Assessing the influence of crop management strategies on the distribution of soil water content by ERT

Marie Chélin[1], Nargish Parvin[1], Marie-Pierre Hiel[1], Aurore Degré[2], Gilles Colinet[2], Bernard Bodson[3], Sarah Garré[1]

[1]Agriculture is life, Université de Liège, Gembloux Agro BioTech, Passage des Déportés 2, B-5030 Gembloux, Belgique
[2]Sciences et technologie de l'environnement / Systèmes Sol-Eau , Université de Liège, Gembloux Agro BioTech, Passage des Déportés, 2, B-5030 Gembloux, Belgique
[3]Unité de Phytotechnie des Régions Tempérées et Ferme Expérimentale, Université de Liège, Gembloux Agro BioTech, Passage des Déportés, 2, B-5030 Gembloux, Belgique

Contact: mchelin@ulg.ac.be, sarah.garre@ulg.ac.be

Context

Current climate models predict both **an increase of precipitation and of the duration of dry periods in summer** in northern Europe (EEA, 2008). These climatic changes are likely to **affect the soil water content (SWC) distribution and dynamics**, and thus the crop yields. Therefore, an **adapted crop management will be necessary.**

SWC dynamics can be determined by various methods, but most of them are destructive, and are applicable only to relatively small soil volumes. **Electrical Resistivity Tomography (ERT**) is amongst those methods that allow measuring the SWC in **large volumes** and **without disturbing** the soil porous media.

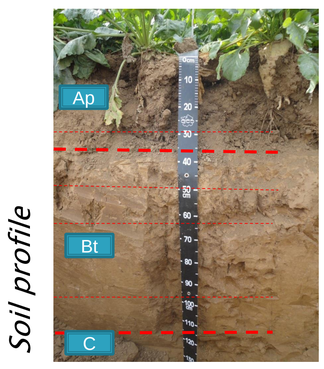
Objectives

This study aims at studying the **influence of different crop management strategies on the dynamics of soil water content.** Particular focus will be put two main processes:

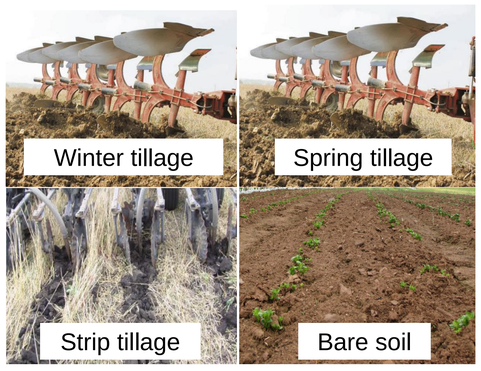
- **rainfall infiltration**
- **root water uptake during dry periods**

Experimental site

The field experiments will be conducted at the Bordia experimental farm (Gembloux, Belgium) in a **loamy region**. **Rainfed, fertilized maize** will be sown in spring 2015 and harvested in autumn 2015. The maize rows will be equally spaced (75cm), and the distance between the plants will be 15cm.



Soil profile



Crop management

Three different kinds of crop management will be applied:

- **Winter tillage**: mixing plant material up to a depth of 25cm at the end of autumn + superficial tillage
- **Spring tillage**: mixing plant material up to a depth of 25cm just before sowing + superficial tillage
- **Strip tillage:** mixing the plant material up to a depth of 15cm along a narrow band in which the crops are sown
- **The effect of plants** on the SWC distribution will be studied on **bare soil** (burned additional surface) on winter tillage

Experimental setup

ERT (surface electrodes and electrode sticks with stainless steel ring electrodes) will be used to determine the **three-dimensional EC_b and SWC distribution and dynamics** *(Fig. a)* for each of the crop management types. EC_b measured by ERT will be calibrated with TDR probes *(Fig. b)*.

