SOIL BURNING & RAINFALL SIMULATIONS: PRELIMINARY RESULTS OF A LAB-SCALE EXPERIMENT

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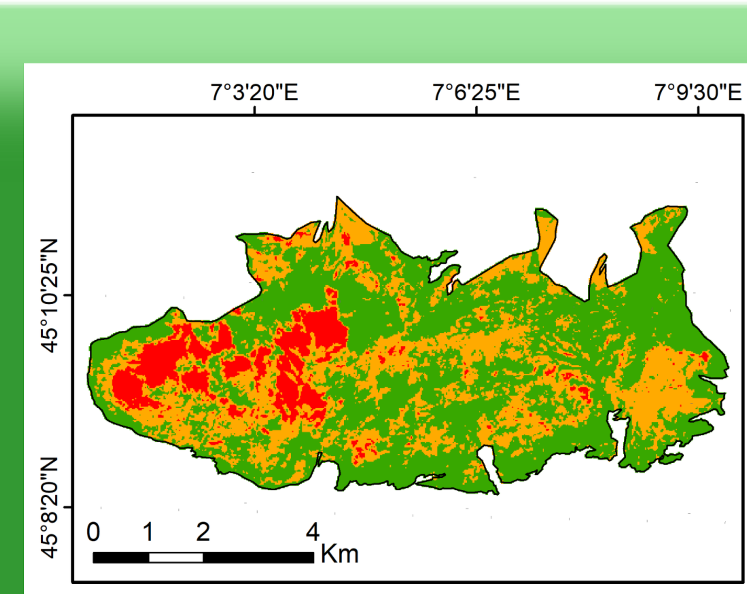
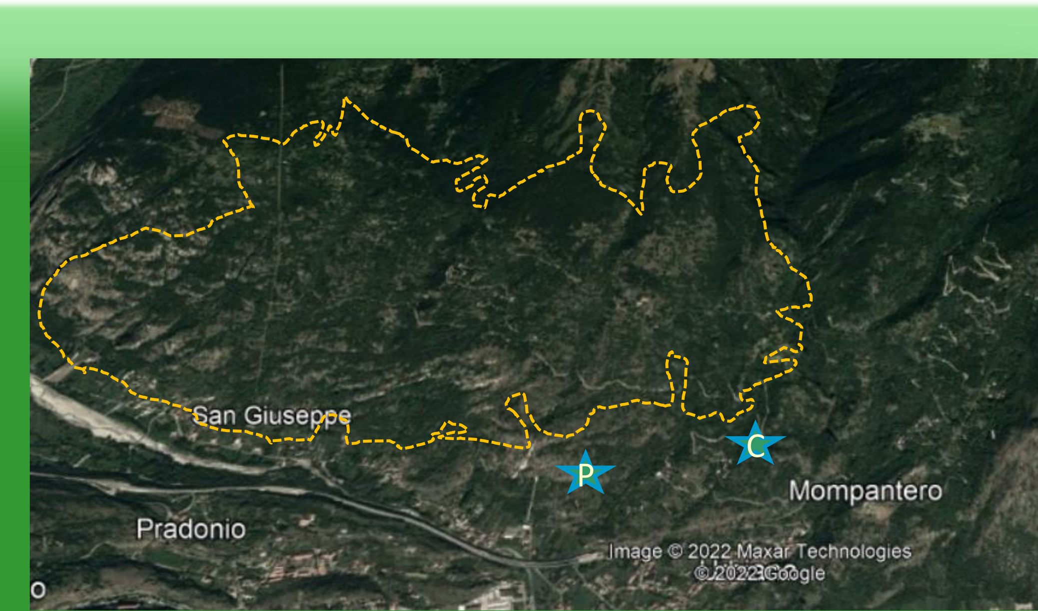
2017 wildfire in Mompantero (TO). After the wildfire, erosion occurred in steep stand-replacing patches. Here tree regeneration was delayed, apparently with micro- and macroscale differences difficult to explain

