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Hydrological consequences of CDSI modelled with SWAP

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Bridging Science to Practice

Source: https://www.canonvannederland.nl/nl/overijssel/twente/denekamp/ruilverkaveling

Weather: more extreme & more frequently

Wet

Colijnsplaat (NL), November 2019
Photo: Gé van den Eertwegh

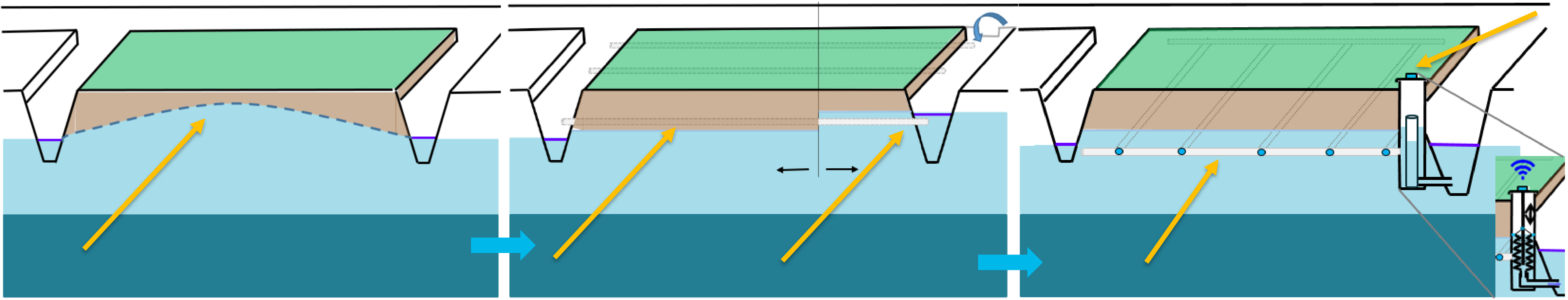
Dry

Colijnsplaat (NL), June 2020
Photo: Jon Mensink

Colijnsplaat (NL), July 2021
Photo: Eelco Boot

Development of drainage systems in NL (1950-2020)

No drainage | Conventional/ controlled drainage | Composite, controlled drainage with subirrigation



De Wit et al. (2022),
DOI: 10.1016/j.agwat.2022.107677

Conventional/ controlled drainage:

1) Discharge water

1) Discharge water
2) Retain water

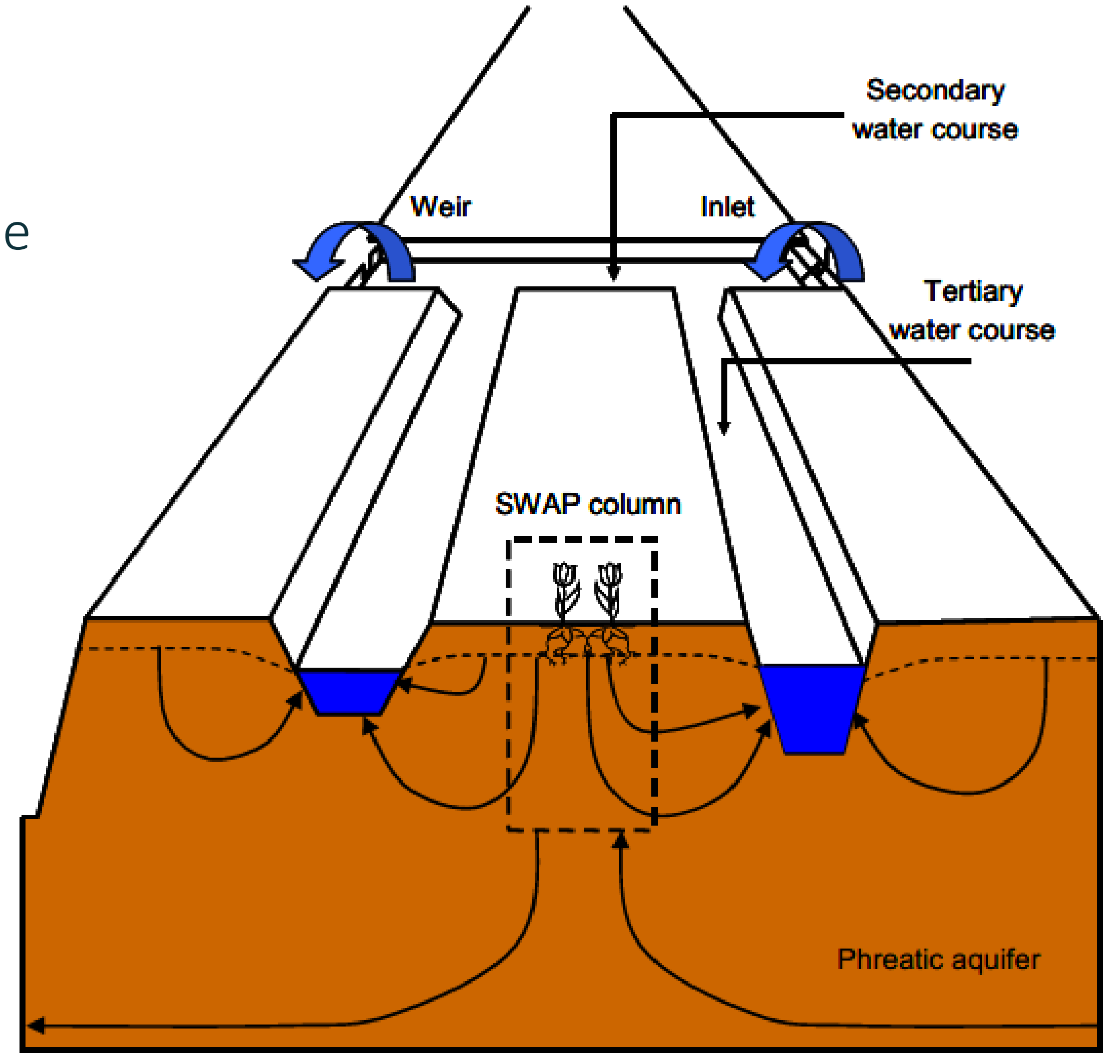
Composite, controlled drainage with subirrigation:

