

INTERNATIONAL CONFERENCE ON  
MOUNTAINS AND CLIMATE CHANGE

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# Impacts of Climate Change on Mountain Permafrost

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## ○ Permafrost and Climate Change

Permafrost temperature can be a very useful tool for understanding recent climate change and its impact on the cryosphere. Permafrost changes in distribution and thermal characteristics can lead several types of impacts. In mountain environment the more important are:

### ○ 1) Increase in slope instability, why, where and when?

Permafrost degradation can trigger slope instability phenomena (creep, gelifluction, debris flows, landslides, rock avalanches) in «warm» permafrost areas or linked to the seasonal-annual active layer thickness changes or at multidecadal permafrost warming or thawing.

Permafrost degradation can change the mechanical characteristics of loose sediments (frozen-partially unfrozen-unfrozen) or rock joints

- 2) changes in vegetation composition and C fluxes.

Soil disturbance due to the 1) can directly induce mechanical stress to the roots of the plants and also modify soil structure, drainage, chemical composition and therefore induce vegetation changes. Soil and vegetation changes can also lead important C fluxes variations.

- 3) changes in water circulation and water management.

Active layer thickening change the water infiltration capacity and the permeability of the soil. Therefore water runoff and underground water circulation can variate significantly. The knowledge of these phenomena now simply not considered can improve the water management and flooding prevention.

# 1) Increase in slope instability , why, where and when?

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**Sediments** - faster creep, faster and more frequent gelifluction events – soil slipes- debris flows – subsidence

**Rock Outcrop** – More frequent rock falls or toppling – Possible Landslides or Rock Avalanche





# 1) Increase in slope instability , why, where and when?

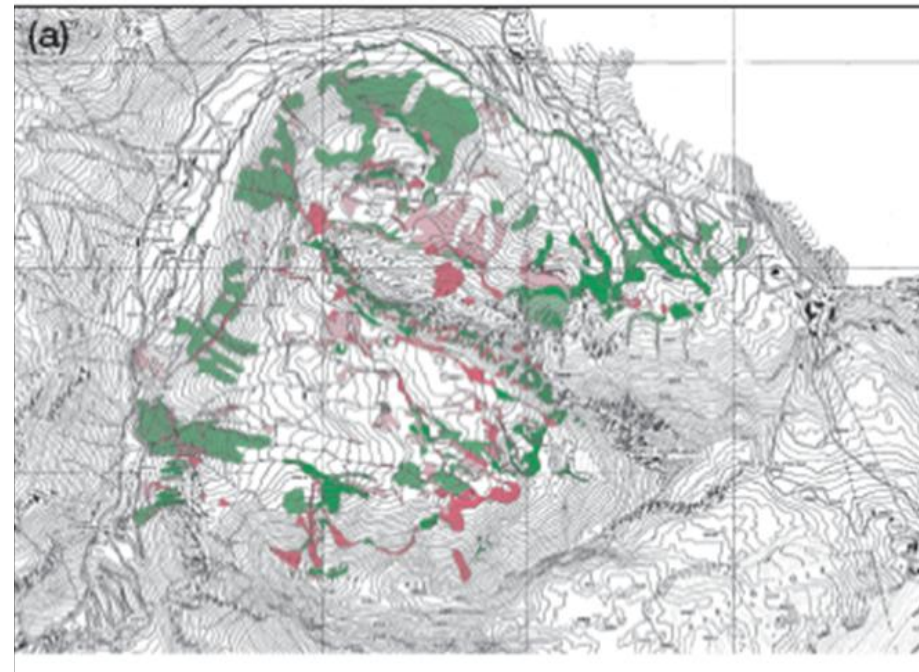
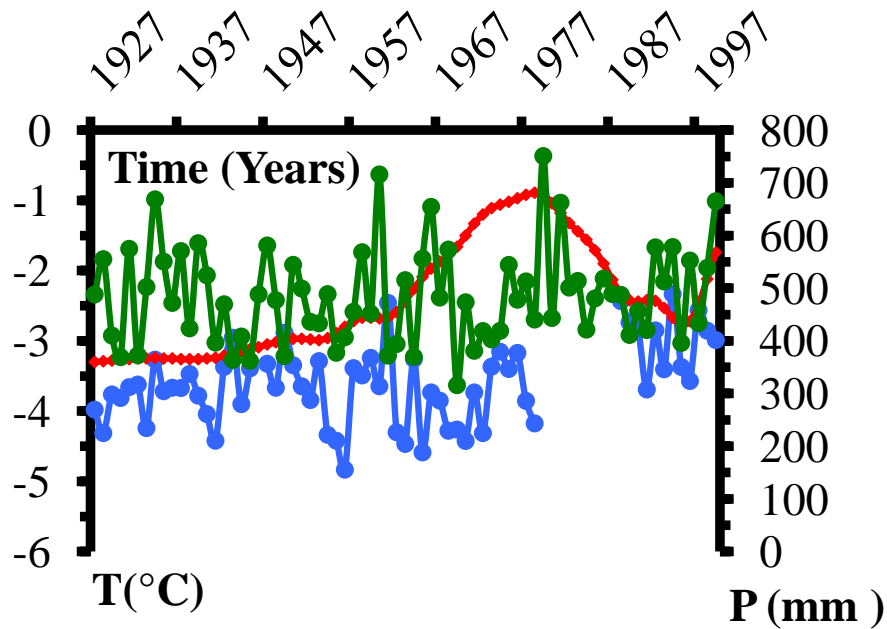


