SPARSELY CROSSLINKED BIODEGRADABLE HYDROGEL AS A MULTIFUNCTIONAL SOIL AMENDMENT

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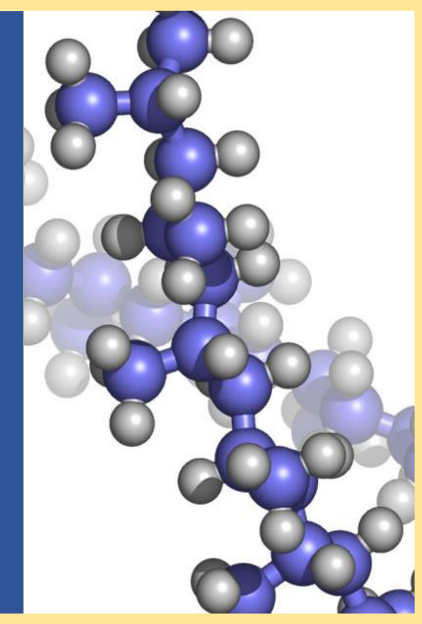


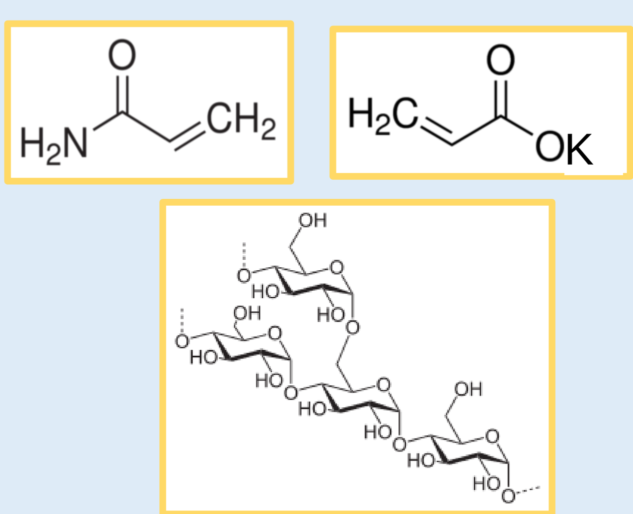
RESEARCH MOTIVATION

Soil degradation is one of the serious ecological problems nowadays. It happens due to erosion, desertification and a variety of other factors, caused by human activities and naturel processes.

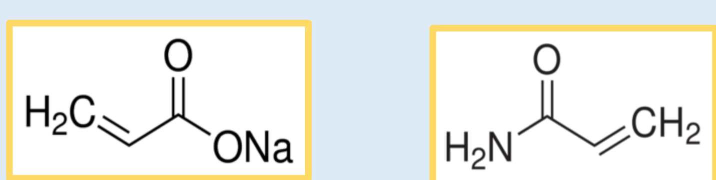
A promising way to solve soil problems is to use polymeric amendments. There are two main directions: linear polymers form polymer-soil coatings that protect the soil from erosion, however, they do not directly improve the water-holding capacity of soils. Hydrogels of network structure improve the water regime of soils, but do not have the ability to stabilize the soil structure. This work is devoted to developing a soil amendment, capable of solving both problems.

MATERIALS

PAM-PAK#
Synthetic copolymer:
Acrylamide/potassium acrylate/starch
0.04% cross-linking
6.4 mmol/g COO^-

