# Comparing soil functions for agricultural soils under bioenergy plants using a combined isotope-based observation and modelling approach

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## Research Areas Lignocellulose / Biogas – Interconnected Project

## Introduction

Increase of bioenergy will result in changes in land use and may generate new chances and risks. We developed a new, rapid measurement approach to investigate the influence of energy plants on the water cycle. The environmental assessment is focusing on water use and water quality, percolation, risk of erosion and nutrient export from the different energy plants. A database for Baden-Württemberg (BW) to be used by the energy sector and for water management for a targeted use of energy plants is in development. It can be used to propose new land use planning to find the optimum between water protection and bioenergy use.

## Methods and approach

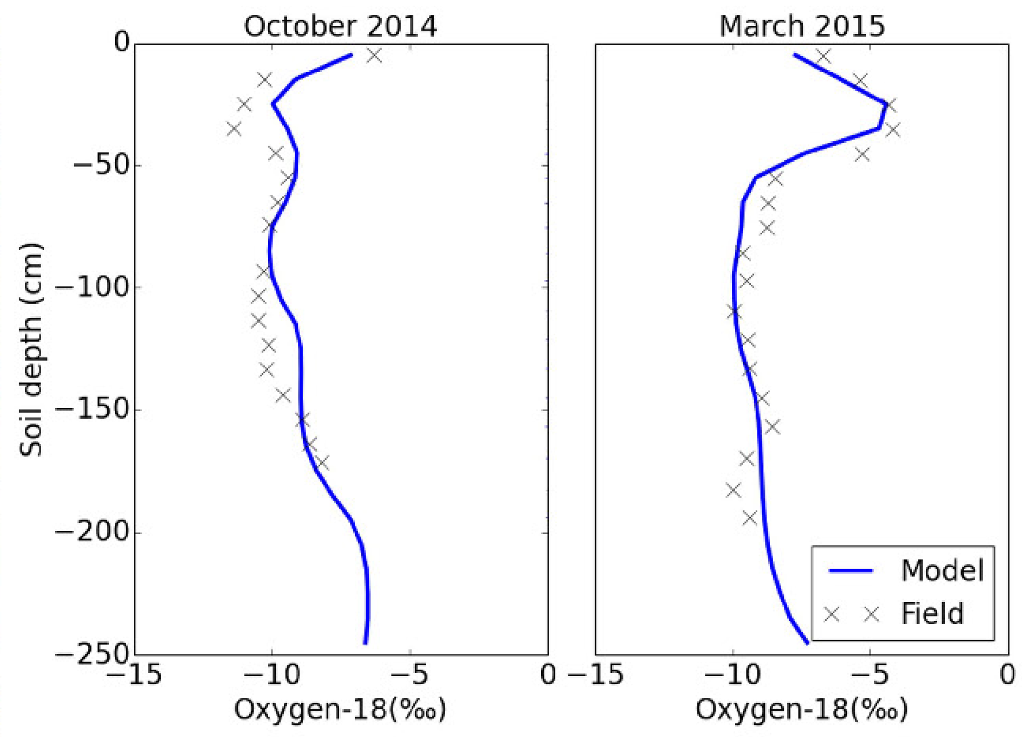
**Field Campaign**
- 11 Sites and 89 Plots in BW
- 70 Energy Plant Plots
- 11 Infiltration Experiments

