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1st Meeting of the

International Network of Salt-Affected Soils

(INSAS)

EFFECTS OF GREY WATER USE ON SALINITY AND SODICITY: CASE STUDY FROM BELGIUM

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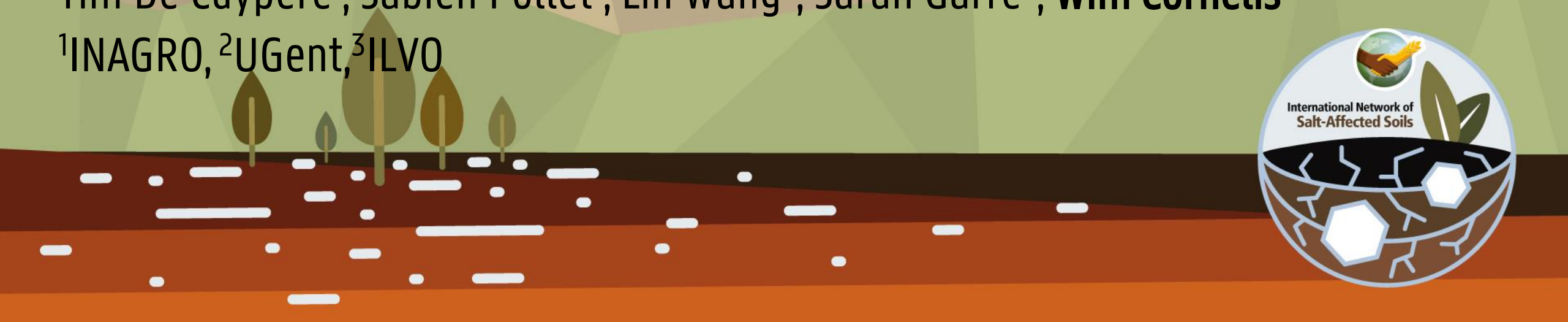
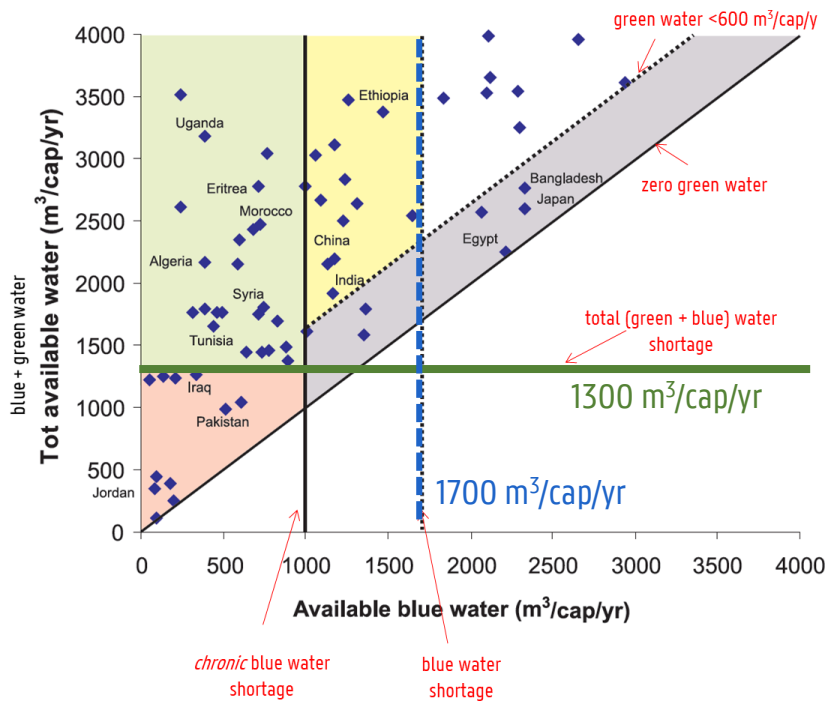
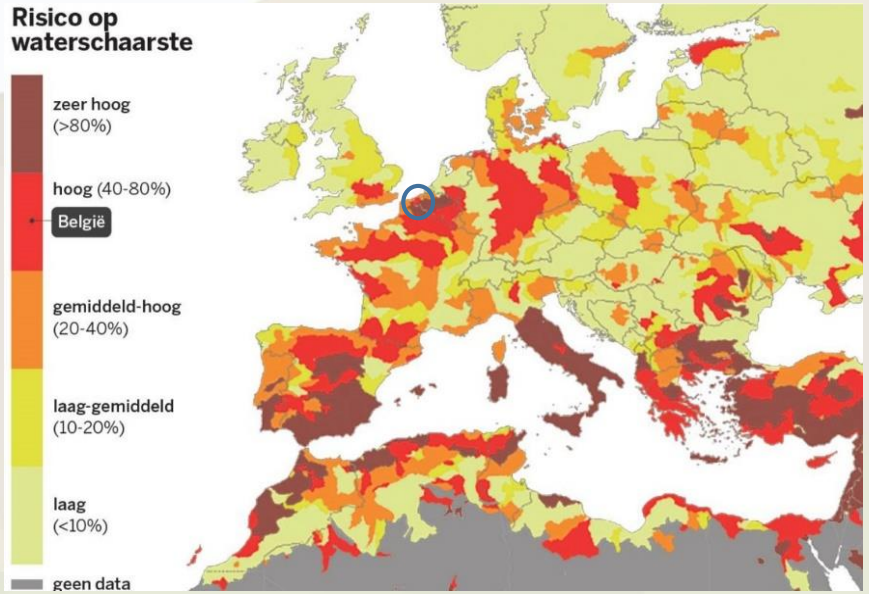