1) Discharge water
2) Retain water
3) Recharge water

Drainage module in SWAP

- Drainage systems (2D) = surface water module with a hierarchical system (1D-model).
- Today’s focus: extended drainage in SWAP

  - Inlet + outlet (weir)
  - Primary water course: canal
  - Secondary water course: ditch
  - Tertiary water course: small ditch



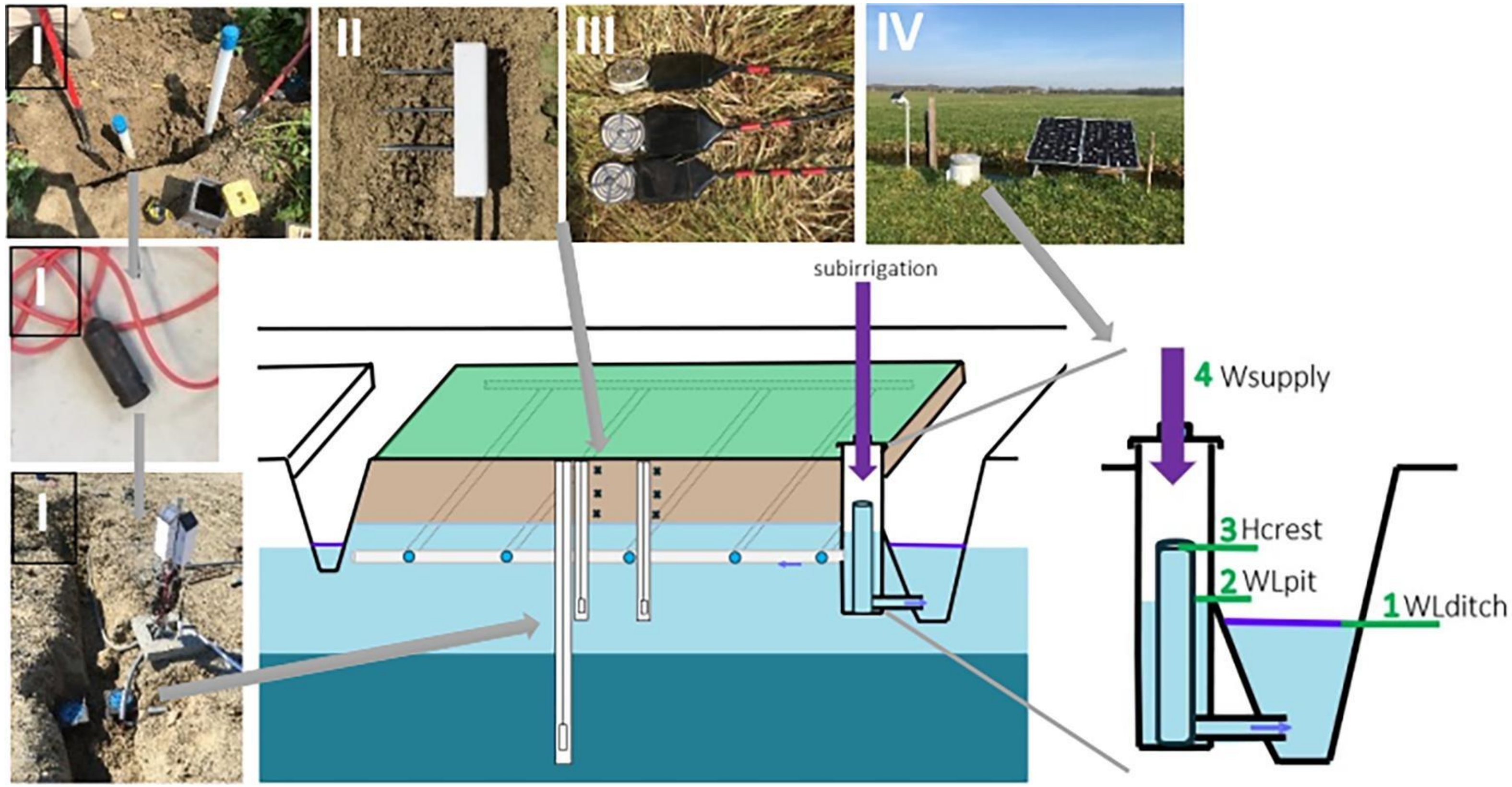
Kroes et al. (2017)

