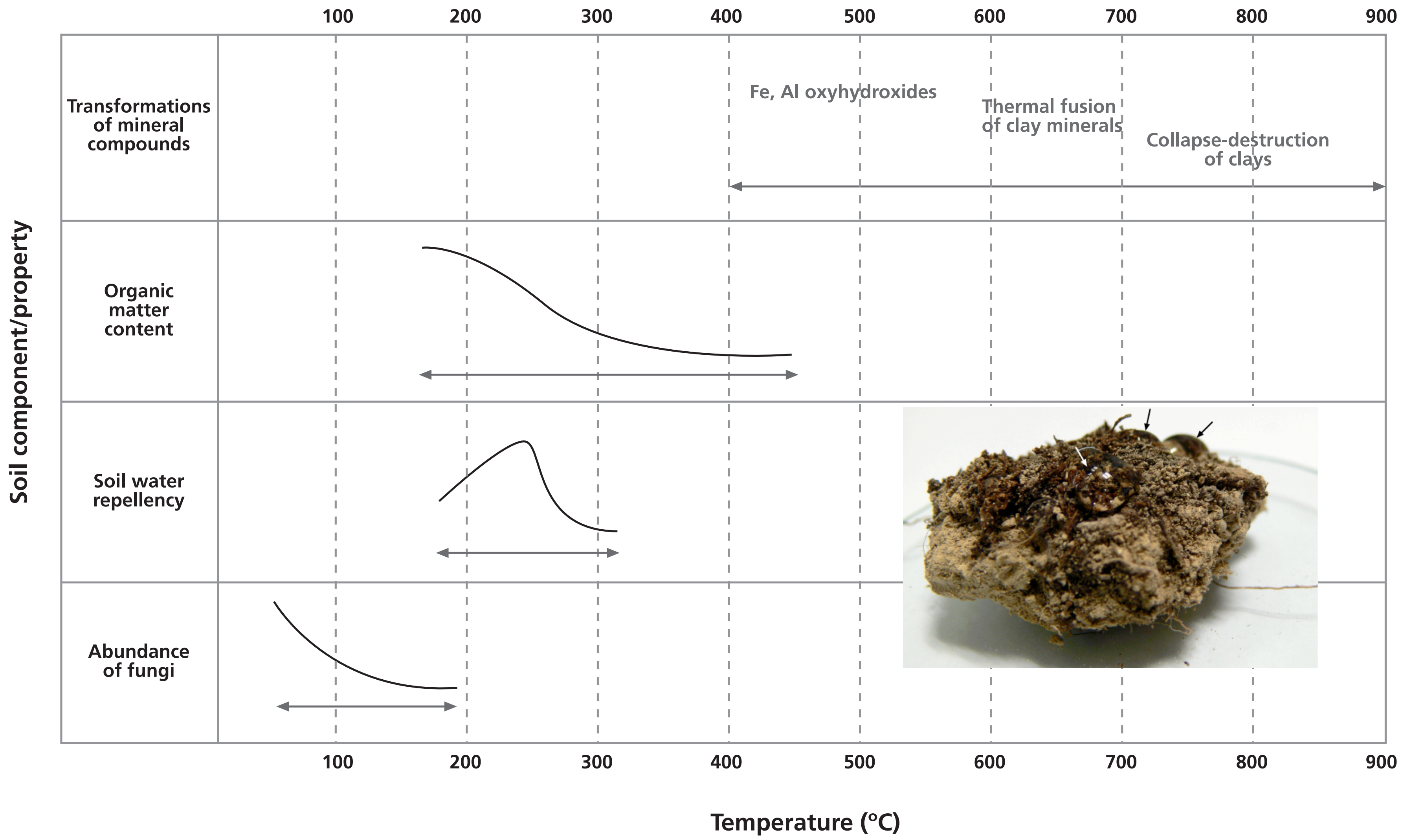
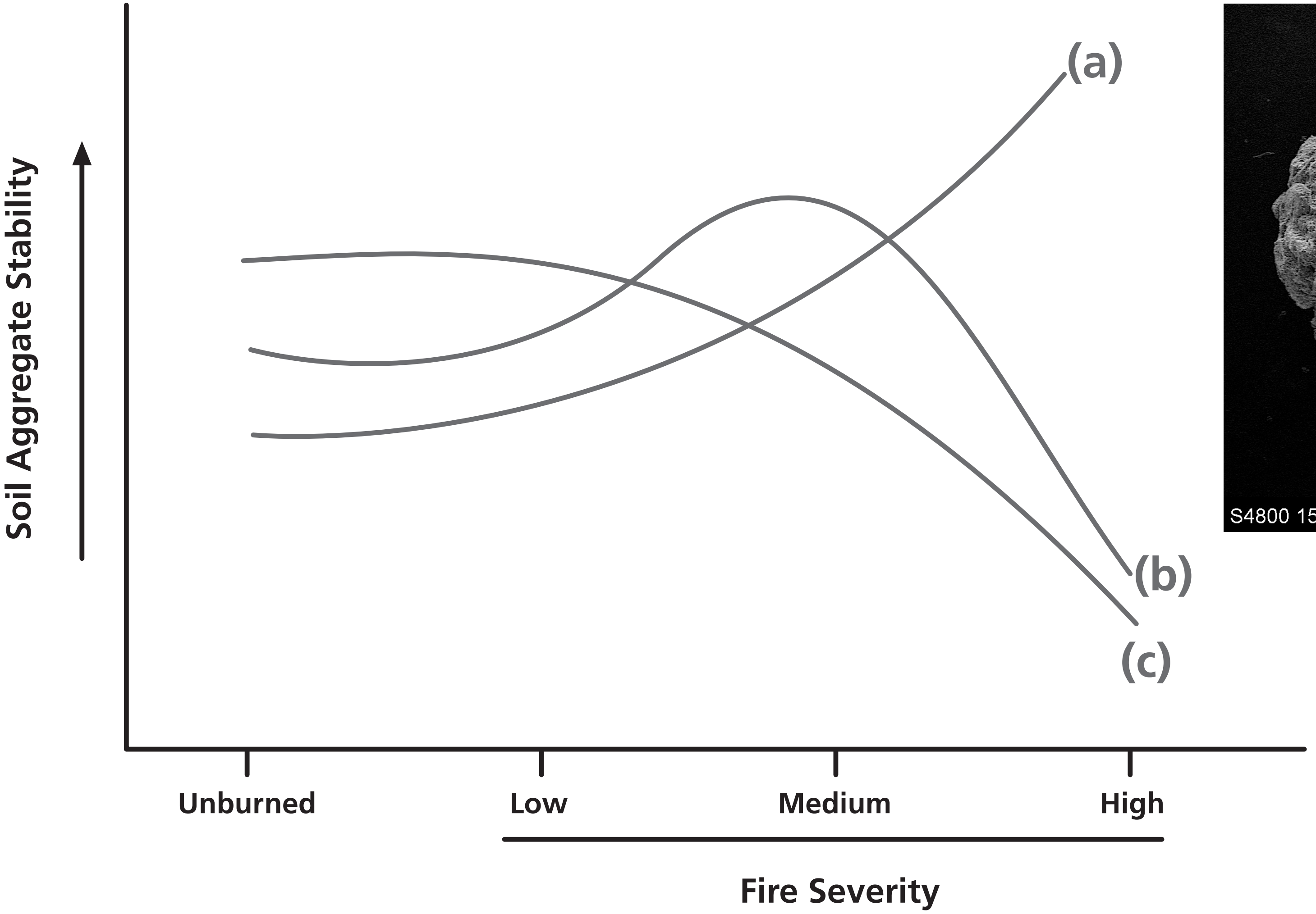


Fig. 3. The main soil components or properties relevant to aggregation and their changes at different temperatures. Horizontal lines indicate the approximate range of temperatures at ones which each property changes. The curves represent the magnitude and trend of the changes induced by fire at particular 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).

