

POST-FIRE SOIL EROSION MITIGATION TREATMENTS: A GLOBAL COST-EFFECTIVENESS ANALYSIS



8TH
INTERNATIONAL
WILDLAND FIRE
CONFERENCE

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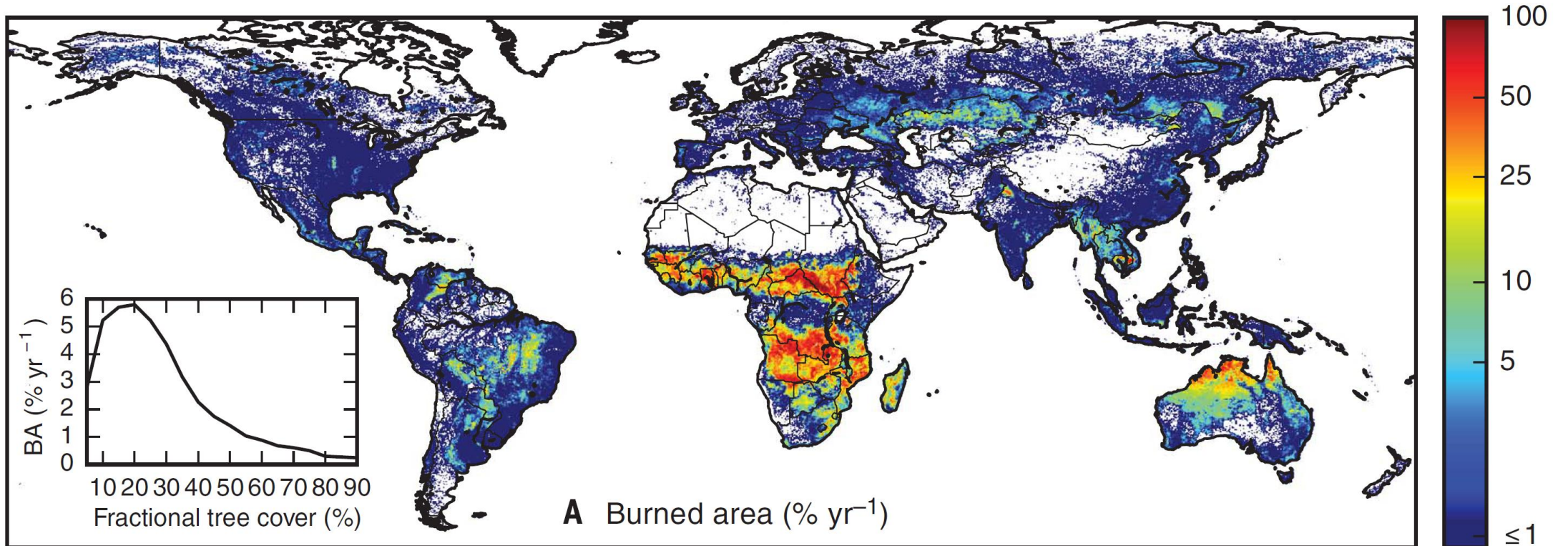
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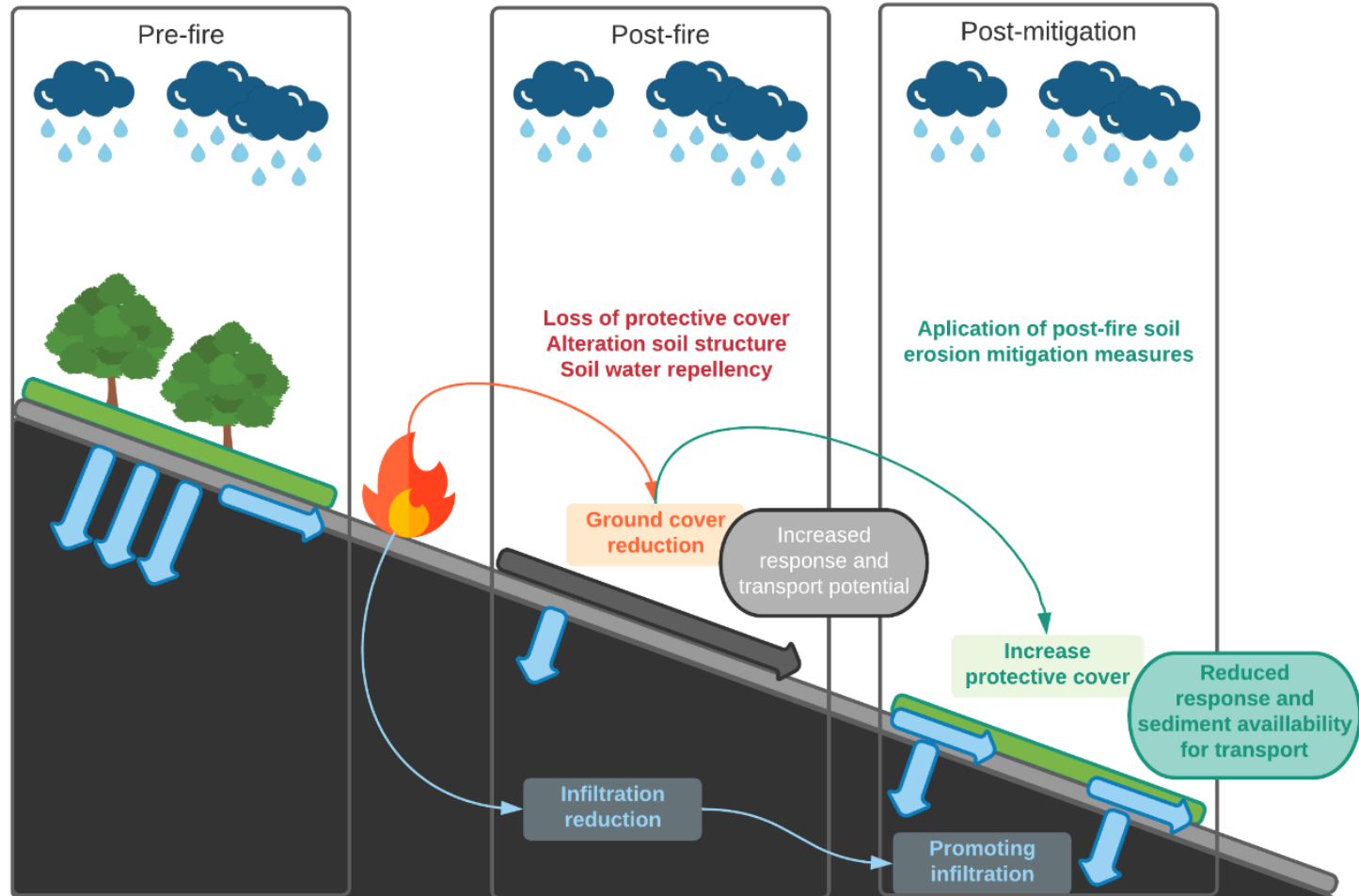
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Background



