Food and Agriculture Organization of the United Nations

Swansea University Prifysgol Abertawe

GLOBAL SYMPOSIUM on SOILS and WATER

02-05 October, 2023

Soil and water: a source of life

Wildfire impacts on soil and water: the role of wildfire ash

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Many different types of fire…

Post-fire soil erosion and ash transport: on-site and off-site effects

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- Reduction in infiltration
- Loss of vegetative cover
- Alteration of soil stability

- Floods
- Mud and debris flows
- Water contamination

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The McKinney Fire, California, 2022

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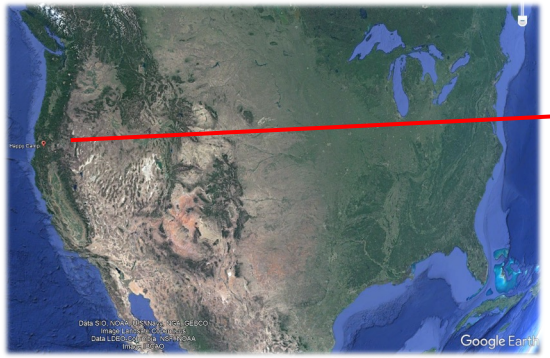
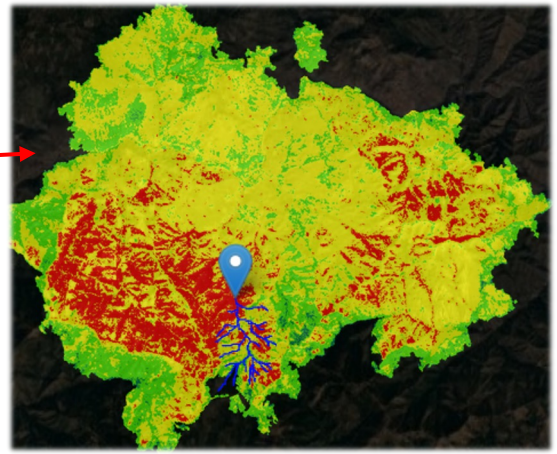
80 mm storm extinguished the fire but results in large debris flow impacting the fisheries…





The Guardian

Wildfire implicated in death of tens of thousands of fish, California tribe says

Karuk Tribe suspects debris flow in Klamath River due to flash flooding over a burned area

This image courtesy of the Karuk Tribe department of natural resources shows dead fish at Seiad Creek, a tributary of the Klamath River, near Happy Camp, California, on Friday. Photograph: AP

A year on… 15 mm rain results in another debris flow

Wildfire ash…?

"the particulate residue remaining or deposited on the ground, from the burning of wildland fuels and consisting of mineral materials and charred organic components" (Bodí et al., 2014, p. 104).

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Fire mostly concentrates in the ash elements that are not volatilized (e.g., C, Ca, Al, Fe…).

Nutrient flux to soils ('fertilizing effect'). Slash and burn agriculture.

Enriched in nutrients and potentially toxic metals compared to soil → potential pollution source.

Very light and loose → highly mobile by wind and water.

Wildfire ash transport to streams and reservoirs

- Social, environmental and economic impacts of wildfire ash.
- Enhanced runoff and erosion transports nutrients and harmful substances to rivers and reservoirs.
- A better understanding of ash chemical composition is needed to facilitate assessment and prediction of these impacts.