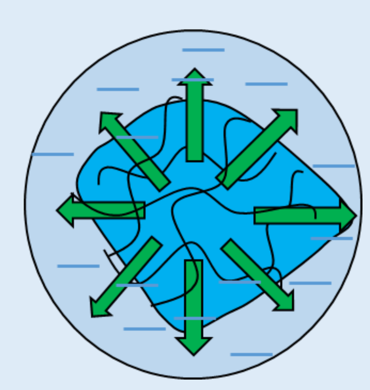


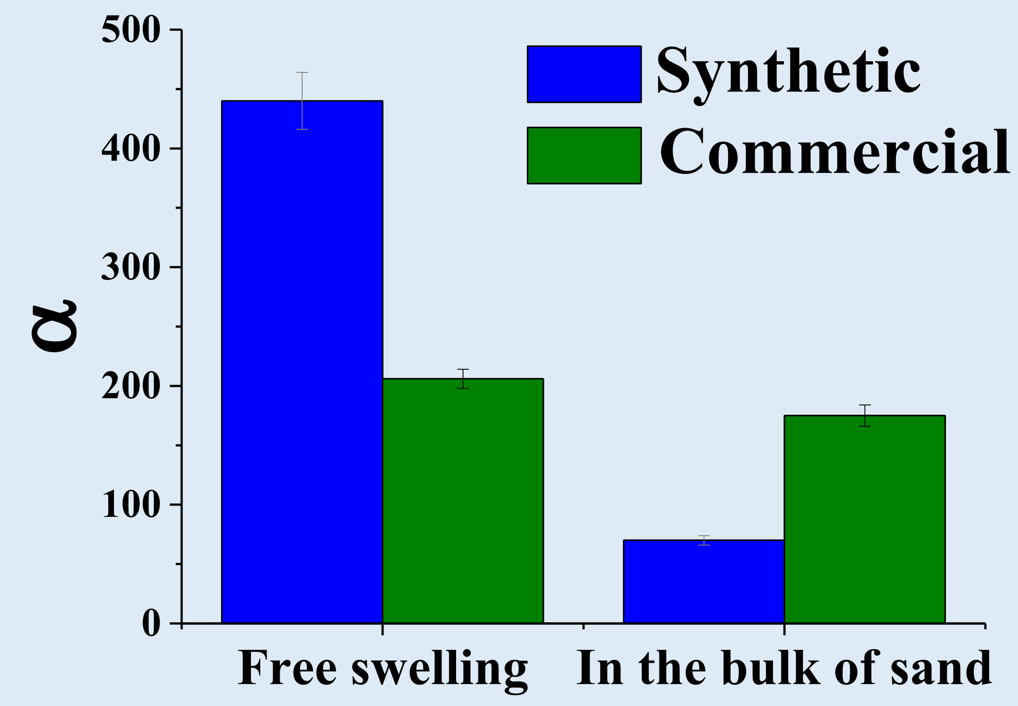
Commercial copolymer:
Acrylamide/sodium acrylate
0.2% cross-linking
2.2 mmol/g COO^-

