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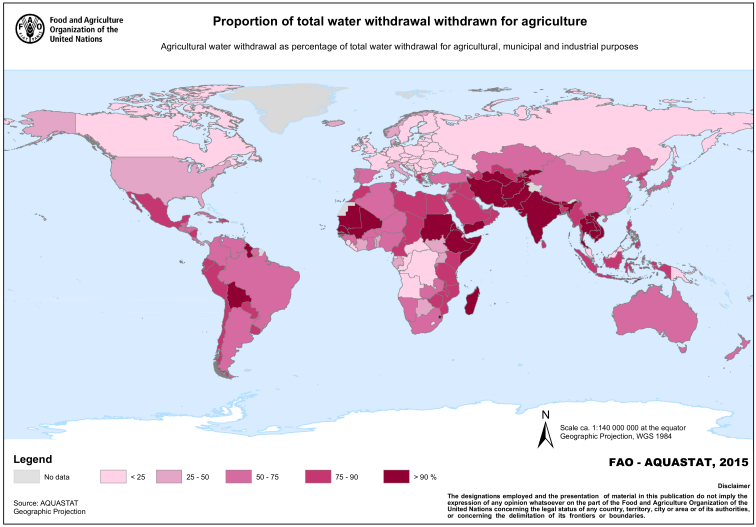
TU Dresden

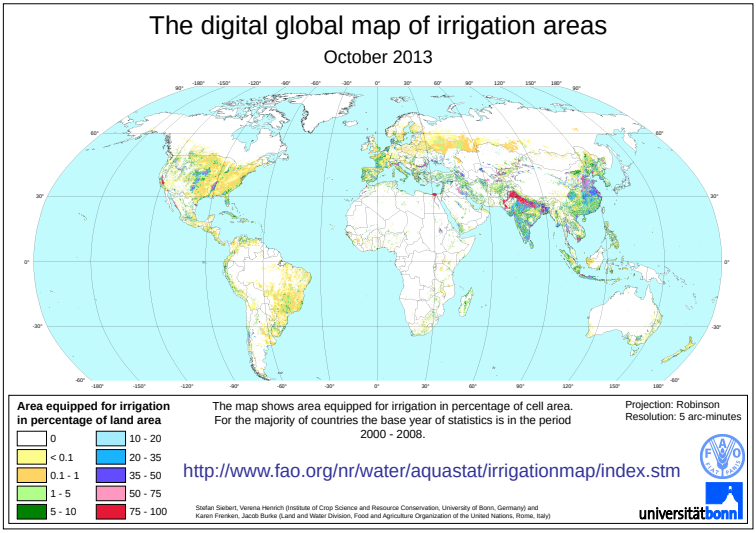
Comparison of the value of information for the management of deficit irrigation systems in different climate regions

EGU General Assembly 2022, 24. Mai 2022

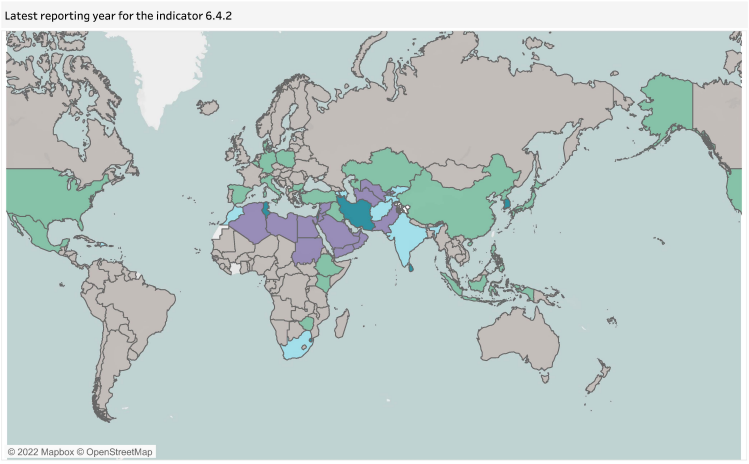
Water demand for agriculture



Water and food (irrigated areas)



