

## The WormEx I Experiment: Effects of biopores and earthworm holes on soil hydraulic conductivity, sorptivity and macroscopic capillary length.

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### Session SSS6.6

*Preferential flow and mass transfers in heterogeneous soils, porous fractured media and complex geological structures.*



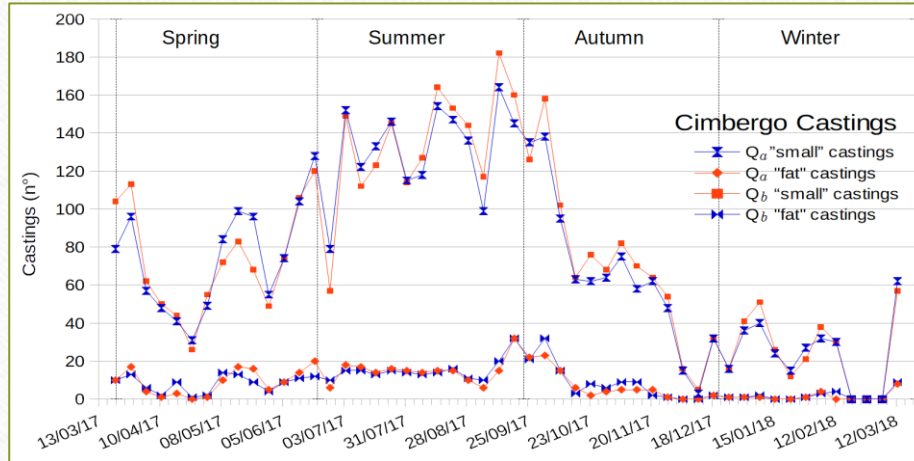
## The WormEx I Experiment



- ❖ Project duration: 2016, March – 2019, December.
- ❖ Objectives: find how earthworms can change Soil hydrological properties and how digging activity is related to soil boundary conditions and atmospheric situation.
- ❖ Methods: Bibliographic research, earthworms activity direct observation, meteorological data collection (temperature, precipitation, soil water content), use of ammendants (Calcium carbonate).
- ❖ Experimental fields: Civate Camuno (BS), Cimbergo (BS) Central Italian Alps.
- ❖ Main instruments: tension infiltrometers (TI) and single ring infiltrometers (Beerkan Estimation of Soil Transfer method).  
Hydraulic conductivity and sorptivity analysis.



## About earthworms



Square	Spring	Summer	Autumn	Winter	Annual
Qa small	64,5	117.0	60.8	21.6	66.9
Qb small	64,2	119.1	64.9	21.6	68.6
Qa fat	9.0	14.7	7.3	1.4	8.3
Qb fat	8.3	15.4	8.8	1.9	8.8
Qa total	73.5	131.7	68.2	23.0	75.1
Qb total	72.5	135.3	73.8	23.5	77.4

