UNIVERSITÀ DI PAVIA
Dipartimento di Scienze della Terra e dell'Ambiente

MICRONIZZAZIONE INNOVATIVA

Use of Anionic Polyacrylamide to improve soil properties and challenge slope instabilities: preliminary data

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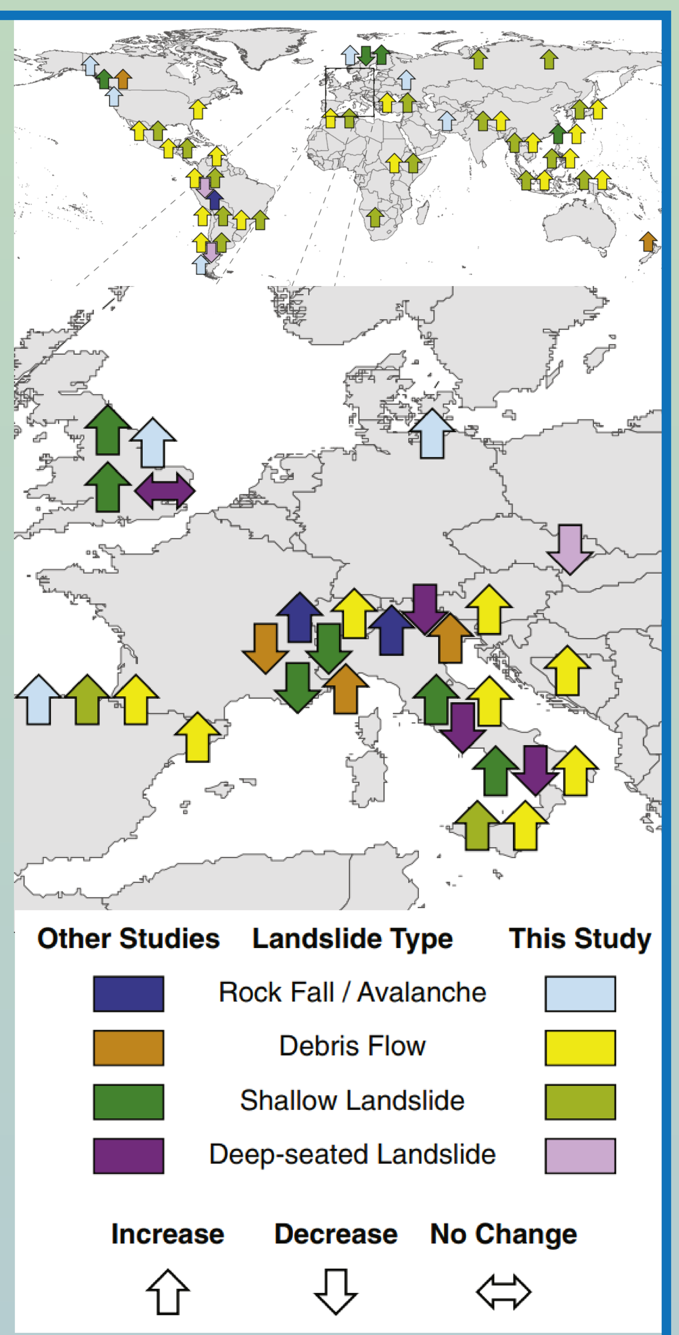
About the Problem

Shallow landslides in a. and d. Italy (Carelli et al., 2007; Bordoni et al., 2015); b. and c. Austria (Zieher et al., 2016)

Shallow slope instabilities

- **erosion and shallow landslides**
- impact on large portions of land including cultivated slopes
- threatening human lives, local economy and infrastructures (FOWZE et alii, 2012; MALLARI, 2016)

Worldwide **augmented** probability of **occurrence** due to **changing climate** (Gariano & Guzzetti, 2016; Haque et al., 2019)



The improvement of soil physical and geotechnical properties can be provided through soil conditioners (SOJKA et alii, 2007; HÄHNDEL & PRÜN, 2009)

Polymers such as polyacrylamide (PAM) seem promising in preventing soil degradation, thus reducing the probability of greater damages on human economic activities and safety

