Pump regulated submerged drains to further diminish soil subsidence and C02-emission

Next step in applying submerged drains

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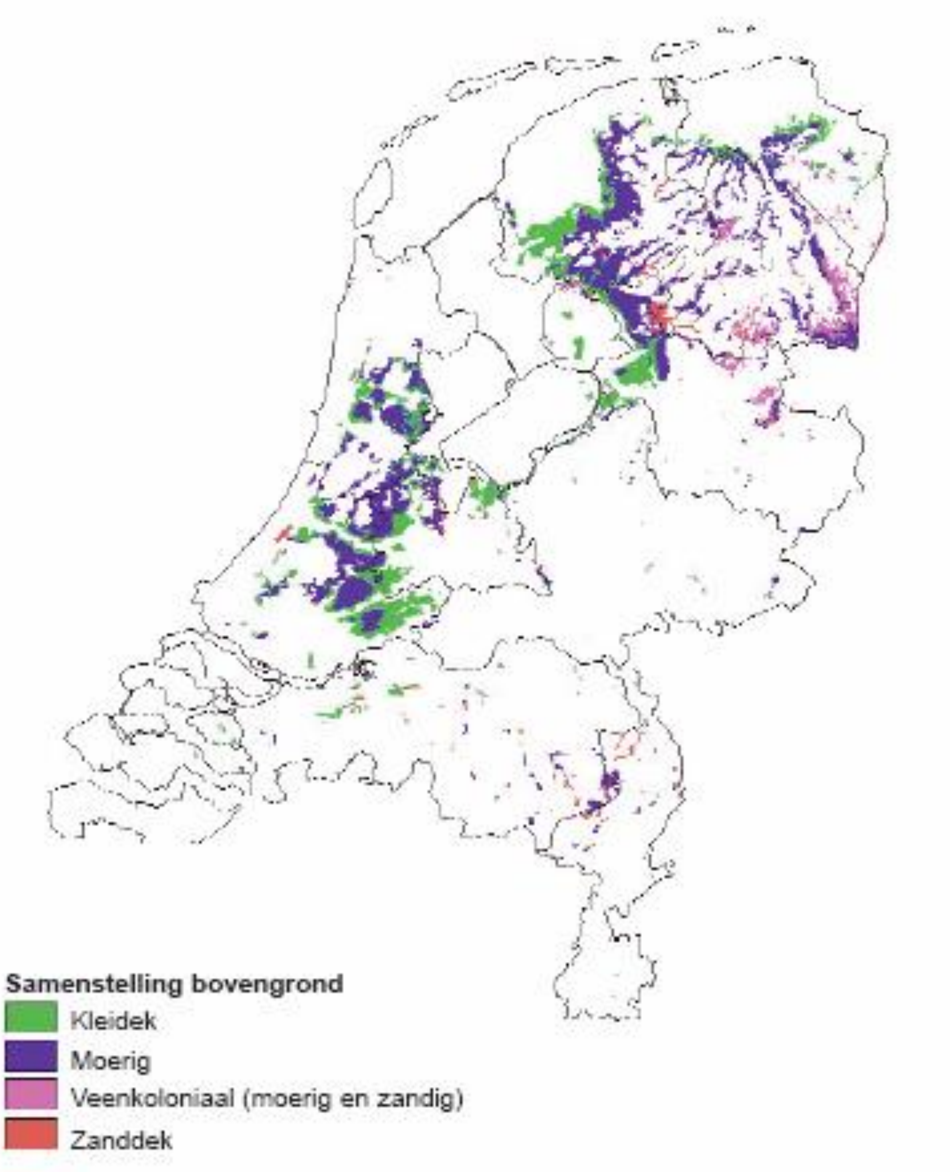
Peat in The Netherlands

- Agriculture 223.000 ha
- Nature 67.000 ha
- Total 290.000 ha



Characteristics farming on peat soil

- Peat soils in The Netherlands represent 19% of the dairy farms and 23% of the total agricultural grass area
- These soils are mainly situated in polders with a regulated (high) surface water level.
- Low bearing capacity of the grass sward
- Poor botanic composition of grass sward
- High density of ditches hampers parcelling

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Watermanagement peat soils

- Compromise between reducing soil subsidence and providing sufficient soil bearing capacity of grass sward
- Regulation with ditch water level
  - High ditch water levels (20 cm below soil surface) for nature purposes and minimizing soil subsidence
  - ‘Low’ ditch water level (60 cm below soil surface) to improve soil bearing capacity and productivity of dairy farms