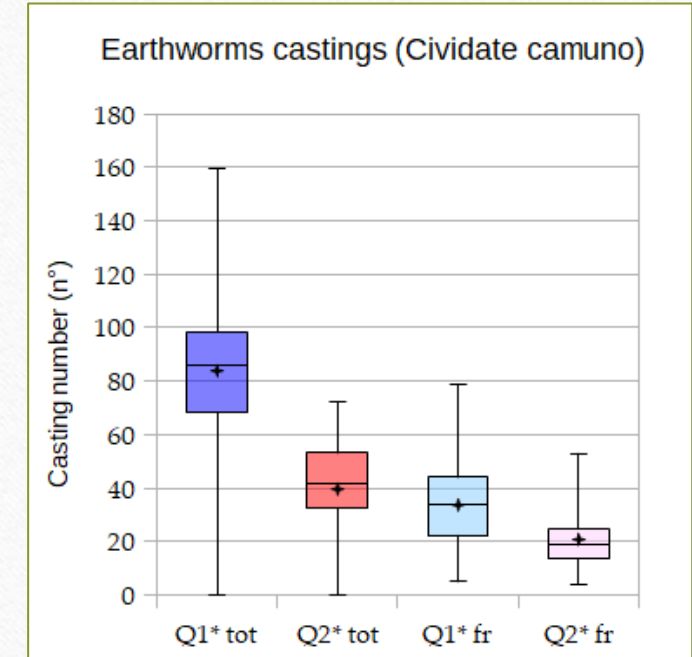
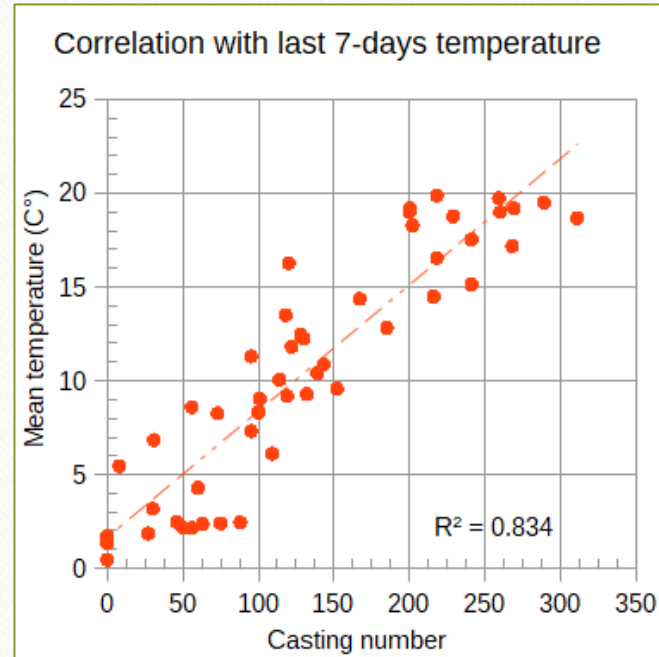
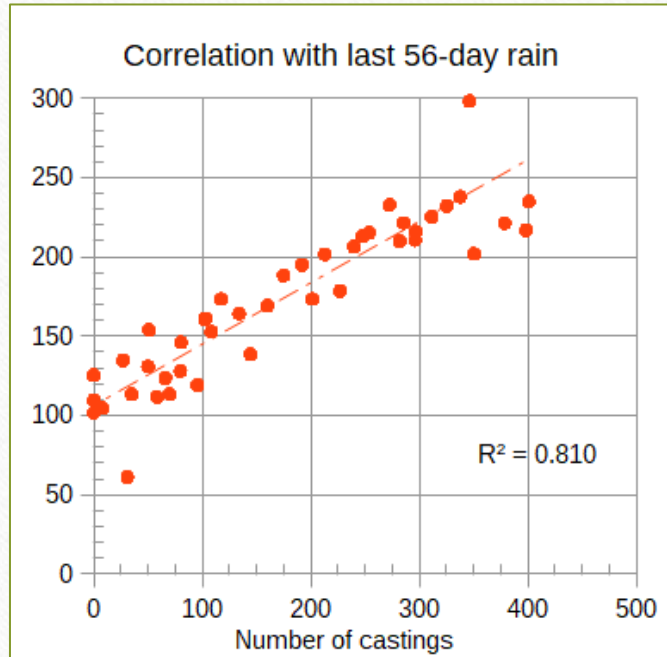
### EARTHWORMS

- ❖ Earthworms are present in almost all types of soils, but they prefer a temperate climate.
- ❖ Earthworms like humid, sand-poor and non-acids soils (basic improvers in fact, e.g. Calcium Trioxycarbonate, increase earthworms activity in a square, and so the macropore number).
- ❖ Earthworms can dig at different depths of soil.
- ❖ Earthworms castings have an important role in preserving soil superficial quality and health.

### LUMBRICUS TERRETRIS

- ❖ Darwin performed many researches on them.
- ❖ Lombricus Terrestris is an anecic digger.
- ❖ Species found in experimental fields do not have a lethargy period, and their activity is strictly related to seasonality, weather and soil conditions.
- ❖ They provide a great contribution in mixing soil, casting on the surface quite 0.5 cm of earth in one year.

