31st International Conference of Young Scientists

Improving The Water Retention Capacity of Soils

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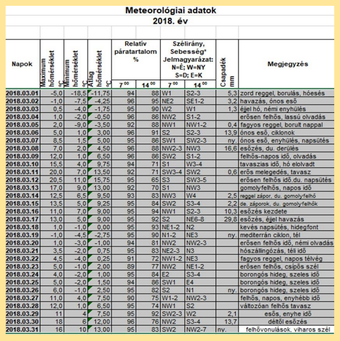
1. Introduction

In recent decades, our weather has become increasingly extreme, affecting the water management of our soils. Our aim is to highlight the problem locally and to study our soils from a water conservation perspective. Our hypothesis is that we can improve the water retention capacity of our soils by using soil improvement materials (perlite, alginite, zeolite,compost , peat, cattle manure, mulch, clay pebbles) and thus influence the water balance of the whole of Hungary in a positive direction.

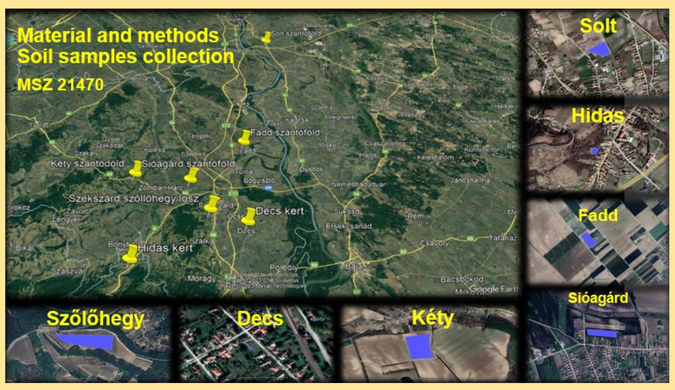
2. Materials and methods



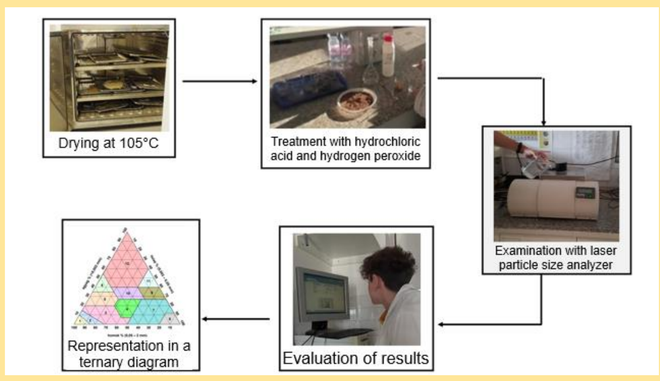
Meteorológiai adatok
2018. év

Napok	Minimum hőmérséklet °C	Maximum hőmérséklet °C	Középhőmérséklet °C	Relatív páratartalom % 7:00	Relatív páratartalom % 14:00	Szélirány, Sebesség* Jelmagyarázat: N=É; W=NY S=D; E=K 7:00	Szélirány, Sebesség* Jelmagyarázat: N=É; W=NY S=D; E=K 14:00	Csapadék mm	Megjegyzés
2018.03.01	-5,0	-18,5	-11,75	94	88	W1	S2-3	5,3	zord reggel, borulás, hóesés
2018.03.02	-1,0	-7,5	-4,25	96	95	NE2	SE1-2	3,2	havazás, órás eső
2018.03.03	0,5	-4,0	-1,75	95	90	W2	W1	1,3	éjjel hó, némi enyhülés
2018.03.04	1,0	-2,0	-0,50	96	86	NW2	S1-2		erősen felhős, lassú olvadás
2018.03.05	2,0	-9,0	-3,50	92	85	NW1	NW1-2	0,4	fagyos reggel, borult nappal
2018.03.06	5,0	-1,0	3,00	96	91	S2	S2-3	13,9	órás eső, zuhogás
2018.03.07	8,5	1,5	5,00	95	86	SW1	SW2-3	ny.	órás eső, enyhülés, napsütés