Mataix-Solera et al., 2011. Earth Science Reviews



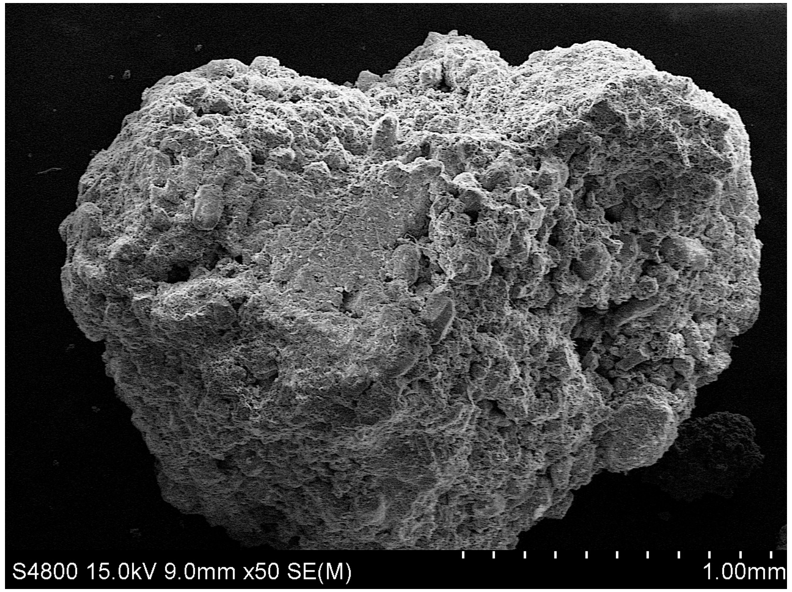


Photo: J. Mataix-Solera

Fig. 6. Three different patterns of aggregate stability changes in relation to fire severity: a) soil with a high 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.

Mataix-Solera et al., 2011. Earth Science Reviews

Catena 147 (2016) 315–324

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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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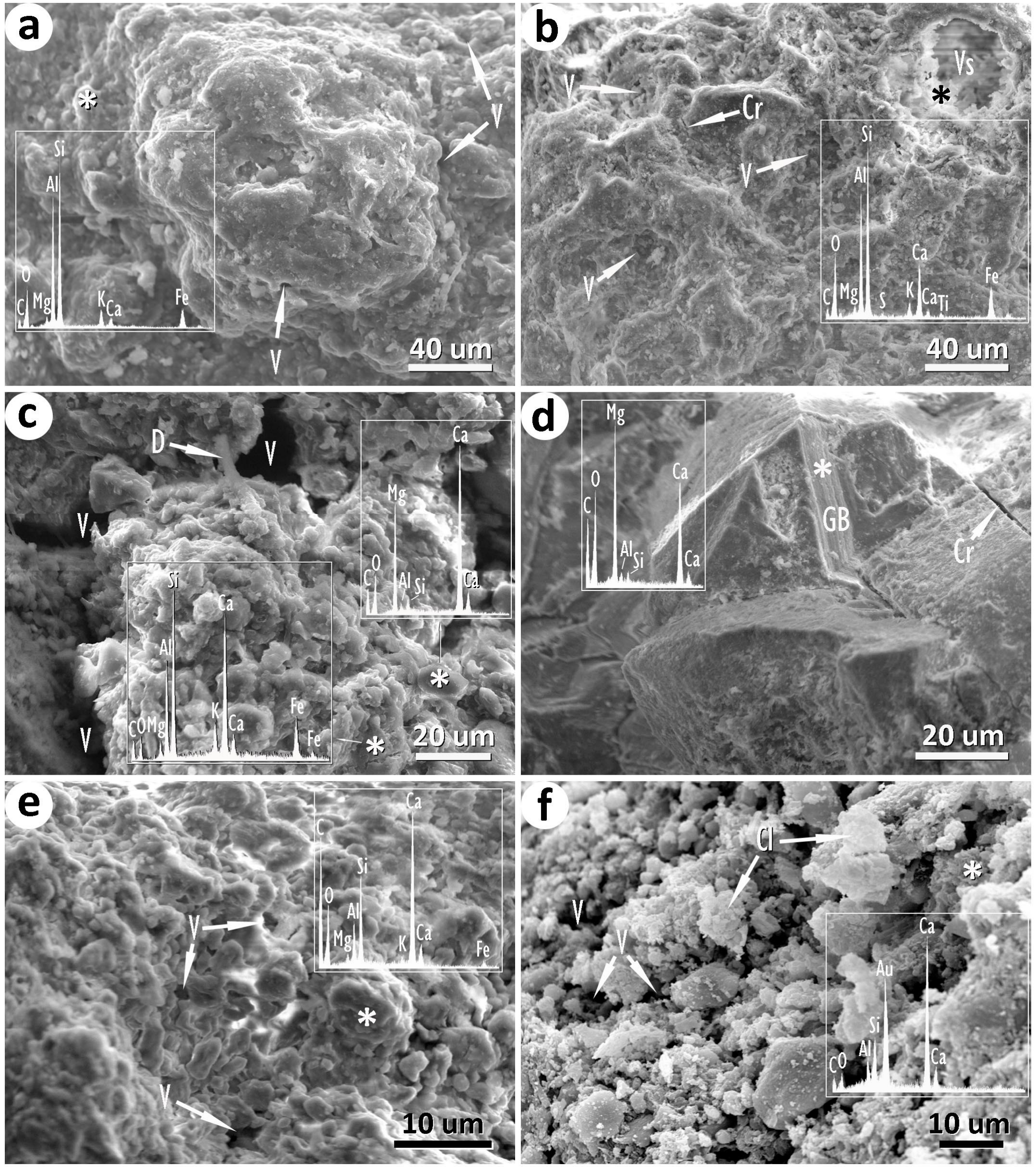

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Jiménez-Pinilla et al., 2016. Catena

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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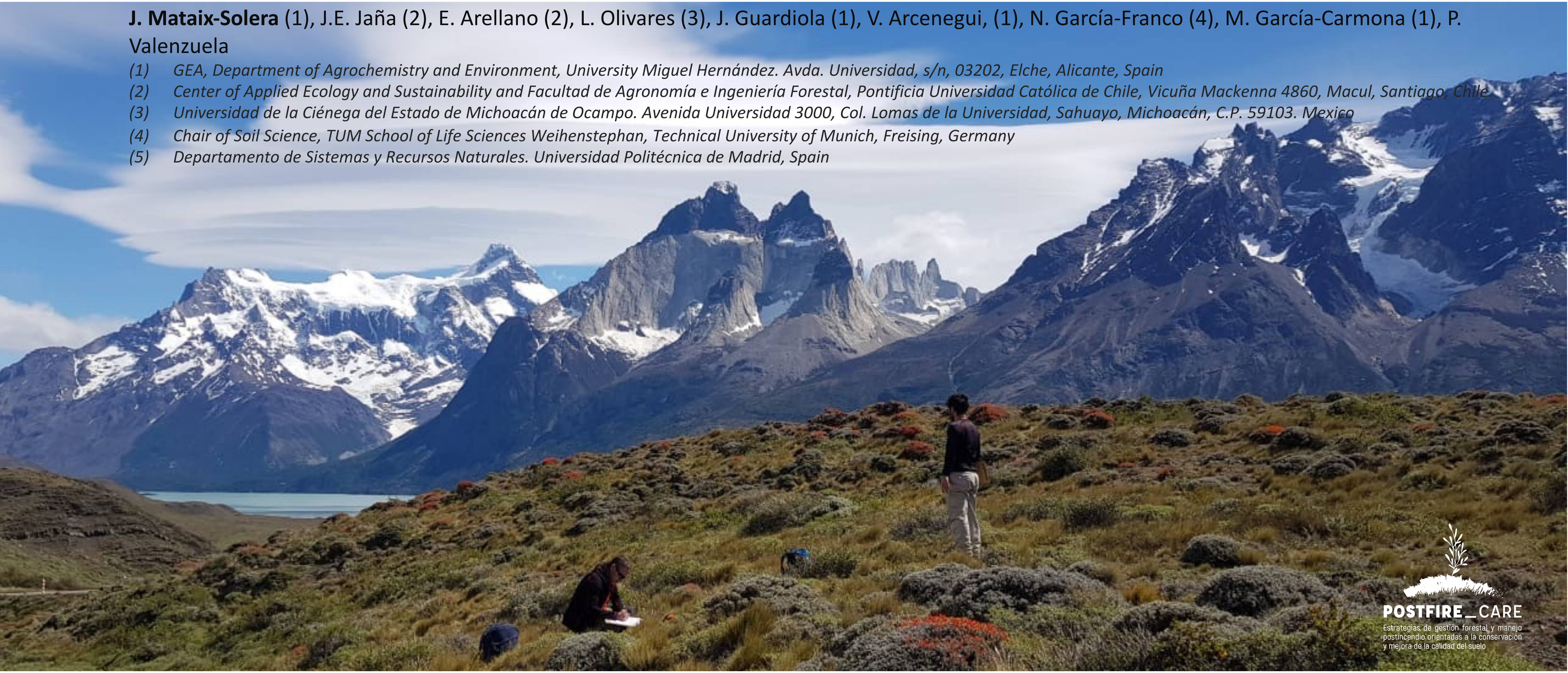