Wildfires burn ~448 million ha/y, and are one of the main causes of soil erosion and land degradation in fire-prone areas, and their impacts on ecosystems and society are expected to increase in the future due to changes in climate and land use.

Increased post-fire hydrological and erosive response



Main post-fire hillslope erosion mitigation treatments



Research gaps and questions

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Review Article

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

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✓ Which is the effectiveness of the different treatment types, materials, and application rates?

✓ How do time-since-fire, burn severity, ground cover evolution, and rainfall influence treatment's effectiveness?

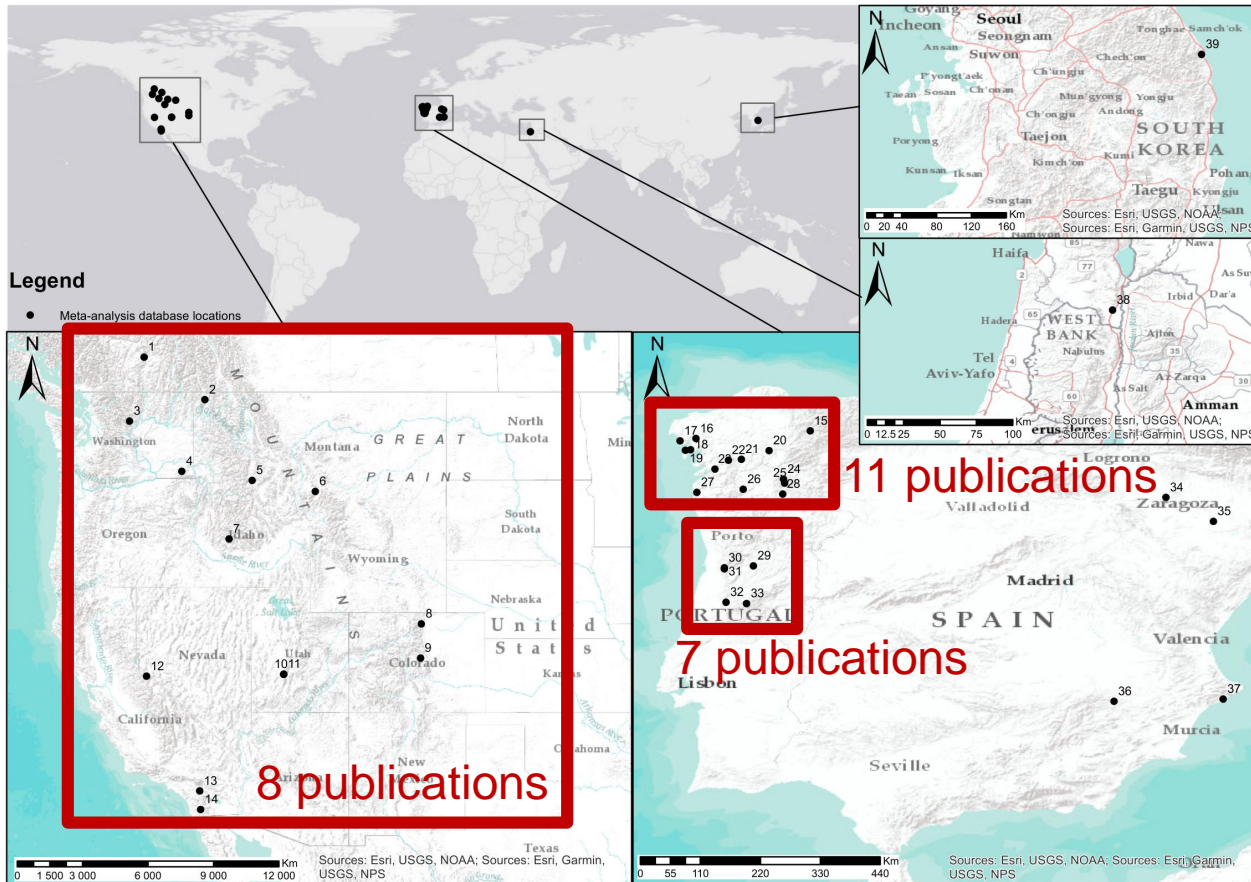
✗ How much do these treatments cost?

✗ How cost-effective are they?

✗ How much does it cost to reduce post-fire erosion to tolerable rates?

✗ Are these treatments justified?