Wildfires frequency and severity are increasing in the Alps, and future climate scenarios suggest to put more efforts into natural hazard prevention, mitigation and restoration. At present, limited research exists on the small-scale physico-chemical transformations along the temperature gradient, which could help to explain the large differences in natural regeneration success often observed in the field. We studied a fire-prone area located in the Italian W Alps (Mompantero – TO) affected in 2017 by a large, mixed-severity fire (burnt area ~4.000 ha), with several stand-replacing patches where the complete mortality of the pre-fire conifer stands was registered, resulting in extensive portions of bare soil over steep slopes.



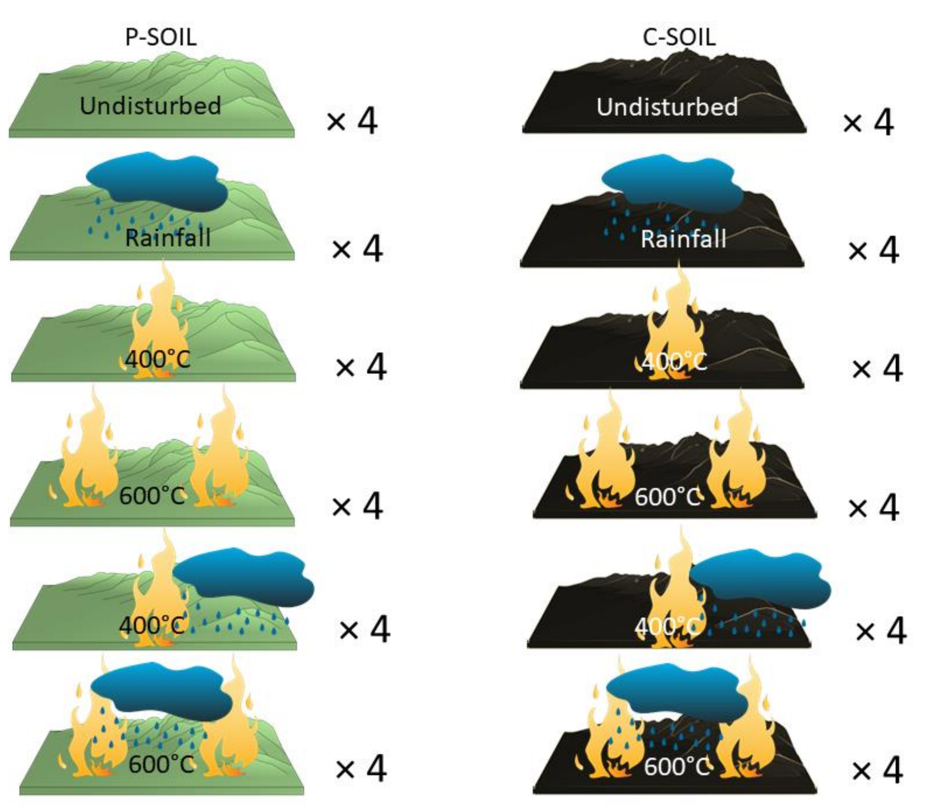
2017 wildfire in Mompantero (TO). Fire severity (red: high; orange: medium; green: unburnt to low) https://doi.org/10.1016/j.rse.2021.112800



Sampling locations. Unburnt sampling sites were chosen close to the area affected by the 2017 wildfire, considering 2 representative lithologies, i.e. 2 soil parent materials: P = prasinites with amphiboles and chlorite-shcists; C = calcshcists intercalated with sandstone

