Modeling regional irrigation demand

2023 Water-Earth Systems PhD School Conference

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Schweizerische Eidgenossenschaft
Confédération suisse
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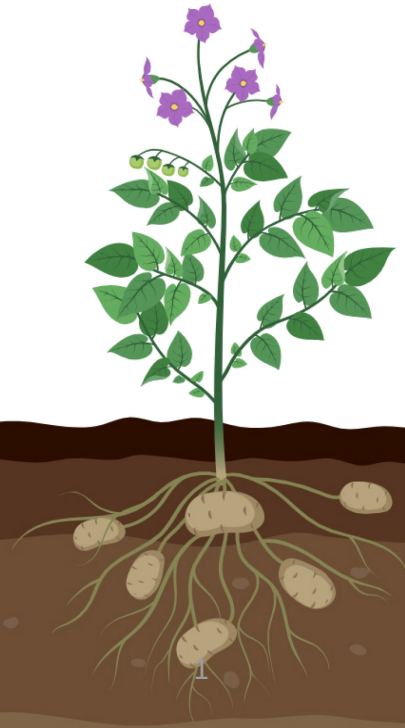
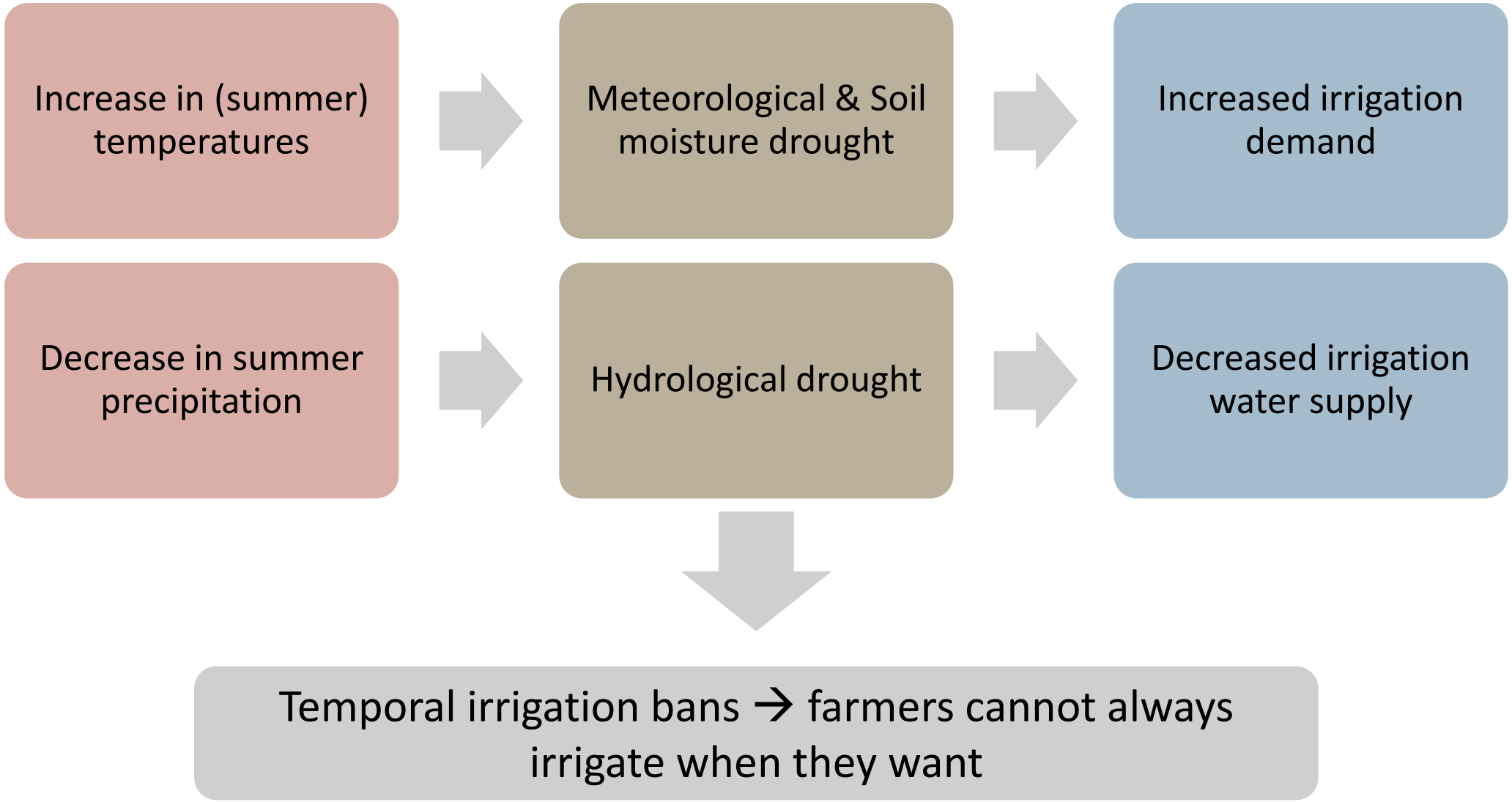
AGROSCOPE

UNIVERSITÄT BERN
OESCHGER CENTRE
CLIMATE CHANGE RESEARCH



Context


Increase in (summer) temperatures
Meteorological & Soil moisture drought
Increased irrigation demand
Decrease in summer precipitation
Hydrological drought
Decreased irrigation water supply
Temporal irrigation bans → farmers cannot always irrigate when they want

Avec la sécheresse, les interdictions d'arrosage sont de retour

Nyon et quelques communes du district de Morges interdisent le gaspillage du précieux liquide. Les sources se tarissent rapidement.

TROCKENHEIT

Erste Bewässerungsverbote in Aargauer Gemeinden: «Es geht nicht mehr anders»

Auf den Aufruf zum Wassersparen folgt das Bewässerungsverbot.

Hitze und Trockenheit

Tiefe Wasserstände, extreme Wärme: Wie die Behörden jetzt handeln

Aktualisiert am Mittwoch, 20.07.2022, 10:35 Uhr

Schweizer Bauer

Politik & Wirtschaft | Markt & Preise | Regionen | Tiere | Pflanzen | Landtech

Tessin: Wasser wird knapp

sda | 17.07.2022 16:39

Trockenheit zwingt Schweizer Landwirtschaft zum Umdenken

Startseite > News > Tagesschau > UT 14.07.2023 · 3 Min

Die Landwirtschaft braucht in den heissen Sommern viel Wasser, gleichzeitig gibt es immer mehr Wasserentnahmeverbote wegen Trockenheit. Nun braucht es für eine sparsame Bewässerung neue Ideen.

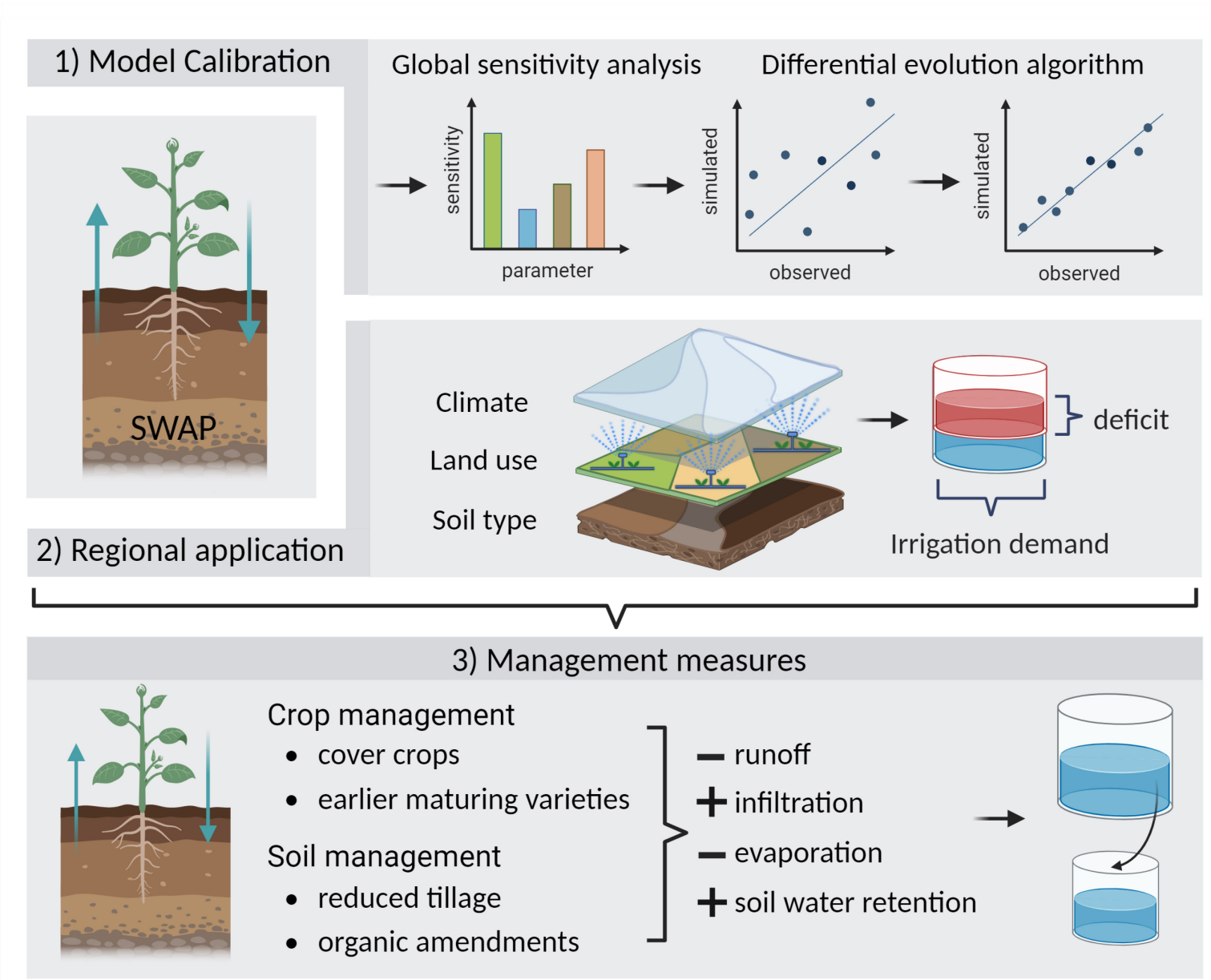
Objectives

Temporal irrigation bans

Lack of data on demand

- How high is the regional irrigation demand?
- What are the impact of irrigation bans?
- To what extent can crop & soil management help?