Controlled drainage with subirrigation in SWAP

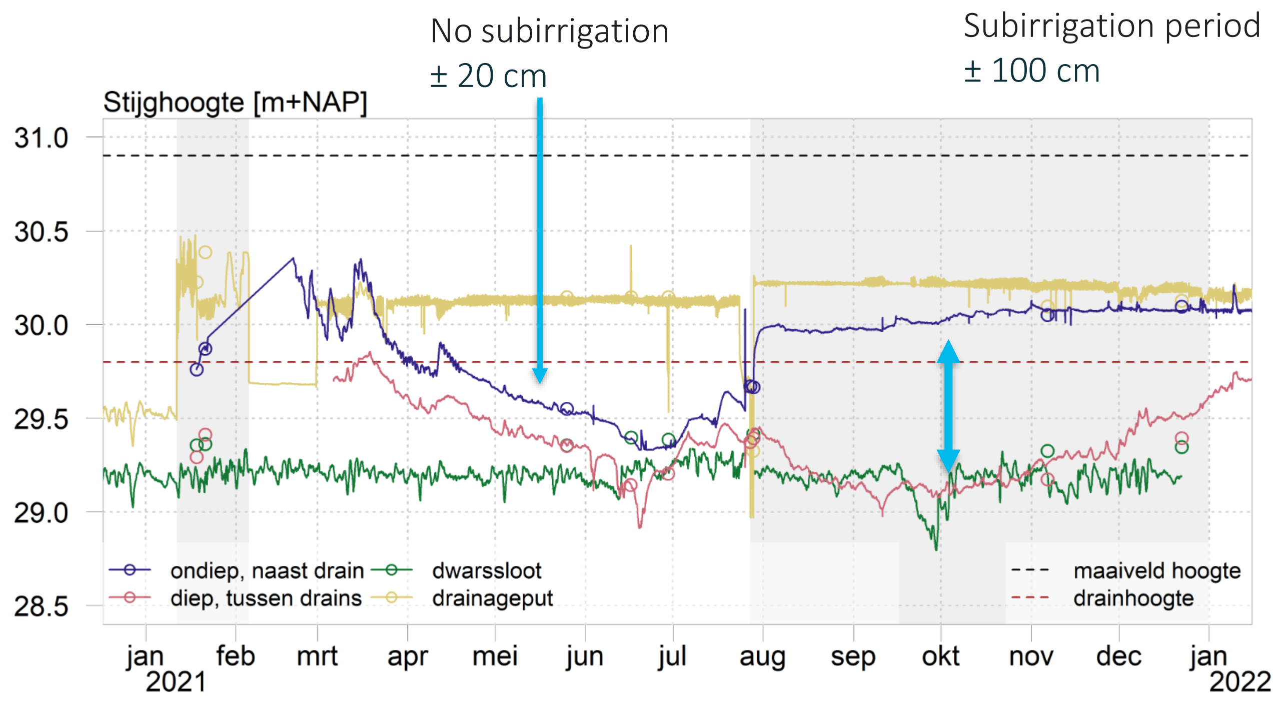
General set-up

- *Inlet* = control pit with water supply (Wsupply)
- *Primary water course* = ditch (WLditch)
- *Secondary water course* = pit level (WLpit)