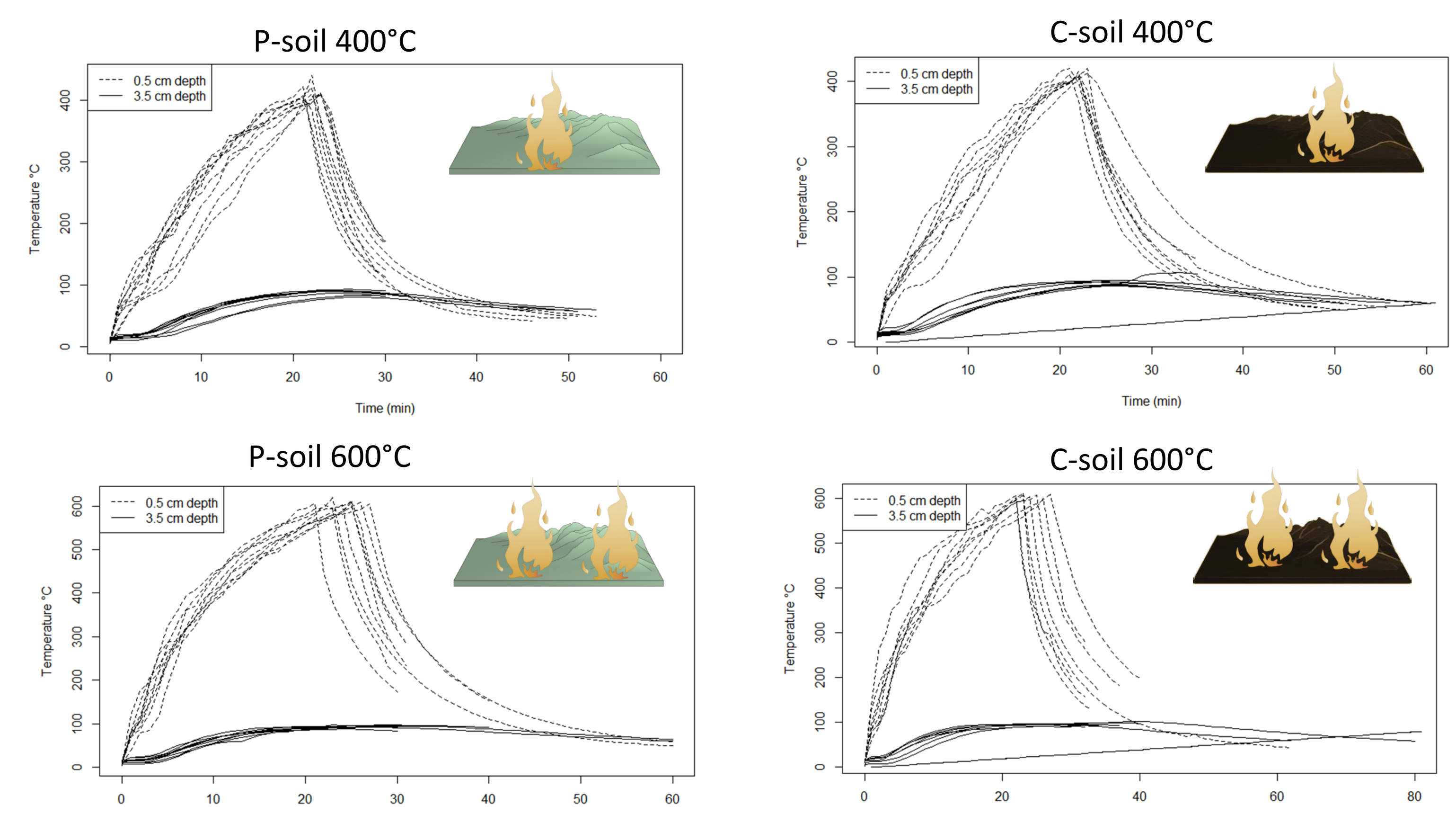
EXPERIMENTAL PLAN – UNDISTURBED SOIL PROPERTIES

Lab burning experiments were carried out on soil trays filled with material from A horizons, reaching 400 and 600°C at the surface, followed by rainfall simulations.