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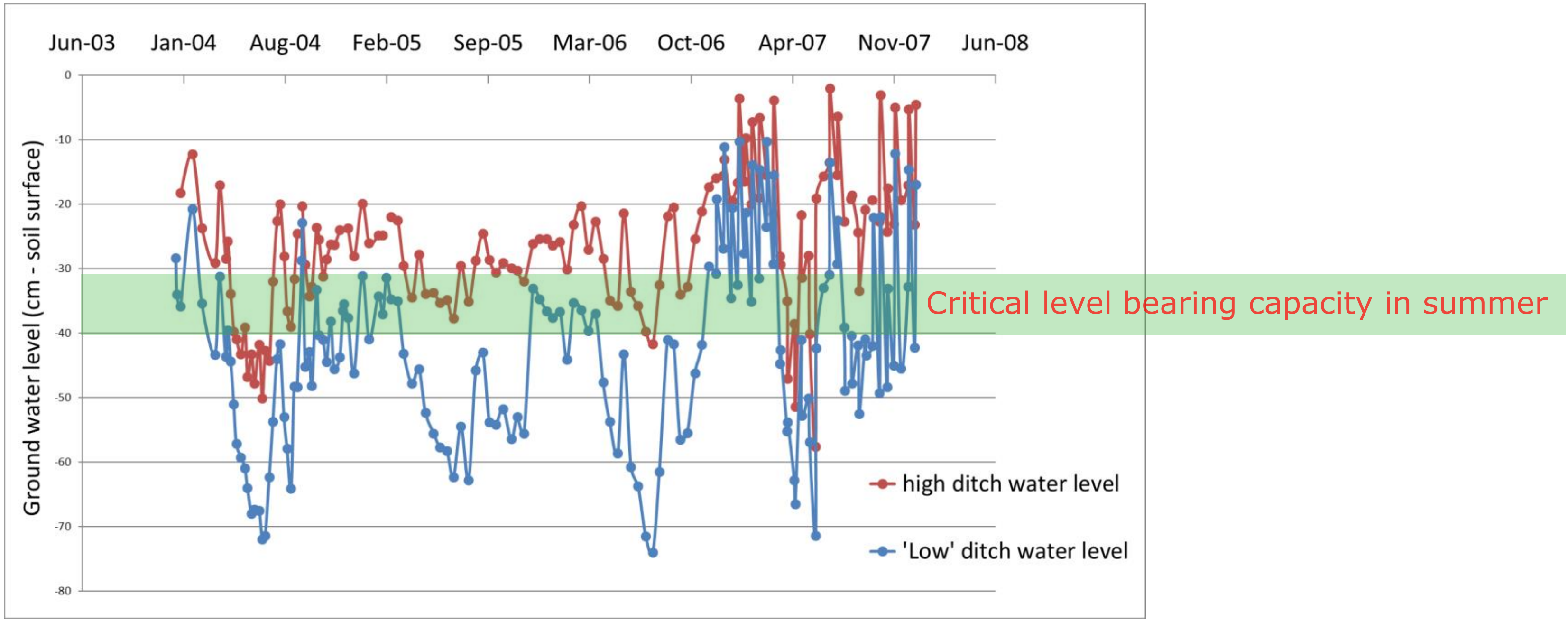
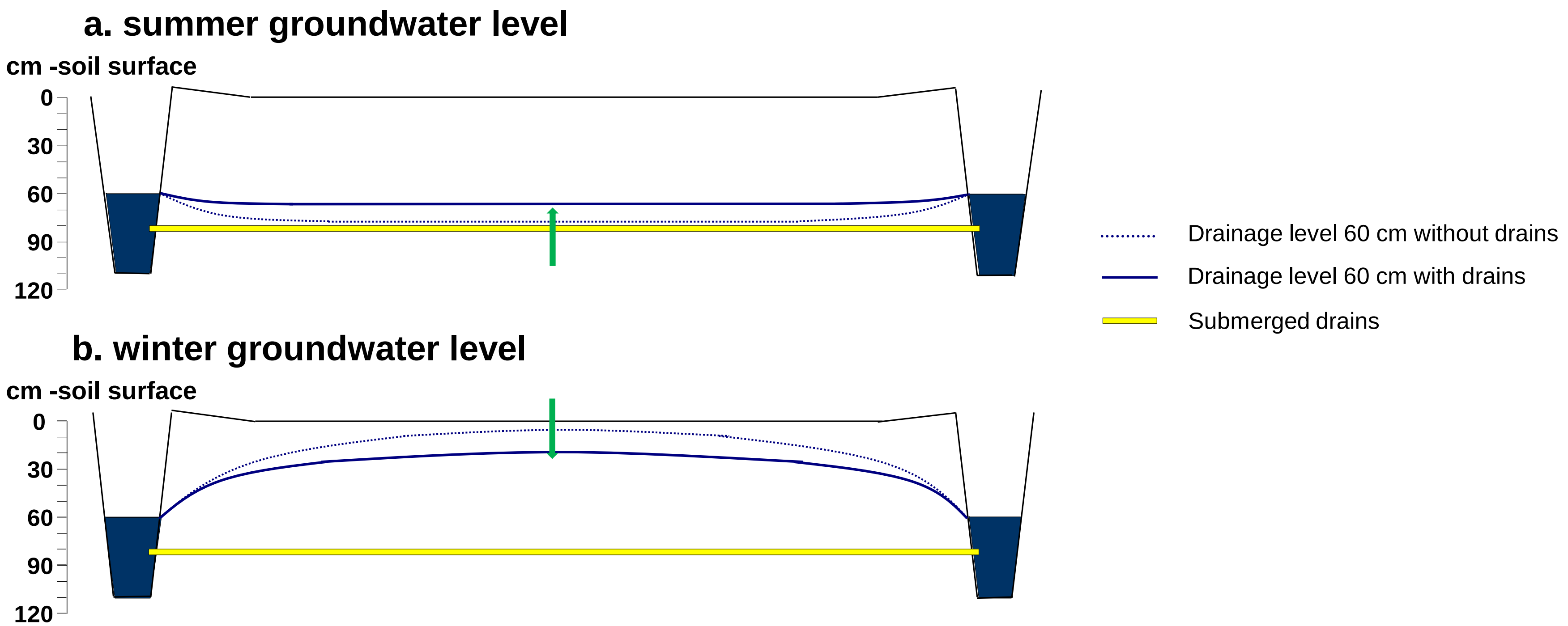
Annual variation groundwater level