- Water level in the control pit as input -> pit level = **fixed**
- Simulated water level in the control pit -> pit level = **dynamic**



Rising groundwater level through subirrigation



De Wit et al. (2024)

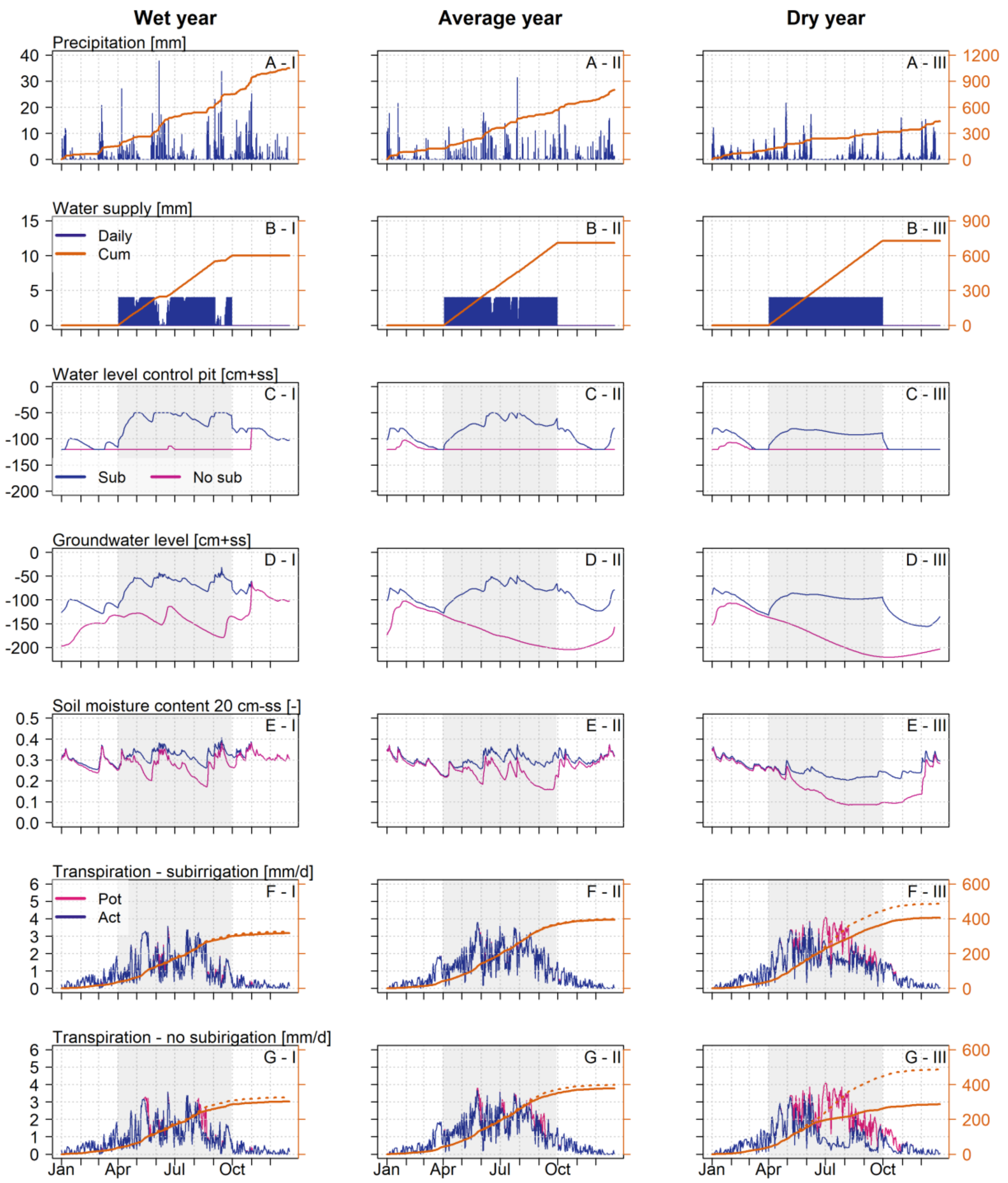
Hydrological changes due to subirrigation