Soil property	P-soil	C-soil
Soil moisture at sampling (%)	17	14
Color (Munsell)	2.5Y 4/3	10YR 4/1
Hydrophobicity	Scarce	Scarce
Texture USDA	LS	LS
pH	8.0	8.1
Organic C (g kg^{-1})	28.1	31.7
$CaCO_3$ (g kg^{-1})	68.5	204.3
C/N	11.2	10.9
POlsen (mg kg^{-1})	6.94	8.25
CEC (cmol+ kg^{-1})	12.8	14.2
Exch+sol Ca (cmol$_+$ kg^{-1})	23.9	25.5
Exch Mg (cmol$_+$ kg^{-1})	1.06	1.01
Exch K (cmol$_+$ kg^{-1})	0.12	0.20
Skeleton (%)	3	18

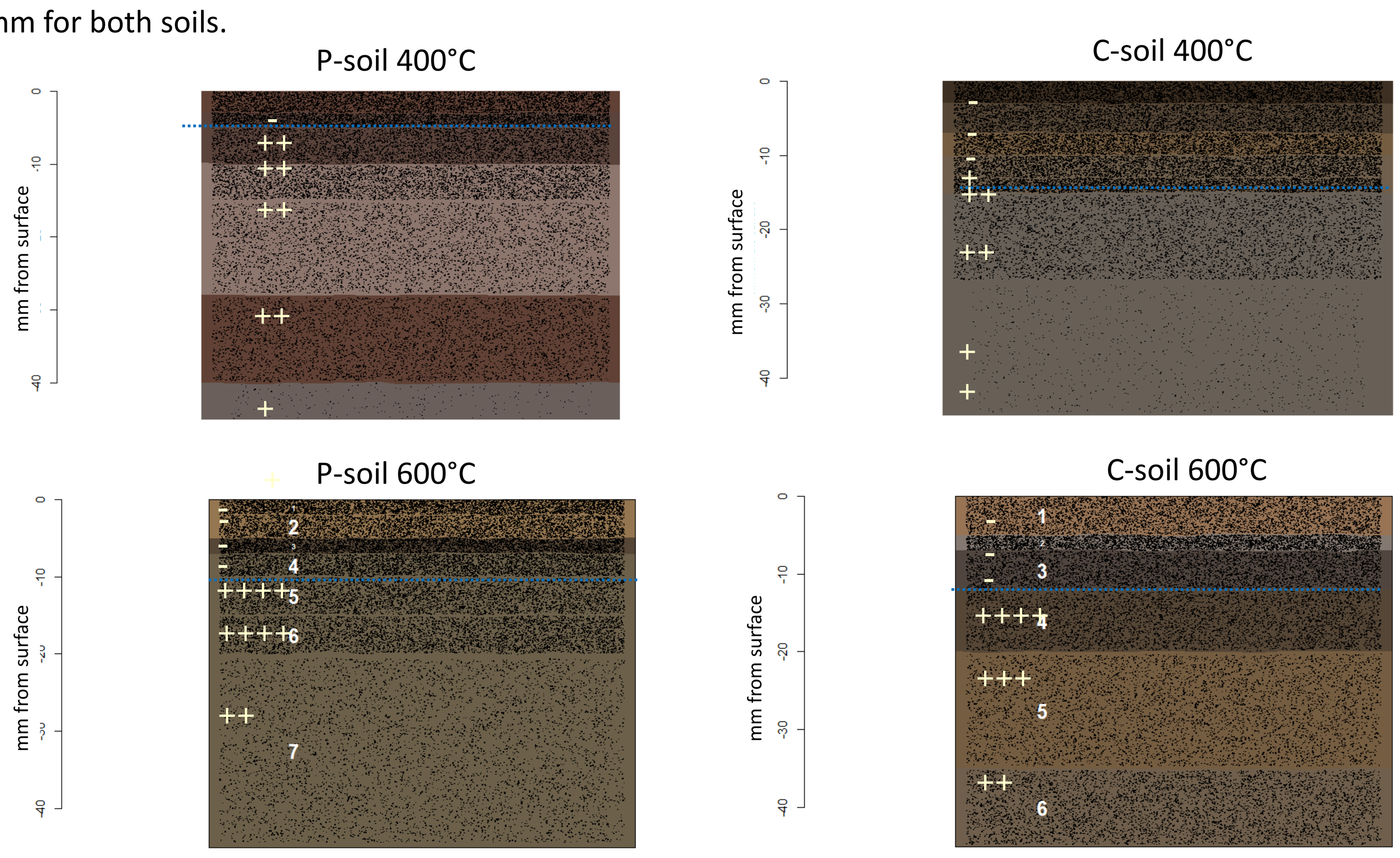
SOIL BURNING - THERMAL GRADIENTS



The max. surface temperature was reached within 25 min., then rapidly declined, while at 3.5 cm depth it never exceeded 97°C, still retaining part of the water. The reversal of the depth temperature gradient occurred within 30-40 minutes after the end of burning.