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Soil Vulnerability Indicators to Degradation by Wildfires in Torres del Paine National Park (Patagonia, Chile)

Jorge Mataix-Solera[1]*, Eduardo C. Arellano[2,3], Jorge E. Jaña[2,3], Luis Olivares[4], José Guardiola[1], Victoria Arcenegui[1], Minerva García-Carmona[1], Noelia García-Franco[5] and Patricio Valenzuela[6]

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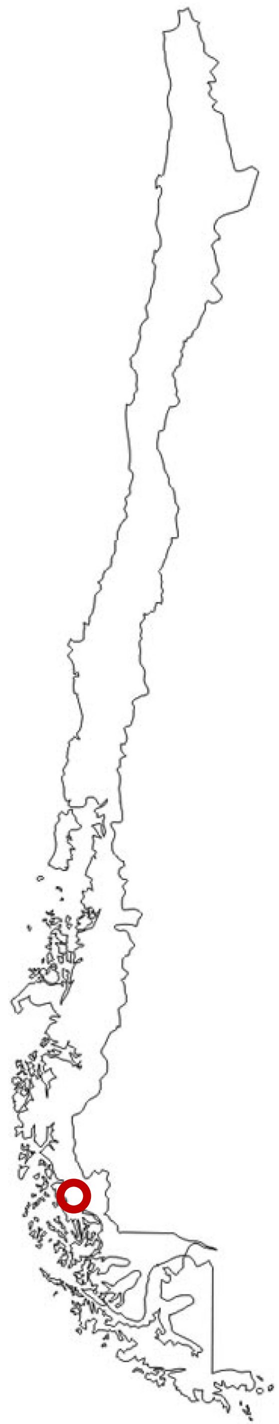
Study area

- **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 1500 mm and 300 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.



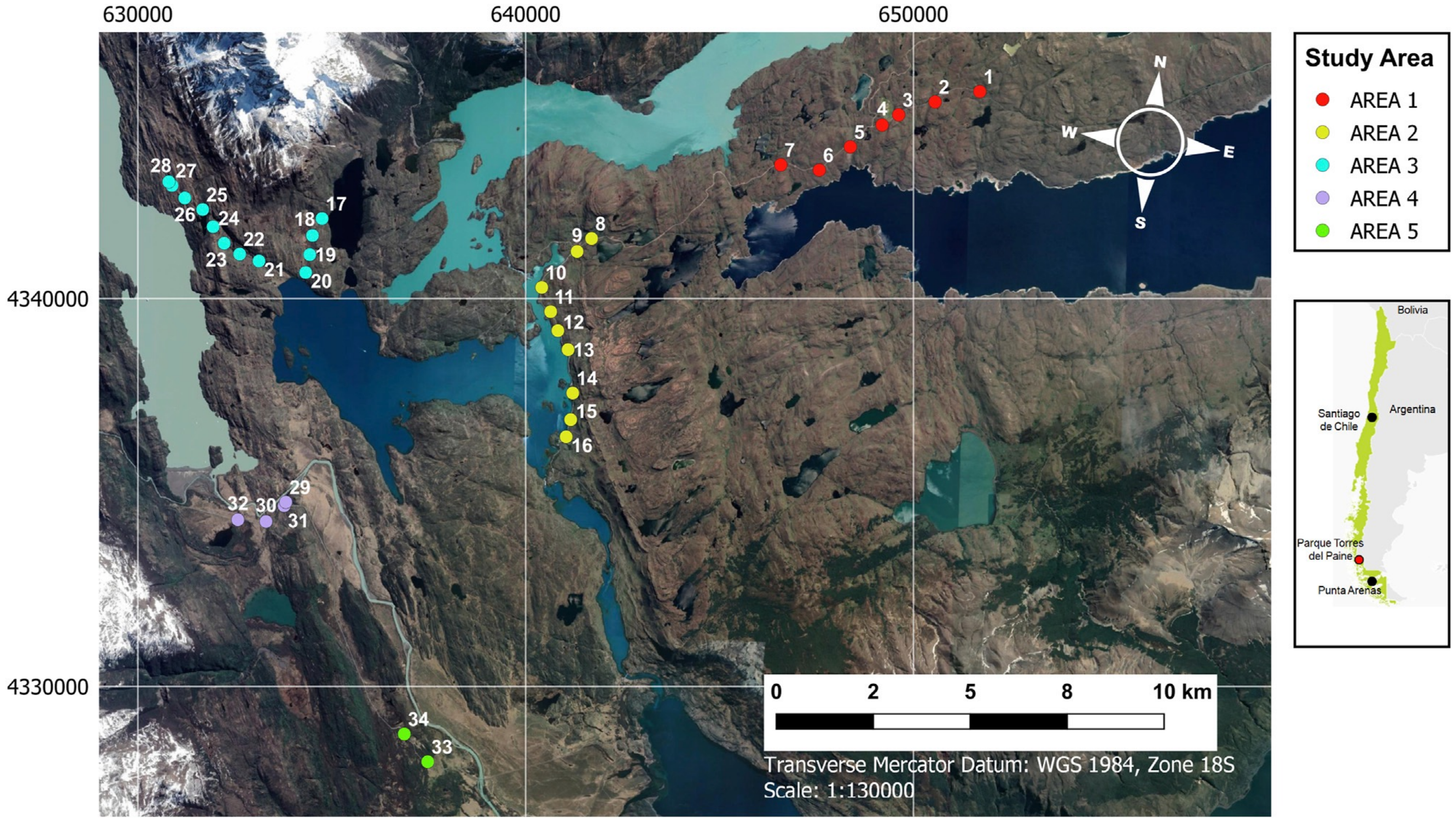
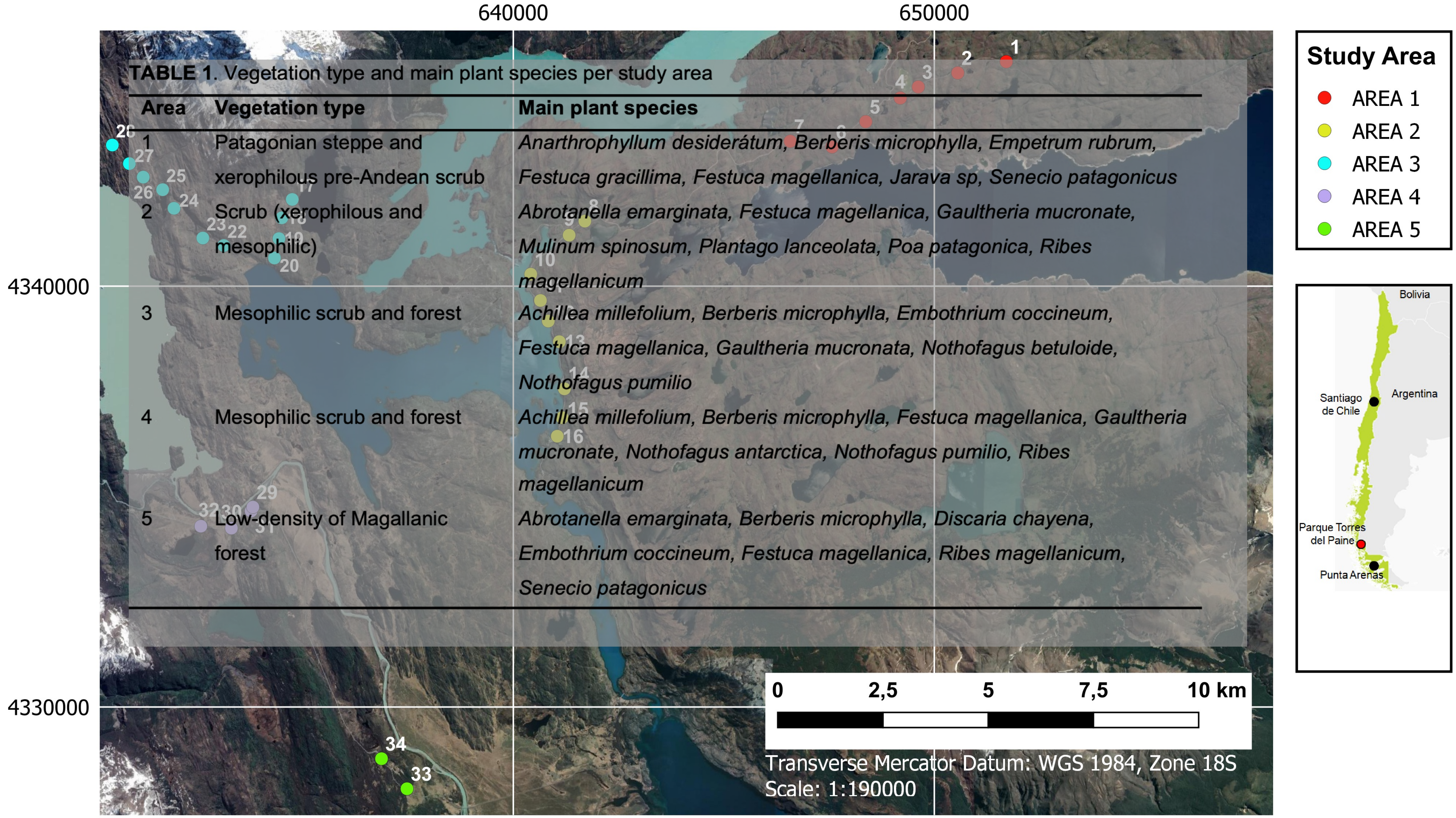