## 2) changes in vegetation composition and C fluxes.

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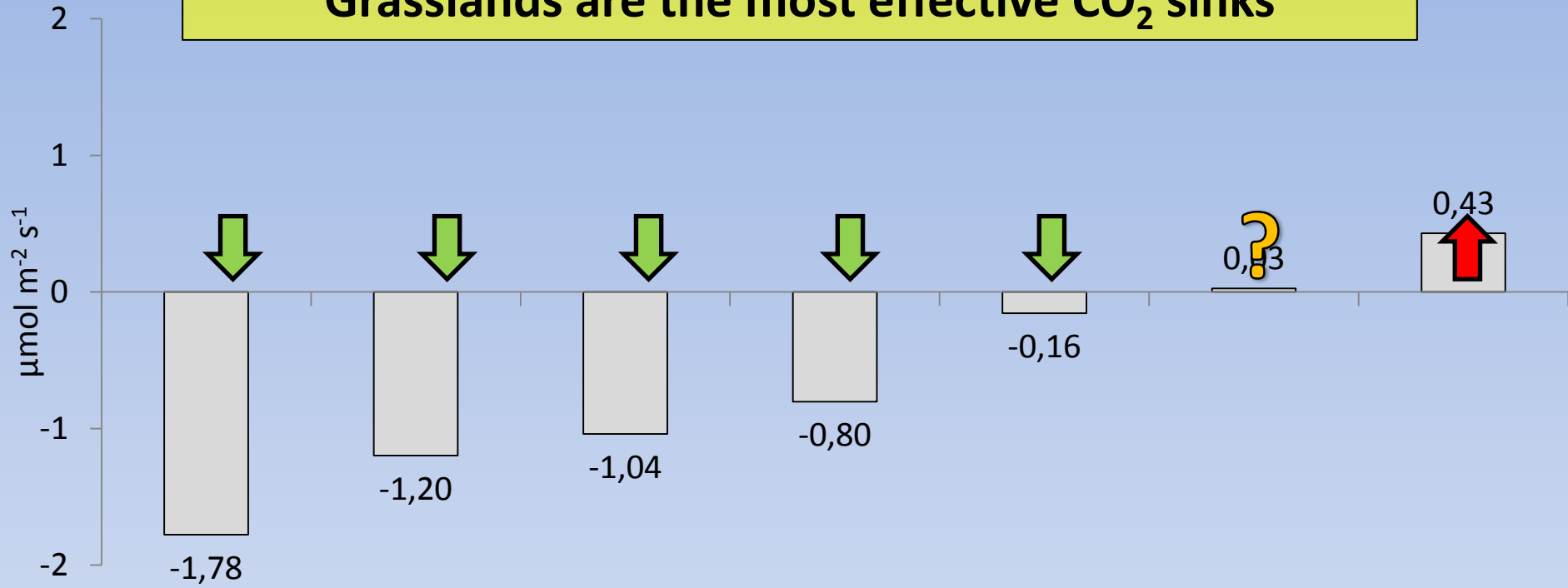
Soil disturbance induces vegetation changes in coverage, vegetation compositions  
Vegetation changes induces C fluxes changes