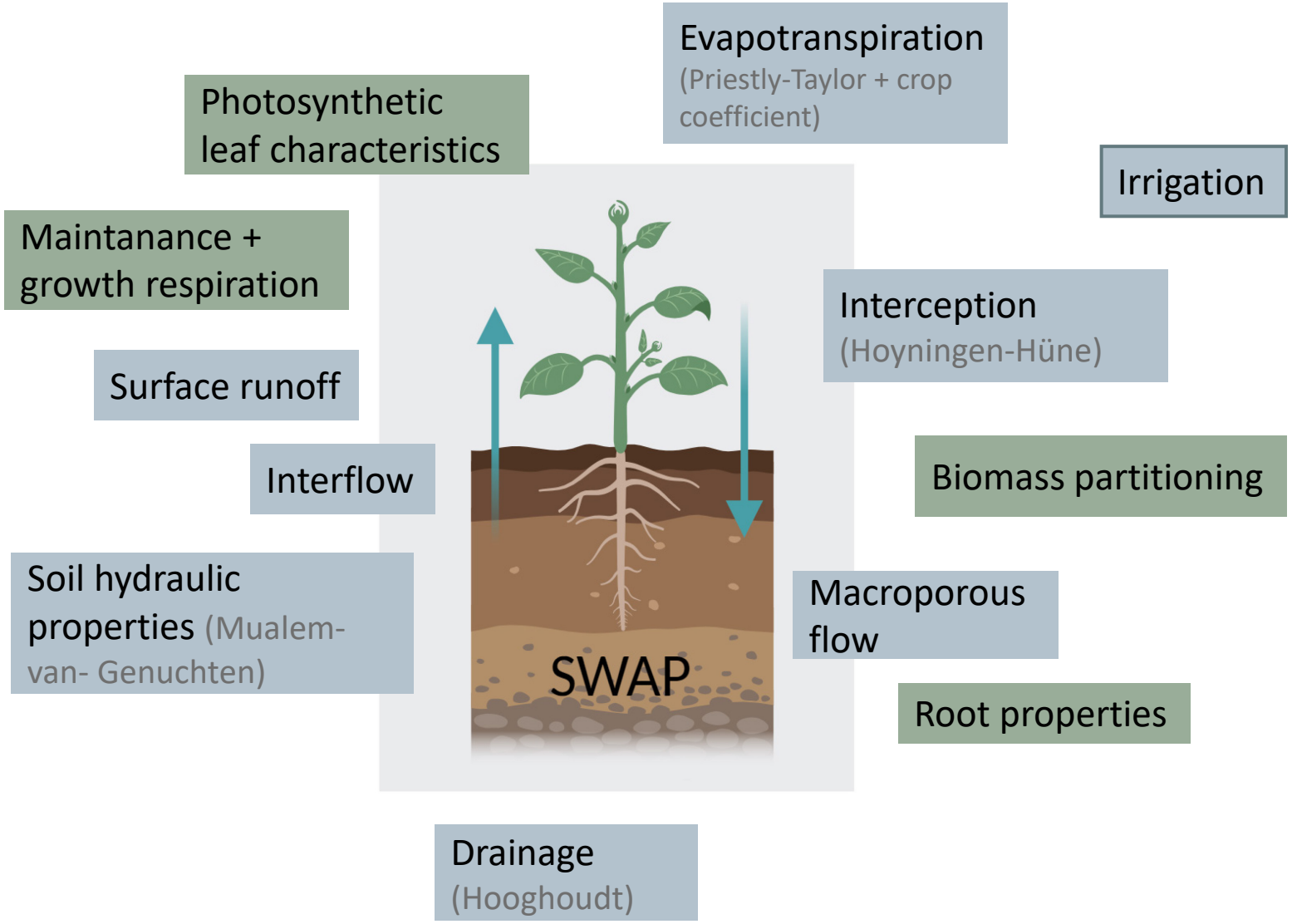
Data and Methods



Data and Methods

SWAP

- Field scale model
- Simulates heat, solute & water flow
- Physically based
- 1-d (vertically)
- Crop modul (WOFOST)

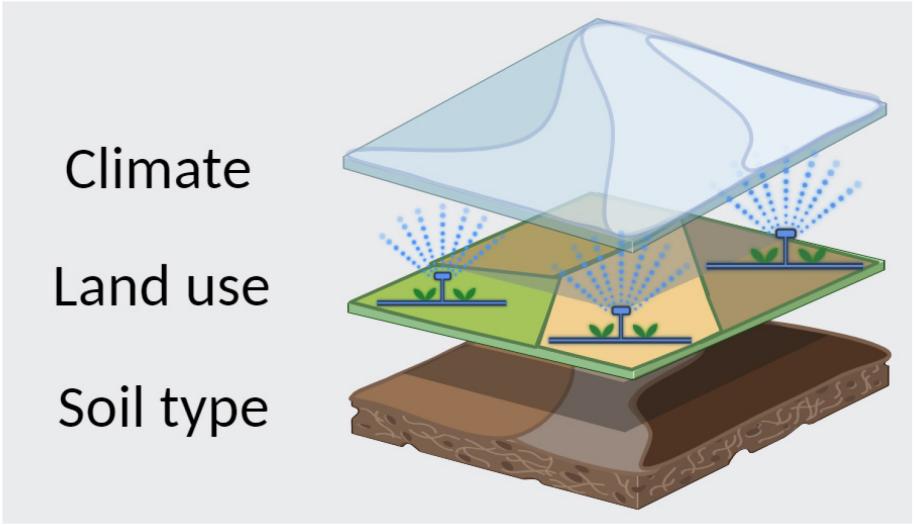


Data and Methods

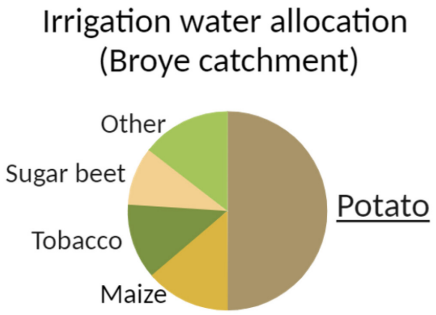
Climate = gridded data, 1km and daily resolution (MeteoSwiss)

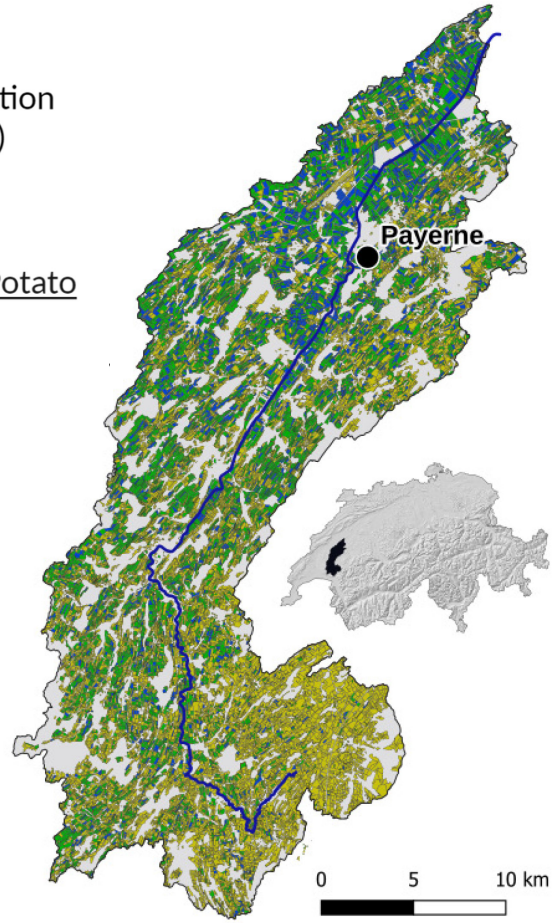
Land use = field-scale shapefile on yearly landuse (AGIS-BLW)

Soil type = gridded soil maps, 30m resolution (KOBO)