- Belgium faces blue water shortage (<1700 m^3/cap/yr) (surface/ground water)
- Climate change → blue water shortage not always compensated by green water (soil moisture from rain)



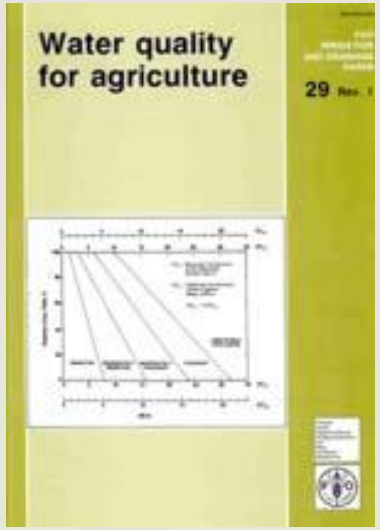
Rockström et al. (2009, Water Resourc. Res.)

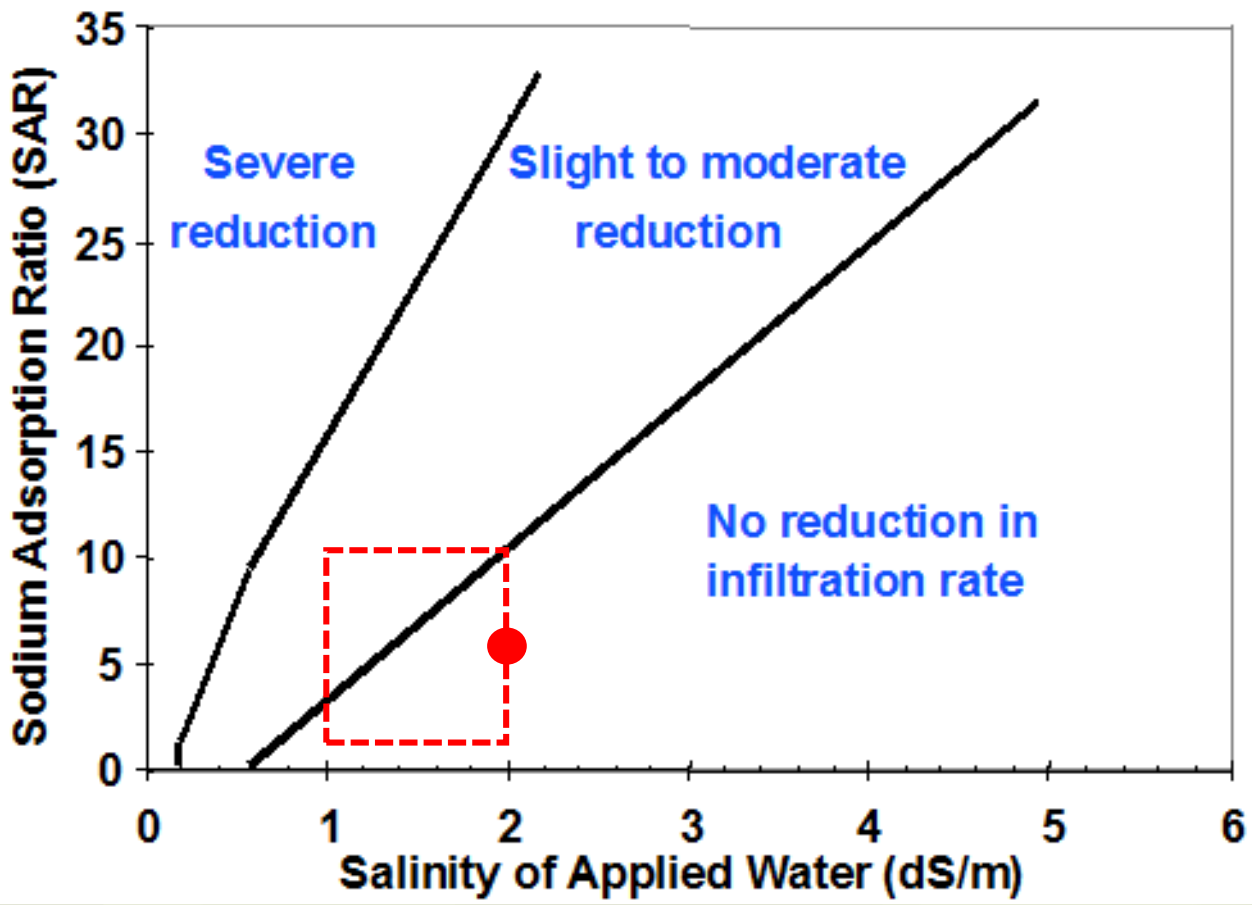


Aqueduct WRI (2019)

Photo: Kurt Desplenter

- Large water demand, part. in horticulture (vegetable production)
- Alternative water resources → grey water: waste water containing nitrate, phosphate, organic matter, surfactants, heavy metals, pharmaceuticals, oils, pathogens, … + salts
  = «reclaimed» water, COM(2018) 337
- Risks: salinity and sodicity (among others) → salt stress, infiltration problems (FAO I&D paper 29, rev. 1 – Ayers and Westcott, 1994)
  – osmotic potential (EC)
  – soil structural degradation: clay swelling, dispersion, aggregate breakdown, … (SAR + EC)





Source: Univ. of California (modified from Ayers & Westcott 1994; adapted from Rhoades 1977; Oster & Schroer 1979)

- "Most water quality criteria are based on short-term laboratory experiments with continuous water flow in packed soil columns.