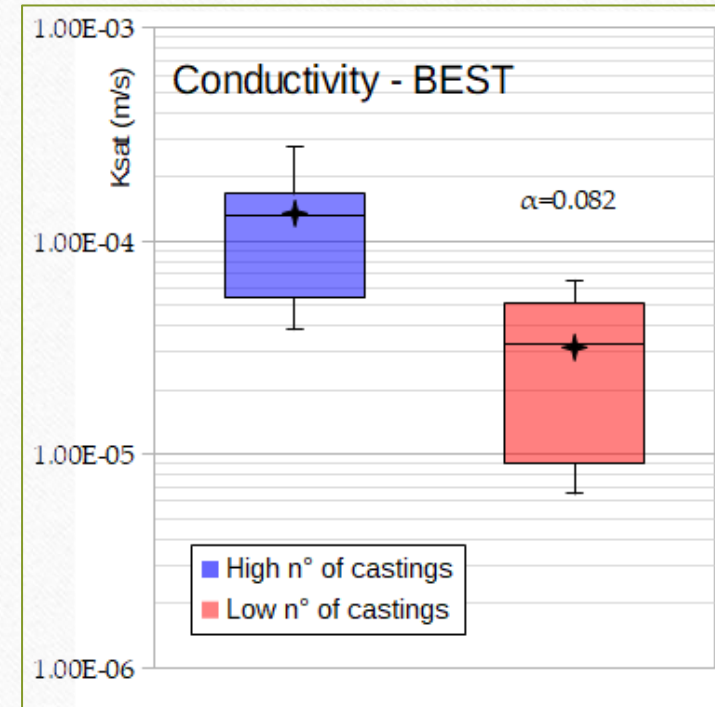
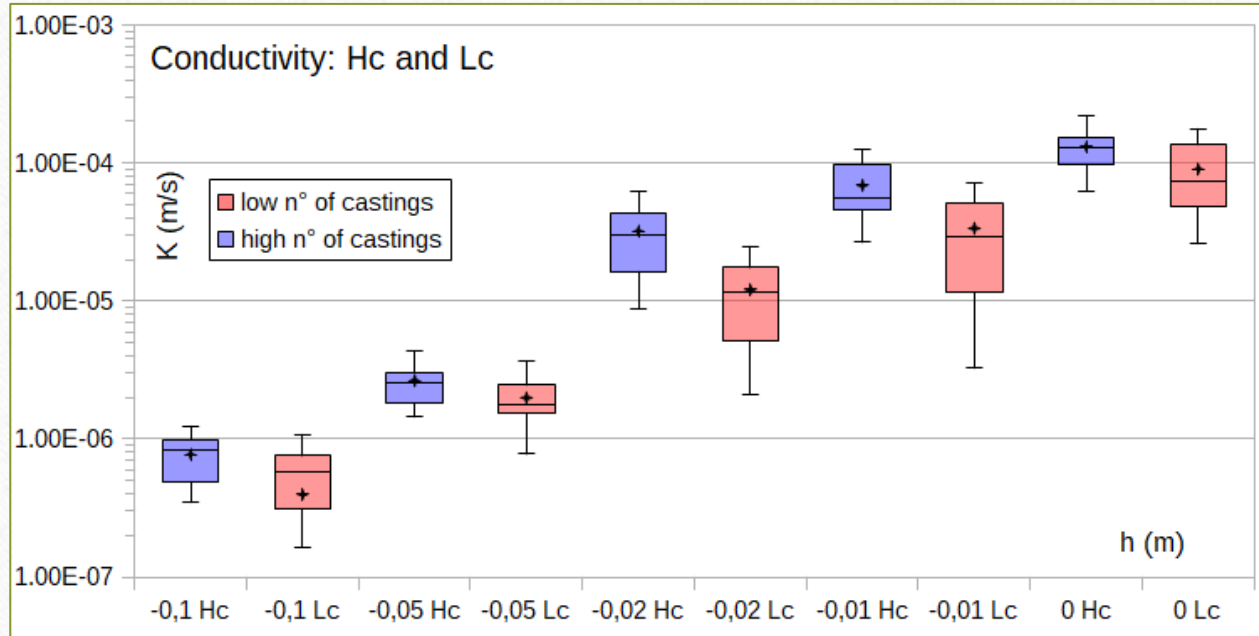
## Activity and external factors



- ❖ Total earthworms castings showed a correlation with precipitation, for long-time cumulated rain (figure 1).
- ❖ Dependence from temperature was more evident, particularly if we consider periods of one week or longer (figure 2).
- ❖ Correlation between earthworms activity and soil water content had its maximum for one day fresh castings and two days average humidity, evaluated along the first two horizons (22 cm).
- ❖ As explained in last graph (figure 3) the square which had the soil improver ( $\text{CaCO}_3$ ) showed a greater (almost double) earthworms activity.