**Lab Analytics**
- 1150 Soil Samples
- $N\text{-}NO_3$; $\delta^{18}O$ and $\delta^{2}H$

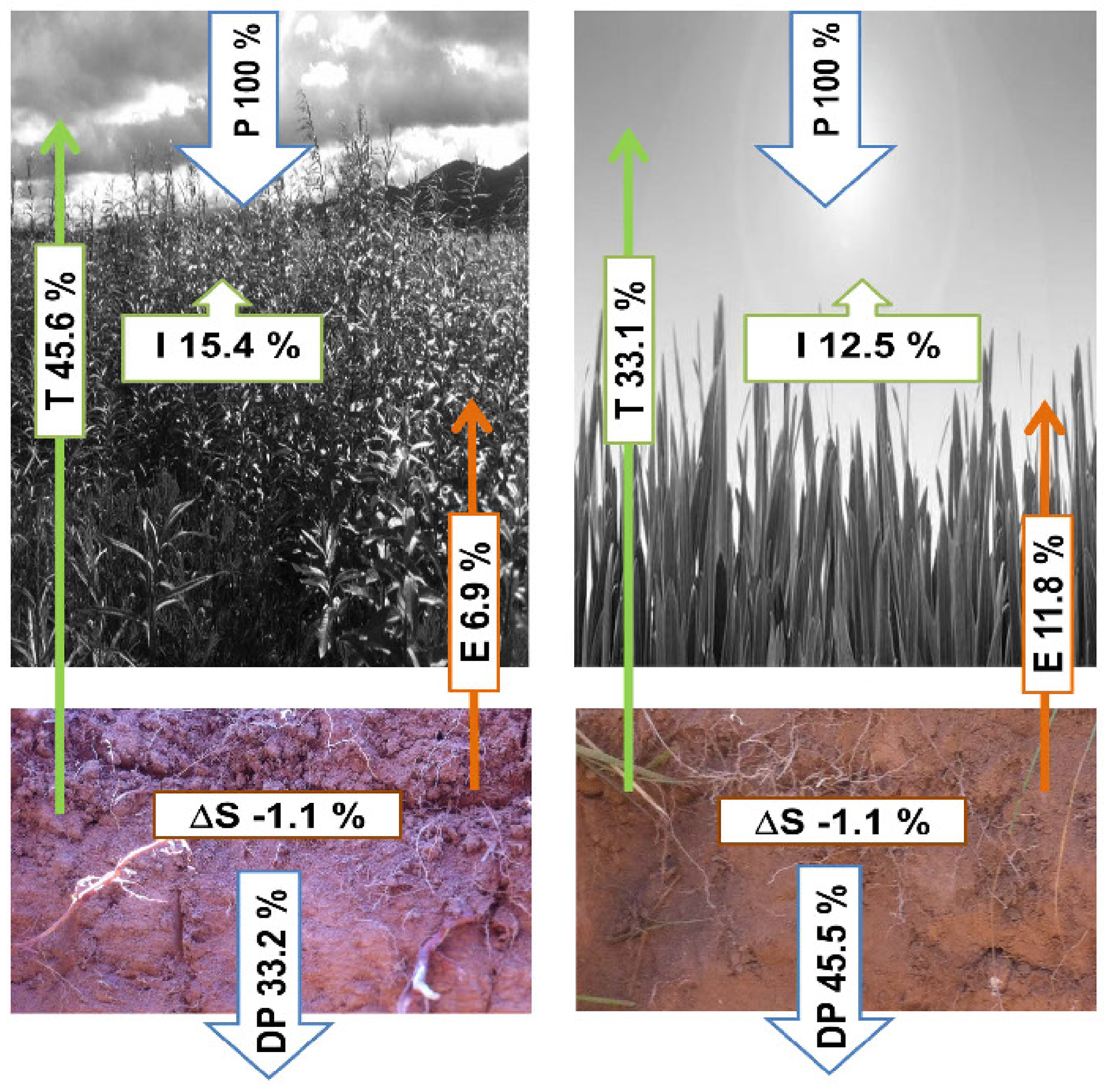
**Models**
- Data Regionalization
- Soil Model Development
- Validation and Prediction