  Rain events on a sodic soil cause a reduction in soil EC and hence may have an adverse impact of soil physical properties." (Suarez et al., 2006)
- On loam and clay, adverse impacts on infiltration at EC = 1 and 2 dS/m at SAR = 2, 4, 6, 8, 10 (Suarez et al., 2006)

- Overall aim: study salinity and sodicity problems (among others) resulting from use of different grey waters in **cauliflower**, **potato** and **spinach** (open field) cultivation
- Special attention to **soil-water dynamics**: effects of alternating rain and irrigation, and drying between irrigations on soil structure degradation

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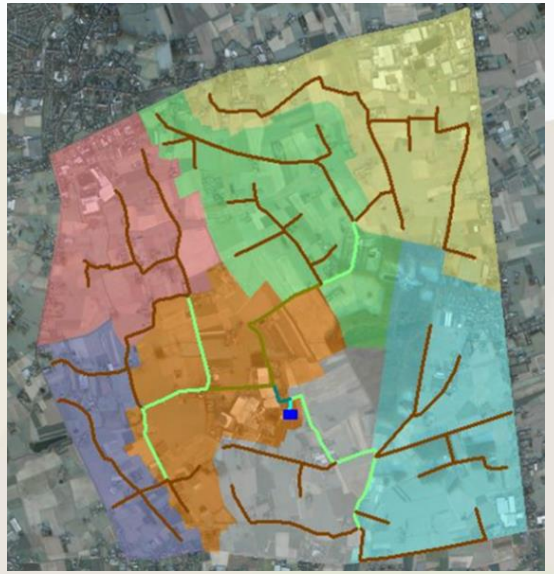

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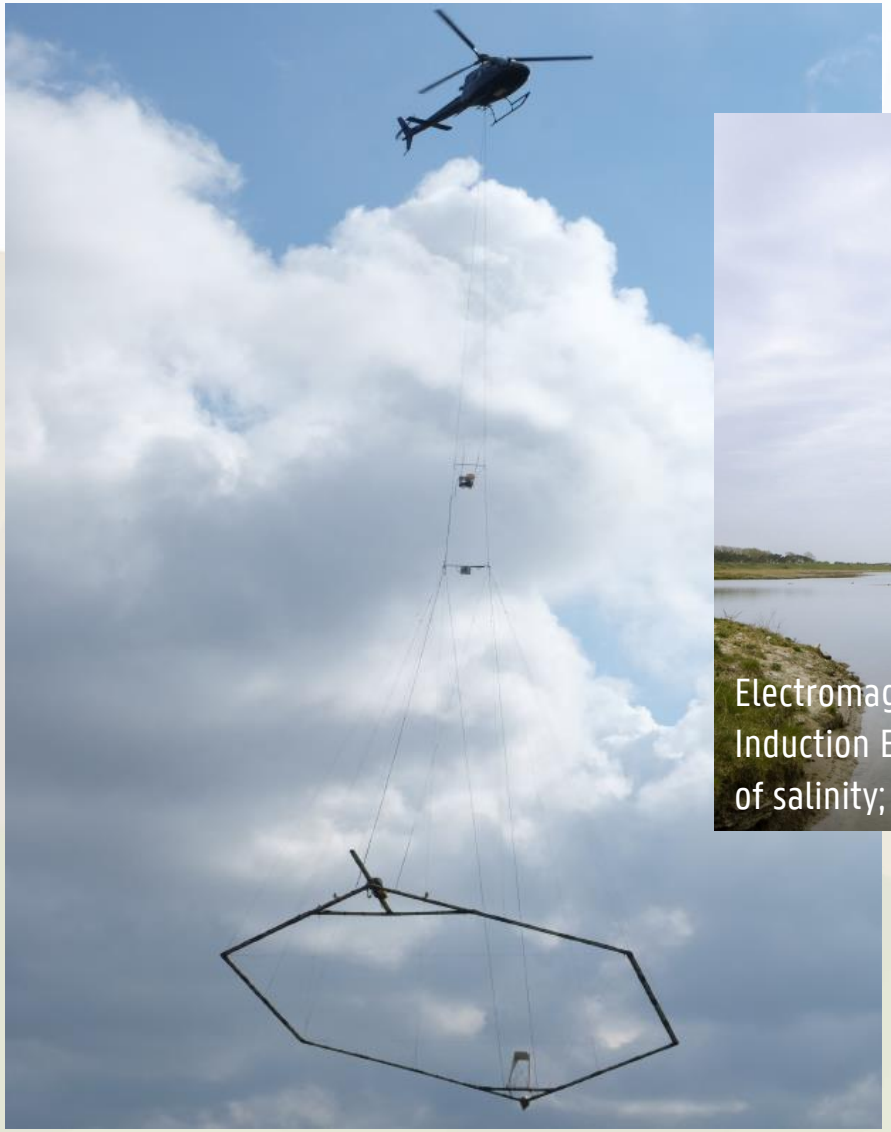
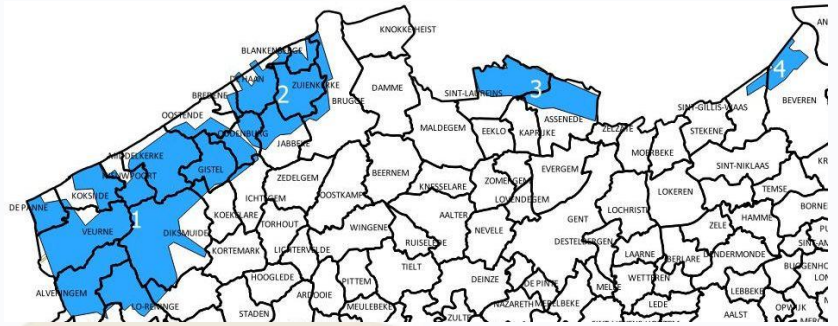
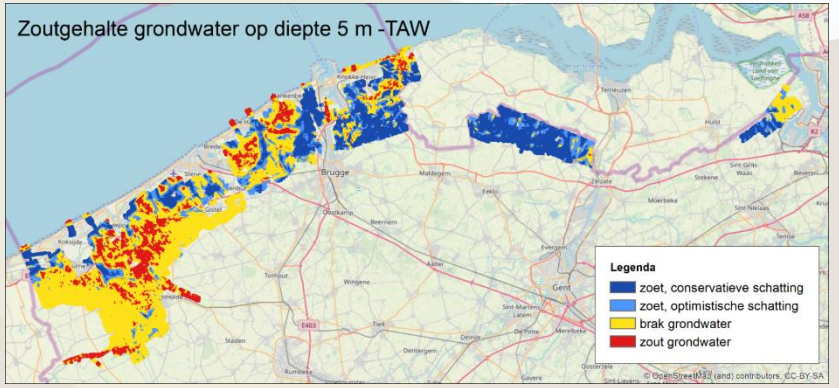
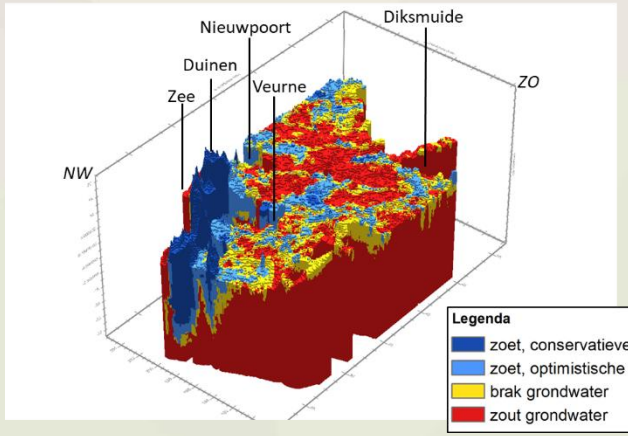