Freshwater withdrawals



source: FAO

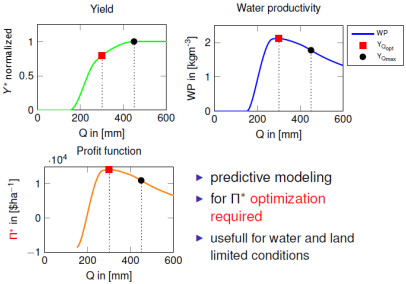
Improving water productivity: Deficit irrigation strategy

- More crop per drop: Improvement of Water Productivity (WP)
  - Improvement of crop growth
  - Efficient and sustainable irrigation
  - Preservation of farmland through better cultivation practices
- WP = gain over expenses
  - (Marketable) yield over total irrigation amount or evapotranspiration
- Typical ranges of WP_{ET}

Maize:
0.3 – 1.7 kg m^{-3}

Wheat:
0.6 – 1.5 kg m^{-3}

Rice:
0.4 – 1.4 kg m^{-3}

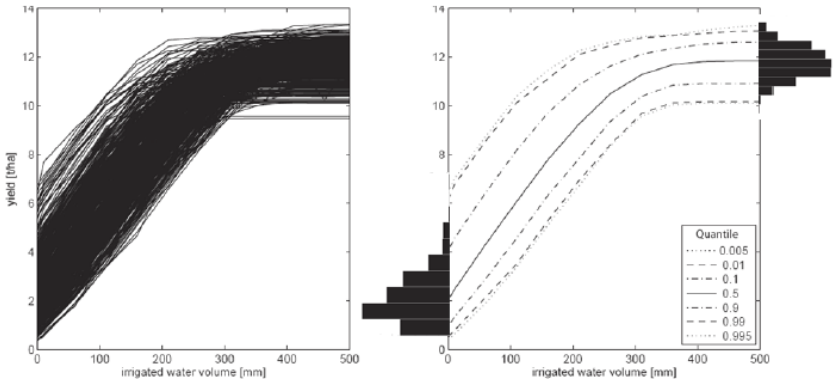


The Deficit Irrigation Toolbox (DIT) – http://bit.ly/TUD-DIT

New approach:

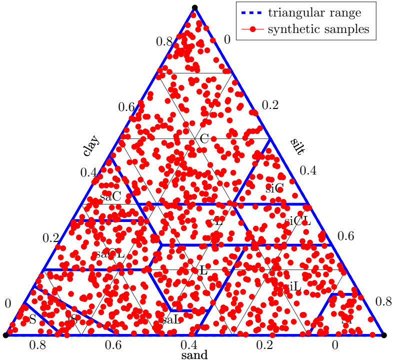
- higher water productivity→ optimal scheduling
- increase of food security→ adaptive management

Climate variability

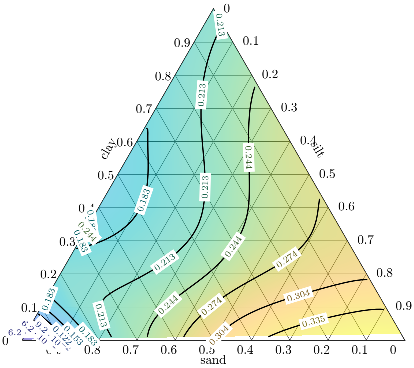


Variability in yield for rainfed, supplemental and full irrigation for maize (Montpellier, France)