2018.03.08	7,0	2,0	4,50	96	88	NW2-3	NW3	16,6	esőzés, du. derjárás
2018.03.09	12,0	1,0	6,50	96	86	SW2	S1-2		felhős-napos idő, olvadás
2018.03.10	15,5	4,0	9,75	94	71	S1	W3-4		tavaszias idő, hő elolvadt
2018.03.11	20,0	7,0	13,50	92	71	SW3-4	SW2	0,6	erős melegedés, tavasz
2018.03.12	20,5	11,0	15,75	95	65	S3	SW3-5		erősen felhős idő, du. napsütés
2018.03.13	17,0	9,0	13,00	92	79	S1	NW3		gomolyfelhők, napos idő
2018.03.14	12,5	6,5	9,50	93	83	NW3	W4	2,5	reggel zápor, du. gomolyfelhő
2018.03.15	13,5	5,0	9,25	95	84	SW2	S3-4	2,2	de. zápor, du. gomolyfelhők
2018.03.16	11,0	7,0	9,00	95	94	NW1	S2-3	10,3	esőzés kezdete
2018.03.17	13,0	5,0	9,00	95	92	S2	NE6-8	29,8	esőzés, éjjel havazás
2018.03.18	1,0	-1,0	0,00	95	93	NE1-2	N2		tavaszias napsütés, hidegfront
2018.03.19	-1,0	-4,5	-2,75	95	90	N1-2	NE3	ny.	mediterrán ciklon, hó
2018.03.20	1,0	-3,0	-1,00	94	81	NW2	NW2-3		erősen felhős idő, némi olvadás
2018.03.21	3,5	-2,0	0,75	95	83	NE2-3	N3		hószállingózás, téli idő
2018.03.22	4,5	-4,0	0,25	91	72	NW1-2	NE3		fagyos reggel, napos télvég
2018.03.23	5,0	-1,0	2,00	89	77	NW2	NE1-2		erősen felhős, csapós szél
2018.03.24	4,0	-2,0	1,00	95	84	E2	S3-4		borongós hideg, szeles idő
2018.03.25	5,0	-2,0	1,50	94	86	SW1	E4		borongós hideg, szeles idő
2018.03.26	6,0	-1,0	2,50	95	82	S2	N1	ny.	borongós hideg, szeles idő
2018.03.27	11,0	-4,0	7,50	96	75	W1-2	NW2-3		felhős, napos, enyhébb idő
2018.03.28	12,0	1,0	6,50	95	74	NW1	S2		változóan felhős tavasz
2018.03.29	11	-4	7,50	95	92	SW2-3	W2	2,1	eső, enyhe idő
2018.03.30	18	6	12,00	96	76	NW2	S3-4	13,7	délről esőzés
2018.03.31	16	10	13,00	95	83	SW2	NW2-7	ny.	felhővonulások, viharos szél