Electromagnetic Induction EMI survey of salinity; ©VMM







Topsoil project – mapping of groundwater salinity in coastal and polder areas (for Belgium: VMM, UGent)

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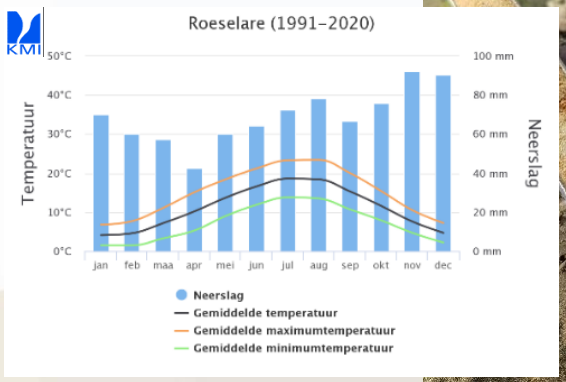
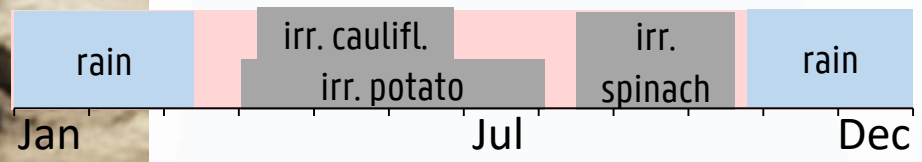
- Climate: temperate maritime, mild winters and warm summers (P = 831 mm)
- Soil: Sandy loam



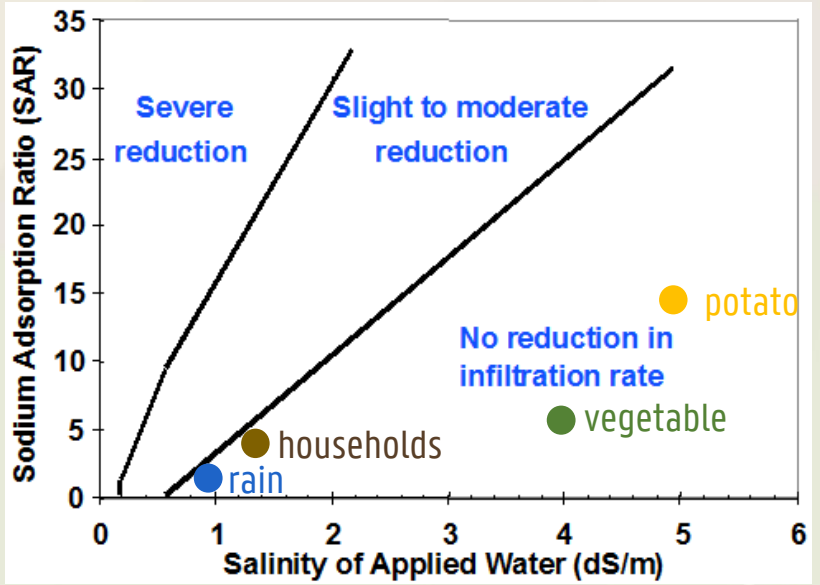


- Five objects (randomized block design, 4 reps), first trial 2019:
  - 1: rainwater + irr. rainwater
  - 2: rainwater + irr. TWW from households (Aquafin)
  - 3: rainwater + irr. TWW vegetable processing industry
  - 4: rainwater + irr. TWW potato processing industry
  - 5: rainfed

