ASTAVIT : A fast, easy and cost-effective new method for soil stability measurement

Julien Wengler, Cottenot Lionel, Saby Nicolas, Frédéric Darboux, Lacoste Marine

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A fast, easy and cost-effective new method for soil stability measurement

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INRAE

Aggregate **ST**ability **A**ssesment using **VI**deo **T**ests

Wengler Julien[1], Cottenot Lionel[1], Saby Nicolas[1], Frédéric Darboux[2], Lacoste Marine[1]*

*corresponding author: marine.lacoste@inrae.fr

[1]Info&Sols, INRAE Centre Val-de-Loire, 2163 Avenue de la pomme de pin, CS 4001 Ardon, 45075 Orléans cedex 2, France

[2]Univ. Grenoble Alpes, CNRS, INRAE, IRD, Grenoble INP, IGE, 38000 Grenoble, France

TAKE HOME MESSAGES

- The ASTAVIT method is a rapid, universal, and straightforward tool for assessing soil aggregate stability.
- **In 30 minutes**, a representative amount of soil aggregates (96 aggregates) can be probed and a **stability index ς∞** can be produced.
- The method is **consistent with the Le Bissonnais** test and effectively distinguishes **tillage practices** and correlates with **soil properties**.
- The method aims to **facilitate and broaden the implementation of soil stability surveys** for (soil science) laboratories.
- The procedure is **sufficiently adaptable** to accommodate other research questions pertaining to stability and disaggregation mechanisms.

BACKGROUND

- Traditional methods like the Le Bissonnais test are complex and labor-intensive
- In 2016, Fajardo et al. [1] developed a procedure to **film soil aggregates disintegrating** in water, **measuring the change in aggregate area over time to calculate a "slaking index".**
- This was later simplified into a **smartphone application** named **SLAKES** (later renamed MOULDER)[2] which was used and tested by [3,4] and in Info&Sols team on RMQS samples.
- Yet fast, and low-cost, **SLAKES had limitations** concerning the correct detection of aggregates, or the capacity to probe enough aggregates to give a representative result.

OBJECTIVES

- Retain the idea of filming the slaking process and measuring the surface area but Improve the SLAKES proof of concept
- Get a robust and reliable method
- Fast: one measurement must suffice
- Can be used by laboratories for scientific studies
- Not for field use (unlike Moulder etc.)

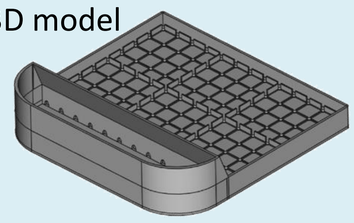
THE PROCESS

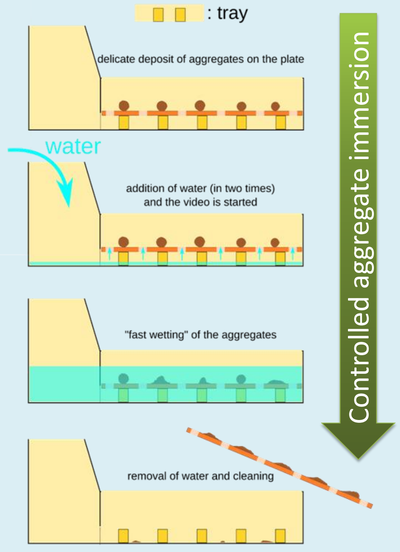
96 aggregates
3-5 mm sieved

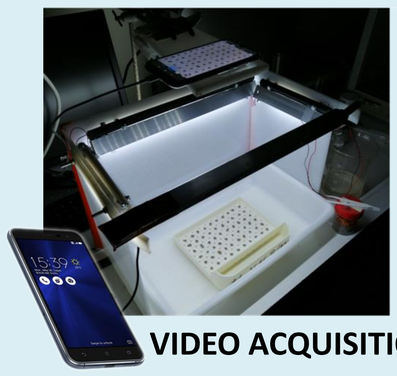
Be careful to my sampling and my fabrication: it is sensitive to the protocol !