LAYERS VISUAL DESCRIPTION & HYDROPHOBICITY (WDT)

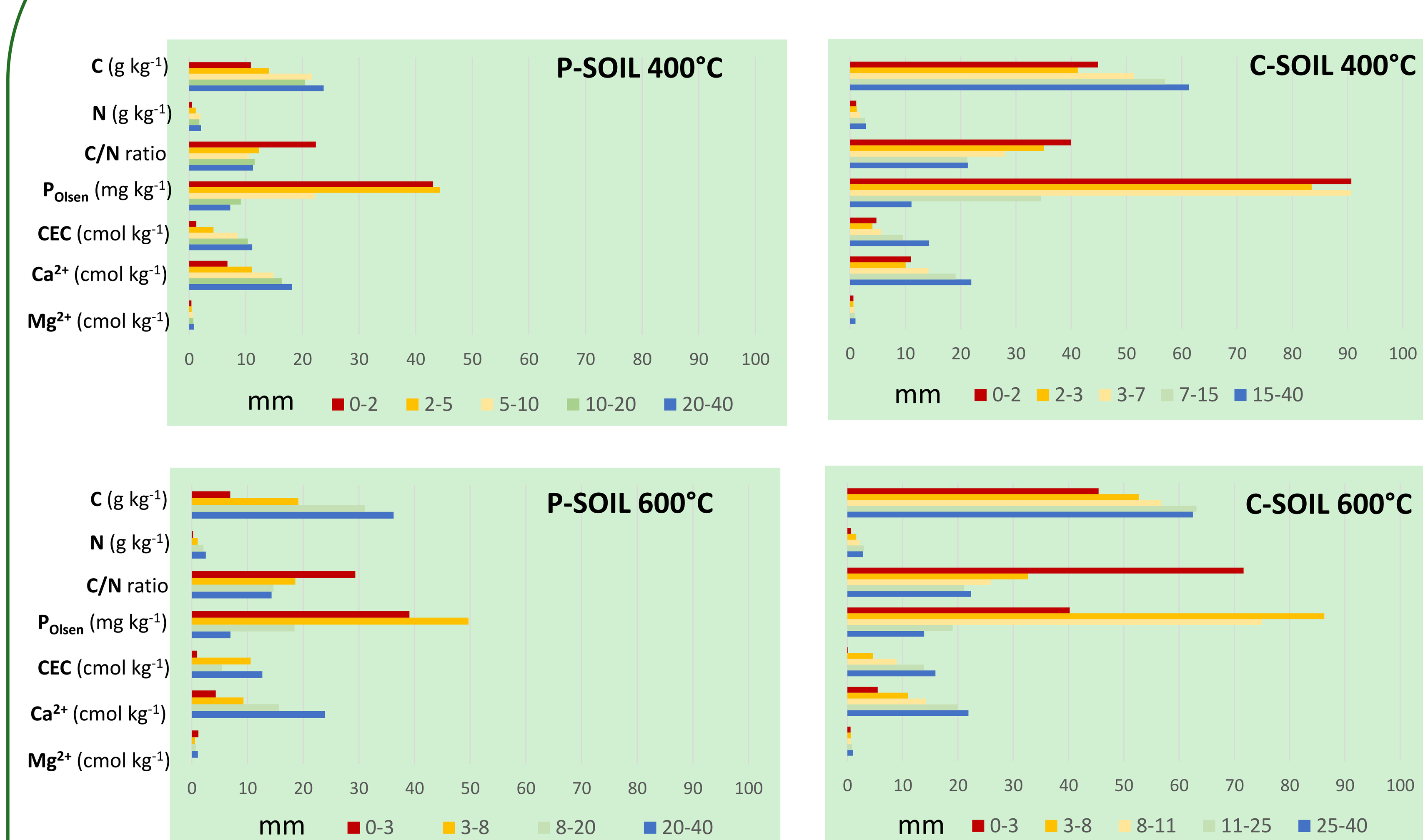
Four mini-profiles were described in burnt trays. Layers were identified and plotted (R-soil profile package), then tested for hydrophobicity (Water Drop Test). Undisturbed trays showed homogeneous properties and negligible hydrophobicity. In burnt soils, 5 to 8 layers were recognizable, with different color, consistency, and hydrophobicity. P-soil400 showed moderate hydrophobicty starting near to surface. C-soil400 showed moderate hydrophobicity at higher depth. With increasing temperature, hydrophobicity increased and shifted below 10 mm for both soils.