Soil variability



soil texture

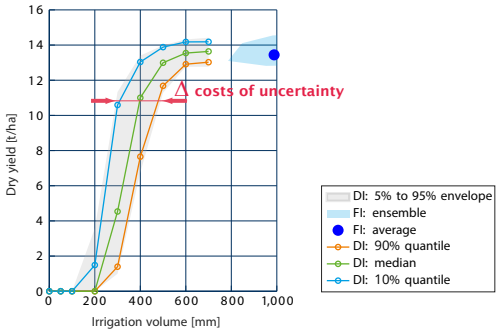


$log(K_s)$

Information Value Theory (R. Howard (1966))

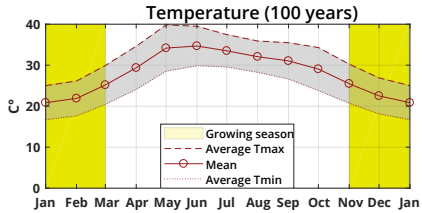
Typical experimental VOI-setup (value of information $\hat{=}$ costs of ignorance)

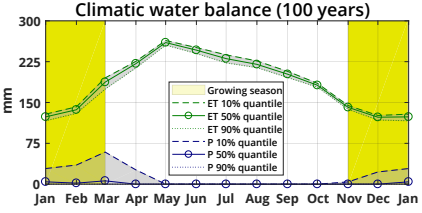
1. Define information for perfect knowledge (climate, soil, management).
2. Define information for total ignorance (no information).
3. Calculate costs of ignorance (additional water requirements).
4. Estimate highest reduction in costs of ignorance for additional information (climate, soil, management).
5. Make a decision related to retrieval of additional information for a specific site.



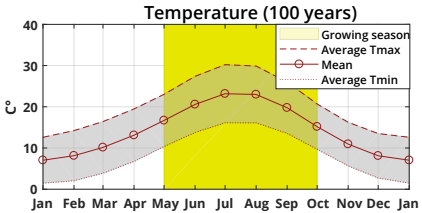
Application to different climate regions

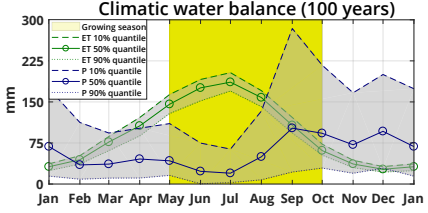
Arid site: Seeb, Oman





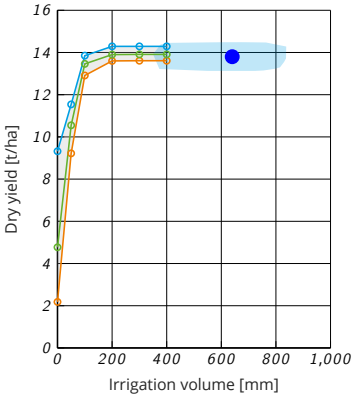
Semi-arid site: Montpellier, France



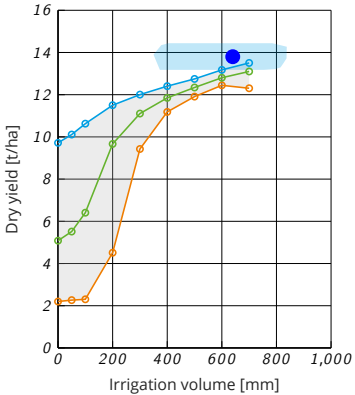


An Example for Oman for mixed variability

Stochastic Crop Water Production Function for wet conditions



irrigation calendar



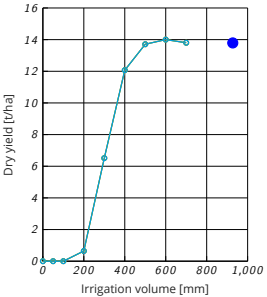
simple deficit irrigation

Yield for maize for an arid site: Oman

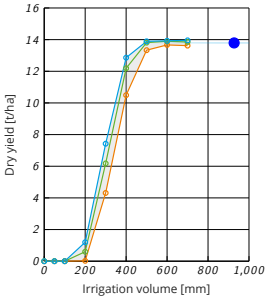
Soil variability: all soils – each season optimized (perfect knowledge)