Methods

POLYACTIVE POWDER

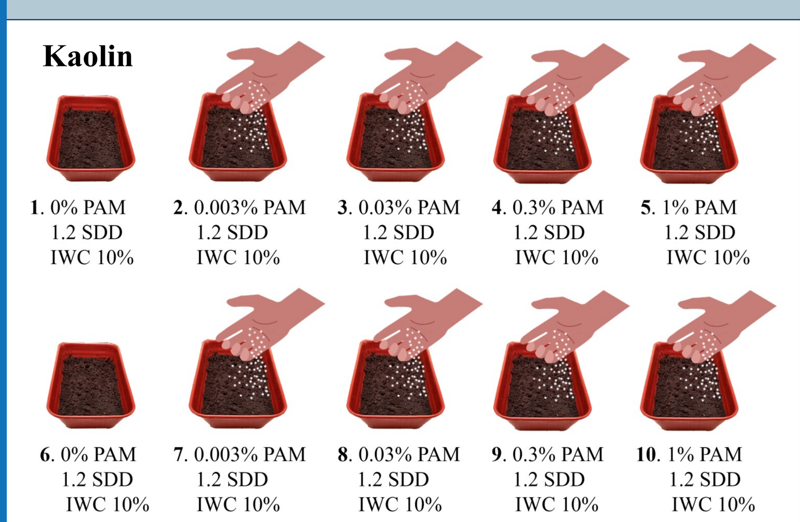
- Kaolin and sandy loam samples reconstructed in laboratory to observe the effects of anionic PAM (Polyactive Powder provided by Micronizzazione Innovativa Srl) on their physical, volumetric, mechanical, and hydrological properties

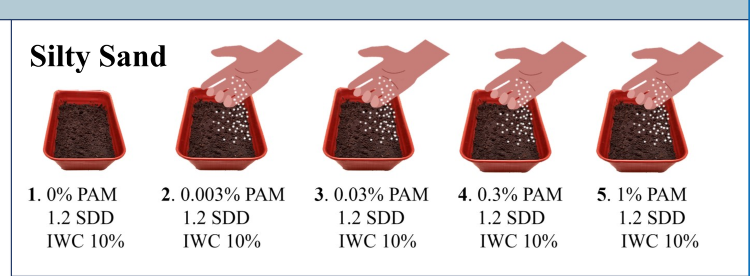
CAPKN80 – KAOLIN AKPrime (Bal - Co S.P.A.)		
Chemical Analysis	SiO_2	46.5 %
	Al_2O_3	37 %
	Fe_2O_3	0.5 %
	TiO_2	0.5-1.0 %
	CaO	0.2 %
	K_2O	0.3-0.8 %
	Na_2O	0.05 %
	P.F.	13.2 %
Granulometry	Laser < 2 µm	70-83 %
	Sieve > 45 µm	0.3 % max
Mineralogical Composition	Kaolinite	87.0 %
	Quartz	3.0 %
	Illite / Montmorillonite	7.0 %
	Feldspar	3.0 %
Other	pH	6.5-8.5
Selected Sand 113-25 (Sabbie Sataf s.r.l.)		
mm	00.20-00.35	