Distribution of the studies



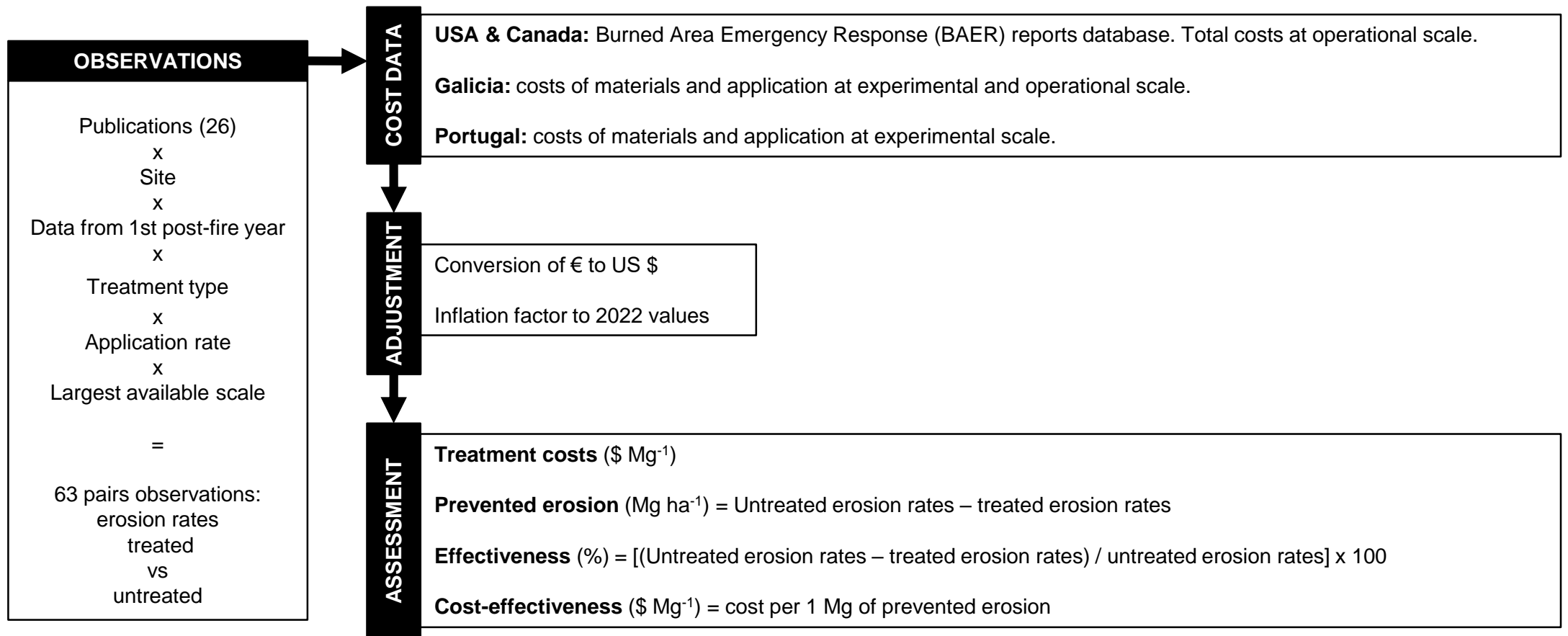
- **Number of publications: 26**

- Girona-García et al. (2021): thorough screening for comparability.