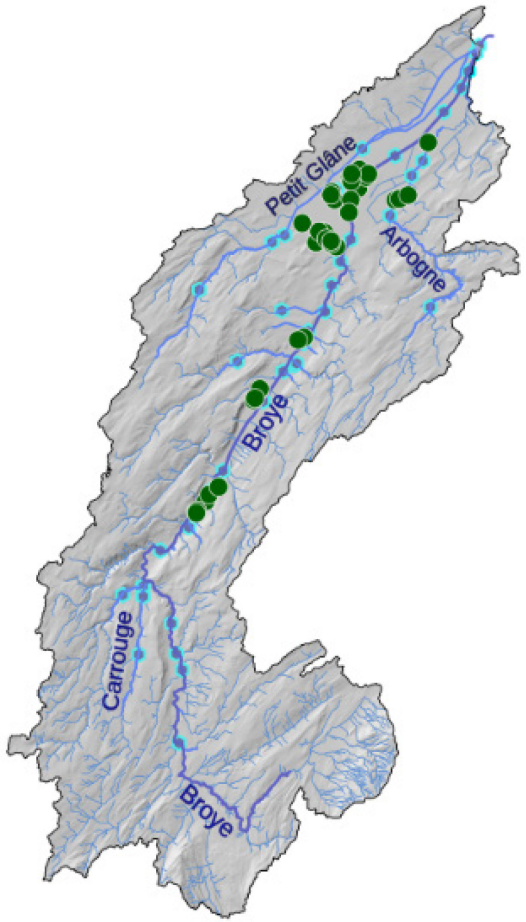


Study area – Broye catchment

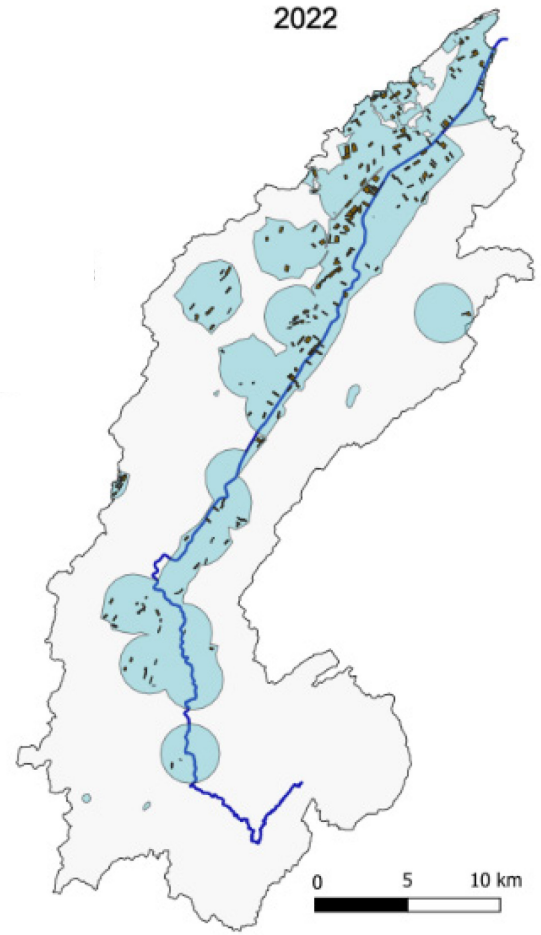




irrigated crops
other arable crops
meadows



water withdrawal points
reference data points
(irrigated potato fields)



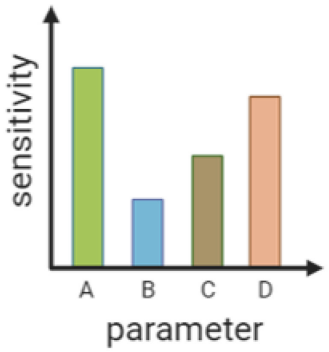
potentially irrigated areas
potato fields

Model Calibration

Global Sensitivity Analysis

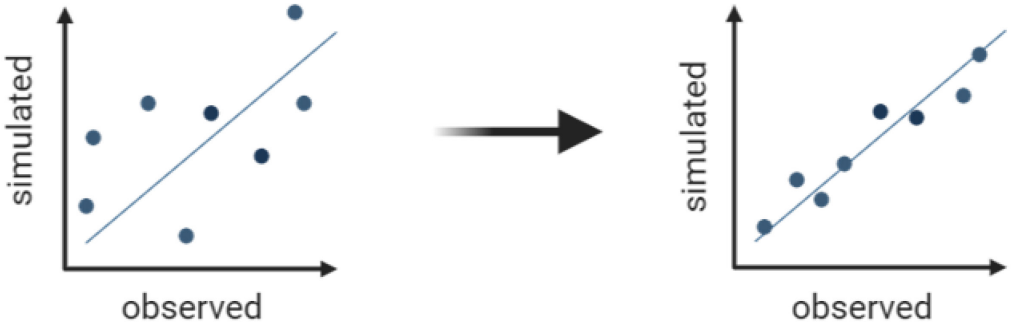
Latin hypercube sampling & Calculation of Sobol Indices

- parameter A
- parameter B
- parameter C
- parameter D
- ...



Parameter Optimization

Differential evolution algorithm (genetic algorithm).
Objective function = maximize fit to seasonal irrigation amounts and crop yield



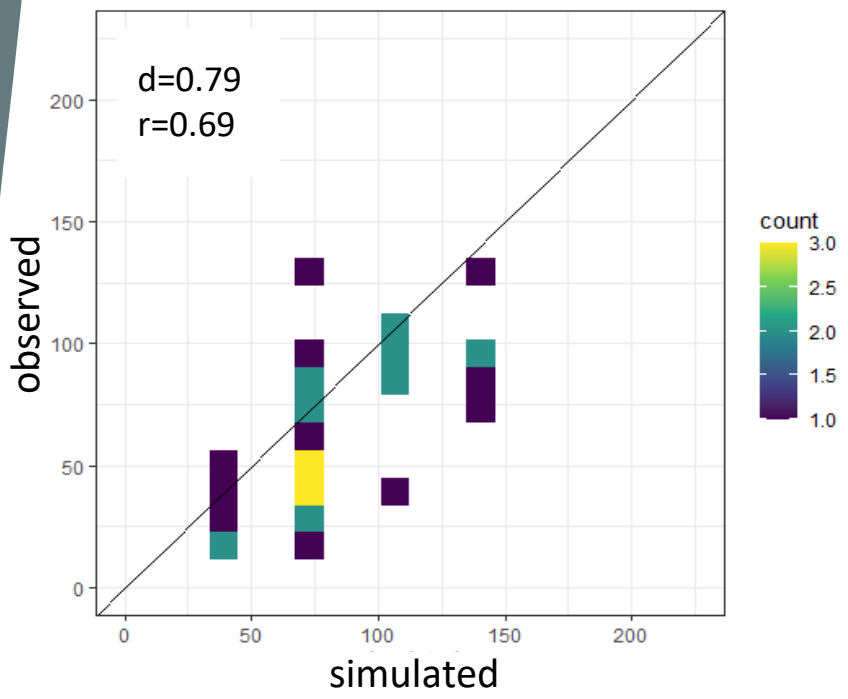
- 10 parameters optimized (regarding photosythensis, phenology, biomass allocation and root architecture)

Fit to reference data from HAFL

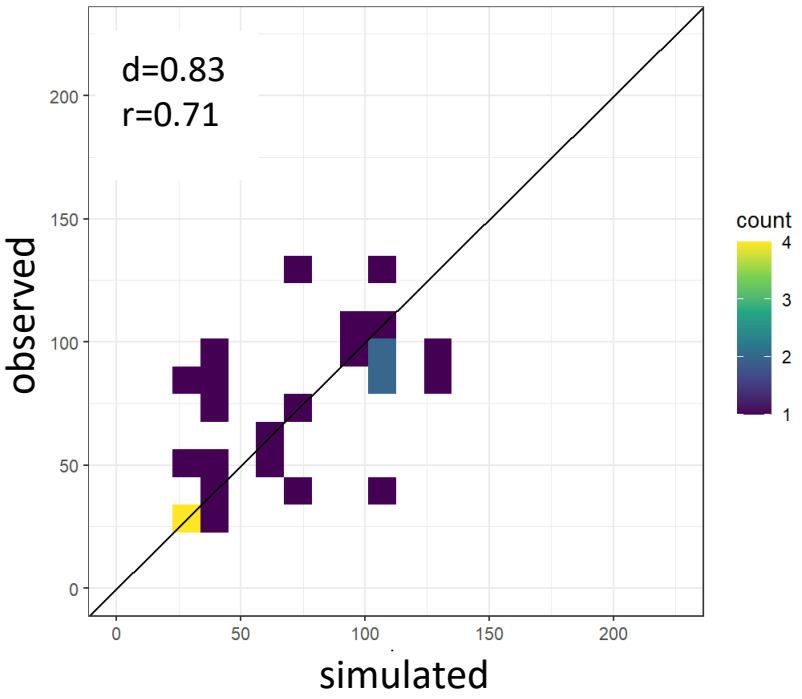
- Irrigation amount

Berner Fachhochschule
Hochschule für Agrar-, Forst- und Lebensmittelwissenschaften HAFL

Default parameterization



Optimized parameterization



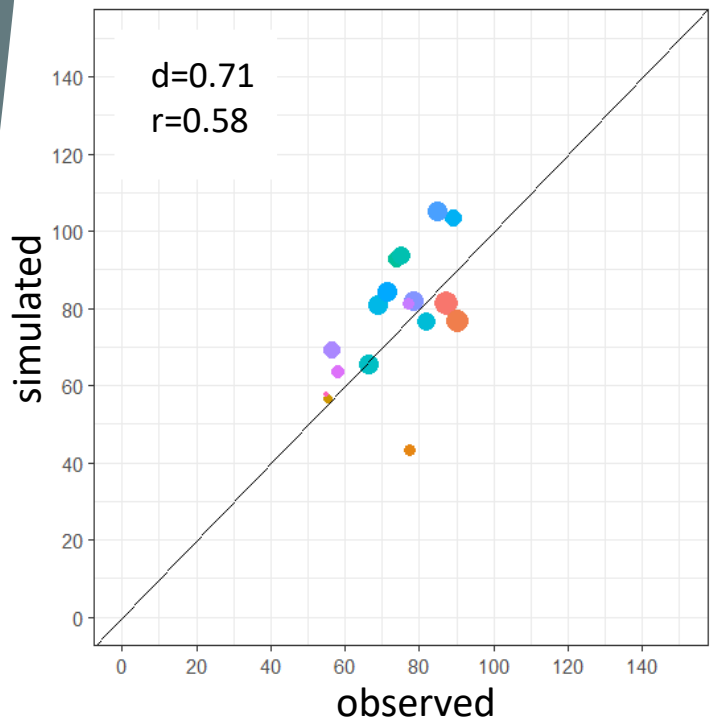
Reference data =

Irrigation timing and amounts for irrigated potato fields within the Broye catchment from 2018-2021 + meta data on site conditions