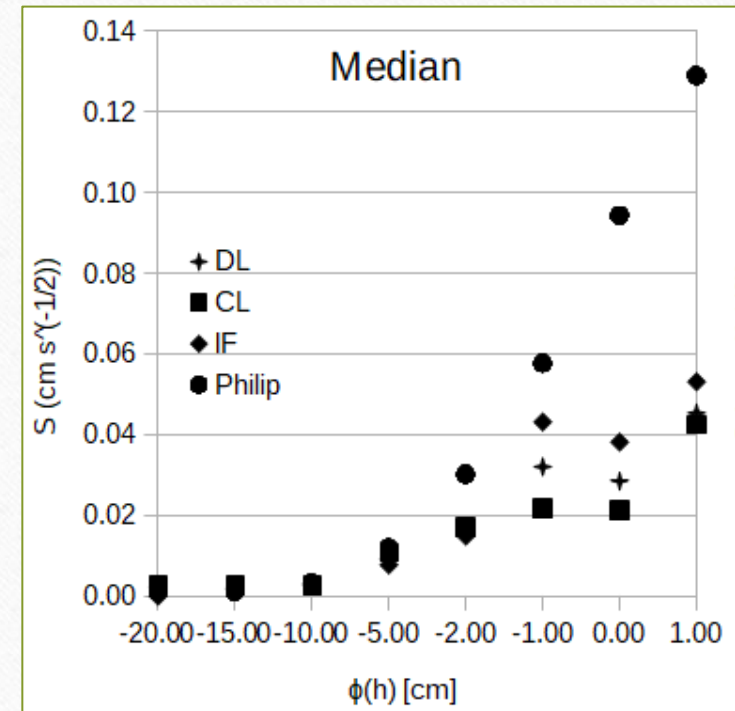
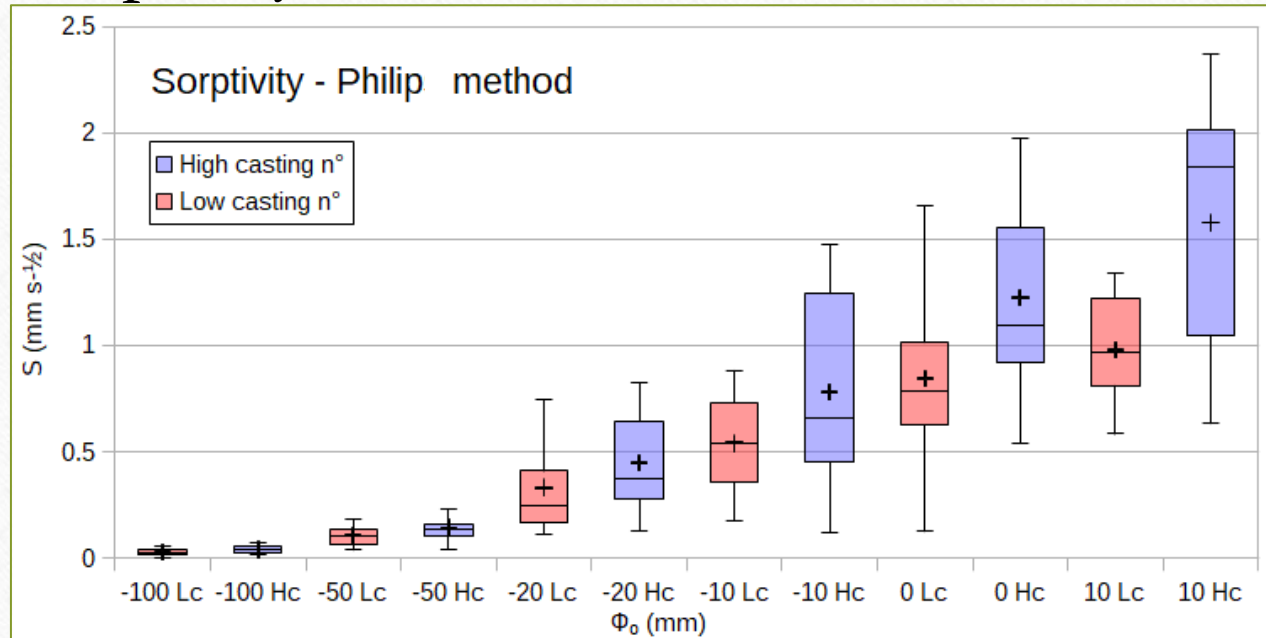


## Hydraulic conductivity



- ❖ Hydraulic conductivity enormously change in both ponding and near-saturation condition. In particular, for saturation, with TI it was found an average increase of 45% and with simplified BEST method was observed an increase of 325%
- ❖ Soil water content changes also biota activity, so more evident results were found in a soil with Optimal conditions (high castings-number and high soil water-content), on average, increase outflow at saturation from 213% to 874%, determined with TI and BEST method respectively.
- ❖ Sorptive number ( $\alpha$ ) needs to be estimated directly in a soil with earthworms activity.

## Sorptivity



- ❖ Four different sorptivity methods were evaluated: Philip method provided more precise and realistic values.
- ❖ Sorptivity significantly changes, in particular near saturation. At ponding conditions its increase was equal to 45% passing from low to high castings, and 114% passing from Optimal to Non-Optimal conditions.
- ❖ Sorptivity can be used to evaluate capillarity forces, and macroporosity at the same way.
- ❖ Finally, like for conductivity, we must consider that field data can greatly change every day, on the same soil, so many tests are needed.



# Thanks for your interest.

For any question feel free to contact us

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