dry

average

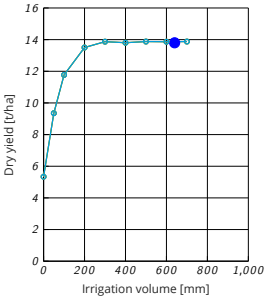


ensemble

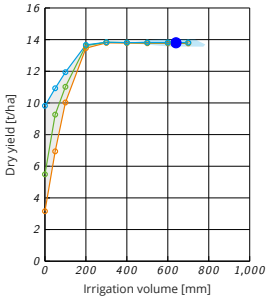


wet

average



ensemble

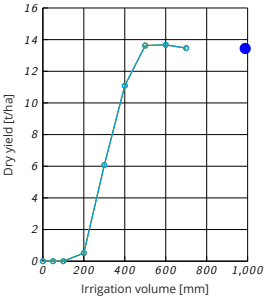


Yield for maize for a semi-arid site: France

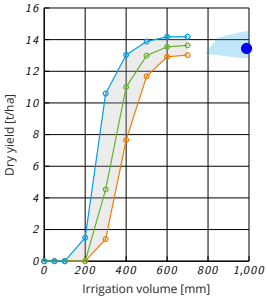
Climate variability – each season optimized (perfect knowledge)

dry

average

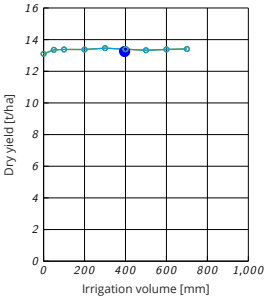


ensemble



wet

average



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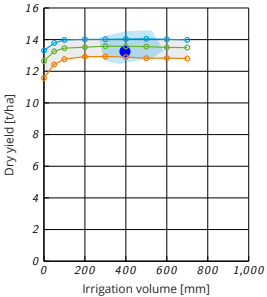
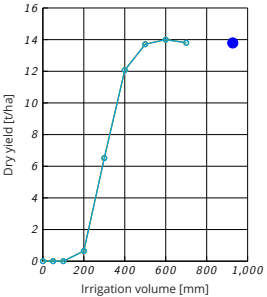


Yield for maize for an arid site: Oman

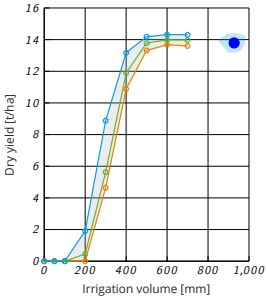
Climate variability – each season optimized (perfect knowledge)