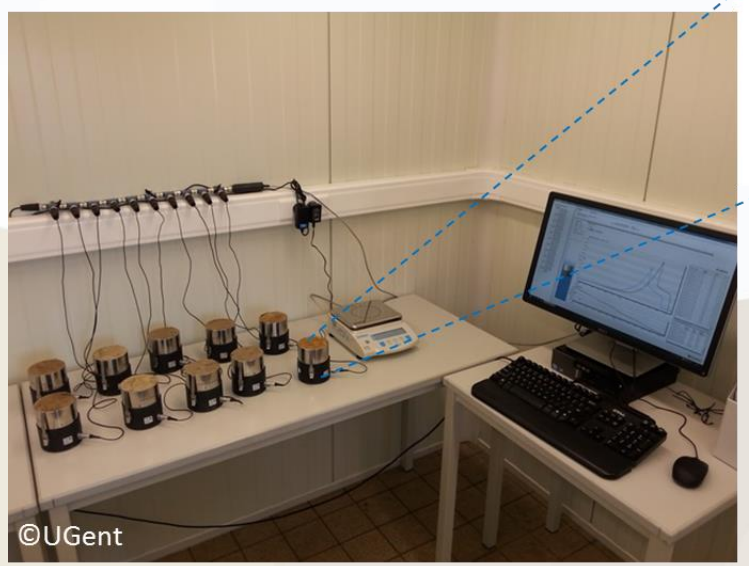
Object 1-4: controlled rainwater (rooftops + open reservoir) supply with sprinklers in rainout shelters, Object 5: open air

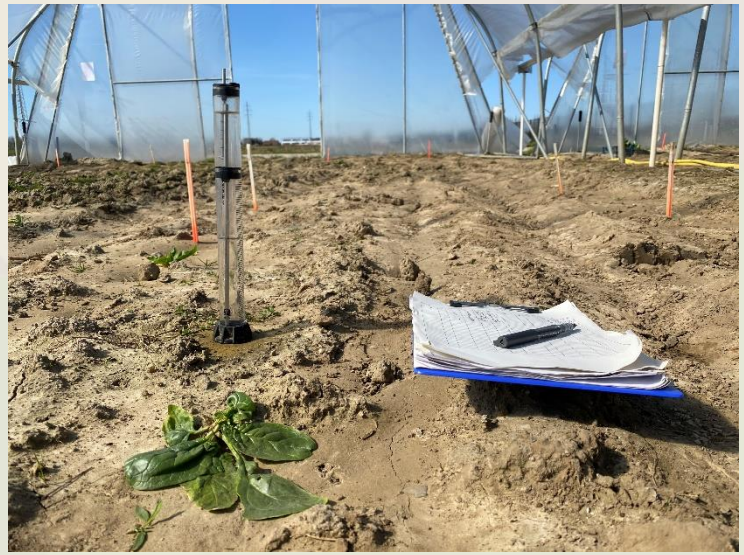
- Quality of water used

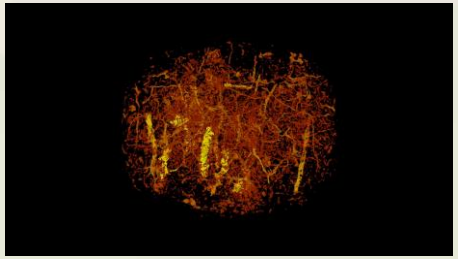
	pH	EC (dS/m)	SAR
Rainwater	7.0-7.3	0.7-1.3	0.3-0.6
TWW households	7.7-7.9	1.0-1.4	4.3-4.7
TWW vegetable industry	8.0-8.3	3.2-4.9	6.2-6.9
TWW potato industry	8.0-9.1	4.6-5.3	13.7-15.6



- Wide range of crop (spinach, cauliflower, potato) and soil props.
  - quantitative & qualitative crop parameters
  - chemical, physical, biological soil quality
- Before and after growing season
- Temporal variation in some physical props.