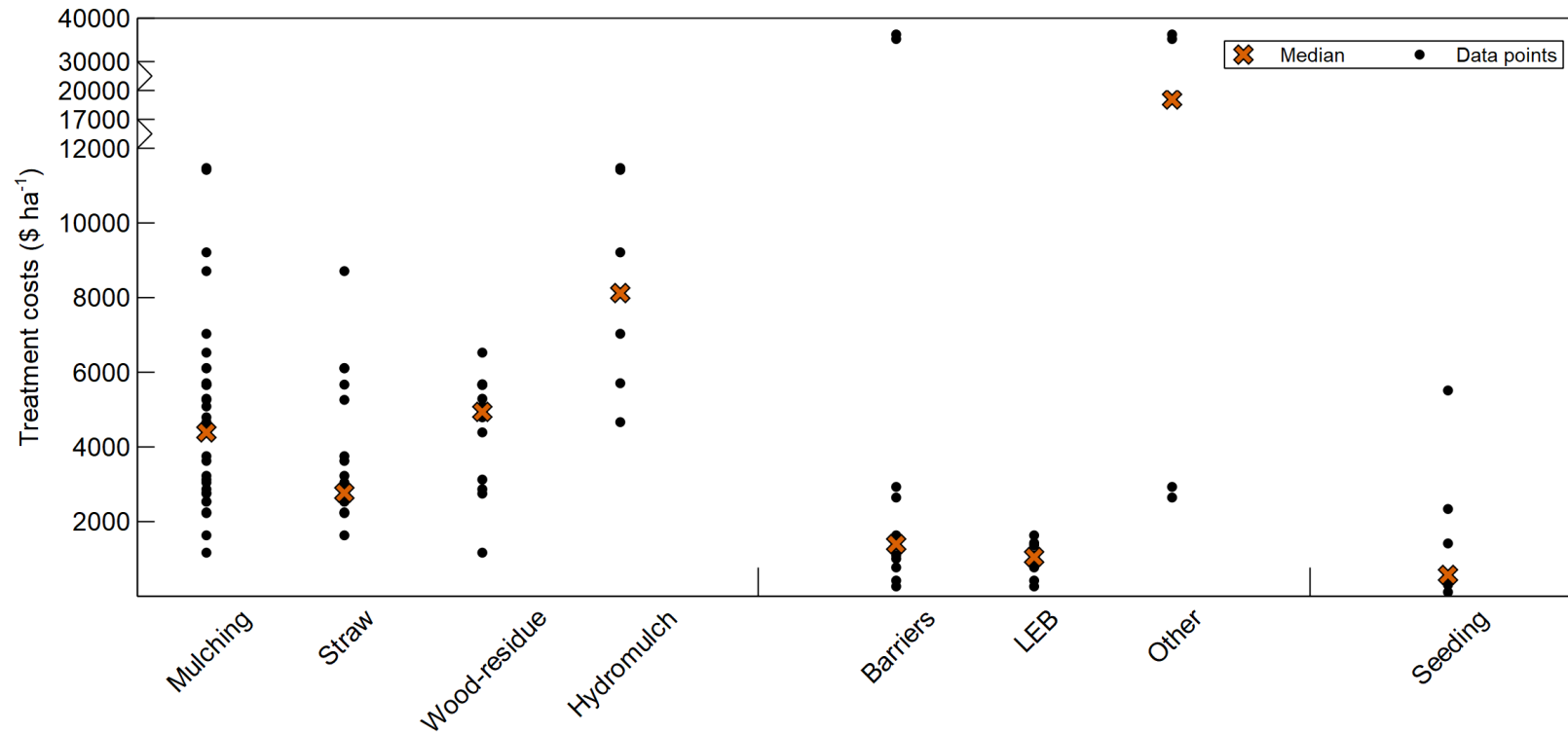
- **Selection criteria:**

- Number of replicates per region
- Similar methodology and procedures
- Monetary values could be obtained