- Water transport is limited due low water conductivity
- This means varying groundwater levels
  - High groundwater levels at precipitation surplus
  - Low groundwater levels at evaporation surplus



Implementation of submerged drains

- Submerged drains accelerate water transport and provide levelling groundwater levels



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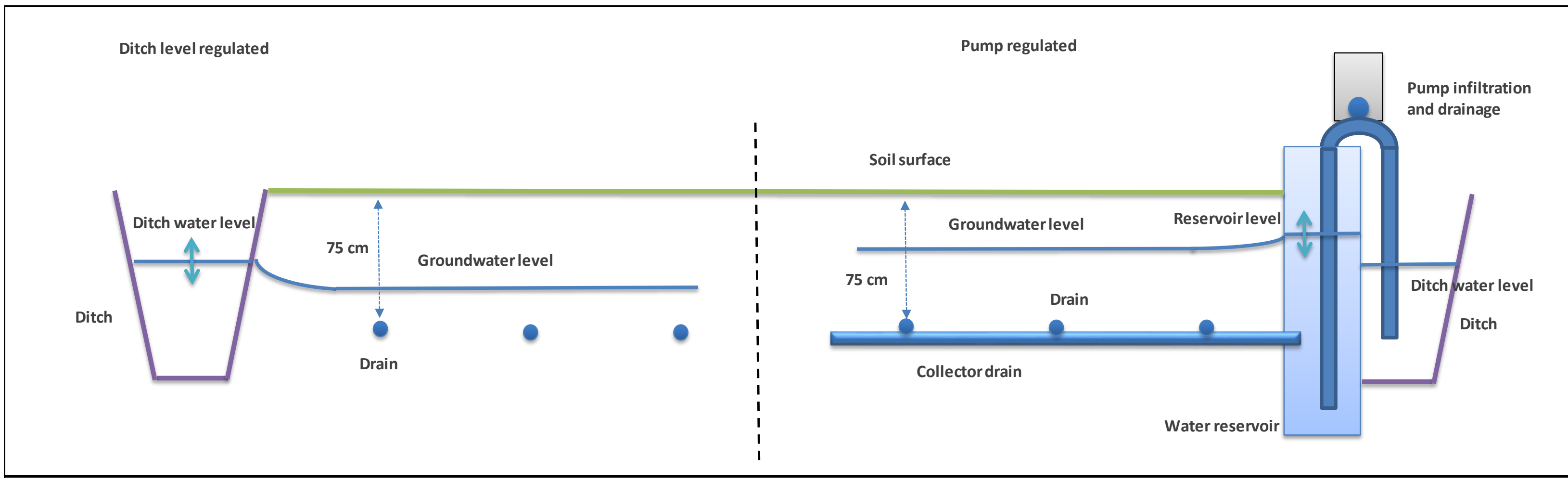
Field experiments and developing steps