**Results**
- Deep Percolation
- Transit Times
- Nitrate Resilience
- Water + Mass Balances

*Soil core*

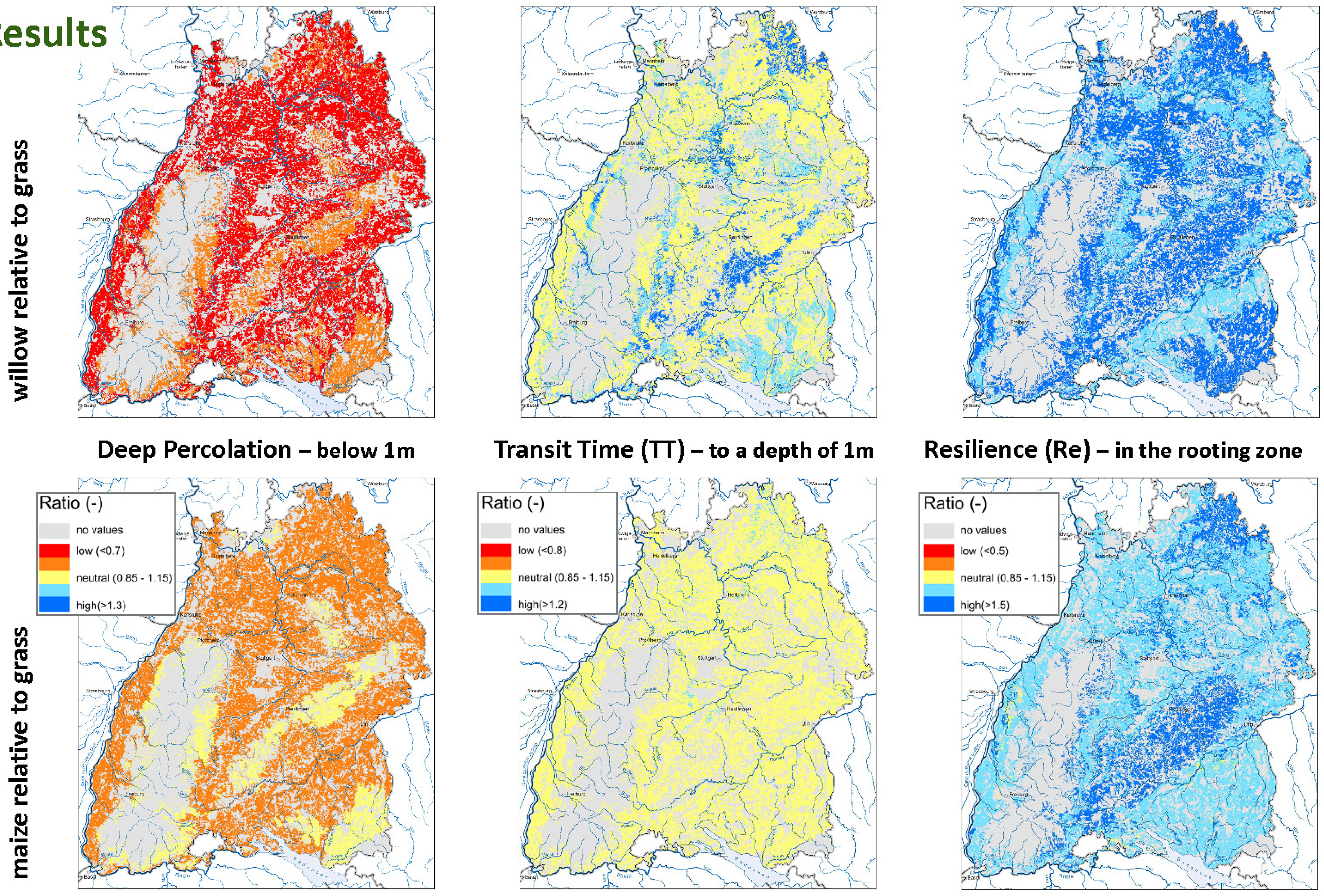



*Example for model validation: field data and modelled data after and before vegetation period of one location near Karlsruhe, land use: willow.*




*Simulated water balance with measured precipitation (P) at a willow side on the left and a grass side on the right in Freiburg. The simulation period starts at 01.01.2010 and ends at 31.03.2017. Components of the water cycle are given in percent of P, which is 6258 mm in total. T stands for Transpiration, I for Interzeption, E for Evaporation, Δ S for change in soil storage and DP for Deep Percolation.*