Varying in meteorological conditions

	Wet year	Average year	Dry year
Precipitation	1000 mm	650 mm	450 mm
Water supply	580 mm 125 days max rate 44 days not max rate 14 days no pumping	700 mm 112 days max rate 13 days not max rate	730 mm 183 days max pumping rate (= always)
Pit level	‘stable’	‘stable’	~ 80 cm-ss
Groundwater level	‘stable’	Slightly lower	~ 100 cm-ss
Soil moisture content (20 cm)	‘stable’	Slightly lower	~ 0.2
Transpiration	Little stress	Little stress	Stress, but less than no sub.

De Wit et al. (2024)

- Wet & avg year: subirrigation hardly contributes to an increased crop water availability.
- Dry year: the crop clearly benefited from subirrigation, but there was also some stress.

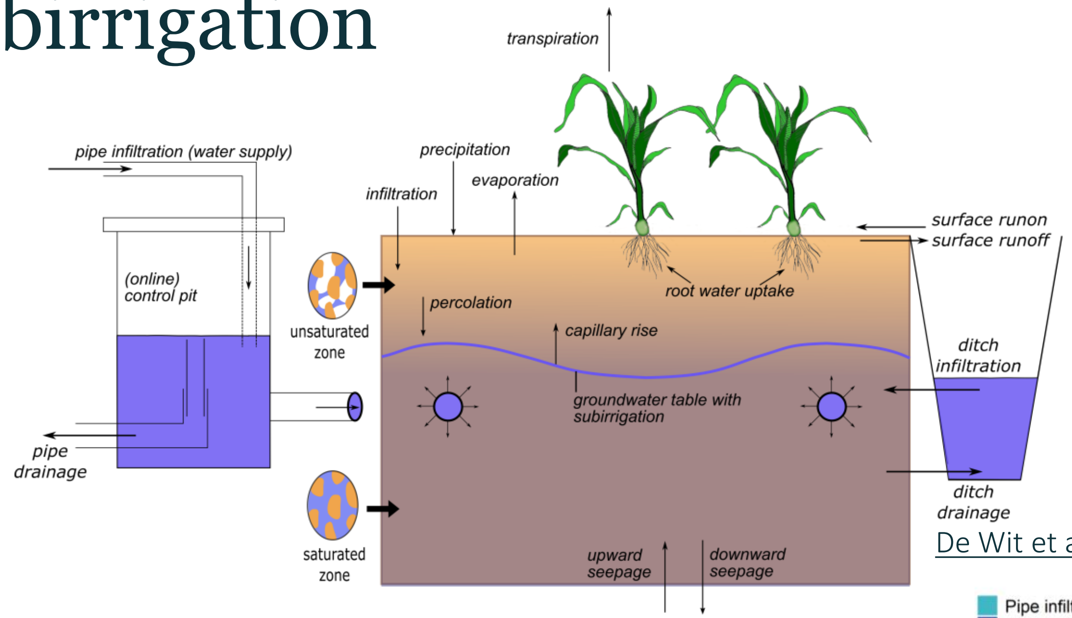


Hydrological changes due to subirrigation

Varying in geohydrological characteristics

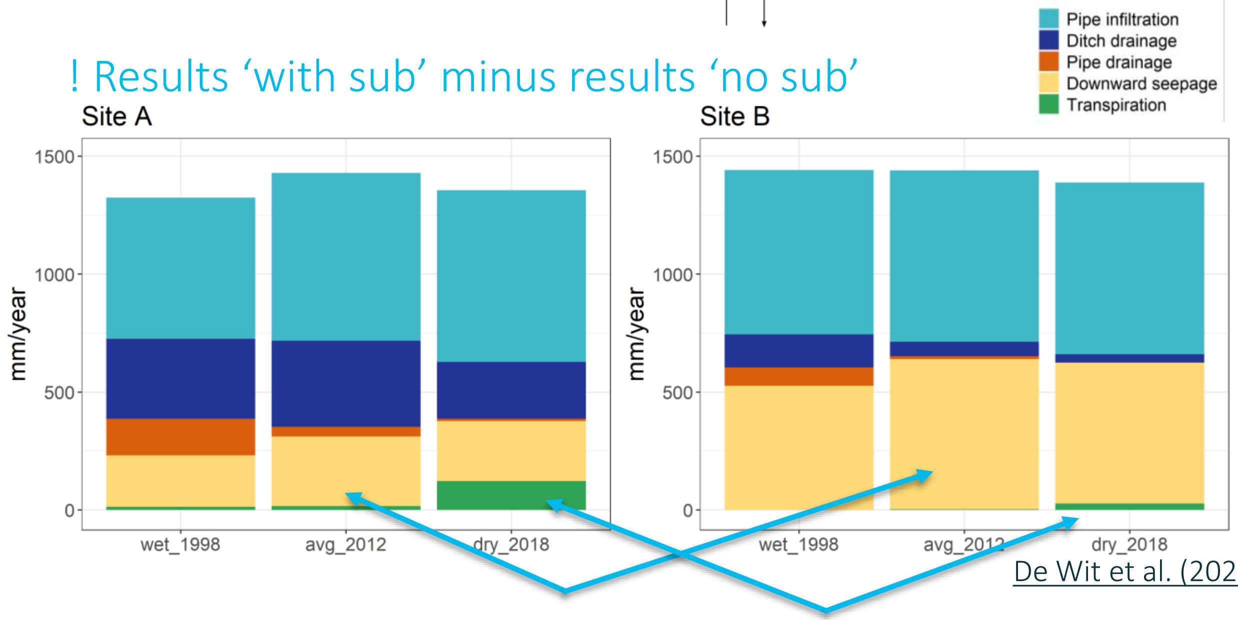
1) Controlled drainage with subirrigation requires a lot of water.
2) Subirrigation alters the water balance components -> strongly depends on geohydrological characteristics.

	A	B	C	D
Ditch drainage	47 %	2 %	46 %	39 %
Downward seepage	37 %	82 %	22 %	45 %
Transpiration	2.4 % – 16.5 %	0.2 % – 5 %	0.5 % – 28 %	1 – 17 %



De Wit et al. (2022)

! Results 'with sub' minus results 'no sub'



De Wit et al. (2024)