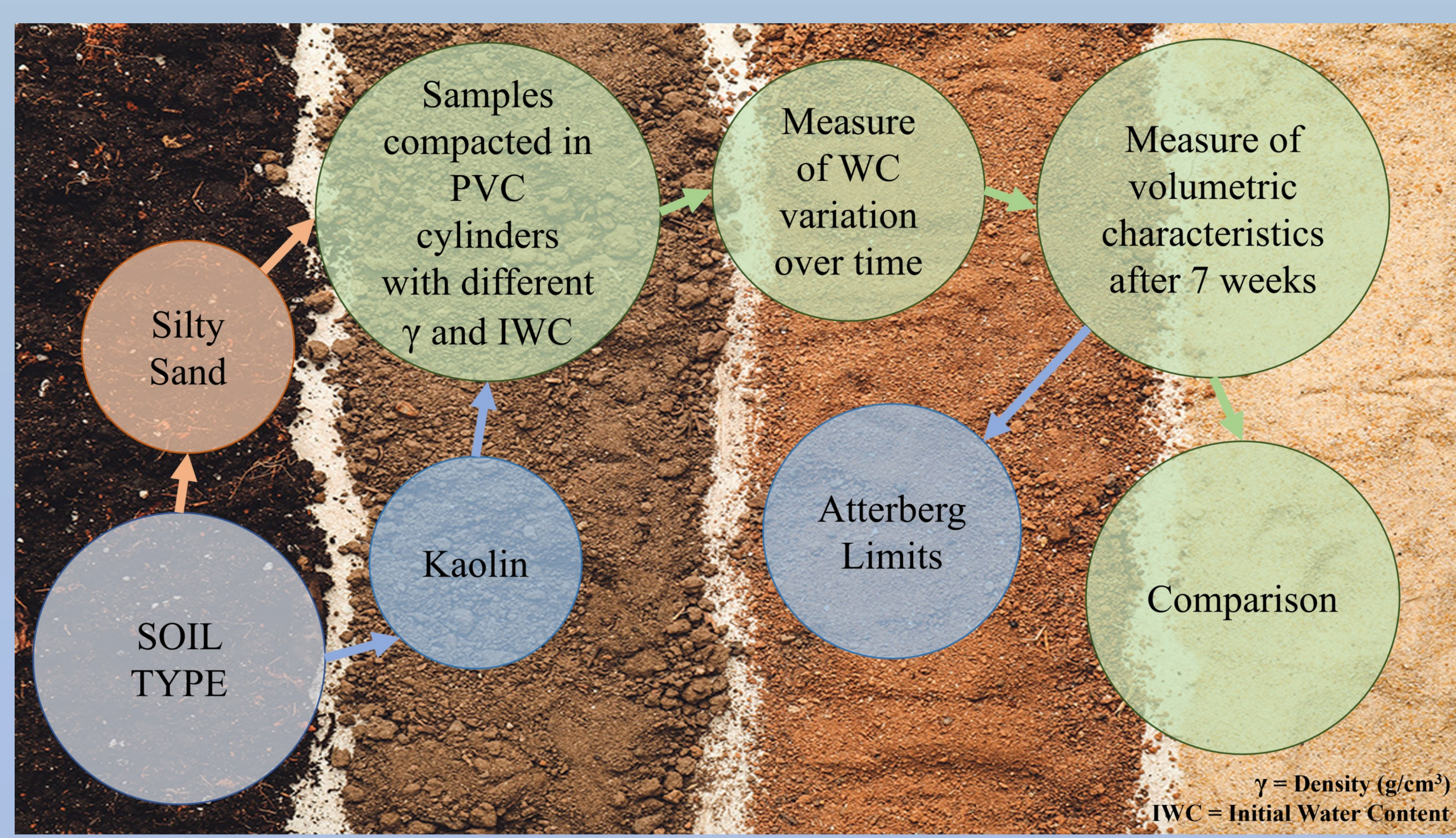
Kaolin Samples	W %	γ_d (g/cm³)	PAM %
F1	20	1.1	0
F2	20	1.1	0
F3	20	1.3	0
F4	40	1.3	0
F5	10	1.4	0
F6	40	1.2	0
F8	10	1.2	0
F9	10	1.3	0
F10	20	1.2	0
F11	40	1.2	0
F12	10	1.3	0

Silty Sand Samples	W %	γ_d (g/cm³)	PAM %
F13	10	1.4	0
F14	20	1.4	0
F15	10	1.6	0
F17	20	1.2	0
F18	20	1.6	0
F19	5	1.2	0
F20	5	1.4	0
F21	5	1.6	0

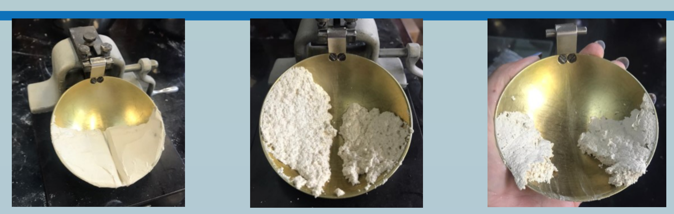
- Five soil-PAM mix designs (i.e., untreated soil and four PAM-treated samples bearing 0%, 0.003%, 0.03%, 0.3%, and 1% by weight) were examined for both kaolin and silty sand. Analyses were carried out according to ASTM standards