FIGURE 1 I Geographical location of Torres del Paine National Park in Chile and Google earth image of the study areas and points of soil samplings.

TABLE 1. Vegetation type and main plant species per study area

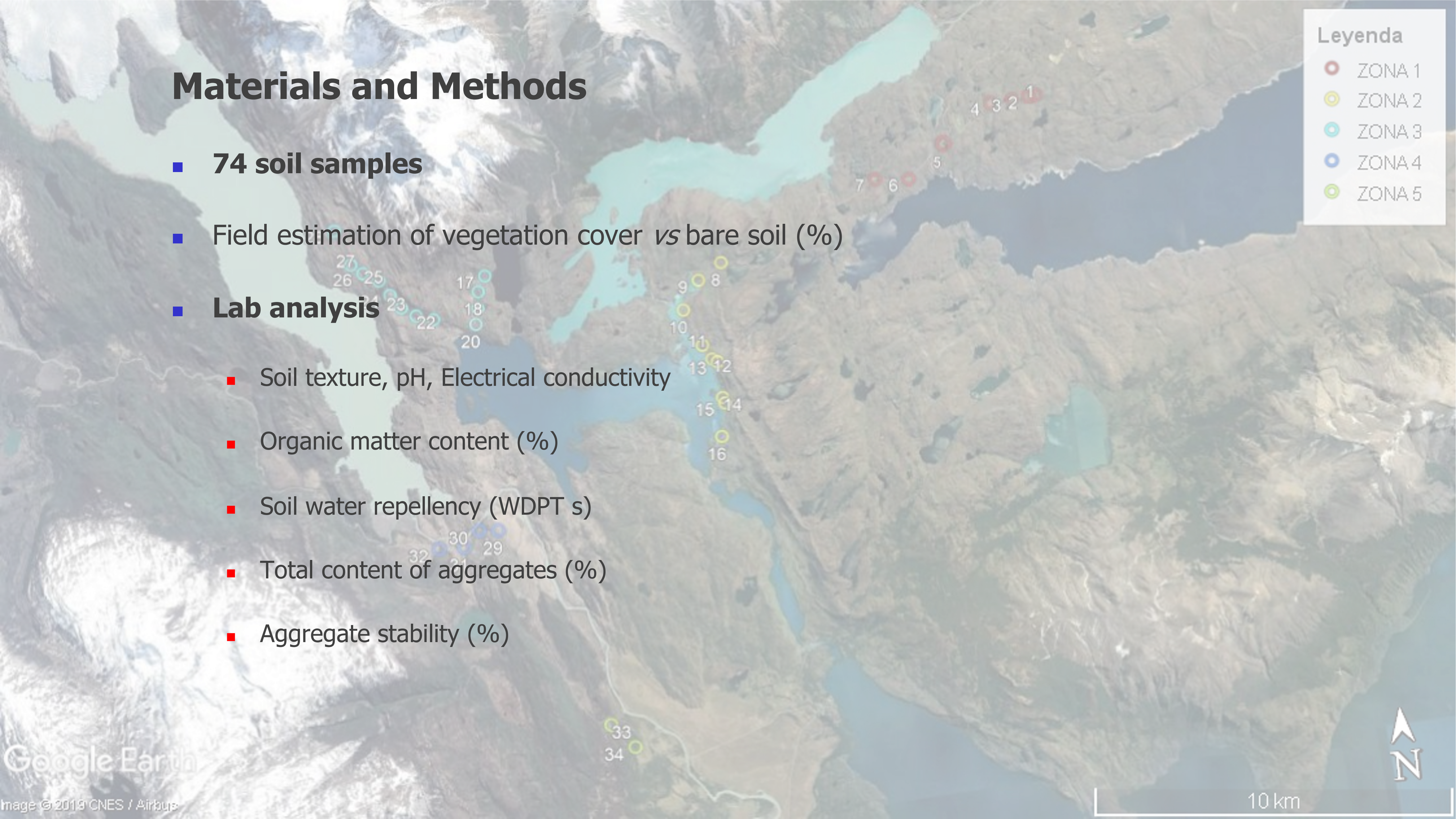
Area	Vegetation type	Main plant species
1	Patagonian steppe and xerophilous pre-Andean scrub	*Anarthrophyllum desiderátum, Berberis microphylla, Empetrum rubrum, Festuca gracillima, Festuca magellanica, Jarava sp, Senecio patagonicus*
2	Scrub (xerophilous and mesophilic)	*Abrotanella emarginata, Festuca magellanica, Gaultheria mucronate, Mulinum spinosum, Plantago lanceolata, Poa patagonica, Ribes magellanicum*
3	Mesophilic scrub and forest	*Achillea millefolium, Berberis microphylla, Embothrium coccineum, Festuca magellanica, Gaultheria mucronata, Nothofagus betuloide, Nothofagus pumilio*
4	Mesophilic scrub and forest	*Achillea millefolium, Berberis microphylla, Festuca magellanica, Gaultheria mucronate, Nothofagus antarctica, Nothofagus pumilio, Ribes magellanicum*
5	Low-density of Magallanic forest	*Abrotanella emarginata, Berberis microphylla, Discaria chayena, Embothrium coccineum, Festuca magellanica, Ribes magellanicum, Senecio patagonicus*