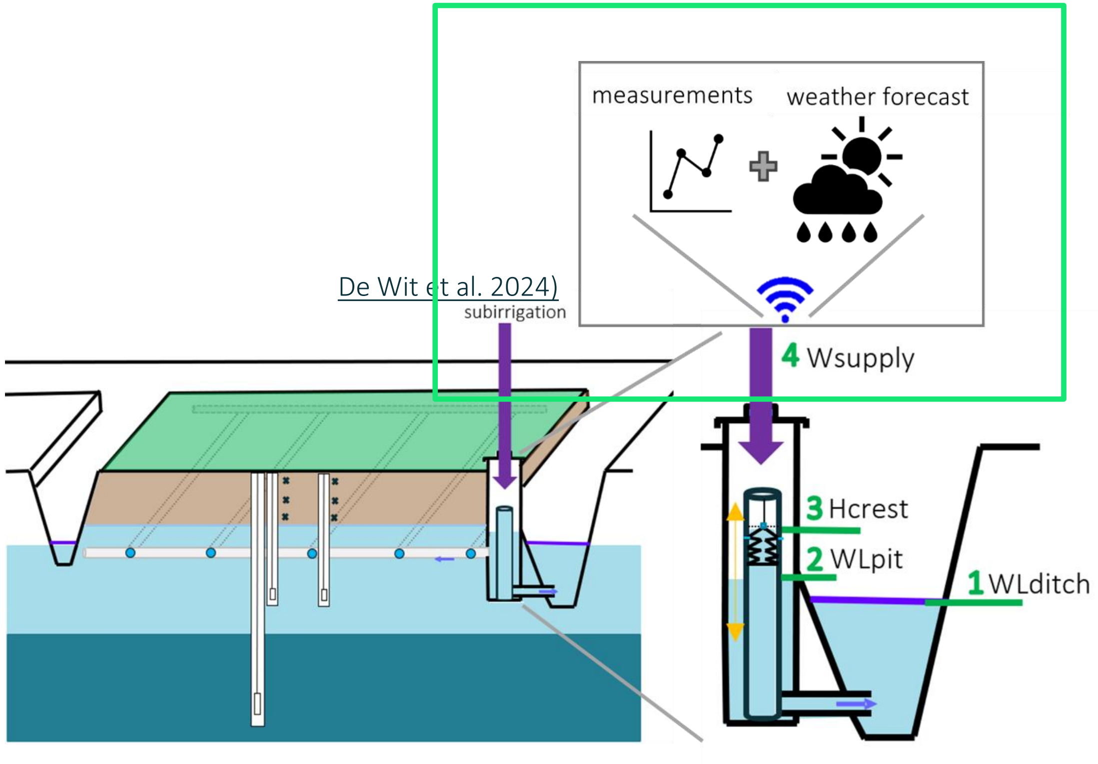
Change the pumping strategy

Controlled drainage with subirrigation – **fixed level**

- Maintaining a specific (fixed) groundwater level

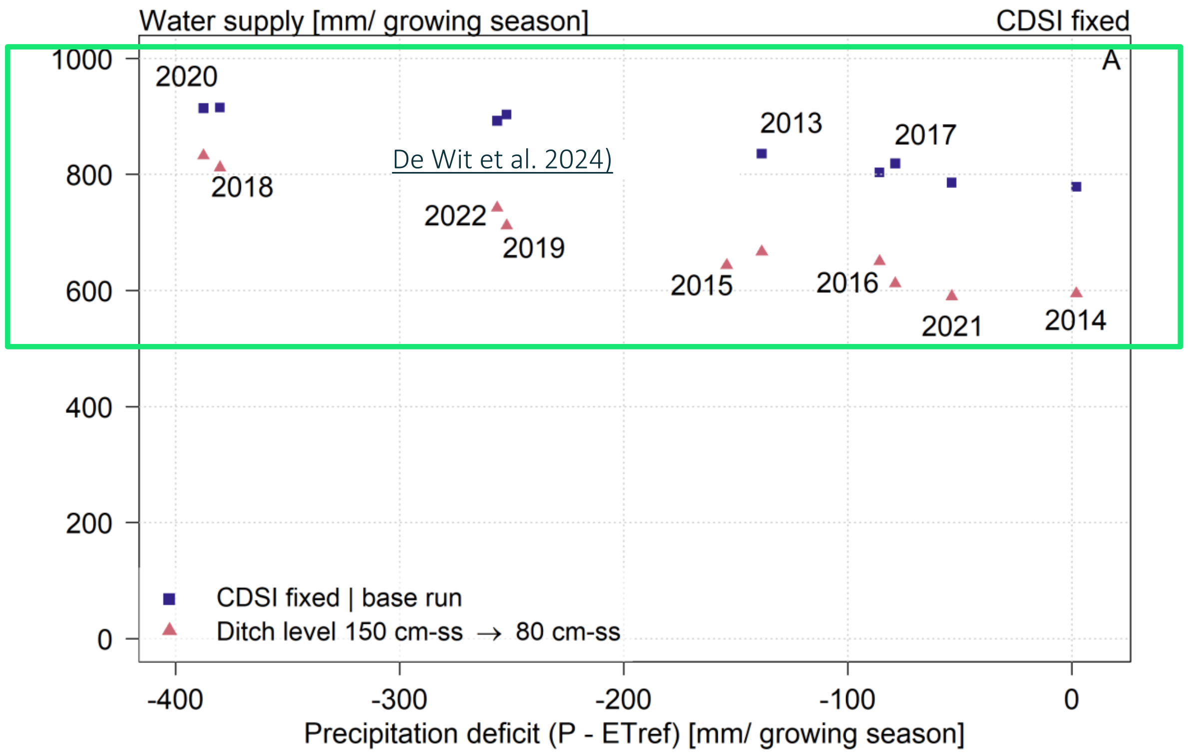
Controlled drainage with subirrigation – **dynamic level**