Data compilation and analysis



Costs of post-fire soil erosion mitigation treatments



Mulching: 4390 \$ ha⁻¹

Straw: 2,767 \$ ha⁻¹

Wood: 4,939 \$ ha⁻¹

Hydromulch: 8,121 \$ ha⁻¹

Barriers: 1397 \$ ha⁻¹

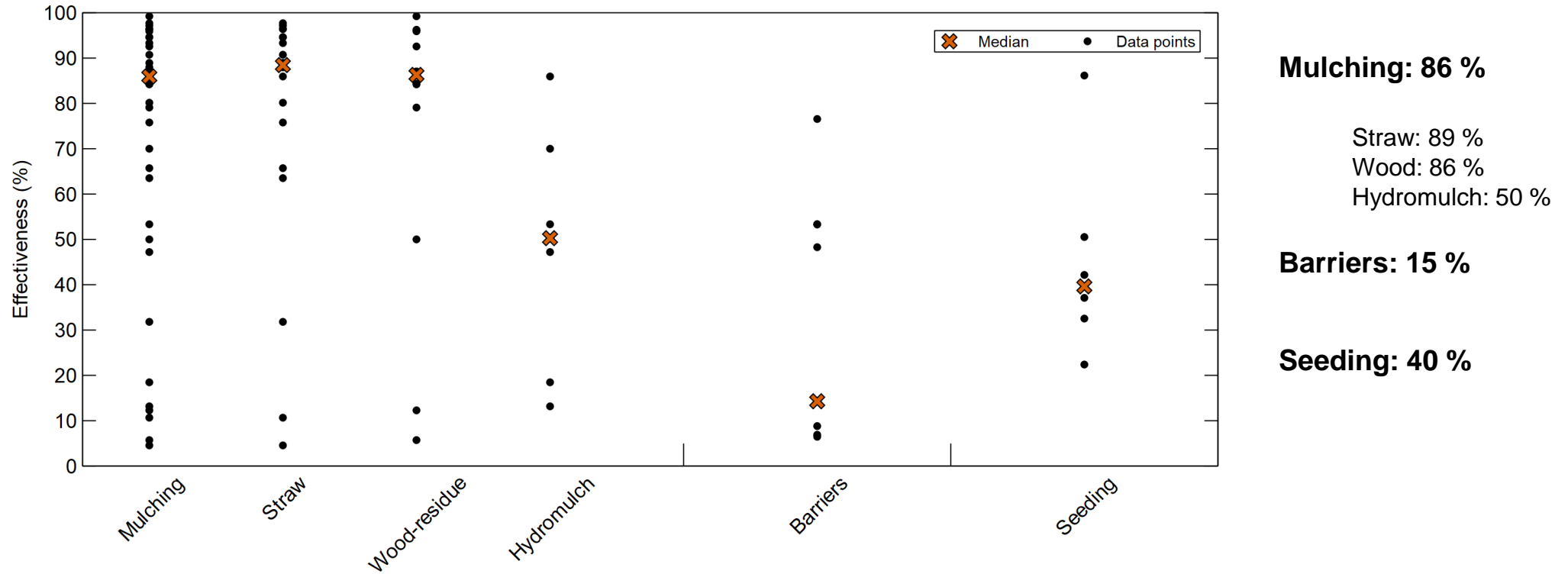