IMMERSION DEVICE

3D model



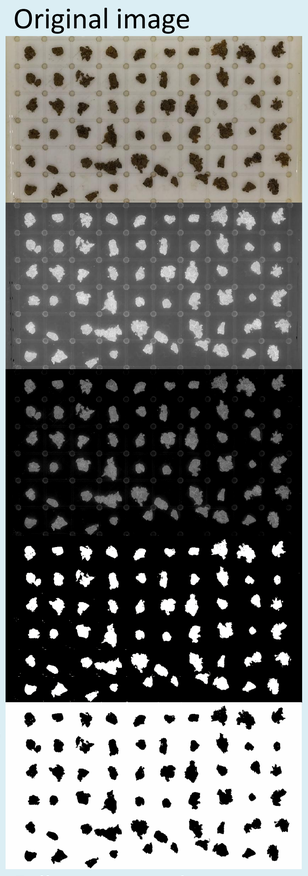




VIDEO ACQUISITION

For the whole process
30 min

Original image



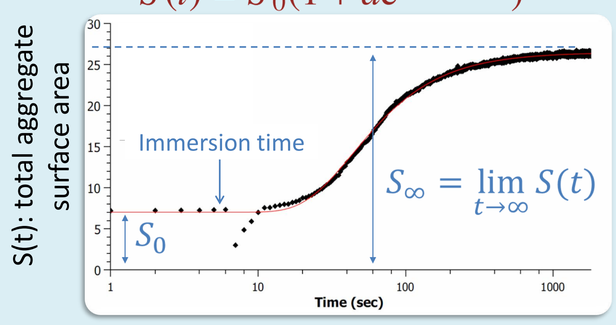
Fully segmented aggregates

IMAGE PROCESSING

ImageJ

ADJUSTMENT with the Gompertz function

$$S(t) = S_0(1 + ae^{-be^{-c\log(t)}})$$



Slaking index $SI_\infty := \frac{S_\infty - S_0}{S_0} = a$

ASTAVIT index $\varsigma_\infty := \log\left(\frac{S_\infty}{S_0}\right) = \log(1 + SI_\infty)$

ς_∞ ↘ = stability ↗

CHARACTERISATION OF ASTAVIT INDEX

Soil sample sources :

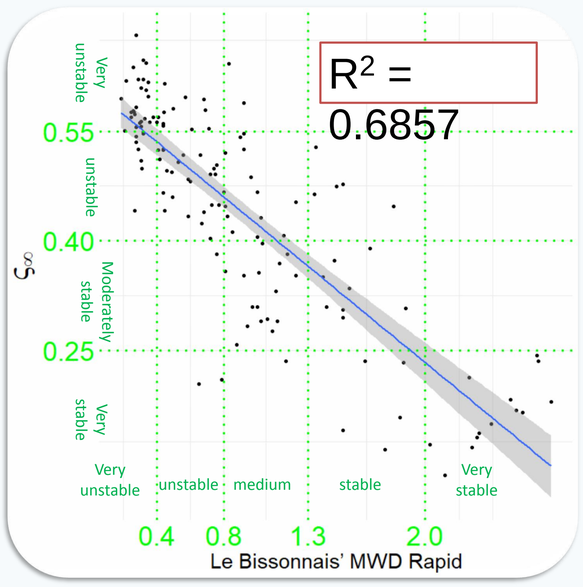
A, B, C: 145 soil samples from the first campaign of the **French Network for Soil Quality Monitoring (RMQS1)** with extensive soil data.

D: Experimental plot of the "Institut Technique des Céréales and Fourrages" at **Boigneville**, France. Clay loam tilled either by conventional tillage (CT) or by direct drilling (DD). Plots established in 1970. Sampling in the 0-15 cm depth.
Experimental plot TS-MO on the **EFELE** platform. Since 2012, cultivation using wheat-maize rotation and white mustard intermediate crops. Tillage is either plowing (P) or simplified tillage (ST), with mineral fertilization. Sampling in 2017 from the 0-15 cm layer.

Le Bissonnais tests were carried out in 2010–2012, SLAKES tests in 2022 and ASTAVIT tests in 2023.