dry

average

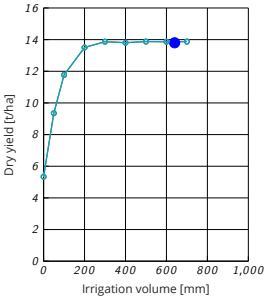


ensemble

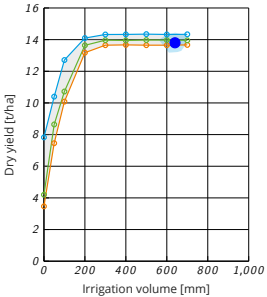


wet

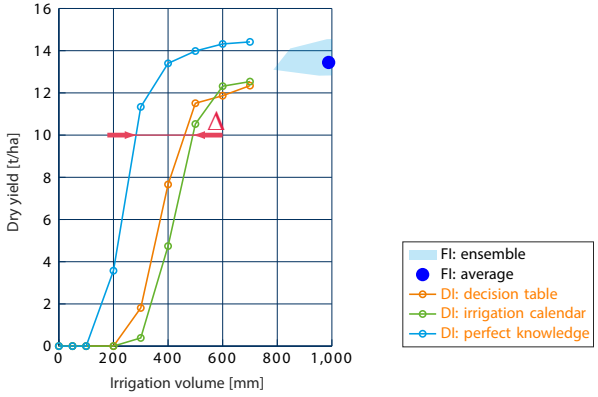
average



ensemble



Analysis of deficit irrigation strategies



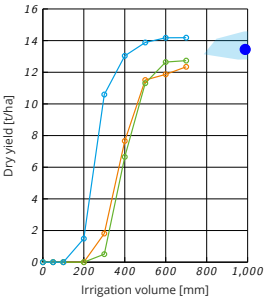
	decision table	irrigation calendar
Costs in [mm]:	178	208

Yield for maize for a semi-arid site: France

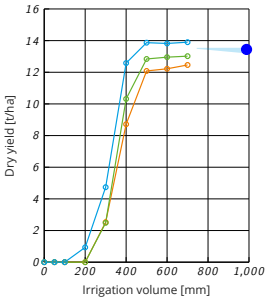
Costs for dry conditions

triangle

climate variability

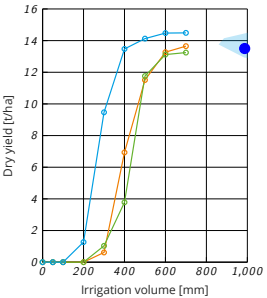


soil variability

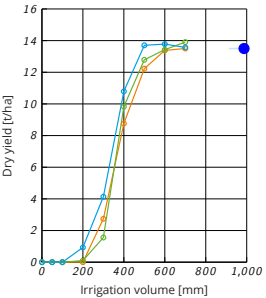


sl

climate variability



soil variability



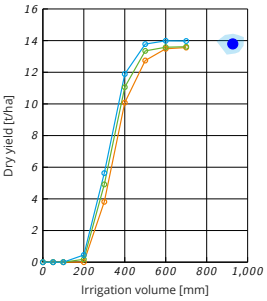
178	180	76	43	172	175	50	21

Yield for maize for an arid site: Oman

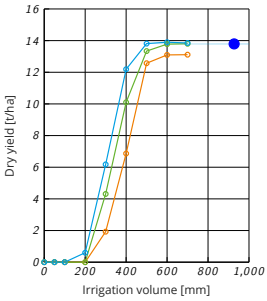
Costs for dry conditions

triangle

climate variability



soil variability



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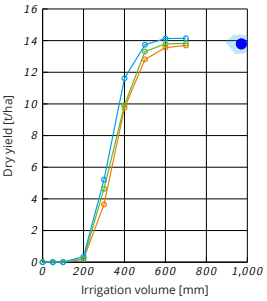
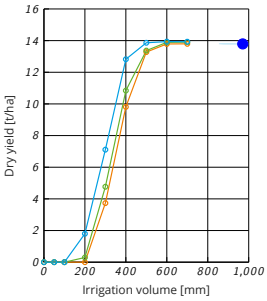
climate variability



soil variability

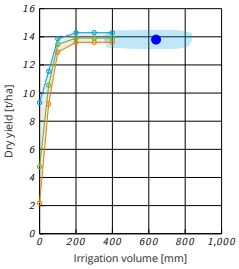


30	10	88	40	40	39	57	40

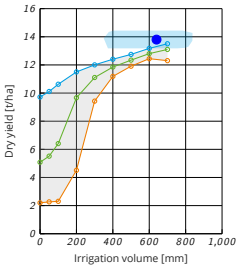
State of the implementation and next steps

Global numerical deficit irrigation experiment (GDIE)

1. **Proof of concept using the 40-member-CESM1 LE data set for a specific site (Oman).**
2. **Proof of concept using the ERA5-Land data set for a specific site (Oman).**
3. **Validation** of **CESM1 LE** and **ERA5-Land** results using data from climate stations in different climatic regions.
4. **Global numerical experiment** for estimating VOI for climate, soil and management.



irrigation calendar



simple deficit irrigation