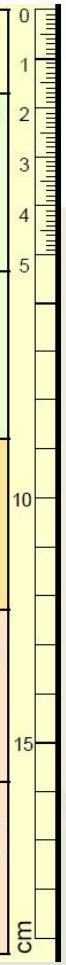
Visual Evaluation Soil Structure VESS (Ball et al., 2007)

good

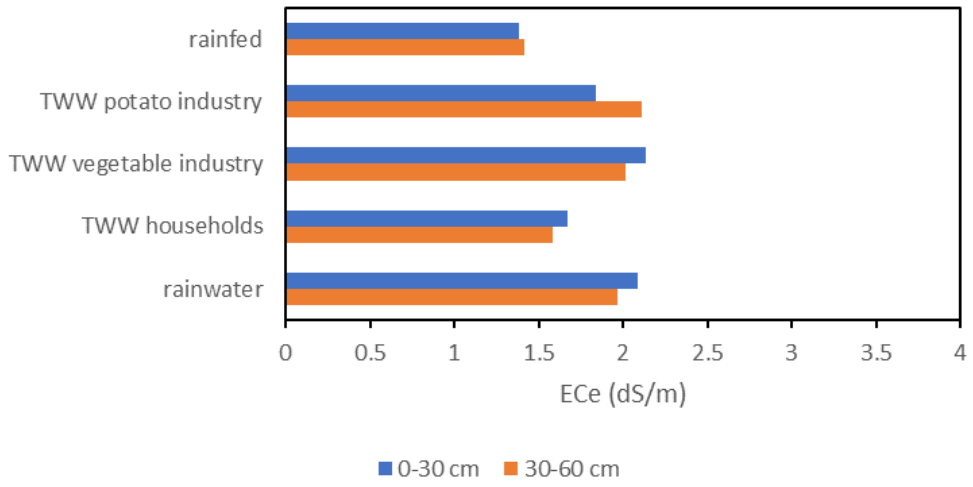
fair

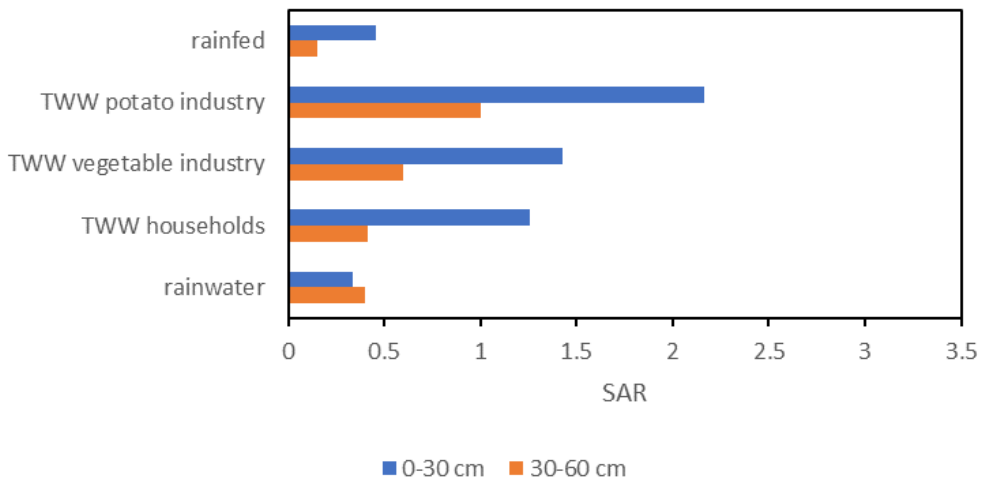
poor

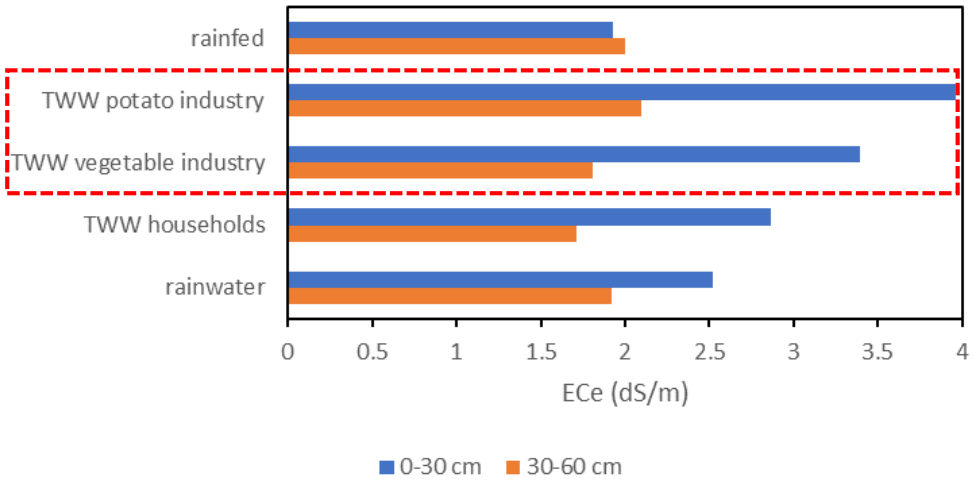
Structure quality	Size and appearance of aggregates	Visible porosity and Roots	Appearance after break-up: various soils	Appearance after break-up: same soil different tillage	Distinguishing feature	Appearance and description of natural or reduced fragment of ~ 1.5 cm diameter
Sq1 Friable Aggregates readily crumble with fingers	Mostly < 6 mm after crumbling	Highly porous Roots throughout the soil			 Fine aggregates	 The action of breaking the block is enough to reveal them. Large aggregates are composed of smaller ones, held by roots.
Sq2 Intact Aggregates easy to break with one hand	A mixture of porous, rounded aggregates from 2mm - 7 cm. No clods present	Most aggregates are porous Roots throughout the soil			 High aggregate porosity	 Aggregates when obtained are rounded, very fragile, crumble very easily and are highly porous.
Sq3 Firm Most aggregates break with one hand	A mixture of porous aggregates from 2mm -10 cm; less than 30% are <1 cm. Some angular, non-porous aggregates (clods) may be present	Macropores and cracks present. Porosity and roots both within aggregates.			 Low aggregate porosity	 Aggregate fragments are fairly easy to obtain. They have few visible pores and are rounded. Roots usually grow through the aggregates.
Sq4 Compact Requires considerable effort to break aggregates with one hand	Mostly large > 10 cm and sub-angular non-porous; horizontal/platy also possible; less than 30% are <7 cm	Few macropores and cracks All roots are clustered in macropores and around aggregates			 Distinct macropores	 Aggregate fragments are easy to obtain when soil is wet, in cube shapes which are very sharp-edged and show cracks internally.
Sq5 Very compact Difficult to break up	Mostly large > 10 cm, very few < 7 cm, angular and non-porous	Very low porosity. Macropores may be present. May contain anaerobic zones. Few roots, if any, and restricted to cracks			 Grey-blue colour	 Aggregate fragments are easy to obtain when soil is wet, although considerable force may be needed. No pores or cracks are visible usually.