LEB: 1,051 \$ ha⁻¹

Other: 19,065 \$ ha⁻¹

Seeding: 571 \$ ha⁻¹

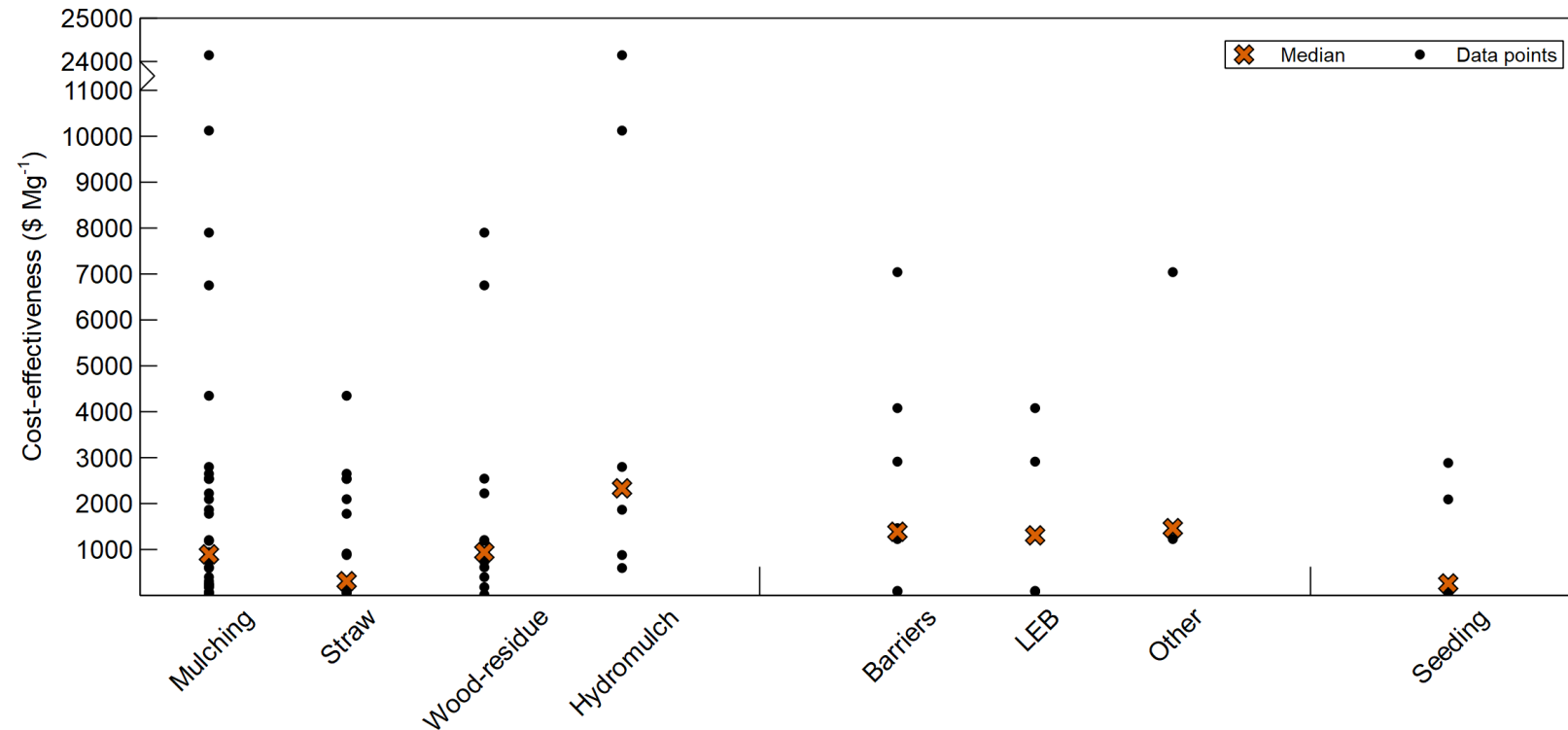
This analysis showed that the median costs of mulching are higher than those of barriers and seeding. However...