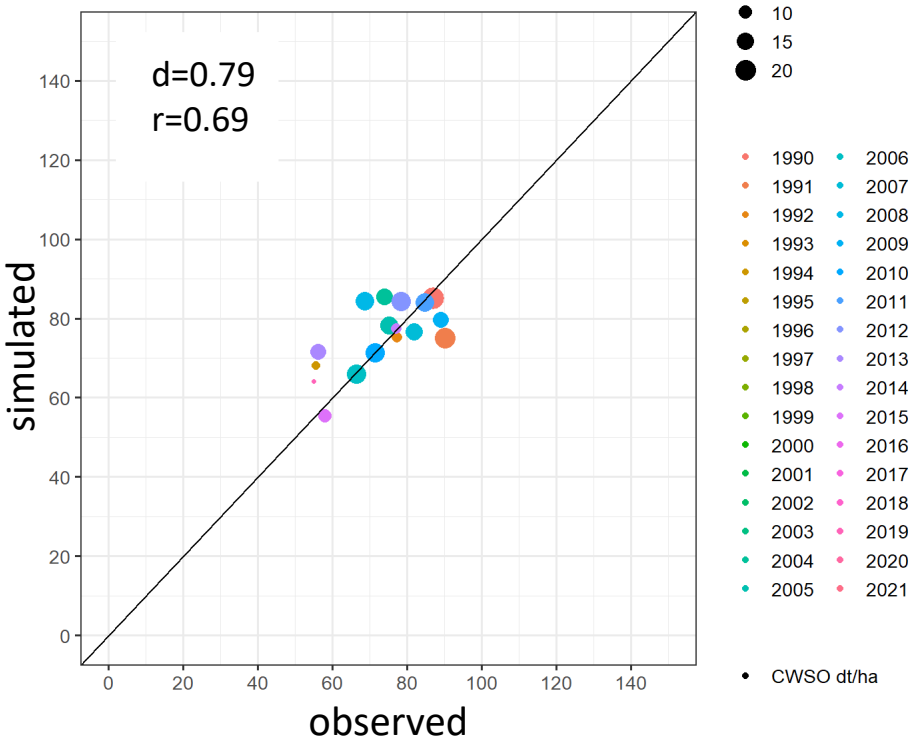
Fit to reference data from Agroscope

- Yield

Default parameterization



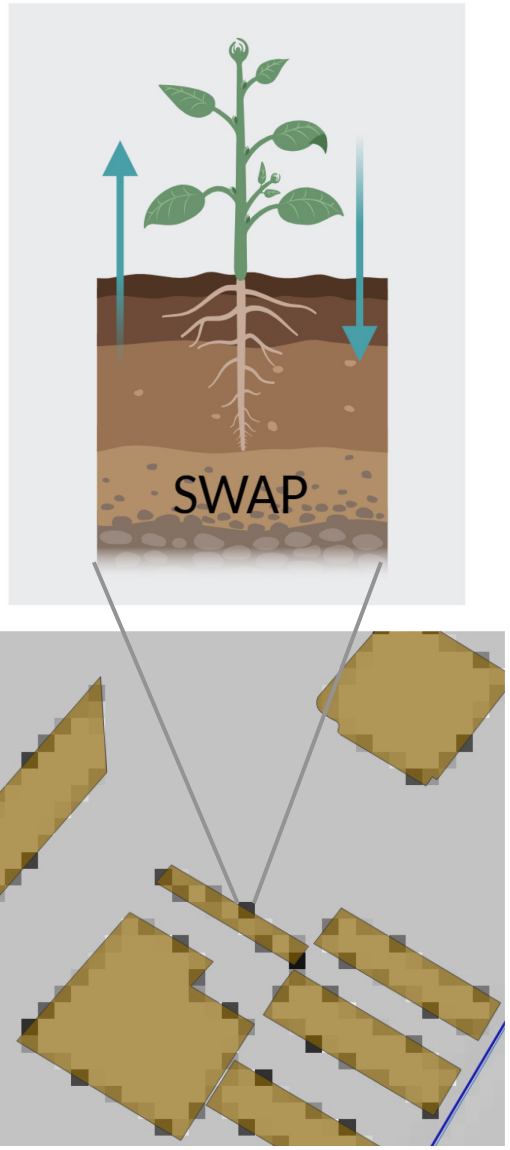
Optimized parameterization



Reference data =

Yield data from farms 15km around Payerne 1990-2021

Regional application



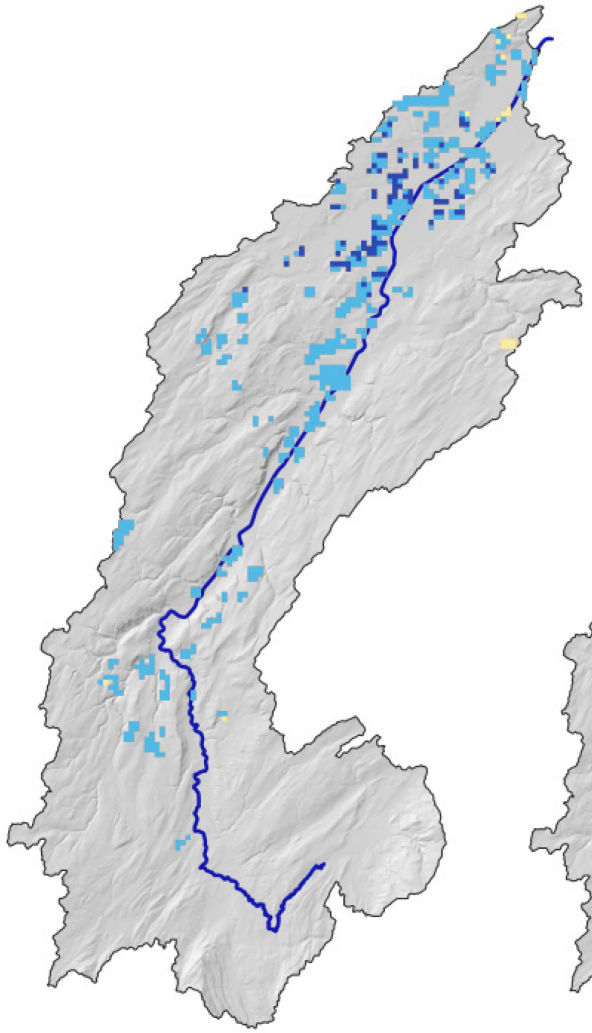
Changed from Soilgrids to KOBO soil maps

250m → 30m

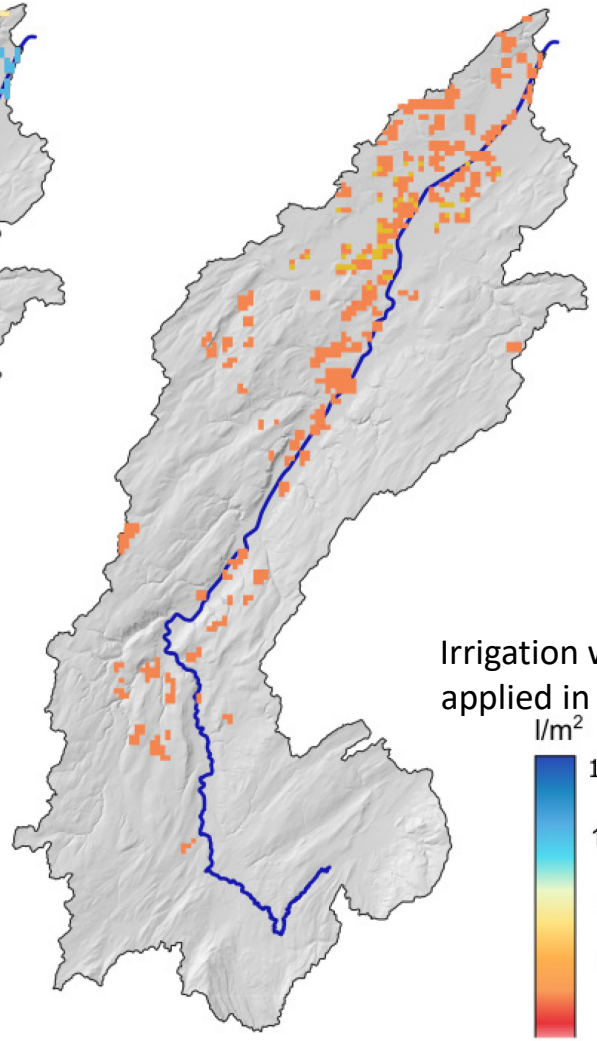
KOBO Kompetenzzentrum Boden
CCSols Centre de compétences sur
CCSuolo Centro di competenze per

Preliminary results

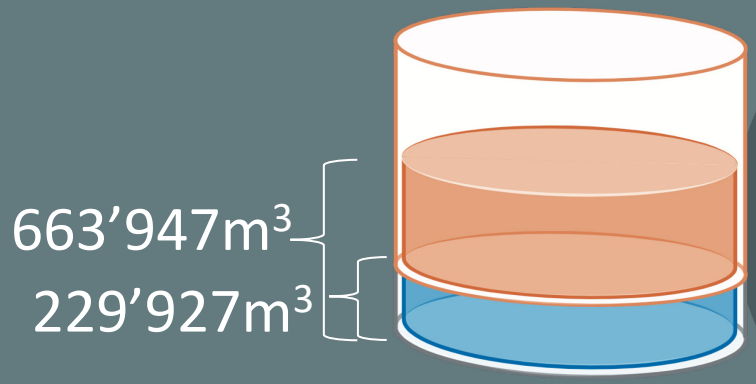
Irrigation demand of potato fields in 2022