Analysis of meterological data

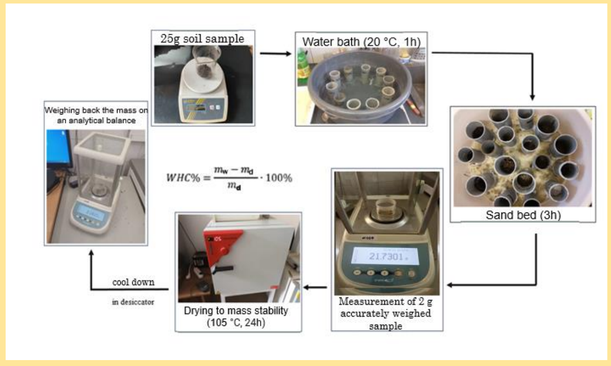


Soil Samples collection

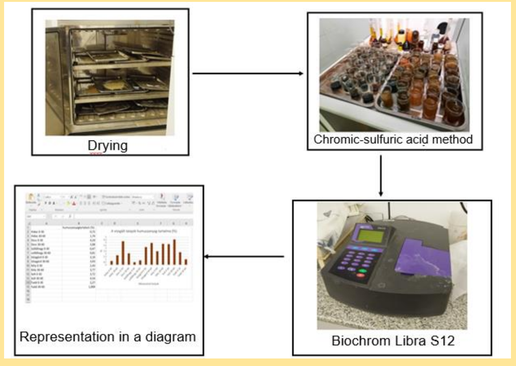


Soil texture analysis

pH measurement



Water holding capacity

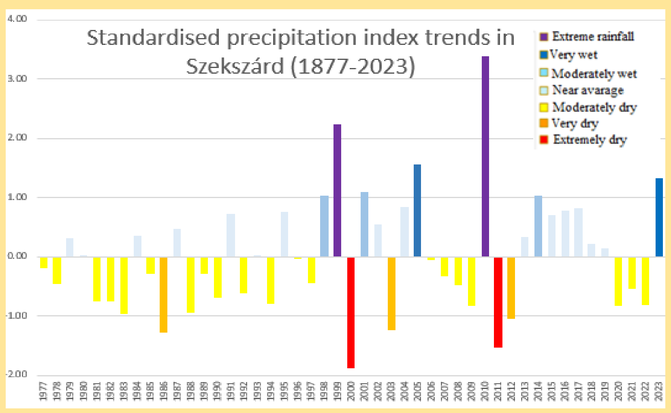


Humus content analysis

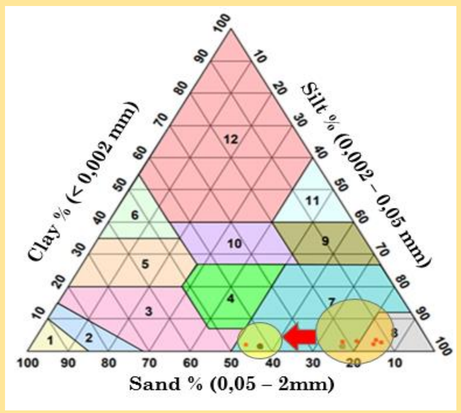
Creation and long-term water retention capacity testing of soil and mixtures in 120 pots

V/V%	S	AL	Z	P	CM	BP	C	Peat	Smix	Lmix
	%	%	%	%	%	%	%	%	%	%
Soil	100	80	80	75	80	80	70	70	55	35
Alginite	-	20	-	-	-	-	-	-	15	5
Zeolite	-	-	20	-	-	-	-	-	15	5
Perlite	-	-	-	25	-	-	-	-	15	10
Cattle manure	-	-	-	-	20	-	-	-	-	15
Beef pellets	-	-	-	-	-	20	-	-	-	-
Compost	-	-	-	-	-	-	30	-	-	15
Peat	-	-	-	-	-	-	-	30	-	15
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