Effectiveness of post-fire soil erosion mitigation treatments



...mulching is much more effective at reducing erosion, especially straw and wood-residue mulch, than barriers and seeding.

Cost-effectiveness of post-fire soil erosion mitigation treatments



Mulching: 895 \$ Mg⁻¹

Straw: 309 \$ Mg⁻¹

Wood: 940 \$ Mg⁻¹

Hydromulch: 2,332 \$ Mg⁻¹

Barriers: 1386 \$ Mg⁻¹

LEB: 1,307 \$ Mg⁻¹

Other: 1,464 \$ Mg⁻¹

Seeding: 260 \$ Mg⁻¹

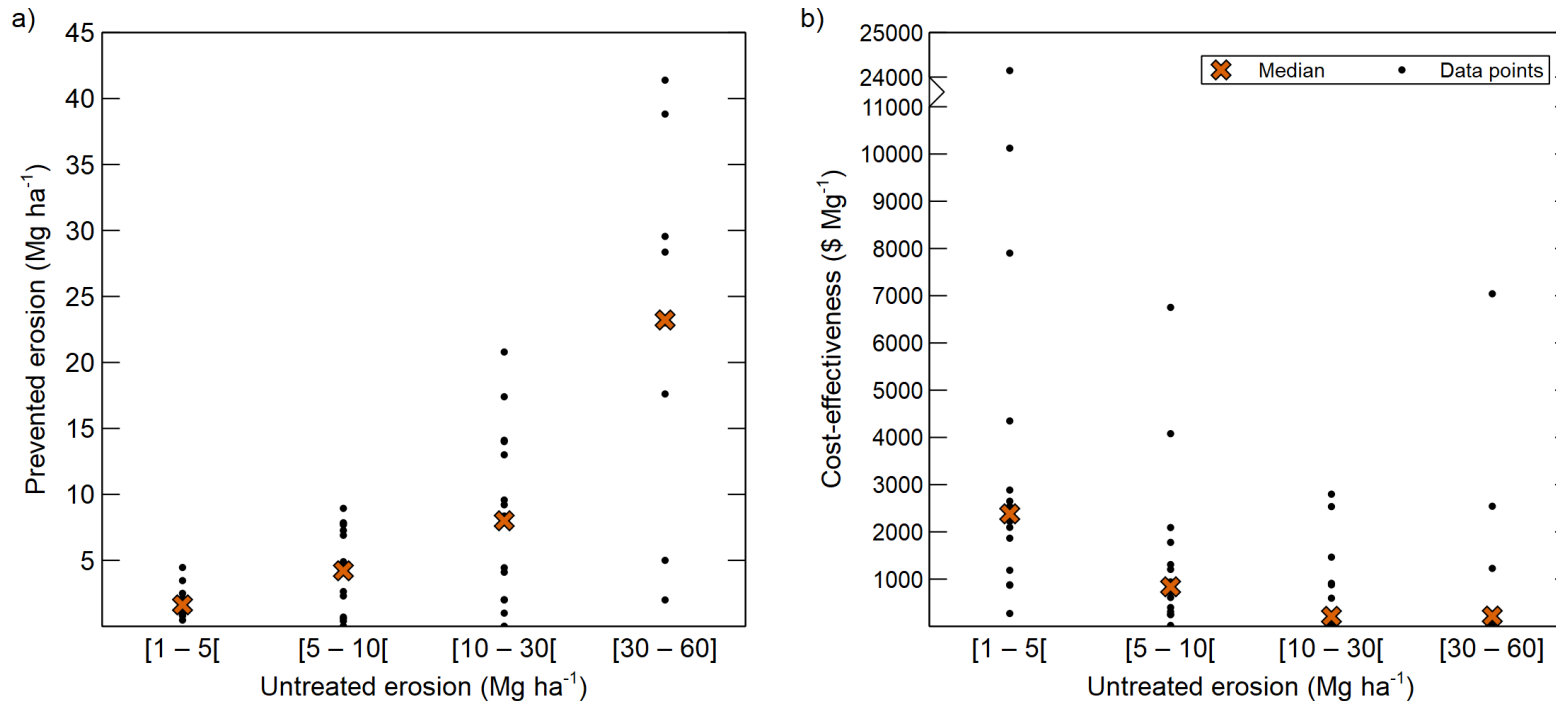
Although mulches are relatively more expensive, they are more cost-effective because of their elevated erosion mitigation capacity.