Actual amounts «demanded»



Actual amounts available (considering bans)

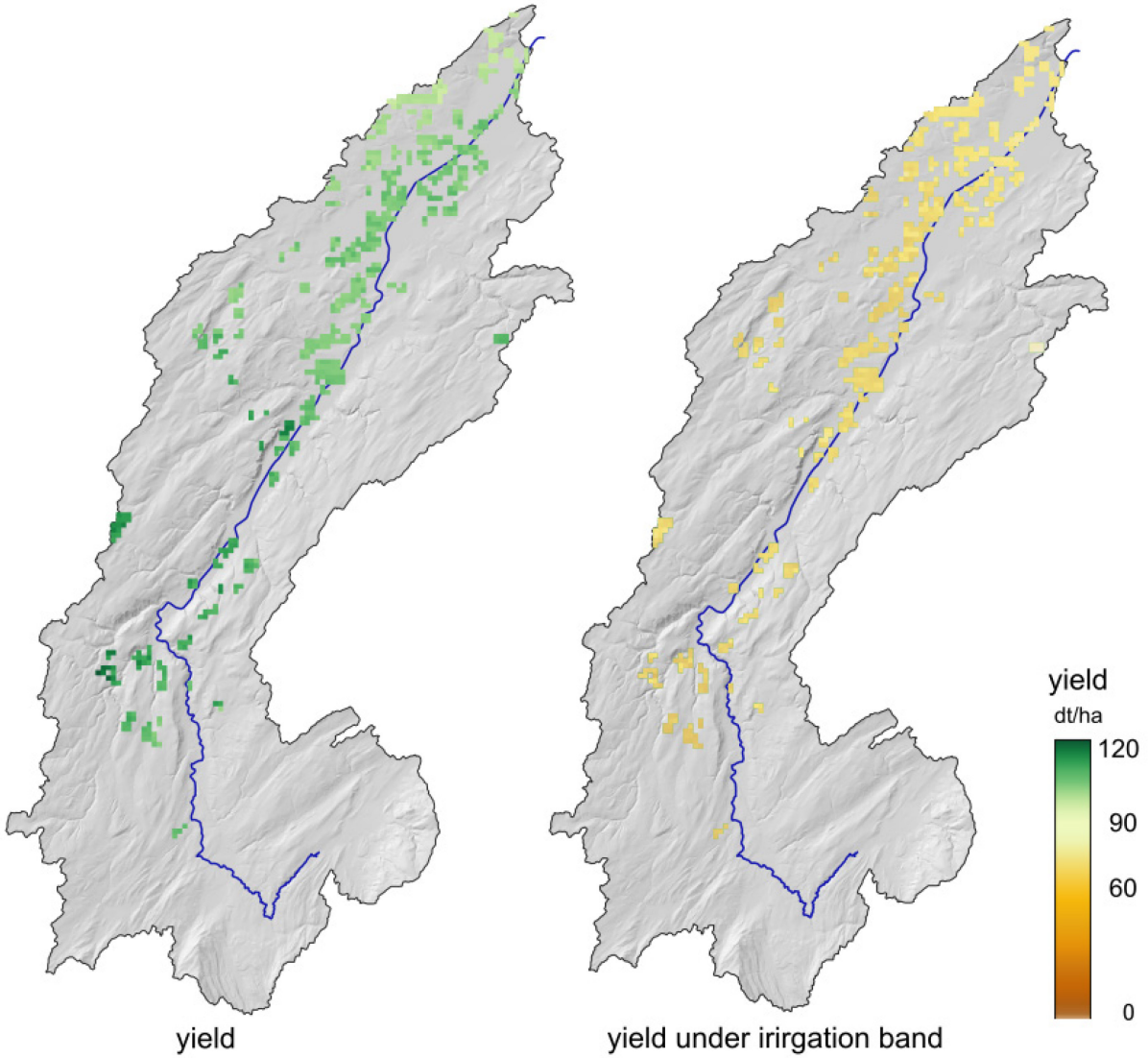


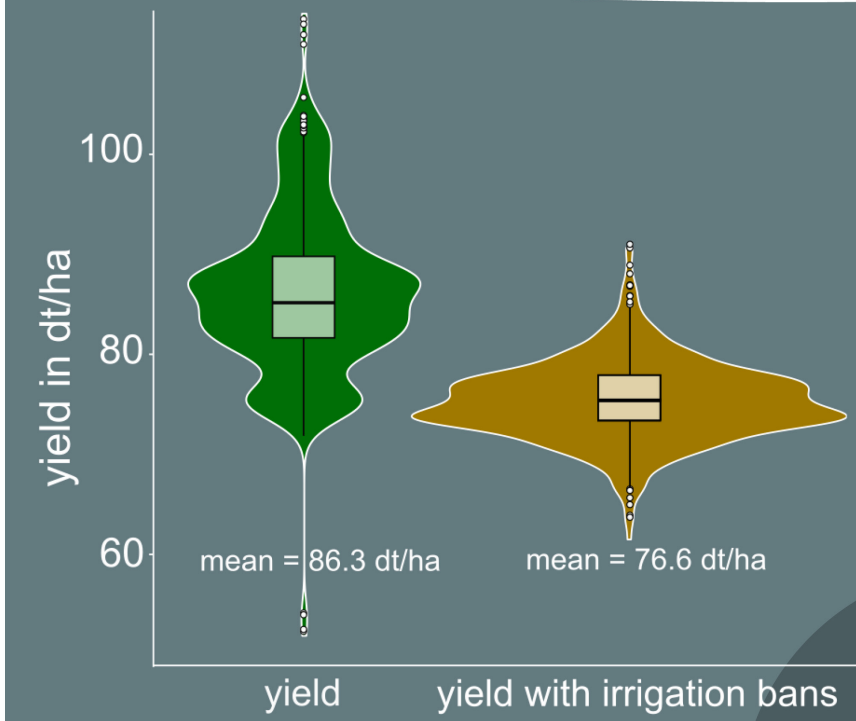
Irrigation water deficit: ~65%

Irrigation ban 2022:
23.06.22 - 26.09.22

Preliminary results

yield of potato fields in 2022



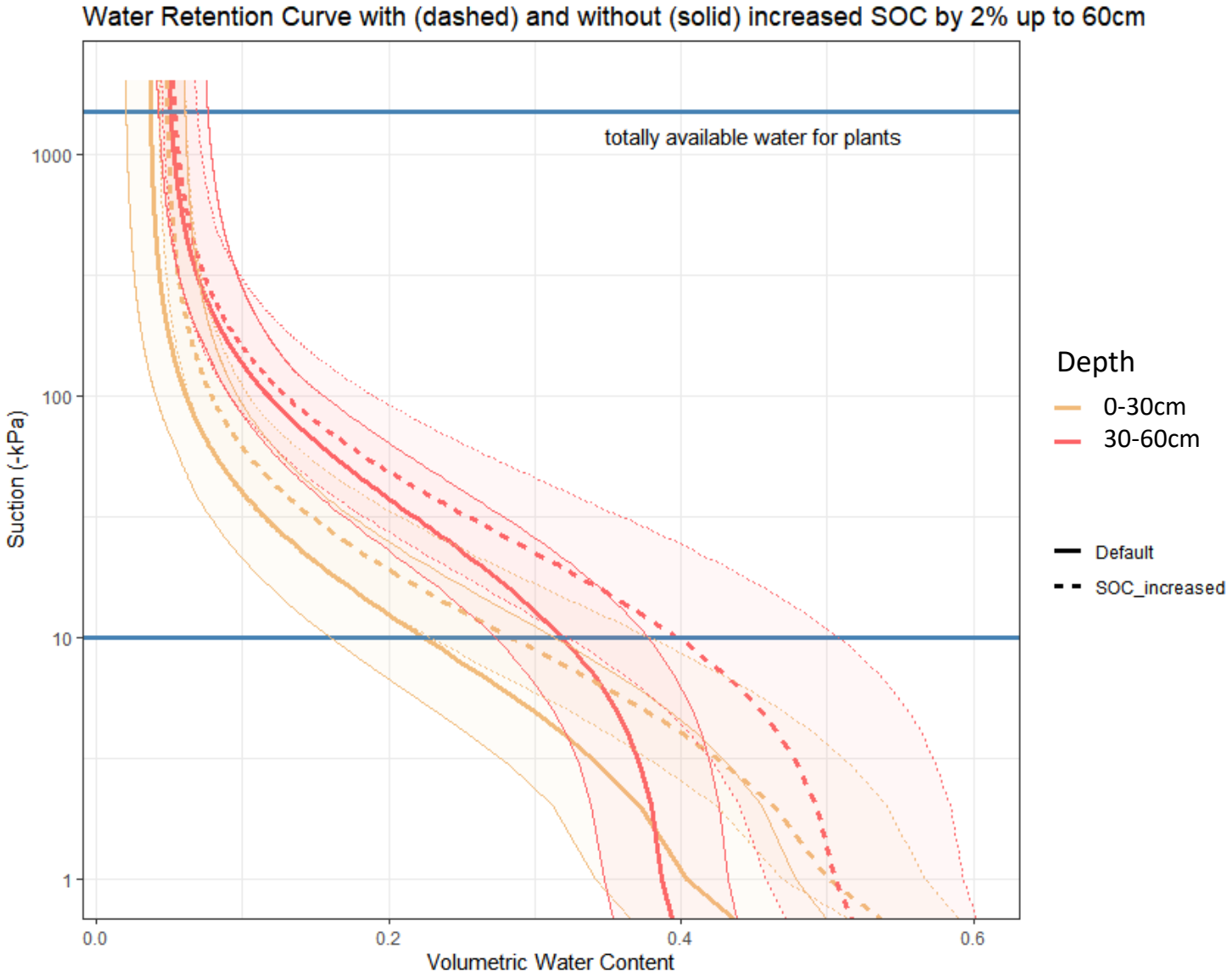


Yield deficit:
(min) ~11%

Potato yield 2022 on the national level:
-11% (2017-2021)
-22% (2020 → good harvest)