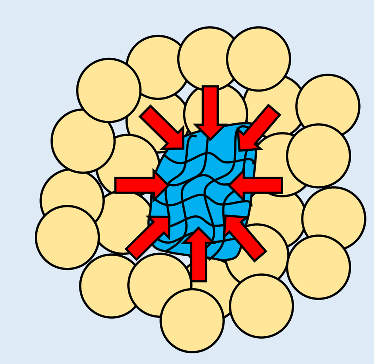


Model soil – quartz sand
0.1 to 0.2 mm grains

WATER RETENTION STUDY

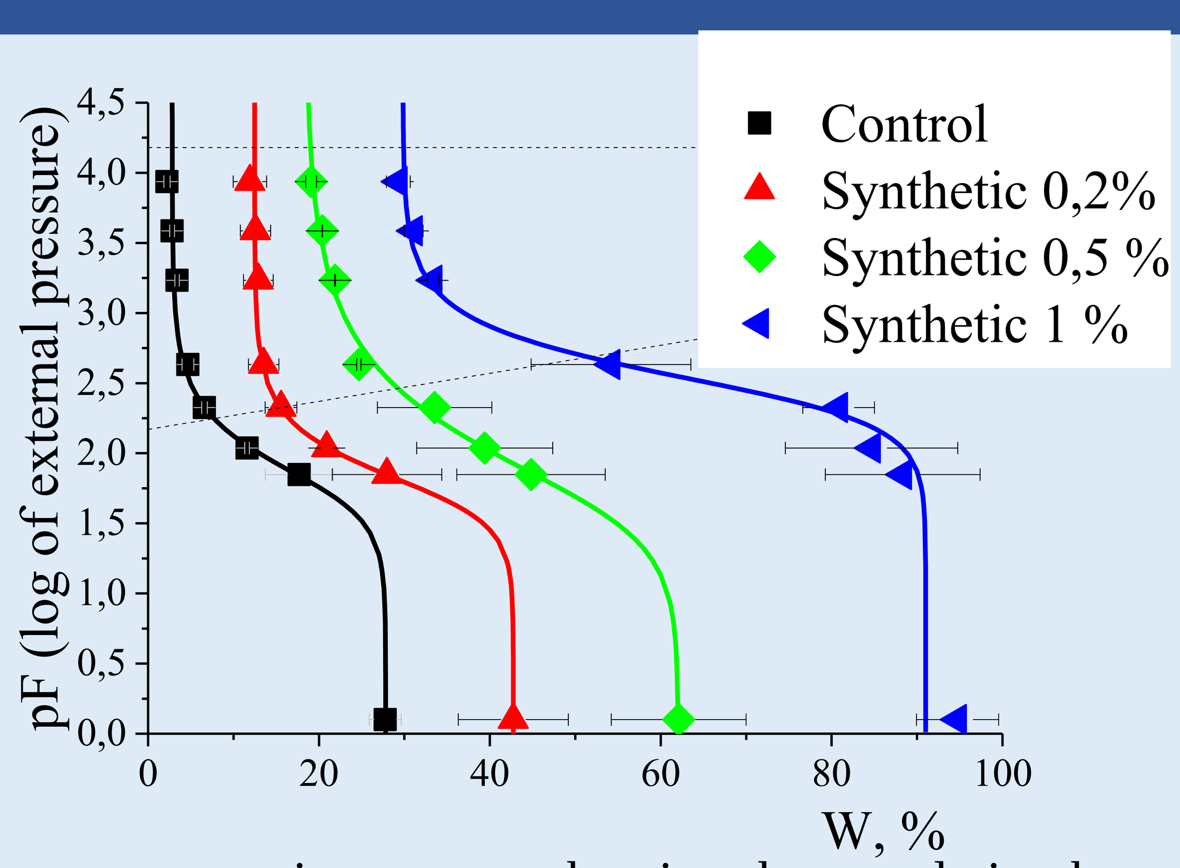


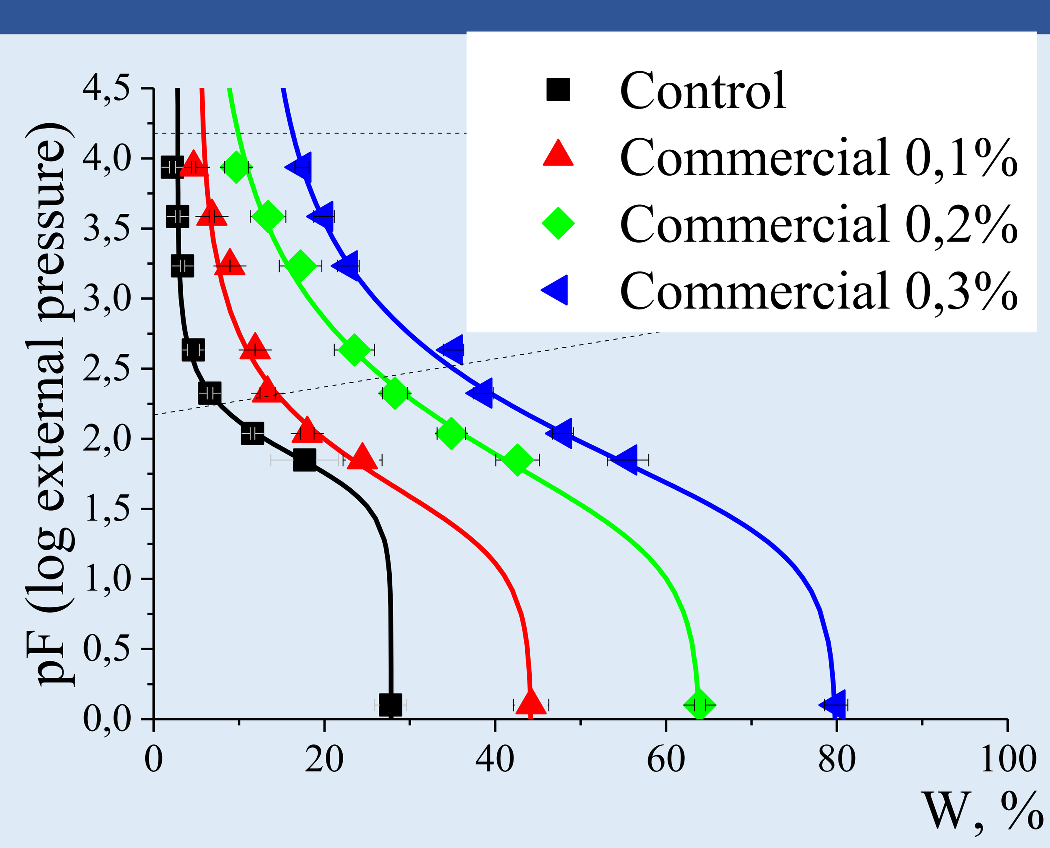


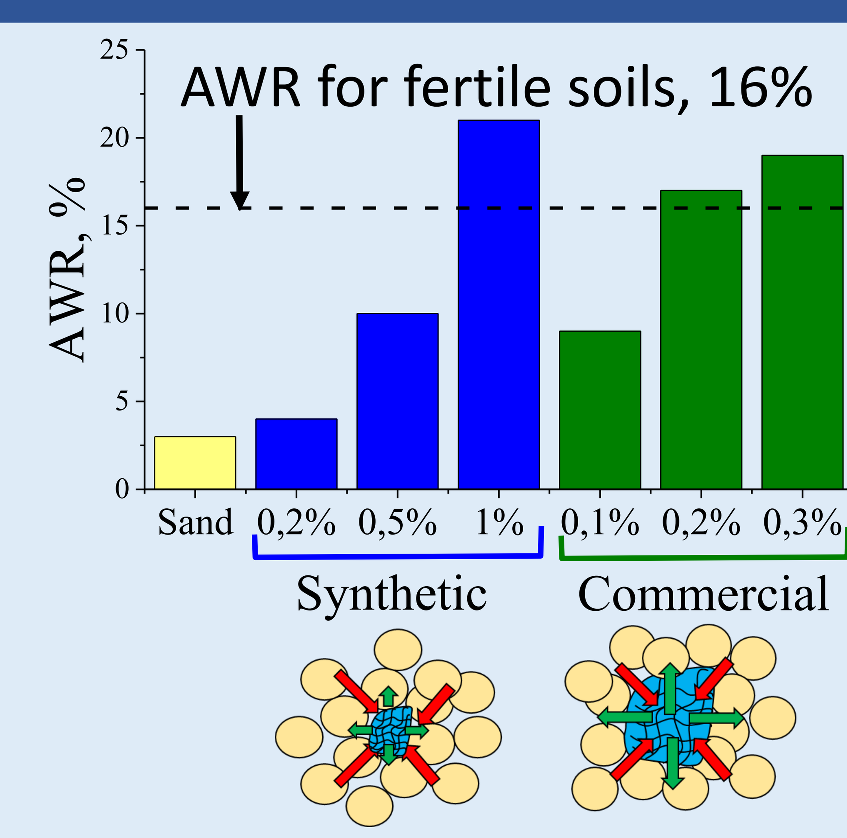


Inversion of water-retention properties is observed: in case of free swelling the synthetic sparsely cross-linked copolymer has higher swelling ratio, however, when swelling in the bulk of sand, the commercial copolymer with higher cross-kinking density takes the advantage.