## Results




*Database (maps) created by Soil Model 'Soil Water Isotope Simulator' (SWIS): combination of 9 representative climate stations (measured data) + 17 soil textures + 3 land use types i.e. Willow, Maize and Grass (459 x 6 combinations).*
*Combinations are regionalized according to soil textures (BK50) and climatic water balance (WABOA). Modelling period: 2010-2016*
*Ratios for each of the three parameters are given for maize and willow relative to grass as reference. Yellow (neutral): comparable with grass, red (low) and blue (high) colors: medium to large deviations compared to grass.*

→ **Model** validation is reliable, simulated isotope profiles are in good agreement with observations in the field.

→ Multiple years of **water** and **mass balances**.

→ **Percolation** is strongly influenced by land use and climate.

→ **Transit Time** is influenced by a combination of soil type, climate and land use, but the effect of soil type is very strong.

→ **Resilience** defined for the non vegetation period is strongly influenced by soil type.

→ **High variability** of transit times and resilience are due to high variability of the temporal distribution of precipitation.

## Conclusion

- Assessment method of the influence of **energy crops** on water cycle is established.
- Multiple years of site **water balances** are gained without an expensive and maintenance intensive measurement system.
- Data can be used for **bioenergy land use planning** and **water protection**.
- **True pressure** on a system is always a combination of theoretical resilience and true input (e.g. fertilization, soil compaction).

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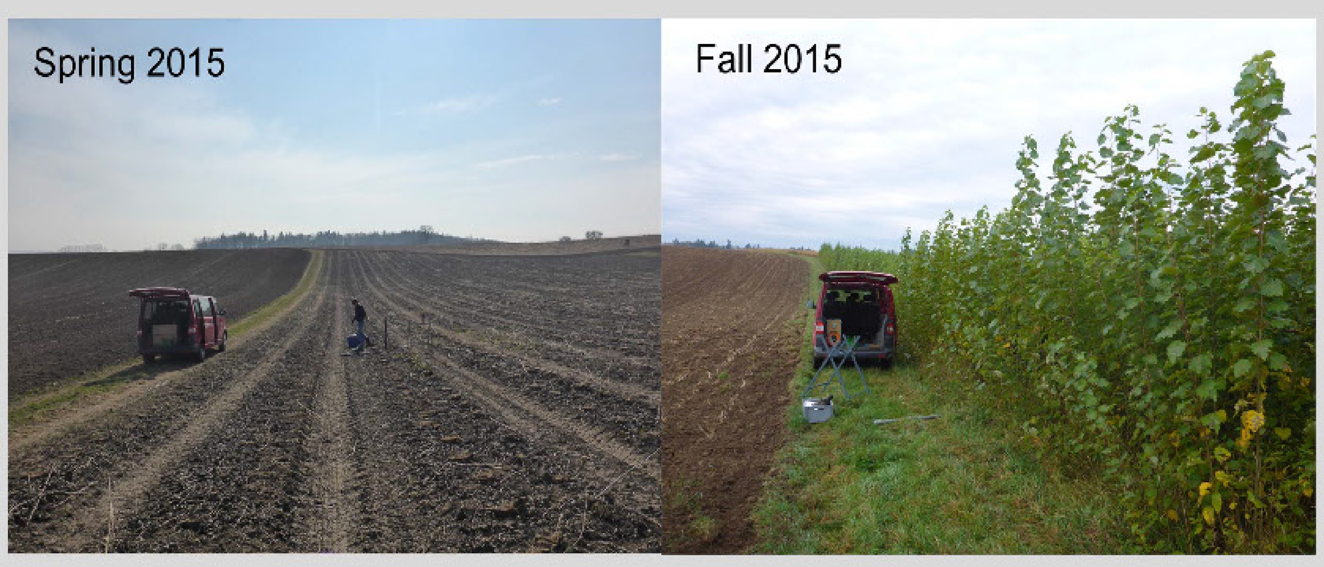


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