Different projects on the hydrological and agricultural effects of application of 'submerged drains' during the last 14 years

1. Tests effects submerged drains at fixed 'low' and high ditch water level
2. Enlarging infiltration effects of submerged drains with dynamic ditch water level
3. Submerged drains in combination with reservoir and pump to have more control on the water table

3. Submerged drains with reservoir and pump

- To enlarge water pressure difference between surface water and ground water
- Test: can we keep groundwater level constantly on 40 cm below soil surface at 'low' and high ditch water level



Construction

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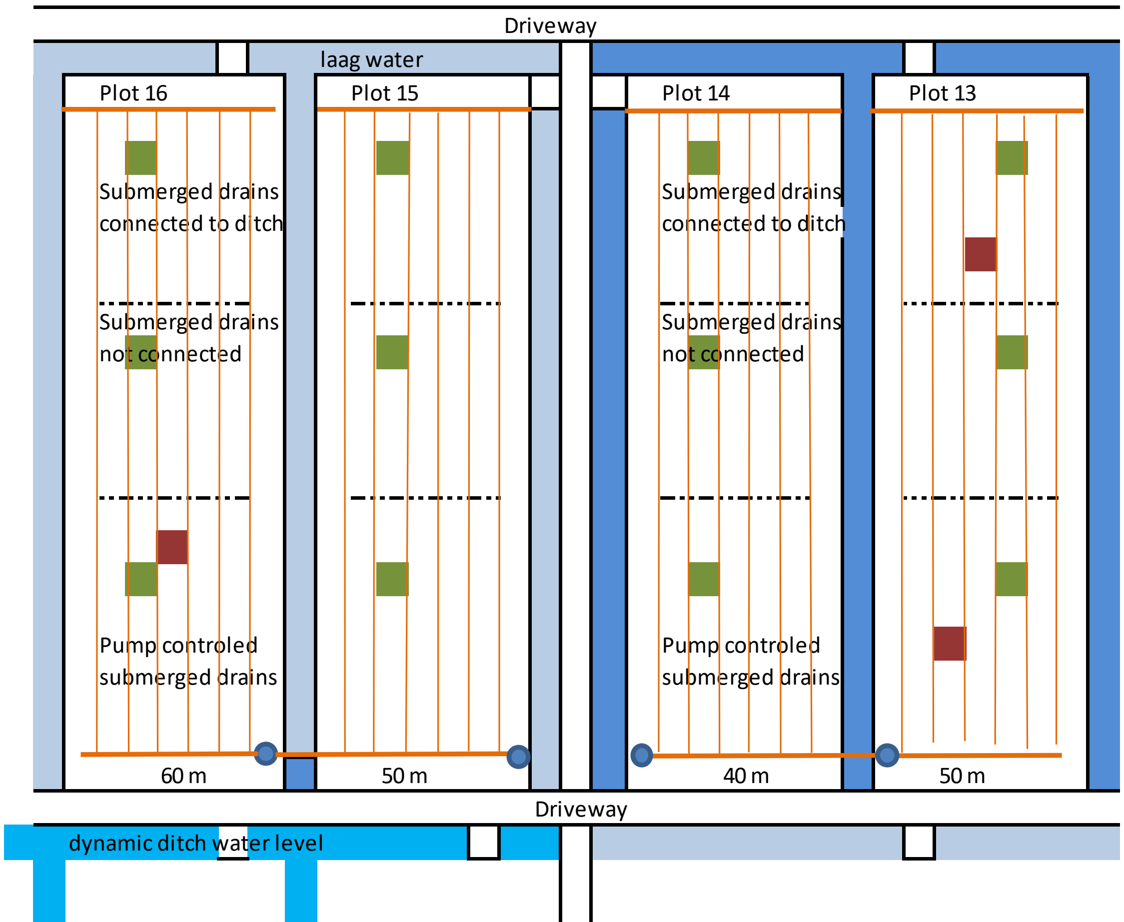
Research design

- Main treatment
  - High ditch water level of 55 cm below soil surface (2 plots)
  - ‘Low’ ditch water level of 20 cm below soil surface (2 plots)
- Sub treatment (1)
  - No submerged drains
  - Submerged drains without pump regulation
  - Submerged drains with pump regulation
- Sub treatment (2)
  - No nitrogen fertilisation (N0)
  - Nitrogen fertilisation (N1)