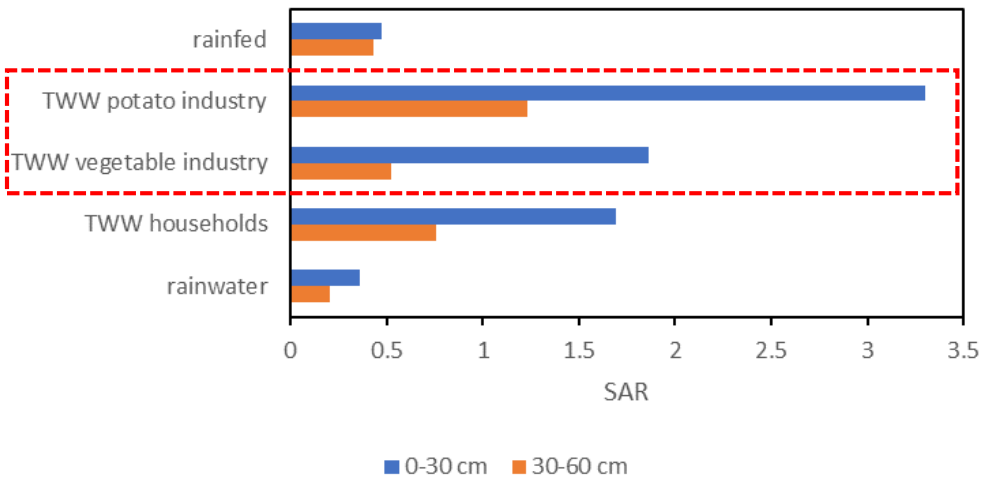


\+ attributes related to salinity and sodicity from Zaman et al. (2018): white salt crust, fluffy soil surface, salt stains


ECe before potato 2020 growing season
rainfed
TWW potato industry
TWW vegetable industry
TWW households
rainwater
0
0.5
1
1.5
2
2.5
3
3.5
4
ECe (dS/m)
0-30 cm
30-60 cm


SAR before potato 2020 growing season
rainfed
TWW potato industry
TWW vegetable industry
TWW households
rainwater
0
0.5
1
1.5
2
2.5
3
3.5
SAR
0-30 cm
30-60 cm


ECe after potato 2020 growing season
rainfed
TWW potato industry
TWW vegetable industry
TWW households
rainwater
0
0.5
1
1.5
2
2.5
3
3.5
4
ECe (dS/m)
0-30 cm
30-60 cm


SAR after potato 2020 growing season
rainfed
TWW potato industry
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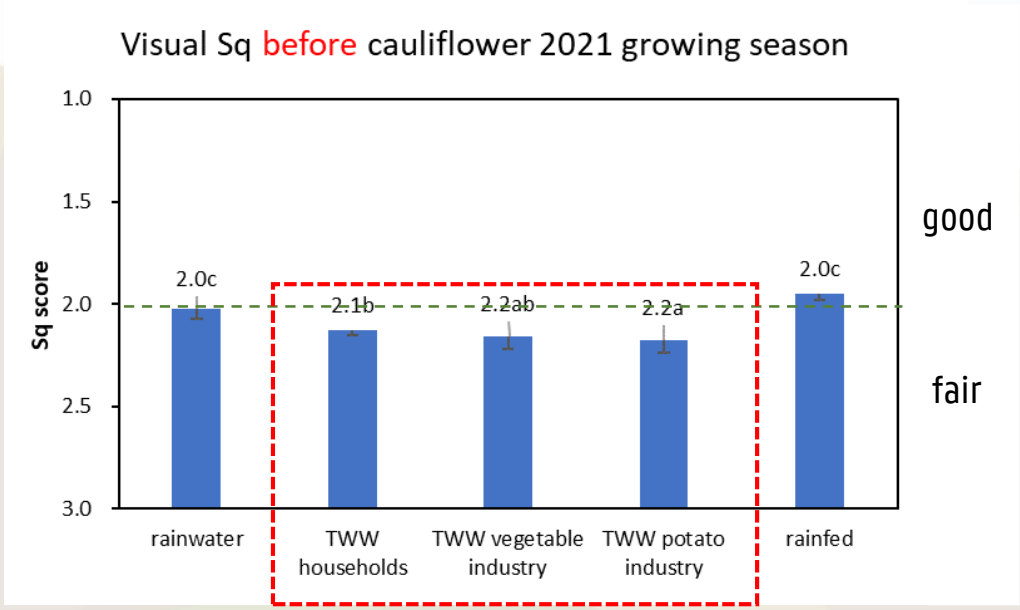
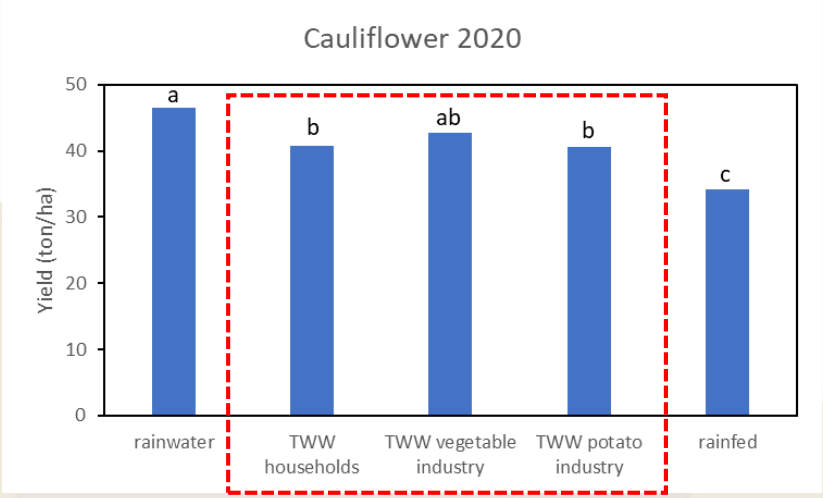
0
0.5
1
1.5
2
2.5
3
3.5
SAR
0-30 cm
30-60 cm