Preliminary results

Impact of Management : Increased soil organic carbon (SOC)



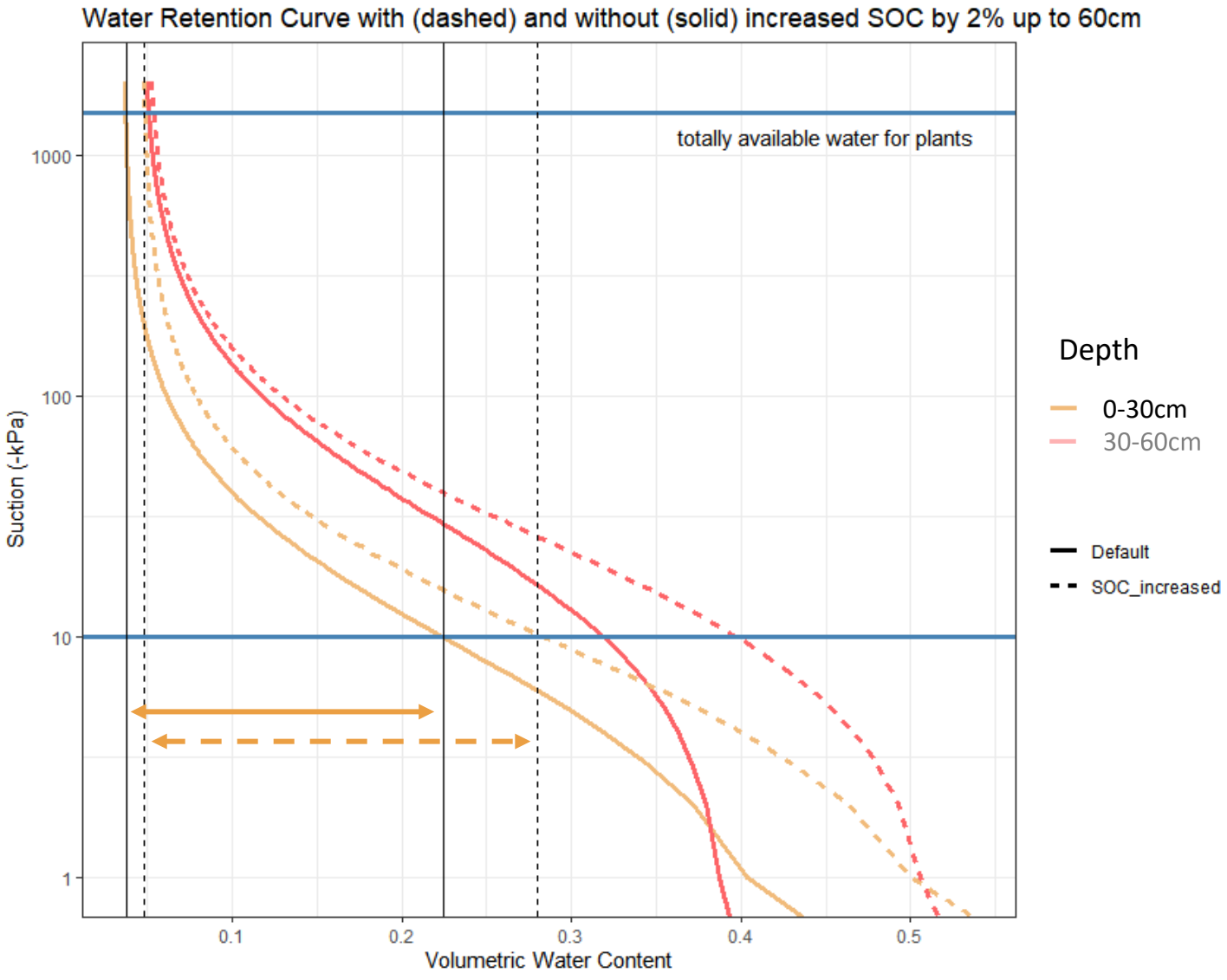
→ SOC decreases bulk density & increases water retention capacity

→ Share of plant available water increases

Mean soil water retention curve over 33 station-years & soil conditions

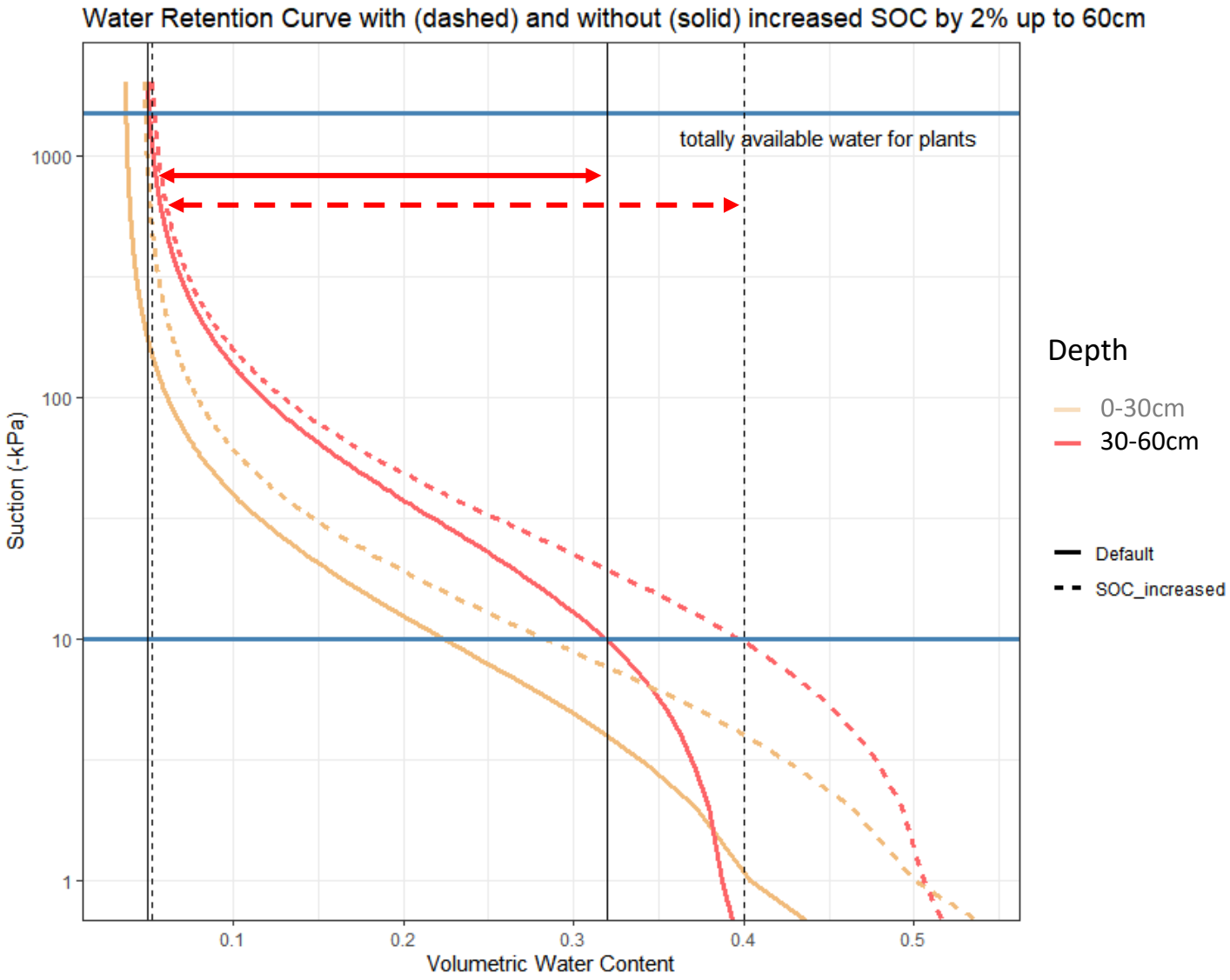
Preliminary results

Impact of Management : Increased soil organic carbon (SOC)



Preliminary results

Impact of Management : Increased soil organic carbon (SOC)