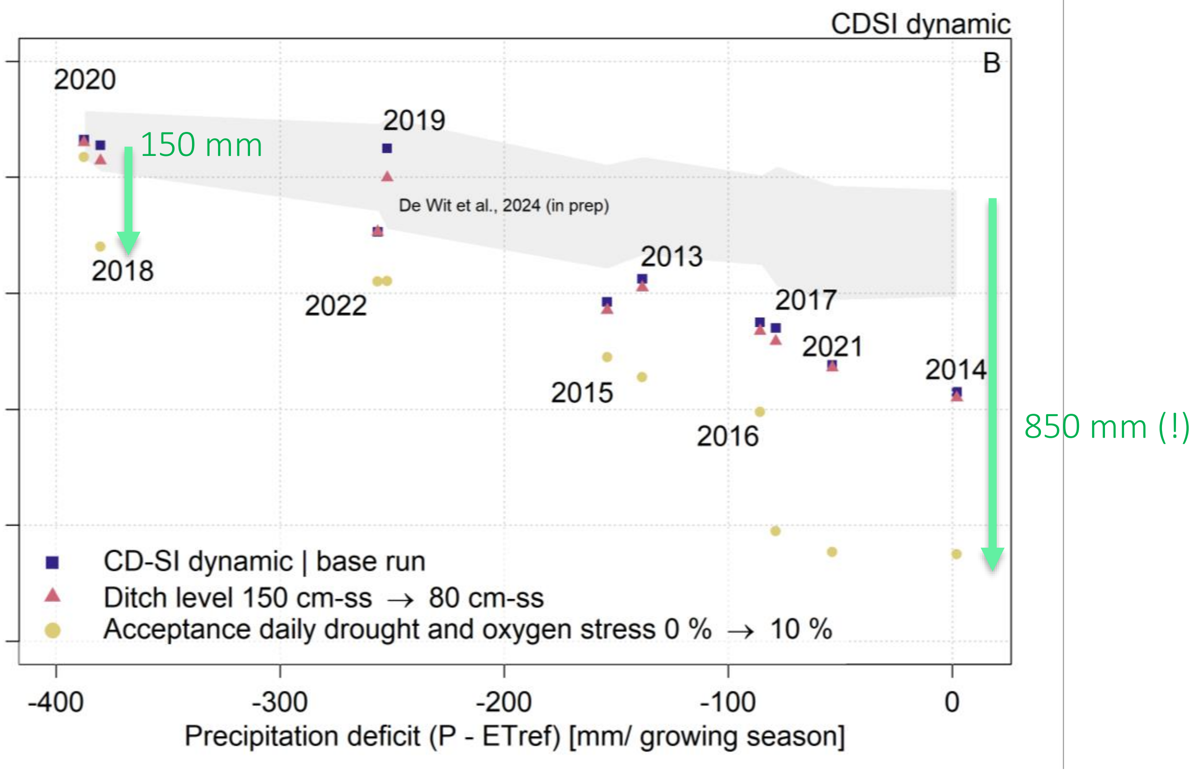
- Water supply automatically includes the actual needs of the crop during the growing season:
  1) Oxygen stress → lower crest to discharge water,
  2) Unnecessary drainage → raise crest to retain water,
  3) Drought stress → maximum crest level + supply water
  4) No oxygen and drought stress, no drainage → no action



Goal: Reduce external water supply for subirrigation by automatic control of CDSI systems.
Method: Combine current field conditions + weather forecast (10d) + SWAP modelling procedure (incl. crop water requirements).

Reduce external water supply for subirrigation





Maintaining a specific (fixed) groundwater level

- Water supply ~ 800 – 950 mm
- Water supply + higher ditch level ~ 600 – 950 mm

Water supply automatically takes into account the actual **crop needs**

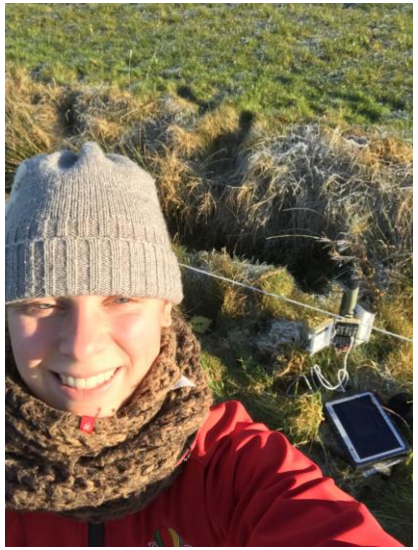
- Water supply ~ 400 – 950 mm
- Water supply + accept minor crop reductions ~ 150 – 850 mm

External water supply could be reduced via dynamic control and taking into account the actual crop water needs

Take home message

Controlled drainage with subirrigation

1) Controlled drainage with subirrigation systems could i) raise the groundwater level, ii) increase soil moisture availability for crops, iii) increase groundwater recharge.
2) Knowledge of geohydrological boundary conditions is key to identify effects of CDSI on components of the water balance.
3) Water supply could be reduced by smarter management.
4) Understanding what a local measure means on a regional scale is key.
5) SWAP could be used to simulate CDSI, both with a fixed and dynamic water level in the control pit



Think integrated !! The whole water system needs to be considered to ensure: enough water, of enough quality at the right place and time

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Colophon

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