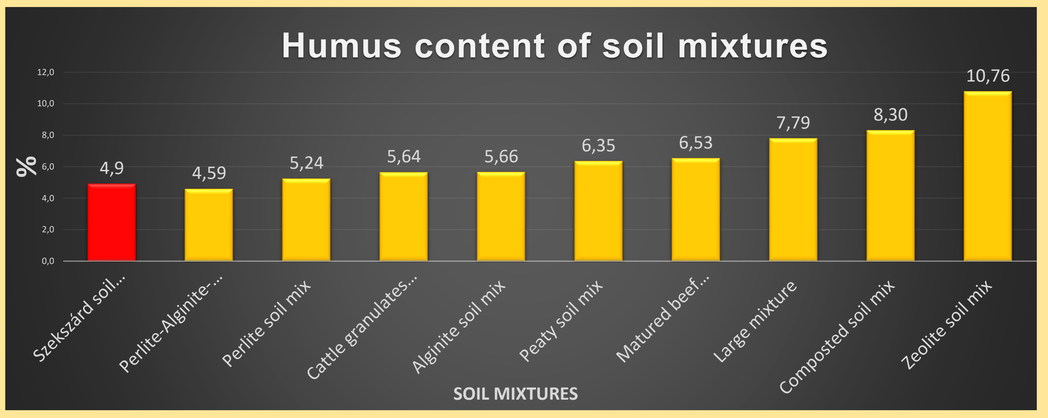
3. Results



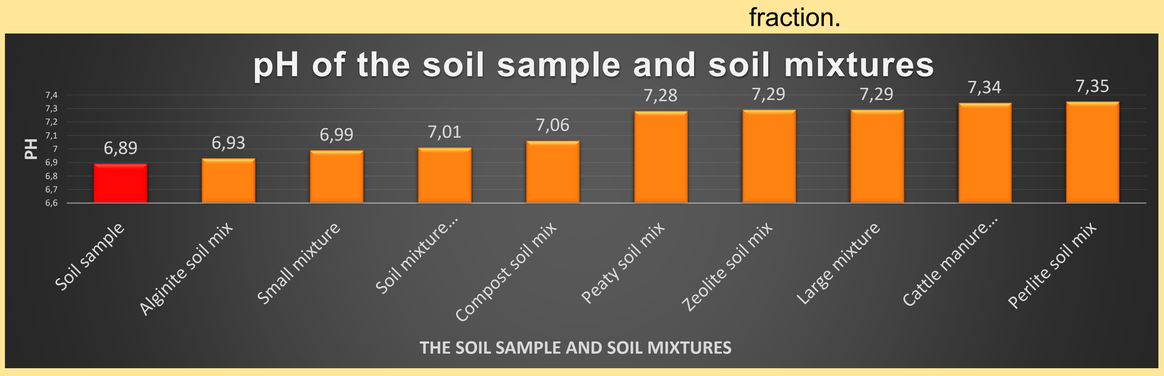
As we move towards the present day, it is becoming increasingly common to see extreme dry years and extreme wet years. But Szekszárd should basically fall into the moderate dry to moderate wet category.



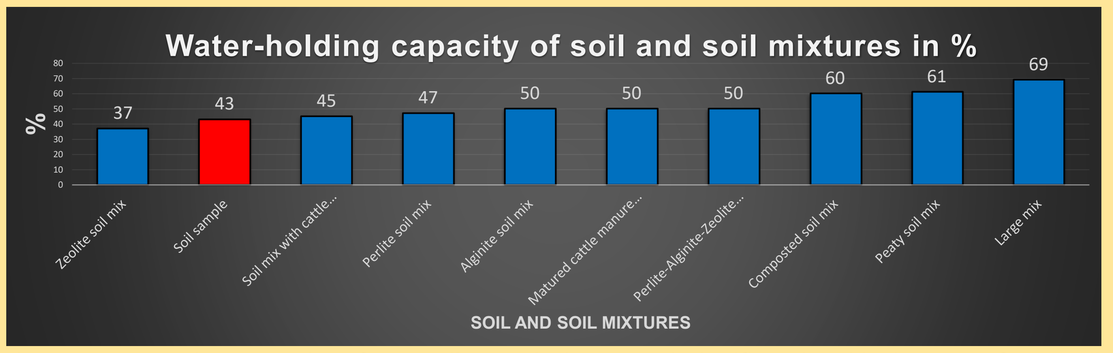
The tested soils can be classified as loam, silt loam and silty loam. The use of soil amendments in the soil mixtures resulted in an increase of the sand fraction.



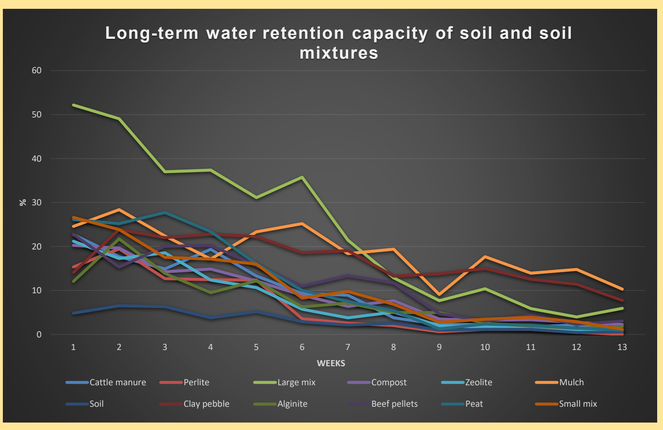
The humus content of our tested soils ranges widely. Overall, it can be concluded that the humus content of the Szekszárd soil samples used for the soil mixtures was slightly increased by inorganic substances and grnot significant for the perlite and alginite soil mixtures, but significant for the zeolitic mixture. eatly increased by organic substances.



The soils tested are generally classified as slightly alkaline. With soil amendments, the mixtures have moved even further in this direction. Plants are basically able to take up nutrients most efficiently in the pH range 6.5-7.