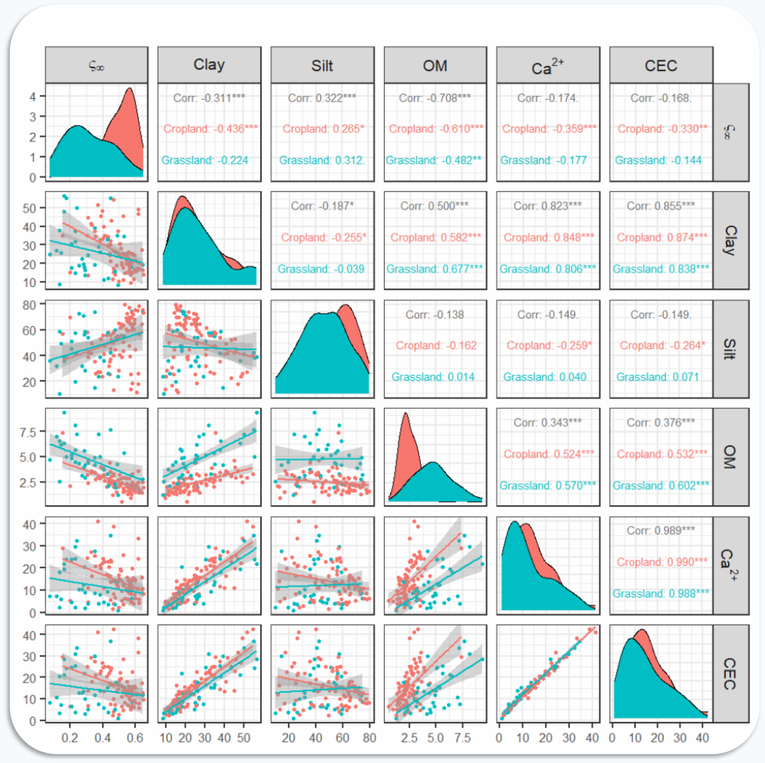
A CONSISTENCY WITH LE BISSONNAIS RAPID WETTING TEST

Index = Mean Weighted Diameter (MWD) in mm
MWD ↗ = stability ↗

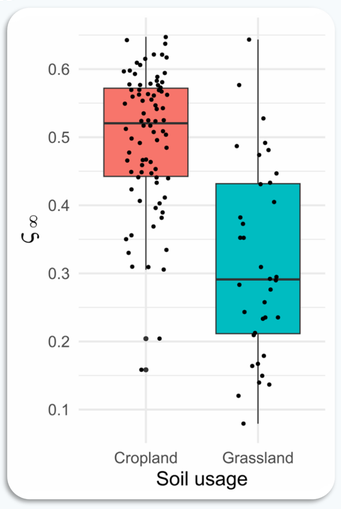


In green: suggestion of stability categories for ς_∞

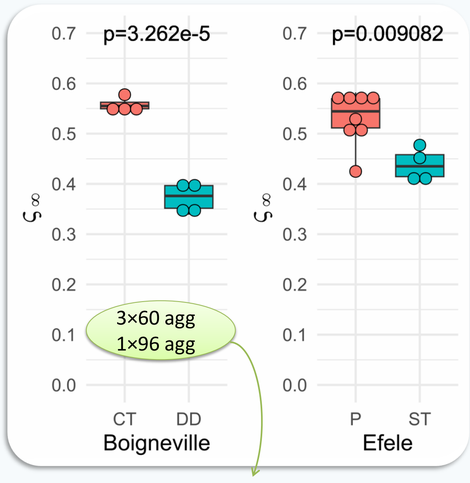
B CORRELATIONS WITH SOIL PROPERTIES



C CORRELATIONS WITH SOIL USAGE



D DISCRIMINATION OF TILLAGE PRACTICES



±1.96σ interval = 5% and 15% of mean value, resp.

MEASUREMENT ACCURACY

Studies of subsample variability showed that very stable or very unstable aggregates need few repetitions, while moderately stable need more repetitions
In any case, 96 aggregates are enough to get at least ±10% accuracy on the result.

1. Fajardo, M., McBratney, Alex.B., Field, D.J., Minasny, B., 2016. Soil slaking assessment using image recognition. Soil and Tillage Research 163, 119–129. https://doi.org/10.1016/j.still.2016.05.018
2. Fajardo, M., McBratney, A., 2023. Moulder: A soil aggregate stability smart-phone app [Mobile application software].
3. Flynn, K.D., Bagnall, D.K., Morgan, C.L.S., 2020. Evaluation of SLAKES, a smartphone application for quantifying aggregate stability, in high-clay soils. Soil Science Society of America Journal 84, 345–353. https://doi.org/10.1002/saj2.20012
4. Jones, E.J., Filippi, P., Wittig, R., Fajardo, M., Pino, V., McBratney, A.B., 2021. Mapping soil slaking index and assessing the impact of management in a mixed agricultural landscape. SOIL 7, 33–46. https://doi.org/10.5194/soil-7-33-2021