Chemical characteristics of wildfire ash across the globe

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Ash sampling

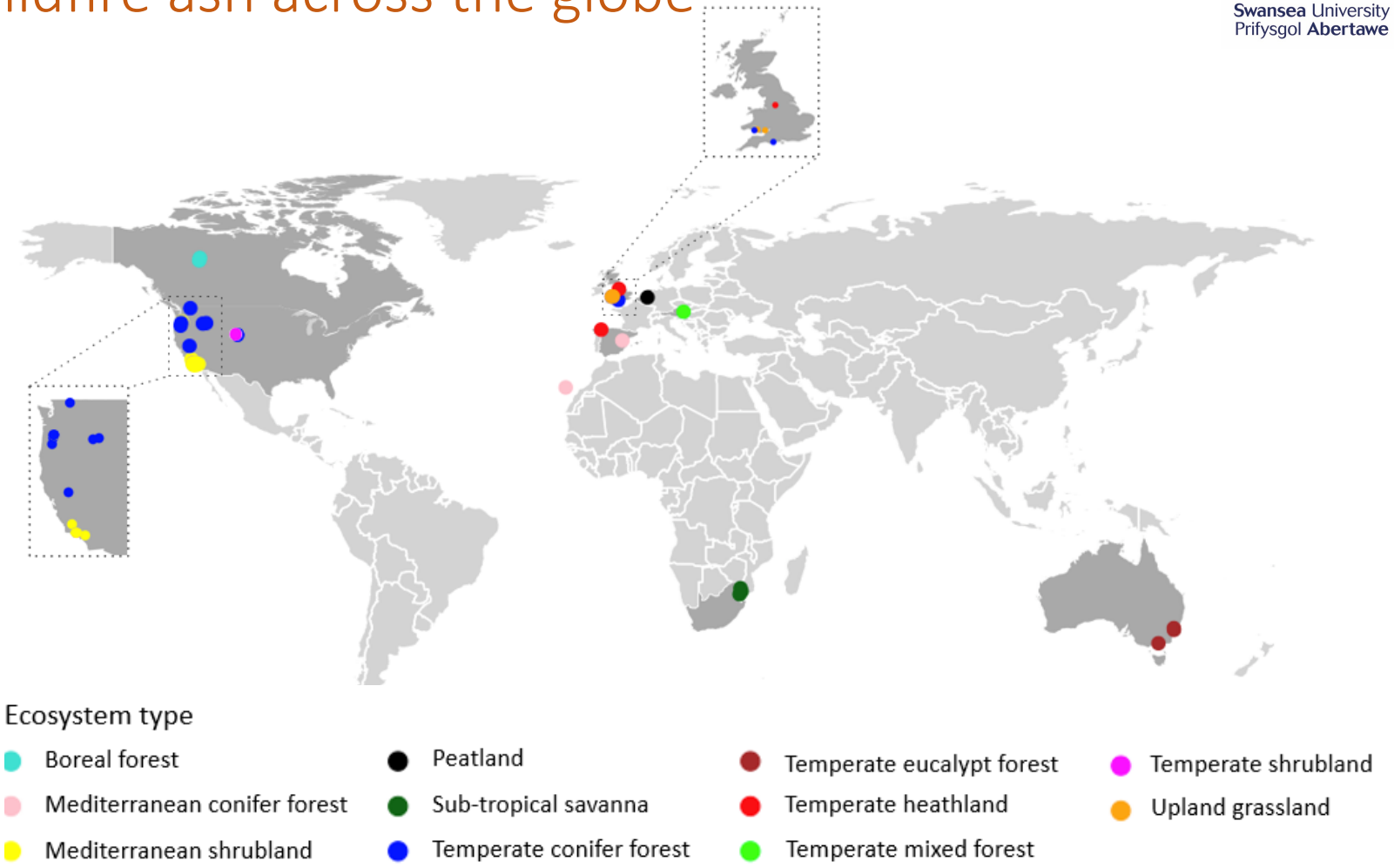
29 sites

11 ecosystems

148 samples in total

High and low burn severity

Sampling before and after rain



Ash analysis

25 chemical characteristics:

pH, EC, total and dissolved element concentrations (e.g., C, N, Ca, P, Al, Fe, Mn, Cu…)

Established procedures (e.g., acid digest, leachate test by Hageman et al. (2007))

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Main components and metals of concern in wildfire ash

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Main components

Chemical parameter (g kg^{-1})	Mean (min and max)
Organic Carbon	204 (0.5 – 450)
Calcium	47.9 (1.3 – 215)
Aluminium	17.9 (0.6 – 69.3)
Iron	17.1 (0.6 – 77.2)
Nitrogen	7.8 (1 – 25)