The water retention capacity of our soil sample increased significantly with the use of our soil amendments, with the exception of the zeolite mixture. The most significant increase in water retention was for the large mixture. The organic materials also increased water retention to a greater extent in this case, while the inorganic materials increased it less



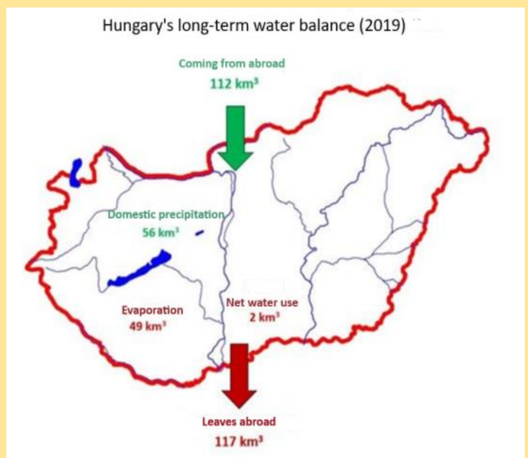
The study showed that the soil sample from Szekszárd (S) had the weakest water retention capacity. It was characterized by water retention below 10% throughout the study period, decreasing to below 5% from week 3-4.At this value, the water retention of all soil mixtures was higher. They ranged from 10-30% in the first 4 weeks and only from week 9 onwards did not show a significant difference. The samples improved with soil cover also gave highly good results. Even after week 7, the soil water content was still above 20%, while the other samples started to show a real decline.

4. Discussion

Many people think that using soil improvers ont the large scale is not feasible but as the map below shows, it can be done without importing. I would like to highlight the Gérce alginite mine where 80% of the world's assets are located. There are also many other soil improvers that can be found in large quantities in our country, such as zeolite, peat or beef manure. Soil covering methods are also easy to implement and can make soil improvement even more productive. Laboratory testing of the soil mixtures has confirmed our previous measurements, and we have been able to demonstrate that their application could retain significant amounts of water in our soils over the long term.

5. Conclusions

Our country receives 112 km³ of water per year from rivers coming from across the border, plus 6 km³ of run-off from within the country. The bigger problem is that we have 117km³ of run-off, which means that we can retain relatively little and use only 1 km³. If we examine our samples, we find an average water retention of 43%. If 20% of the soil is supplemented with better water retaining materials, the water retention capacity increases significantly. We have calculated 20% because this is what is usually recommended when soil amendments are applied. These soil improvers alone have an average water retention of 150%. Overall, we calculated that the water retention capacity of the soil would increase from 43% to 64.4% in this case. Without soil amendments, an area of 1 km² would retain 0.000172 km³ of water, which means that for every 10 000 km² of land, this would be 1.72 km³ of water. If the top 40 cm is amended with one of these materials and the amended value is used, this is 2.56 km³ of water. This means that we can retain 0.86 km³ of water per 10 000 km². Hungary's arable land use is about 55% of the country, or 51166.5 km². On this area we could retain 4.2 km³ more water on average than without soil improving.



6. References

- Z. Pinke, M.K. Kardos, Z. Kern, Z. Kozma, L. Pasztor, T. Acs: Changing patterns of soil water content and relationship with national wheat and maize production in Europe, European Journal of Agro- nomy, 2022
- Olivér Szentes: Drought in Hungary in 2022 and in the past, OMSZ, 2022
- Pál Stefanovits, György Filep György Füleky (1999): Soil Science, Field farmer for rent
- Environmental Engineering Knowledge Repository Series Editor (2011): Dr. Endre Domonkos soil conservation , soil science Editor: Dr. György Füleky Pannon University Institute of Environmental Engineering
- Géza Sipos: How much drinking water does in Hungary? 2011 (https://www.origo.hu)
- László Somlyódi: Water management in Hungary: situation and strategic challenges, Hungarian Academy of Sciences, 2011
- István Kocsis: soil science and agrochemistry, Eger, Eszterházy Károly College, 2012
- János Dömsödi Geological organic and mineral soil improvers, 2023 (https://magyarmezogazdasag.hu/)
- Dr. Imre Kádár : Expert opinion on the agricultural and environmental use of alginite in Gérce Budapest, 2002

Soil Water Retention Soil texture Soil improvers