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

Materials and Methods

- **74 soil samples**
- Field estimation of vegetation cover *vs* bare soil (%)
- **Lab analysis**
  - Soil texture, pH, Electrical conductivity
  - Organic matter content (%)
  - Soil water repellency (WDPT s)
  - Total content of aggregates (%)
  - Aggregate stability (%)



Area	pH	EC (µS/cm)	Sand (%)	Silt (%)	Clay (%)	Textural class (USDA)*
1	6.7 (0.4)	91.2 (31.3)	68	18	14	Sandy loam
2	6.6 (0.3)	125.4 (69.7)	66	22	12	Sandy loam
3	5.7 (0.5)	106.8 (85.5)	52	38	10	Loam
4	6.1 (0.7)	171.7 (77.2)	46	38	16	Loam
5	5.4 (0.2)	160.1 (17.0)	64	20	16	Sandy loam

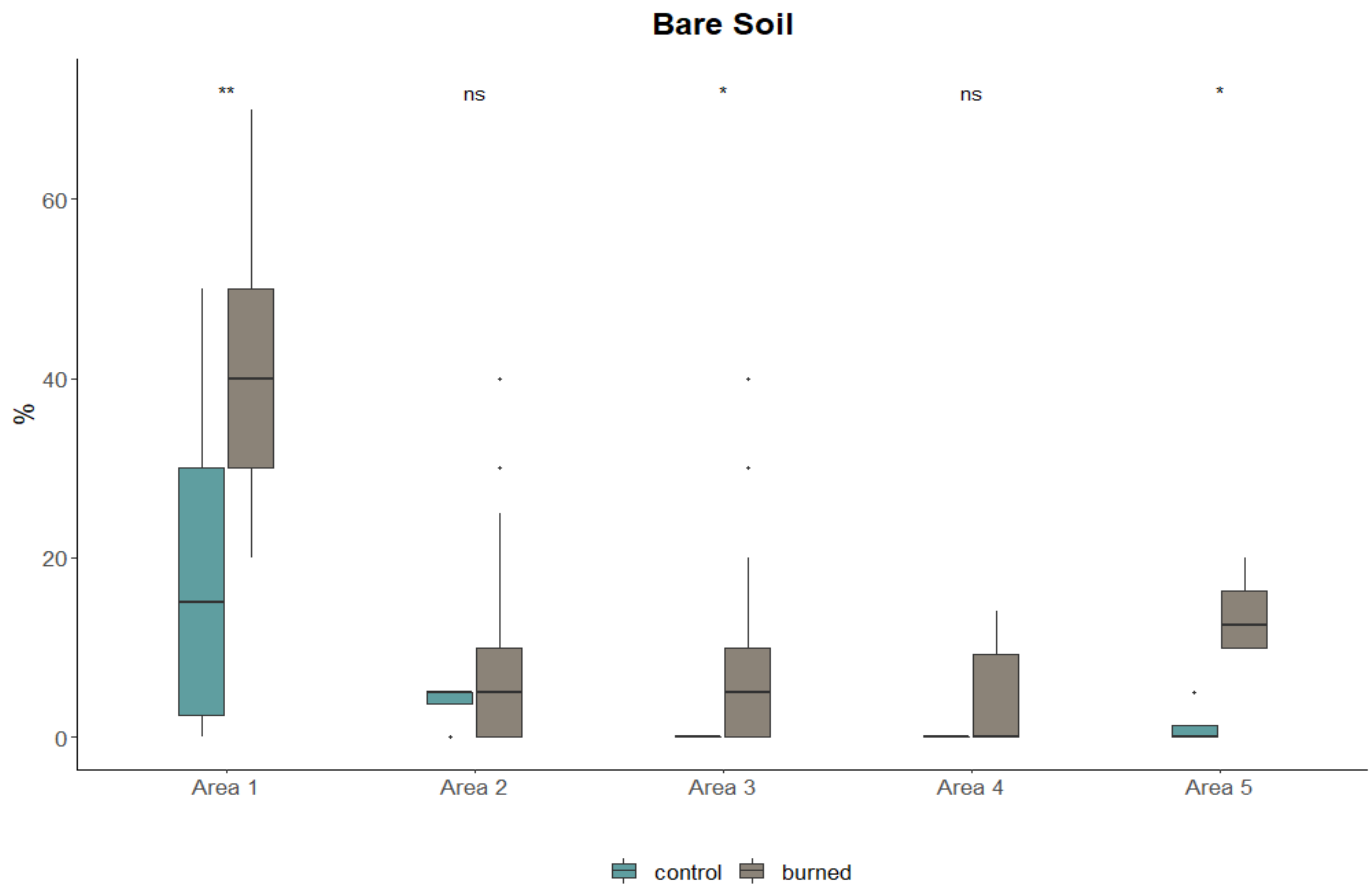


Figure 1. Box-plot of bare soil (%) per study area comparing burned soils vs controls. **, *: significant level for P<0.01 and P <0.05 respectively; ns: not significant at P >0.05