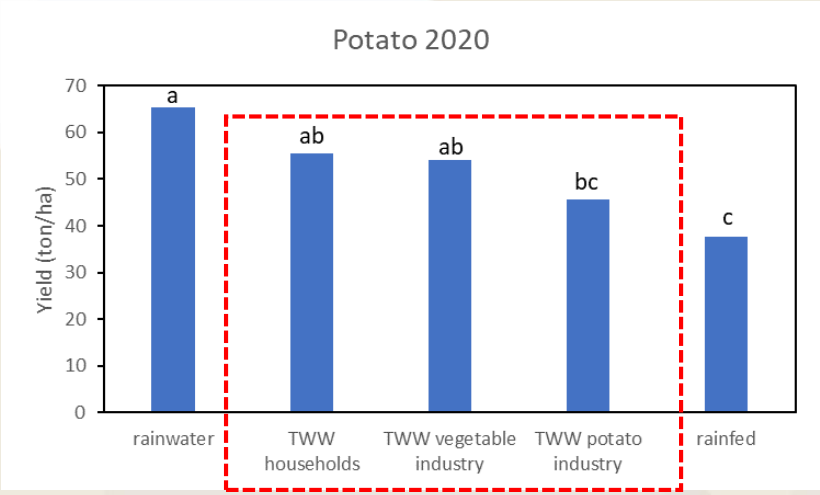


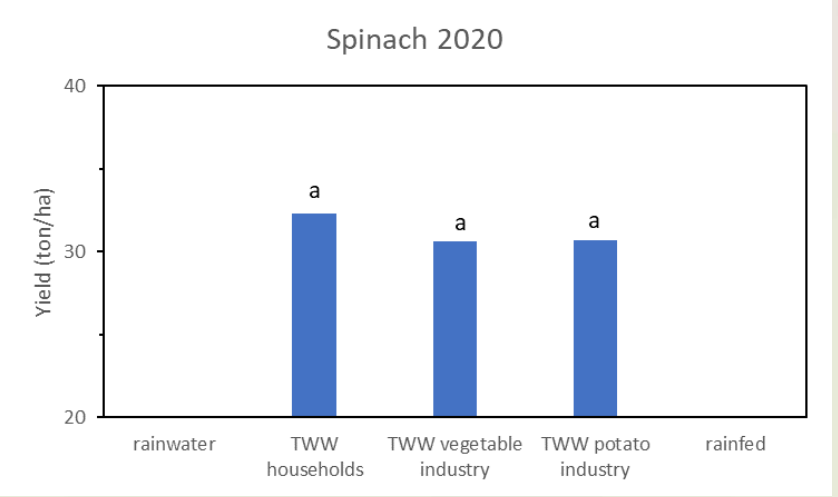
0-20 cm

0-10 cm

10-20 cm


Cauliflower 2020
Yield (ton/ha)
50
40
30
20
10
0
a
b
ab
b
c
rainwater
TWW households
TWW vegetable industry
TWW potato industry
rainfed


Potato 2020
Yield (ton/ha)
70
60
50
40
30
20
10
0
a
ab
ab
bc
c
rainwater
TWW households
TWW vegetable industry
TWW potato industry
rainfed


Spinach 2020
Yield (ton/ha)
40
30
20
a
a
a
rainwater
TWW households
TWW vegetable industry
TWW potato industry
rainfed

So…

- EC and SAR: ↑ after irrigation with grey water: TWW potato > TWW vegetable > TWW municipal > rainwater, primarily in topsoil (0-30 cm)
- Soil structure (very preliminary; first measurements started 3 weeks ago):
  Visual soil quality: TWW potato < TWW vegetable < TWW municipal < rainwater/rainfed
- Yields: cauliflower & potato yield lower under grey water than rainwater use,
  but higher than rainfed

And… lot of work to do: testing assessment methods, different textures, other water qualities, evaluate management options, …

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