Vegetation is often the main contributor

Soil component

Metals of concern for human and ecosystem

Chemical parameter (g kg^{-1})	Mean (min and max)
Manganese	1.5 (0.035 – 15.35)
Zinc	0.2 (0.03 – 1.02)
Lead	0.07 (0.001 – 0.8)
Chromium	0.03 (0.01 – 0.07)
Copper	0.03 (0.005 – 0.09)

Did not generally exceed international contamination thresholds for soils and sediments, except in a few cases…

Other chemical potentially hazardous components: polycyclic aromatic hydrocarbons (PAHs), cyanide, corrosive compounds

Key factors influencing ash chemical characteristics

- Burnt severity
- Rainfall prior to sampling
- Size of the burned area and vegetation characteristics

The real impact of ash will depend on its dilution into environmental matrices (soils, sediment and water)

Contents lists available at ScienceDirect

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

Full length article

Chemical characteristics of wildfire ash across the globe and their environmental and socio-economic implications

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Low severity: darker colour, lower degree of combustion

High severity: lighter colour, higher degree of combustion

WEPPcloud-WATAR Tool: a new online tool to predict post-fire soil erosion and ash transport risks to water quality

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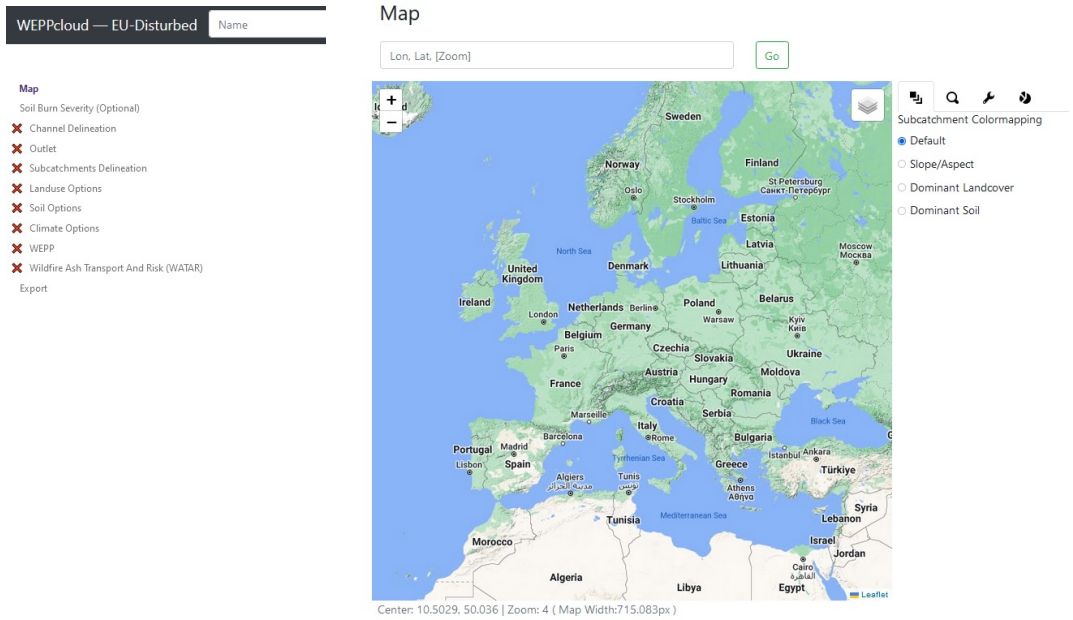