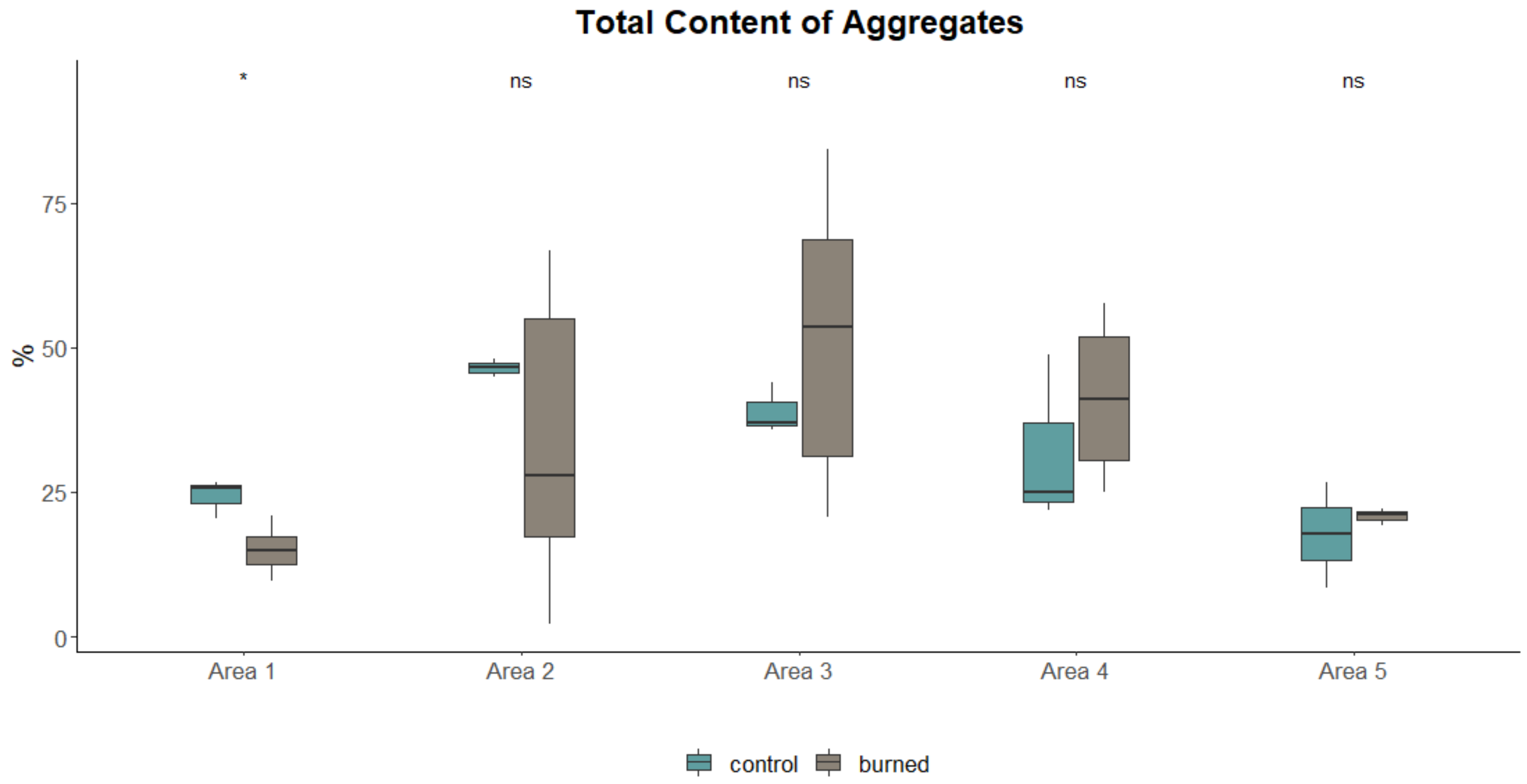


Figure 7. Box-plot of total content of aggregates (TCA %) per study area comparing burned soils vs controls. **, *: significant level for P<0.01 and P <0.05 respectively; ns: not significant at P >0.05

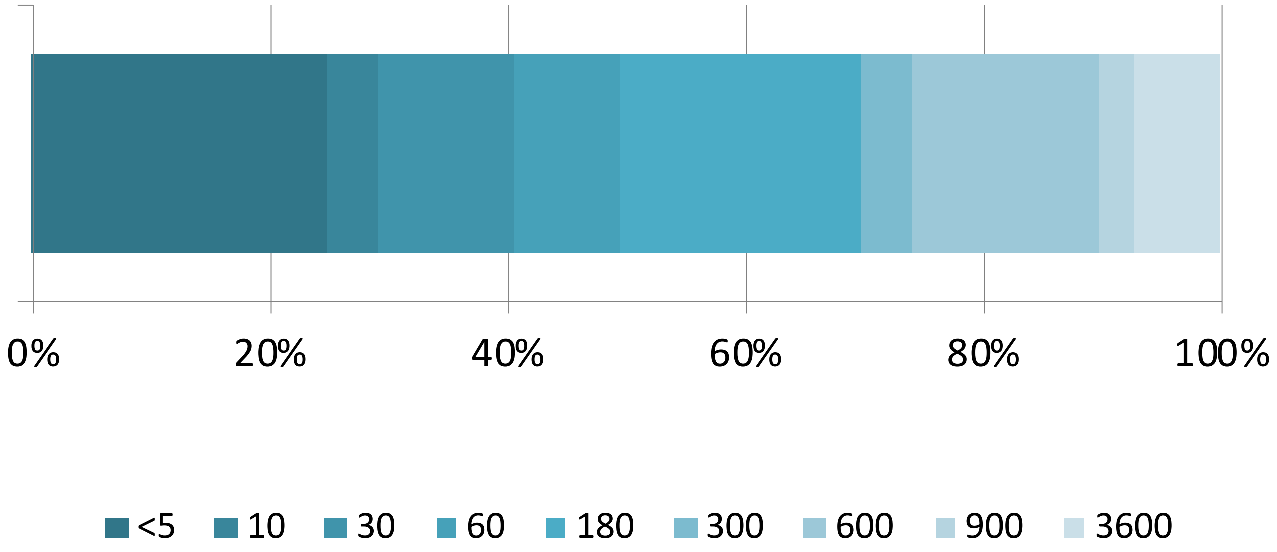


Figure 3. Frequency of distribution of Water Repellency (WDPT (s))

A 75% of samples showed WR from slight to severe

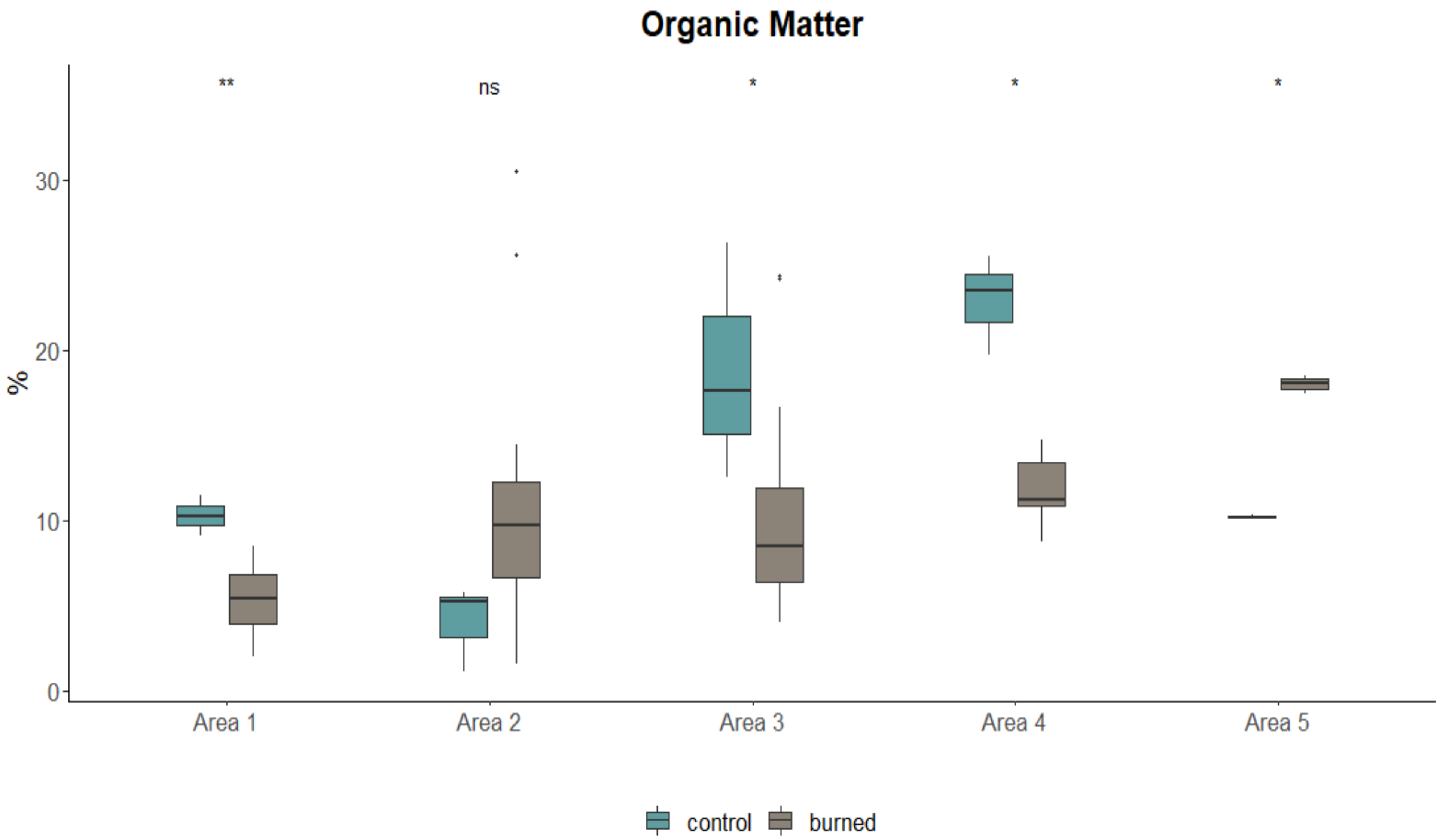


Figure 2. Box-plot organic matter content (%) per study area comparing burned soils vs controls. **, *: significant level for P<0.01 and P <0.05 respectively; ns: not significant at P >0.05