How much does it cost to reduce post-fire soil erosion to tolerable rates?

Untreated erosion (Mg ha ⁻¹ y ⁻¹)	Did treatments manage to reduce it to tolerable rates? ($< 1 \text{ Mg ha}^{-1} \text{ y}^{-1}$)	At what cost? (\$ Mg ⁻¹)
[1 - 5[Yes	2,159
[5 - 10[Yes	735
[10-30[No, but in some cases	58
[30-60]	it could be reduced below 5	244

Erosion could only be reduced to tolerable rates when untreated erosion was below 10 Mg ha⁻¹ y⁻¹
Even when it could not be reduced to tolerable rates, large amounts of soil were prevented from being lost

Should we always apply post-fire soil erosion mitigation treatments?



They should be applied in areas with higher erosion risk (high burn severity, steep slopes), given their capacity to prevent elevated soil losses (a) and to make the best use of the available resources (b)

Are post-fire soil erosion mitigation treatments justified?

Value of the ecosystem services provided by soils¹

Support functions: 136 – 438 \$ ha⁻¹ y⁻¹

Regulating services: 933 – 11,060 \$ ha⁻¹ y⁻¹

Provisioning services: 345 – 29,251 \$ ha⁻¹ y⁻¹

Total: 1,413 – 40,749 \$ ha⁻¹ y⁻¹

+

Value of ecosystem services provided by freshwater bodies²

6,097 ± 3,959 \$ ha⁻¹ y⁻¹

+

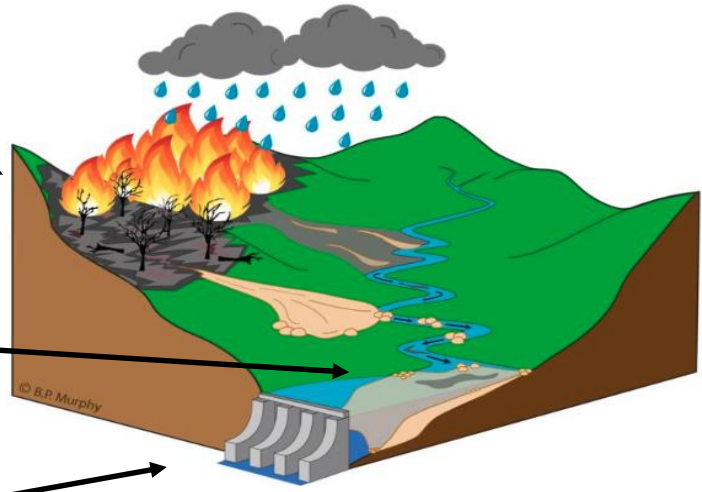
Damage to infrastructures, human lives, and other values-at-risk³

???? \$\$\$\$

=

Potential loss of ecosystem services* and damages to values-at-risk

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	Costs (\$ ha ⁻¹)	Cost-effectiveness (\$ Mg ⁻¹)
Mulches	4,390	895
Barriers	1,397	1,386
Seeding	541	260

¹Jónsson & Davíðsdóttir (2016). **Classification and valuation of soil ecosystem services**. *Agric Syst* 145: 24-38.

²De Groot et al. (2012). **Global estimates of the value of ecosystems and their services in monetary units**. *Ecosyst Serv.* 1: 50-61.

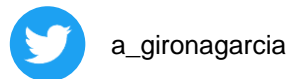
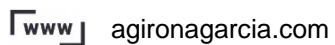
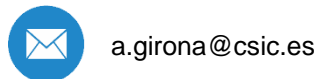
³Robinne et al. (2021). **Scientists' warning on extreme wildfire risks to water supply**. *Hydrol. Process.* 35: e14086.

⁴Girona-García et al. (2023). **How much does it cost to mitigate soil erosion after wildfires?**. *J Environ Manage* 334:117478.

*Considering that a soil loss >1 Mg ha⁻¹ y⁻¹ could compromise soil ecosystem service provision and water quality.

Post-fire soil erosion mitigation treatments are cost-effective as long as they are applied in areas where the erosion rates exceed the tolerable erosion rates and are less costly than the loss of on- and off-site values that they are targeted to protect

Thanks for your attention!



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How much does it cost to mitigate soil erosion after wildfires?

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