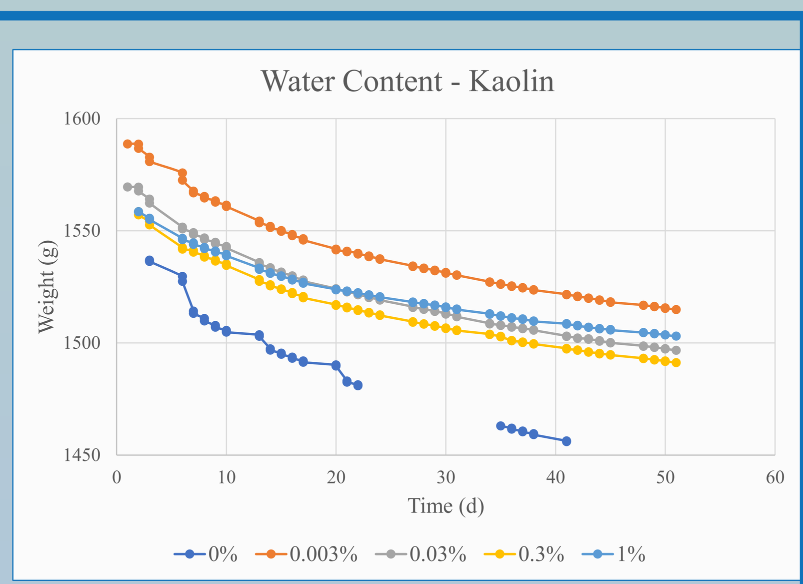


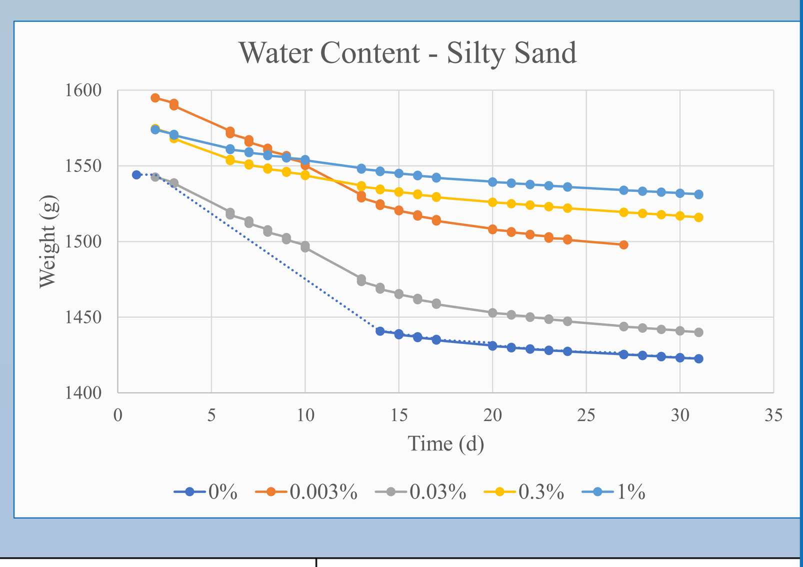


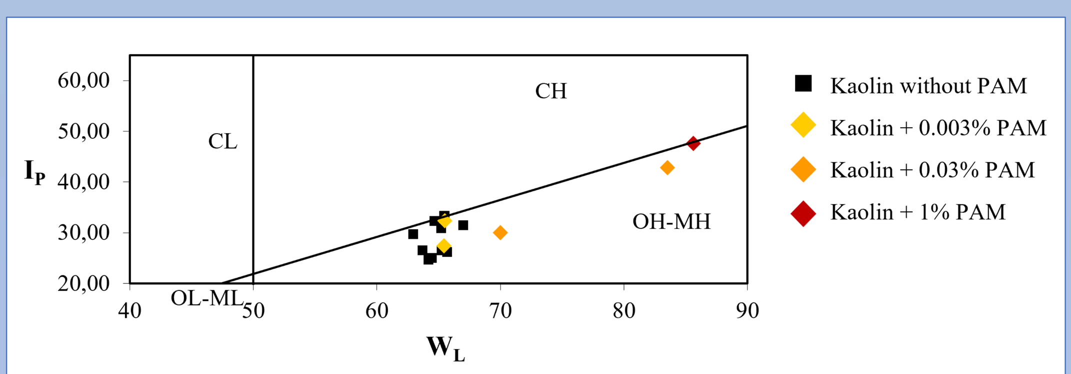
Results

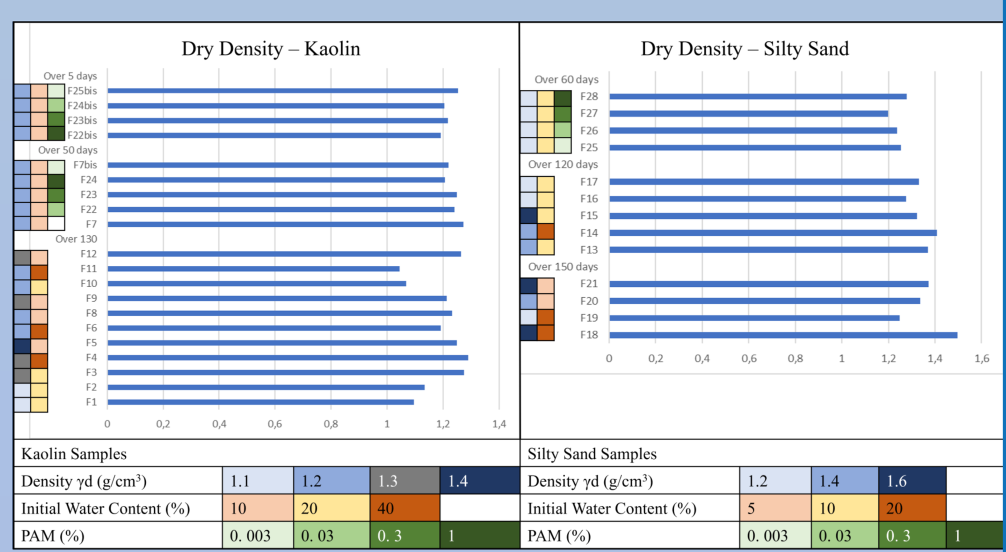


- The increase of PAM % caused an increase of Liquid Limit (LL) and Plasticity Index (PI) and a more regular release of water
- Lower PAM % had little to no consequences on PI, while with rising polymer % samples moved up on the A-line
- It was not possible to obtain PI and WL values for samples bearing 0.3/1% PAM, as their behavior did not allow to submit it to Casagrande Spoon
- PAM % ≥ 1% could result in samples difficult to handle, with possibly unwanted effects on soil. PAM applied beyond a certain amount stops causing changes in soil properties and can become counter-productive (MAJED, 2006)
- PAM effects on dry density (DD) were opposite for kaolin and silty sand: for the former the maximum % coincided with the minimum DD, while for the latter it coincided with the maximum DD









Conclusions

- Despite PAM addition causing a translation nearly parallel to the A-line (on the Casagrande Plasticity Chart), the original OH-MH/CH classification of unamended soil remained valid for all PAM treated cases
- Results are somewhat contrasting, as PAM would be a useful tool to reduce soils proneness to surface instabilities enhancing soil strength, preventing soil erosion (CHEN et alii, 2016) and reducing its water content and absorption (YANG et alii, 2019); preliminary data show that PAM-treated samples would retain more water (CHEN et alii, 2016), therefore further experiments should be conducted
- However, these preliminary results shed light on the possible application of PAM to improve other soil features (i.e., erosion, infiltration rate, shear strength properties) impacting on slope instabilities occurrence, in a frame of sustainable solutions for reduction of landslides susceptibility

Sharing is encouraged

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