Conclusions

- WR is a natural property in these soils. The combination of the high sand content (low specific surface area) and high OM make them very susceptible to develop WR.
- Since these soils have a scarce development with a poor structure, the combination of the WR and the poor soil structure make them very vulnerable to erosion processes after the fire. This could be verified in three of the five study areas and specially the one with plant community in transition between steppe to scrub, which was the one more affected by the perturbation caused by the fire and post-fire erosion processes.
- Measures to protect the soils or accelerate the recovery are recommended in these areas when new human caused wildfires will occur

Vulnerability to degradation of some soils to post-fire treatments

- 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

POSTFIRE_CARE

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

Effect of salvage logging treatments on soil properties. Sierra de Mariola, Alicante. Feb 2013 – Jan 2018

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Effect of salvage logging treatments on soil properties. Sierra de Mariola, Alicante. Feb 2013 – Jan 2018

C: Control plots

SL: Salvage Logging plots

Soil samplings dates:

•1 - C1 and SL1: 1/02/2013. Day of application of salvage logging treatments
•2 - SL2: 12/03/2013
•3 - C3 and SL3: 10/09/2013
•4 - C4 and SL4: 16/05/2014
•5 - C5 and SL5: 23/10/2014
•6 – C6 and SL6: 23/12/2015
•7 – C7 and SL7: 16/01/2017
•8 – C8 and SL8: 15/01/2018

Effect of salvage logging treatments on soil properties. Sierra de Mariola, Alicante. Feb 2013 – Jan 2018

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

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Science of the Total Environment 586 (2017) 1057–1065

Contents lists available at ScienceDirect

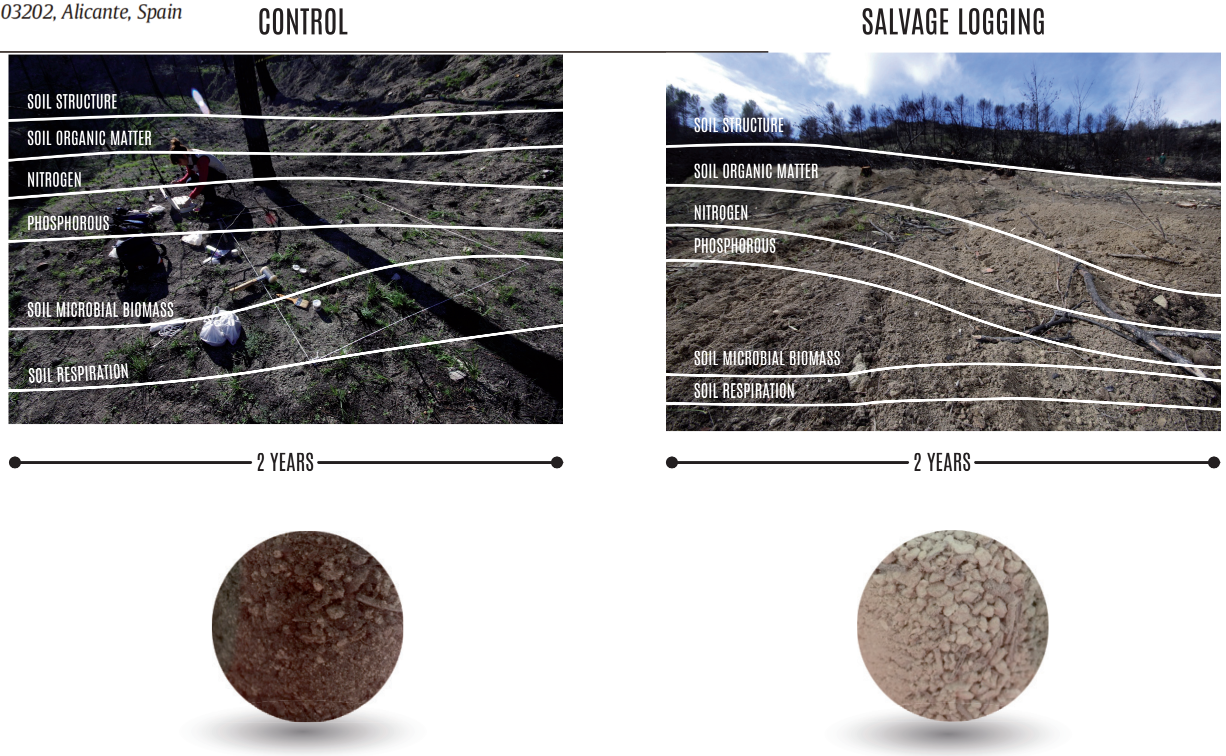
Science of the Total Environment

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

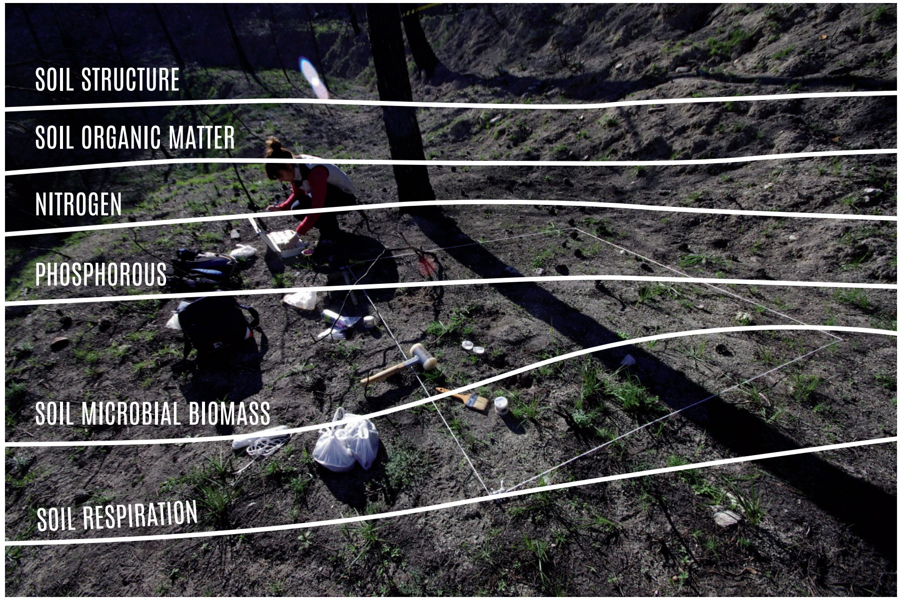
Effects of salvage logging on soil properties and vegetation recovery in a fire-affected Mediterranean forest: A two year monitoring research