Hydrophobicity: absent (-), scarce (+), moderate (++), strong (+++), extreme (++++). Colors correspond to observed Munsell colors.

LAYERS CHEMICAL PROPERTIES

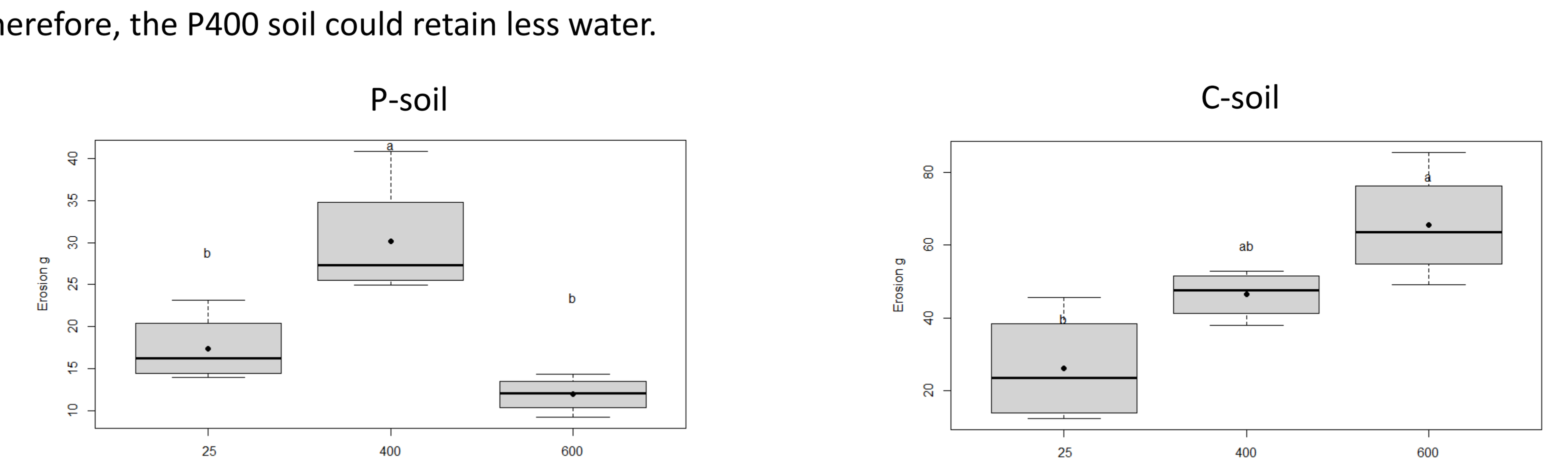
The mini-profile layers were analysed for C and N contents, Olsen P, CEC and exchangeable cations.