## 2) changes in vegetation composition and C fluxes.

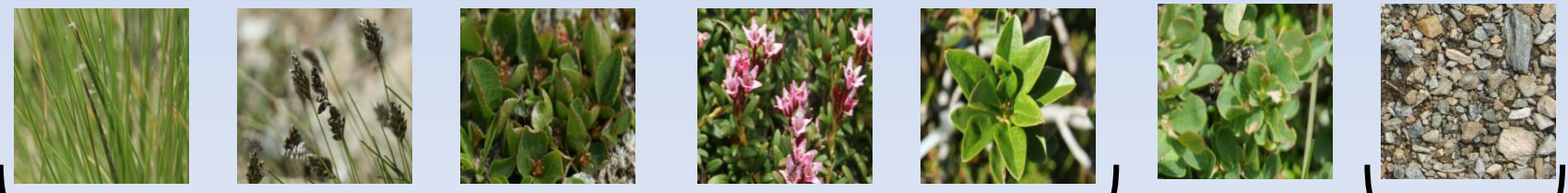




**Mean seasonal NEE of each ecosystem type (p<0.001)**  
**Grasslands are the most effective CO<sub>2</sub> sinks**



GRASSLAND PIONEER SNOWBED DWARF SHRUBS SHRUBS SHRUBS (RF) SHRUBS (VU) BARREN GROUND



From Cannone et al., in prep

**SINKS**

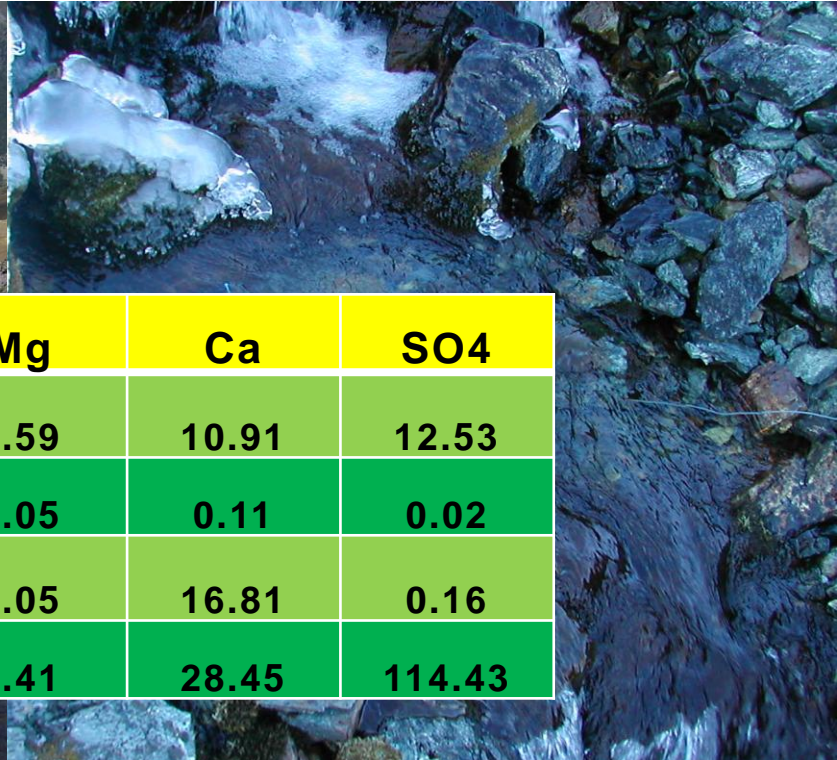

**SOURCE**

# 3) changes in water circulation and water management .

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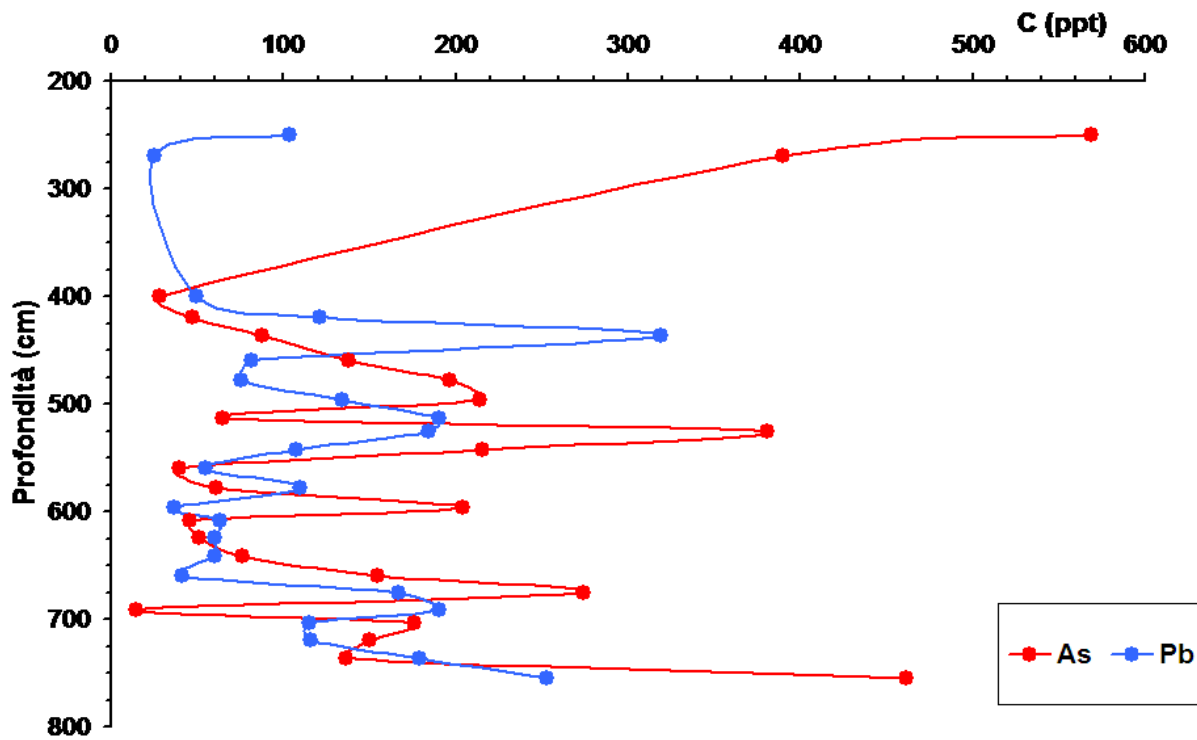
- A) Active layer thickening changes hydraulic properties of the soil
- B) Runoff and possible flooding are influenced by A)
- C) Permafrost aquifers need different water management policy because are temporary confined or semiconfined aquifers

### 3) changes in water circulation and water management .



	Na	K	Mg	Ca	SO4
<i>Moraine spring (no permafrost)</i>	0.90	0.40	0.59	10.91	12.53
<i>Fresh snow</i>	0.00	0.00	0.05	0.11	0.02
<i>Pace Ice core (Rock Glacier)</i>	0.26	0.18	0.05	16.81	0.16
<i>Rock Glacier spring</i>	1.89	0.60	8.41	28.45	114.43

### 3) changes in water circulation and water management .





Thank you for your attention