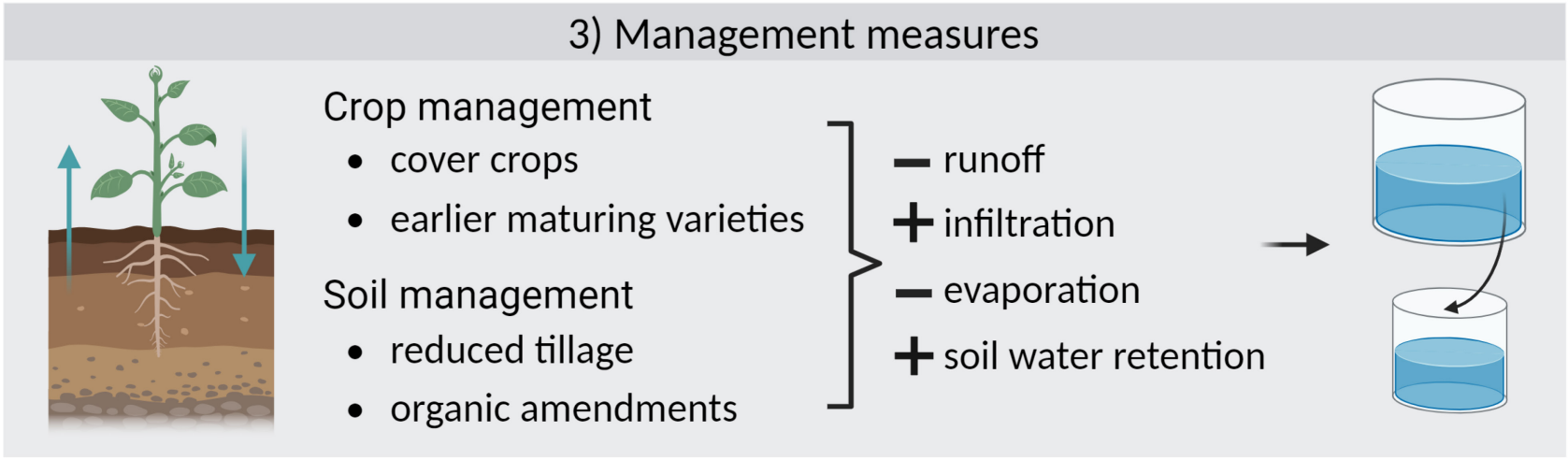


Impact on drought stress? Irrigation demand? Yield? …

Outlook

Implementation of management practices &

Evaluation of their potential to reduce irrigation demand



Thank you

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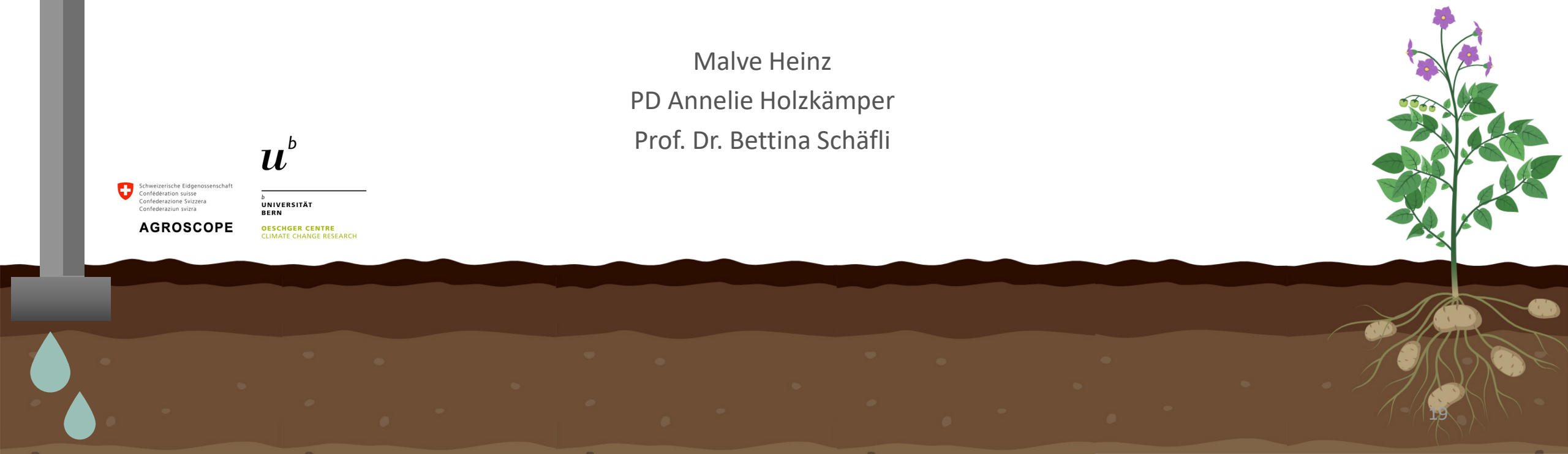
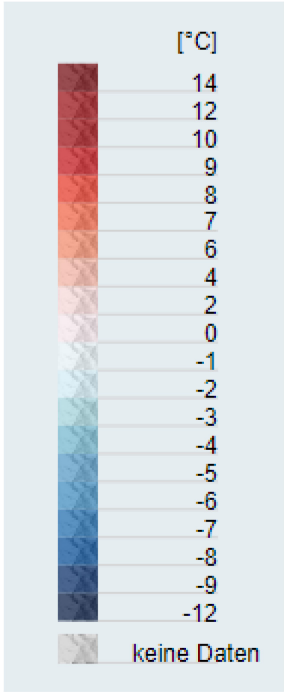
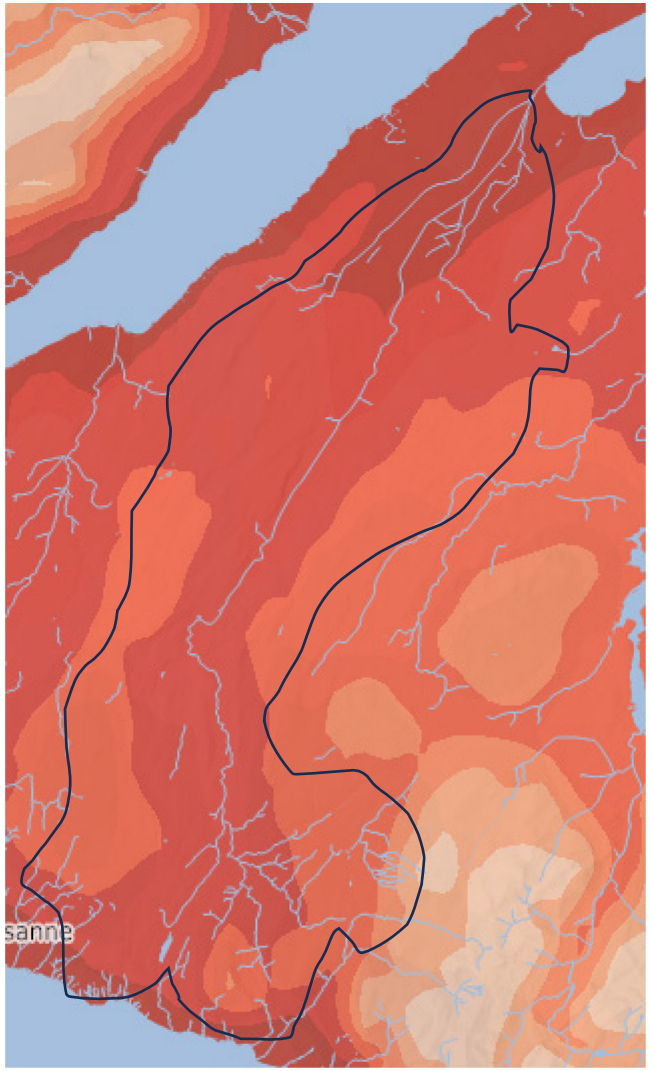
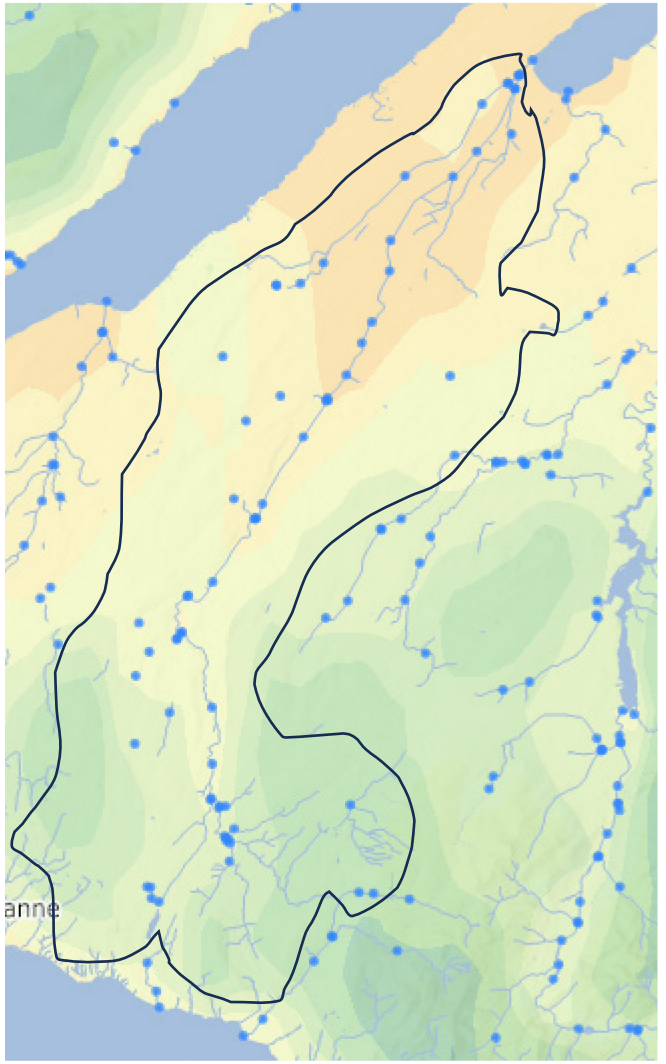
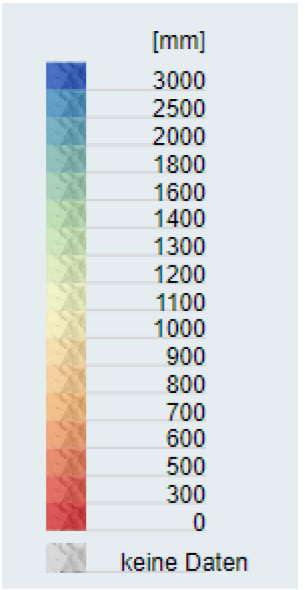