Significant trends in soil properties were observed with soil depth. C and N were decreased by heating, as well as CEC, exchangeable Ca and Mg, probably immobilized as oxides, while exchangeable K was not affected and available P largely increased, probably released by the burnt organic matter.

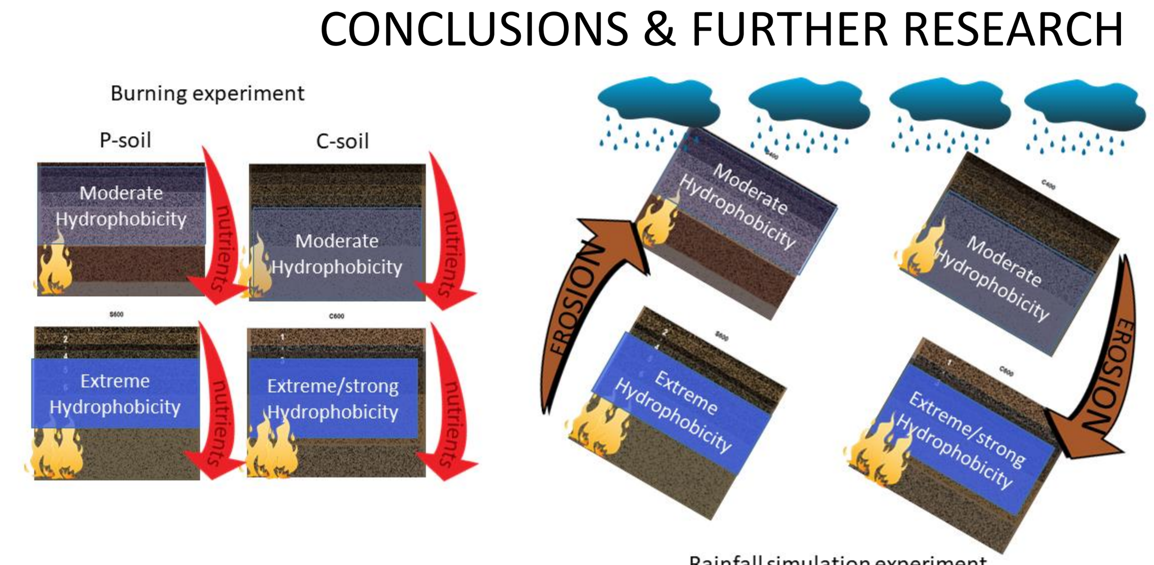
RAINFALL SIMULATION – EROSION RATES

While in C-soil the erosion rates increased with burning temperature, in P-soil the erosion rates were maximum at 400°C probably due to the moderately hydrophobic layer which developed very close to the surface (3 mm). Therefore, the P400 soil could retain less water.



25°C temperature refers to undisturbed samples.

CONCLUSIONS & FURTHER RESEARCH



What determined the different hydrophobicity patterns?

To answer, we need to:

-> assess specific surface

-> check micromorphology

-> focus on SOM properties

Further steps:

Check properties of eroded soils & run-off

Results from greenhouse experiment & natural regeneration

The project was funded by CRT grant "Strumenti per la valutazione del rischio di degradazione del suolo e la gestione dei boschi piemontesi percorsi da incendio". Symbols: Integration and Application Network (ian.umces.edu/media-library).