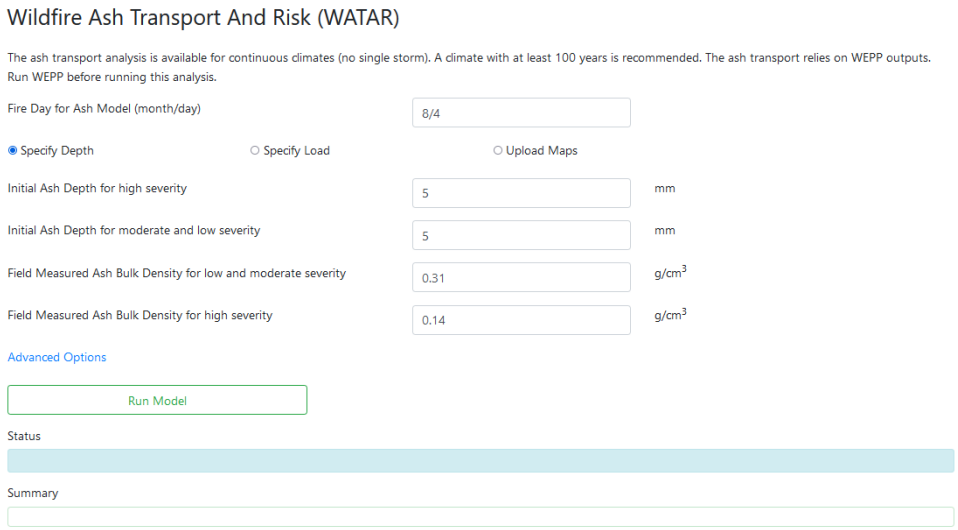

https://wepp.cloud/weppcloud/

Model capabilities

- Runoff and erosion predictions
- Post-fire ash transport, nutrient losses and water contamination risk
- Hillslope and watershed scales
- Identification of runoff, erosion and contamination hotspots
- Enables simulation of concentration of contaminants in reservoirs
- Accesses specific input datasets

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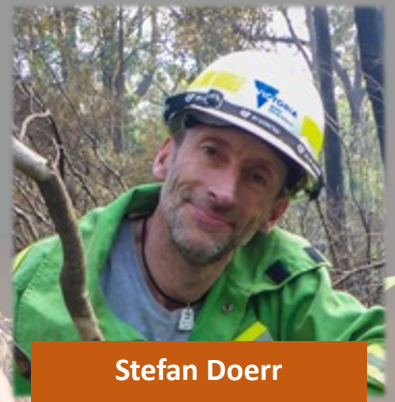
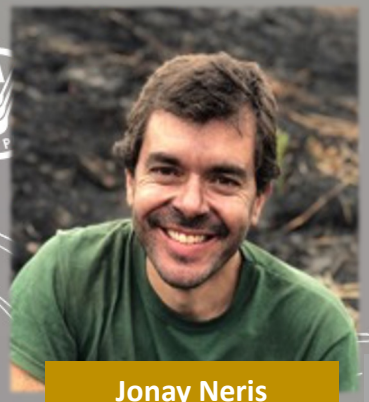
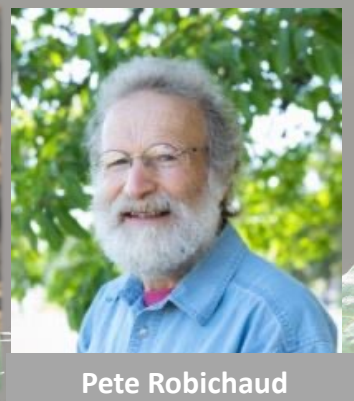


Stefan Doerr

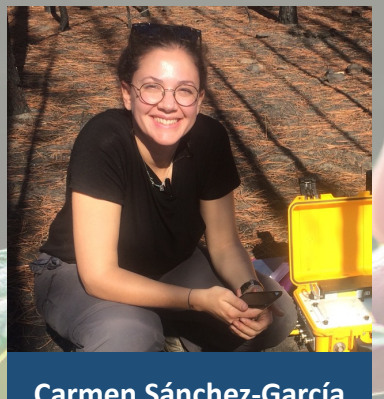
Cristina Santín



Jonay Neris



Pete Robichaud



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Thank you for your attention!

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