Mean temperature & Precipitation 1981-2010

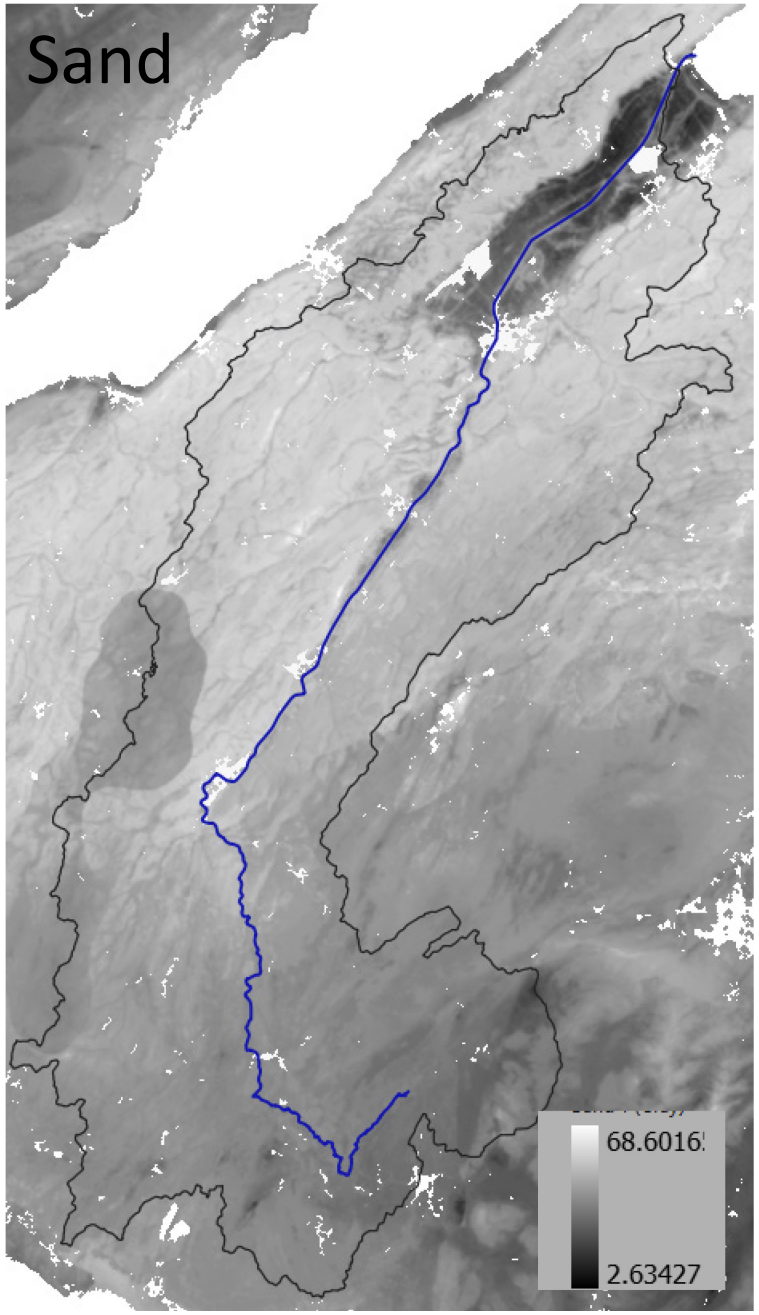


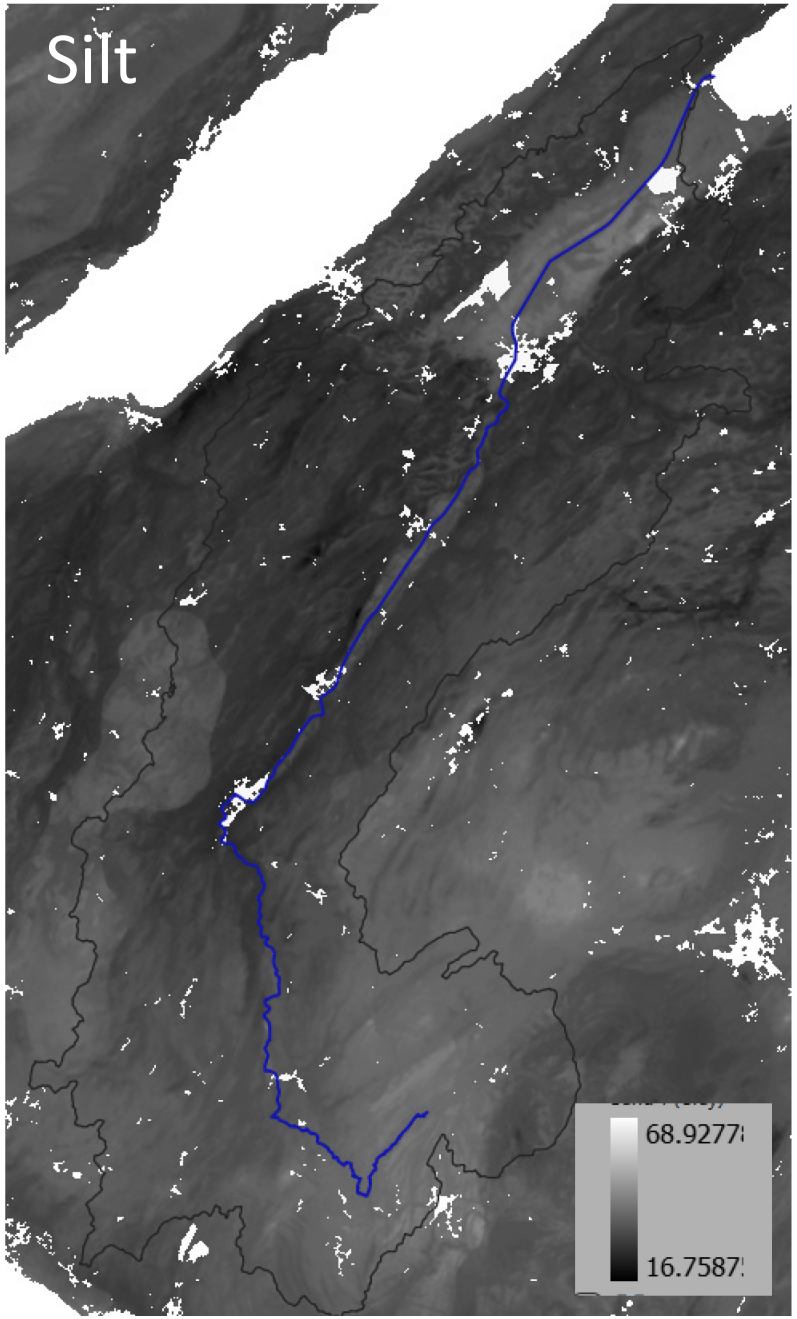


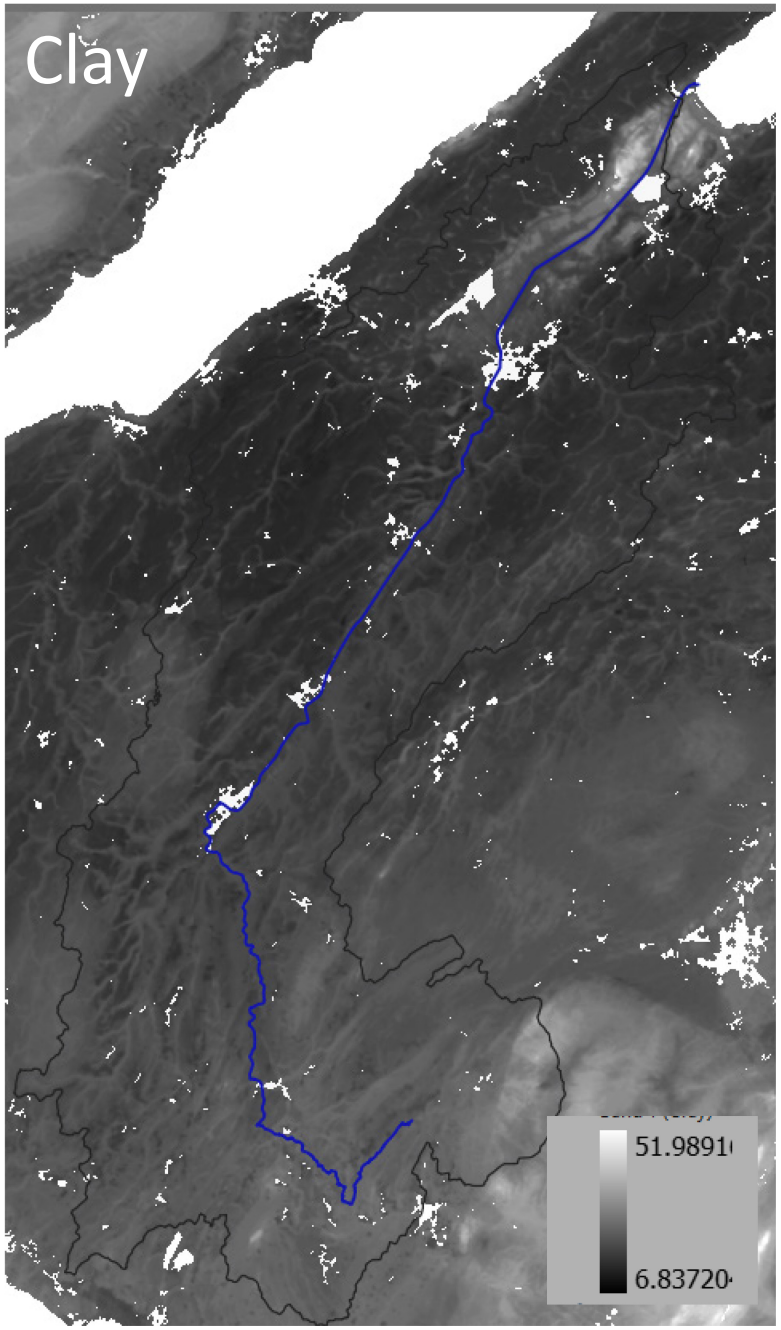




https://hydromaps.ch/#


Sand
68.6016
2.63427


Silt
68.9277
16.7587


Clay
51.9891
6.83720

Data and Methods