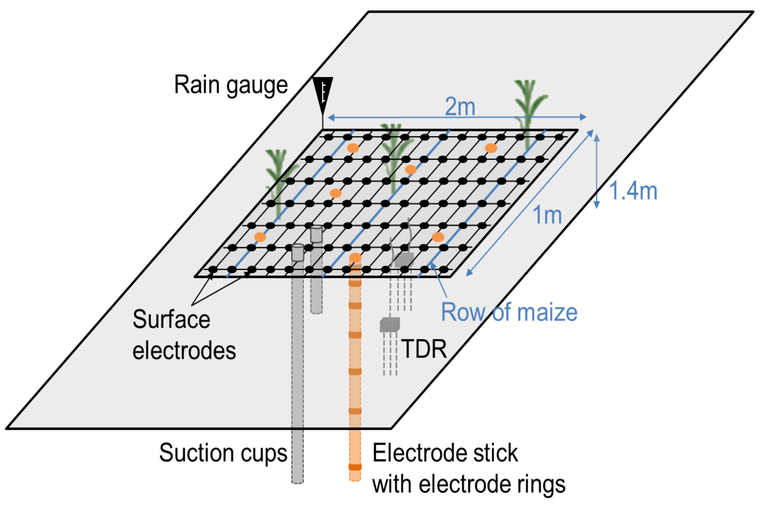


Fig. a: EC_b monitoring

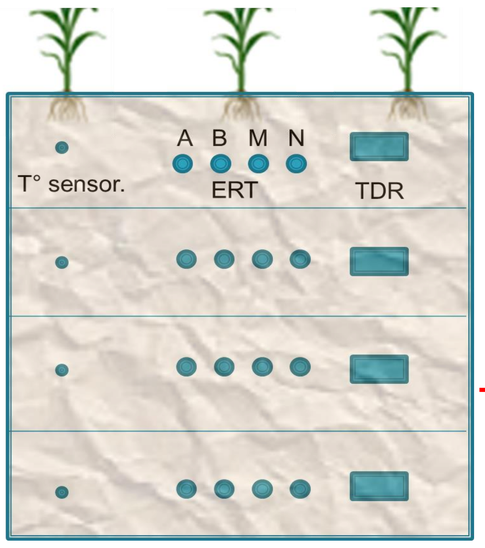
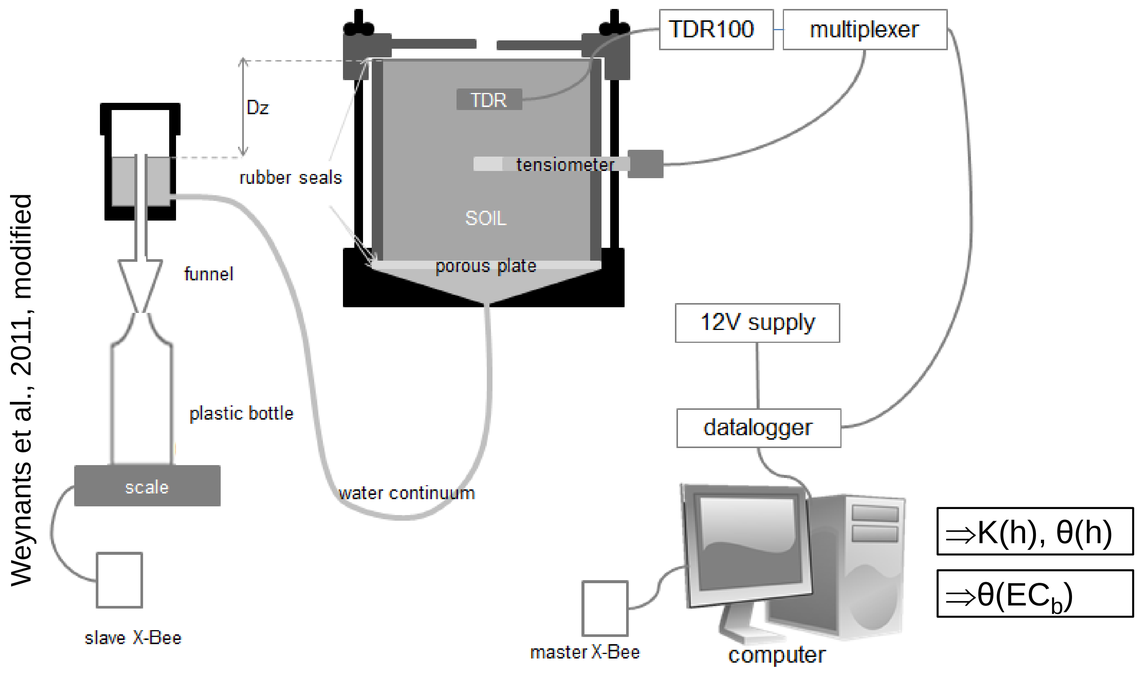


Fig. b: Calibration pit

Hydraulic and pedoelectrical properties

A multistep outflow device (MSO) will be used on 1L samples of undisturbed soil to determine:

- the soil hydraulic functions **K(h) and θ(h)**
- the soil specific bulk pedoelectrical relationships **$\theta(EC_b)$** for different conductivities σ=10, 300 and 700 µS/cm



The obtained soil hydraulic functions will be compared with those from **evaporation** and **pressure plates methods**.

EC_b and SWC monitoring and modelling

The EC_b and SWC assessment includes two main steps:

Step 1: Optimization of survey design

1. Simulation of environmental conditions
2. EC_b model
3. Setup of survey designs and measurement scenarios (MS)
4. Forward modelling + error level determination
5. Inverse modelling
6. Selection of the best MS

Step 2: EC_b and chargeability monitoring

1. Monitoring schedule
2. Inverse modelling
3. Three dimensional, temporal dynamics of SWC

Validation

The obtained SWC model will be validated through:

- the setup of **TDR probes and suction cups** in the experimental zone
- the **water mass balance** estimations, obtained through the meteorological data

$$\Delta SWC = P - D - ETC$$

With: ΔSWC: stock variation of SWC between t and t-1 [mm], P: effective rainfall [mm],
D: drainage [mm], ETC: crop evapotranspiration [mm]

- a study of **the root distribution** (root length density, presence/absence) at several steps of plant development

References

European Environmental Agency (2008) Impacts of Europe's changing climate – 2008 indicator-based assessment. Joint European Environmental Agency (EEA)-Joint Research Council (JRC)-World Health Organization report. EEA Report No 4/2008; JRC Reference Report No. JRC47756 (EEA, Copenhagen, Denmark).

Weynants, M.: Linking soil hydraulic properties to structure indicators : experiments and modelling, PhD thesis, Earth and Life Institute – Environmental Sciences, Université catholique de Louvain, Louvain-la-Neuve (Belgium). available at: http://dial.academielouvain.be/vital/access/manager/Repository/boreal:75972?site name=UCL, 144 pp., 2011.