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

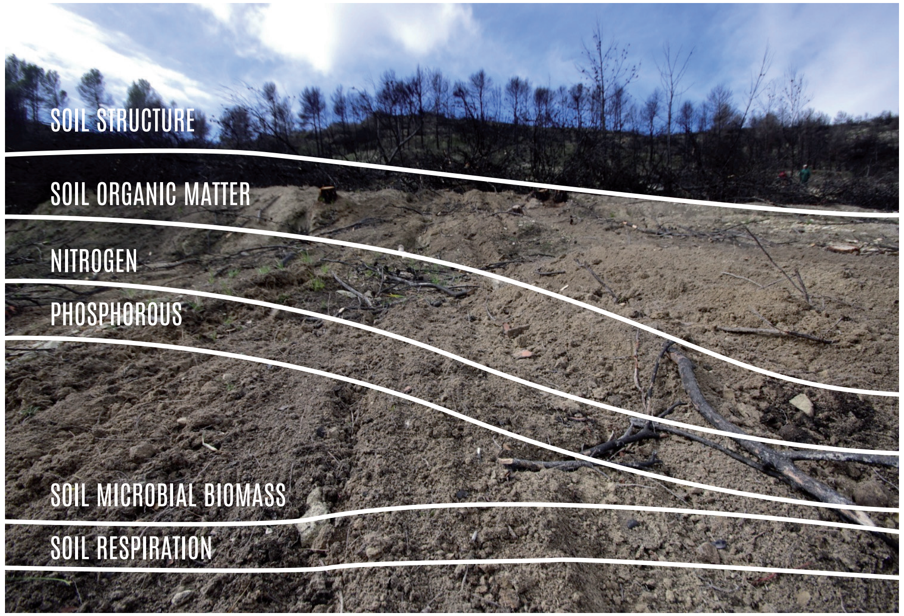


CONTROL



2 YEARS

SALVAGE LOGGING



2 YEARS

Applied Soil Ecology 168 (2021) 104130

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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]

Science of the Total Environment 619–620 (2018) 1079–1087

Contents lists available at ScienceDirect

Science of the Total Environment

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

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]

[a] School of Science and Technology, University of New England, Armidale, NSW 2351, Australia
[b] GEA – Environmental Soil Science Group, Department of Agrochemistry and Environment, University Miguel Hernández, Avda, de la Universidad s/n., 03202 Elche, Alicante, Spain

Journal of Environmental Management 262 (2020) 110287

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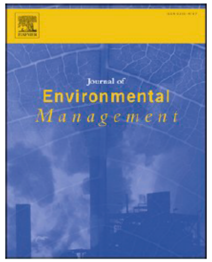

Research article

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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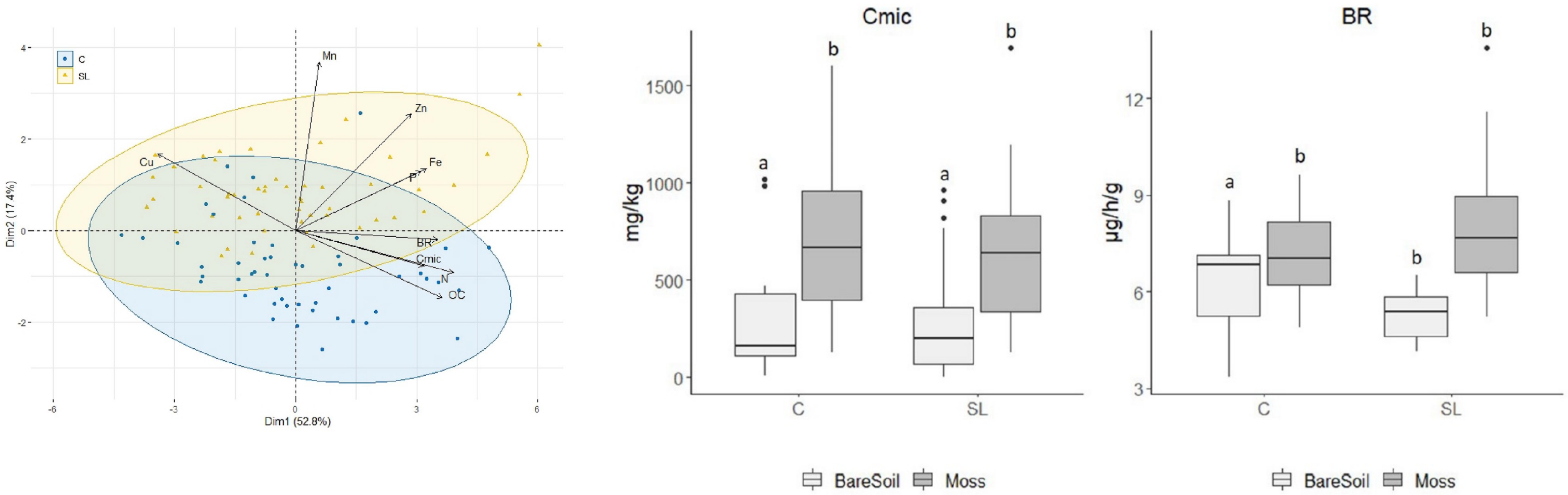

ELSEVIER

Current Opinion in Environmental Science & Health

Volume 22, August 2021, 100264

Fire impacts on soil microorganisms: Mass, activity, and diversity

Ana Barreiro [1], Montserrat Díaz-Raviña [2]

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Highlights

- Response of microbial communities to fire is variable and very complex.
- It is conditioned by fire severity, soil quality, environmental conditions, and time.
- Soil microbial biomass, activity, and diversity show different sensitivity to fire.
- Fire impact on soil microbial diversity can persist in the long term.
- Field studies on the susceptibility resilience of soil to fire events are needed.

ELSEVIER

Soil Biology and Biochemistry

Volume 149, October 2020, 107948

Soil microbiome drives the recovery of ecosystem functions after fire

E. Pérez-Valera [a, b], M. Verdú [a], J.A. Navarro-Cano [a], M. Goberna [c]

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Highlights

- Fire reduces decomposition rates and enzymatic activities related to C and P cycles.
- Recovery of ecosystem functions may take 20 yr in fireprone ecosystems.
- Resilient microbial communities restore the key ecosystem functions.


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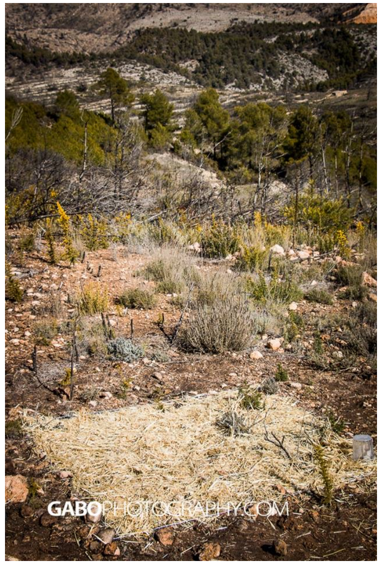
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SIN VEGETACION 1
MULCH PAJA 1
COMPACIADO 2
SACA MADERA 2
MULCH PINOCHA 1
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13-març
DIA DE L'ARBRE 2016
Serelles
LLOC I HORA DE CONCENTRACIÓ:
davant de la Creu Roja, a les 8.30 del matí
Col·locació 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:
Ajuntament d'Alcoi
Departament de Medi Ambient
Col·labora:
25
10 · Charly Alpha
Creu Roja
Miguel Hernández
GENERALITAT VALENCIANA

Mariola, día del árbol. 12 marzo 2017

En resumen:

- El fuego no es el problema, el problema es el cambio de su régimen natural
- Los efectos en el suelo son muy variables y en parte controlados por el tipo de suelo
- Manejos inadecuados en suelos quemados pueden causar mas daño que el propio incendio
- Los manejos post-incendio deben tener en cuenta la fragilidad del suelo y aprovechar la circunstancia como una oportunidad para conseguir bosques futuros más resilientes con el fuego
- Los manejos post-incendio deben tener en cuenta la presencia de musgos dado el papel tan relevante que tienen en la protección y recuperación del suelo
- Más estudios sobre biodiversidad en suelos quemados son necesarios
- Divulgar lo que sabemos es tan importante como investigarlo

POSTFIRE_CARE

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

"La ciencia que no se cuenta, no cuenta"








Muchas gracias

Muito obrigado


POSTFIRE_CARE

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