WATER-RETENTION CURVES FOR SAND-POLYMER COMPOSITES

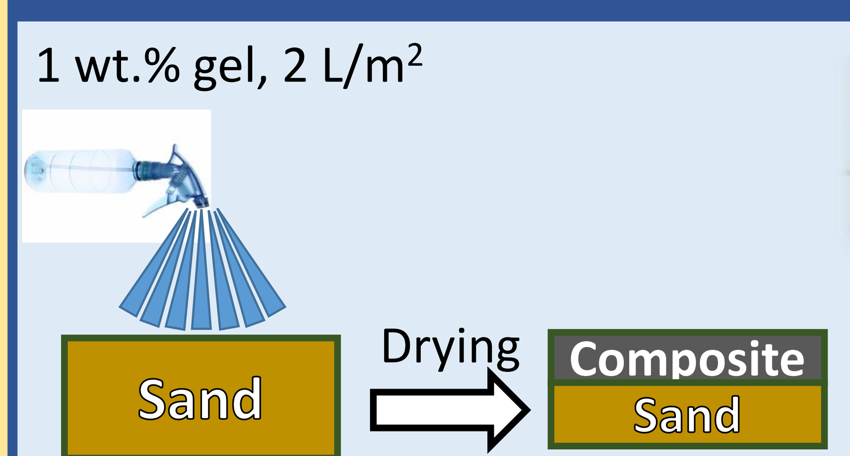






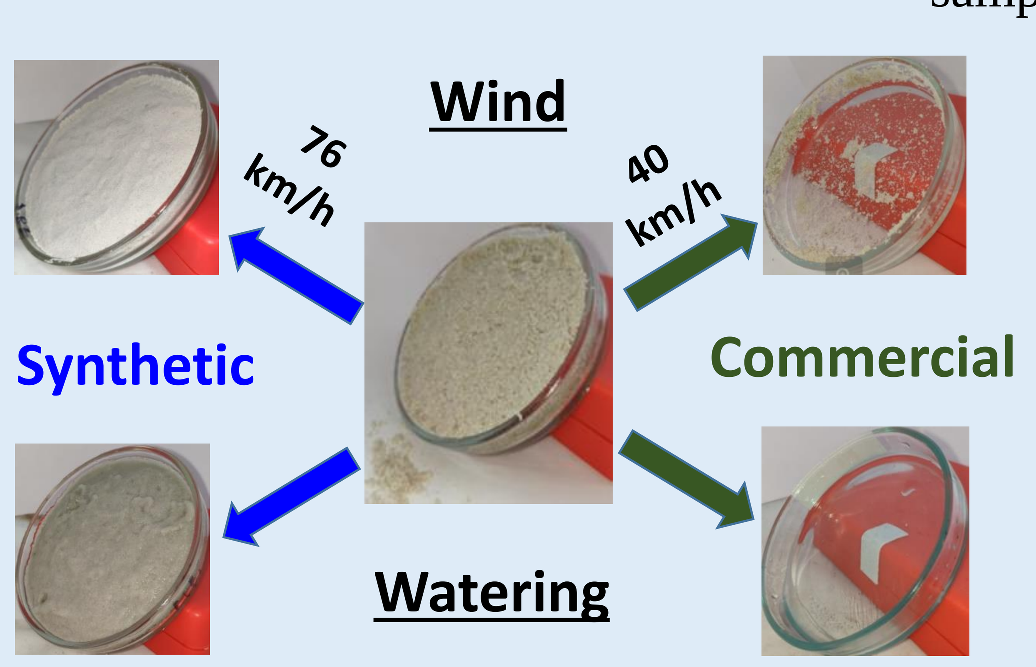
The water-retention curves, showing the correlation between external force (pF) and the sand water content (W) indicate that both synthetic and commercial provide a significant enhancement of the water capacity and retention of sand. However, once again, commercial sample shows better performance. The available water range of 16%, characteristic for fertile soils, is reached at 0.2% ratio of commercial sample and at 0.8% ratio of synthetic sample. Such effects can be connected with the cross-linking density of copolymers: copolymer with higher cross-linking density has higher elastic modulus at swollen state, thus, can withstand the external pressure of sand.

SAND STRUCTURING



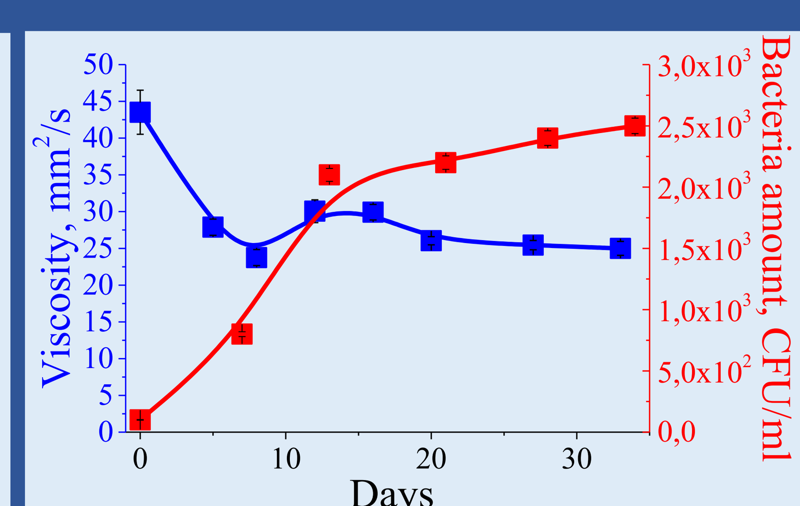
Composite with synthetic sample

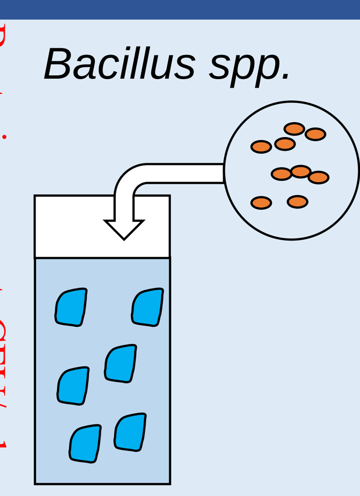
Composite with commercial sample



The synthetic sample is able to create a uniform polymer-sand crust, which is stable against wind and water streams. The commercial one only forms separate aggregates.

BIODEGRADABILITY





The viscosity of hydrogel decreases after adding special bacteria to it, and the population of bacteria shows rapid growth. Thus, the synthetic hydrogel is biodegradable and biocompatible thanks to the starch fragments in it.

CONCLUSION

- The synthetic hydrogel sample shows weaker water retention properties in sand, however, they are still at decent level. At the same time, it can stabilize the sand surface against erosion, while commercial sample cannot. Thus, the new synthetic copolymer is indeed an effective multifunctional soil amendment.
- The synthetic hydrogel is bio-friendly due to starch in its content.

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