Field experiment at high and low ditch level



Water reservoir pump controled submerged drains
Collector drain
Drain tube

High ditch water level (20 cm -soil surface)
Low ditch water level (55 cm -soil surface)

Plot yield measurement grass
Measurement ground level earlier research

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Measurements

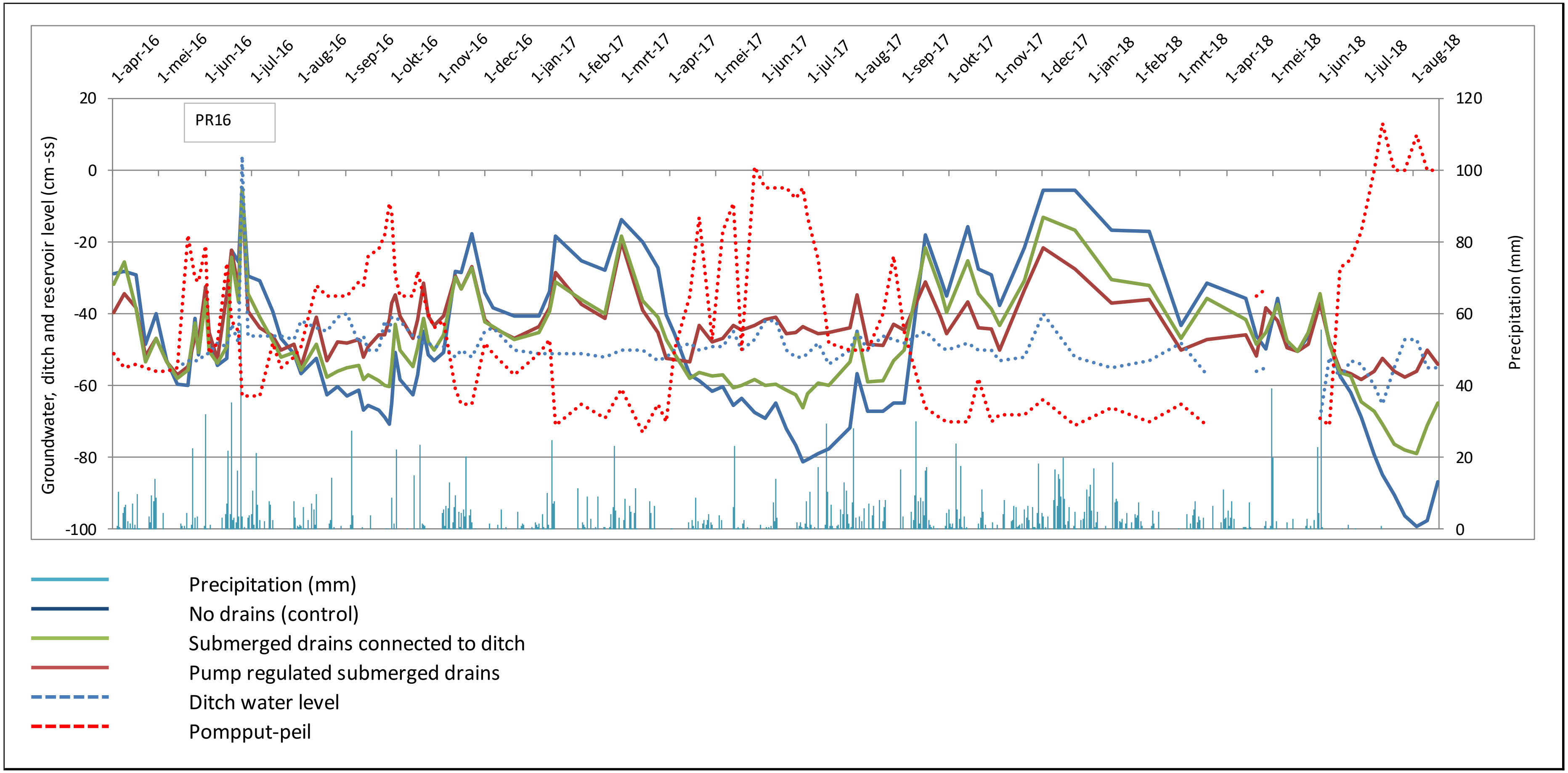
- Groundwater table
  - Manual – weekly
  - Water pressure sensor – high frequent
- Ditch water level
- Grass yield (2016-2017)
  - Duplicate treatments trial fields of 1,5 x 10 m
- Botanical composition
- Ground level
- Analysis N-total grass

Level management

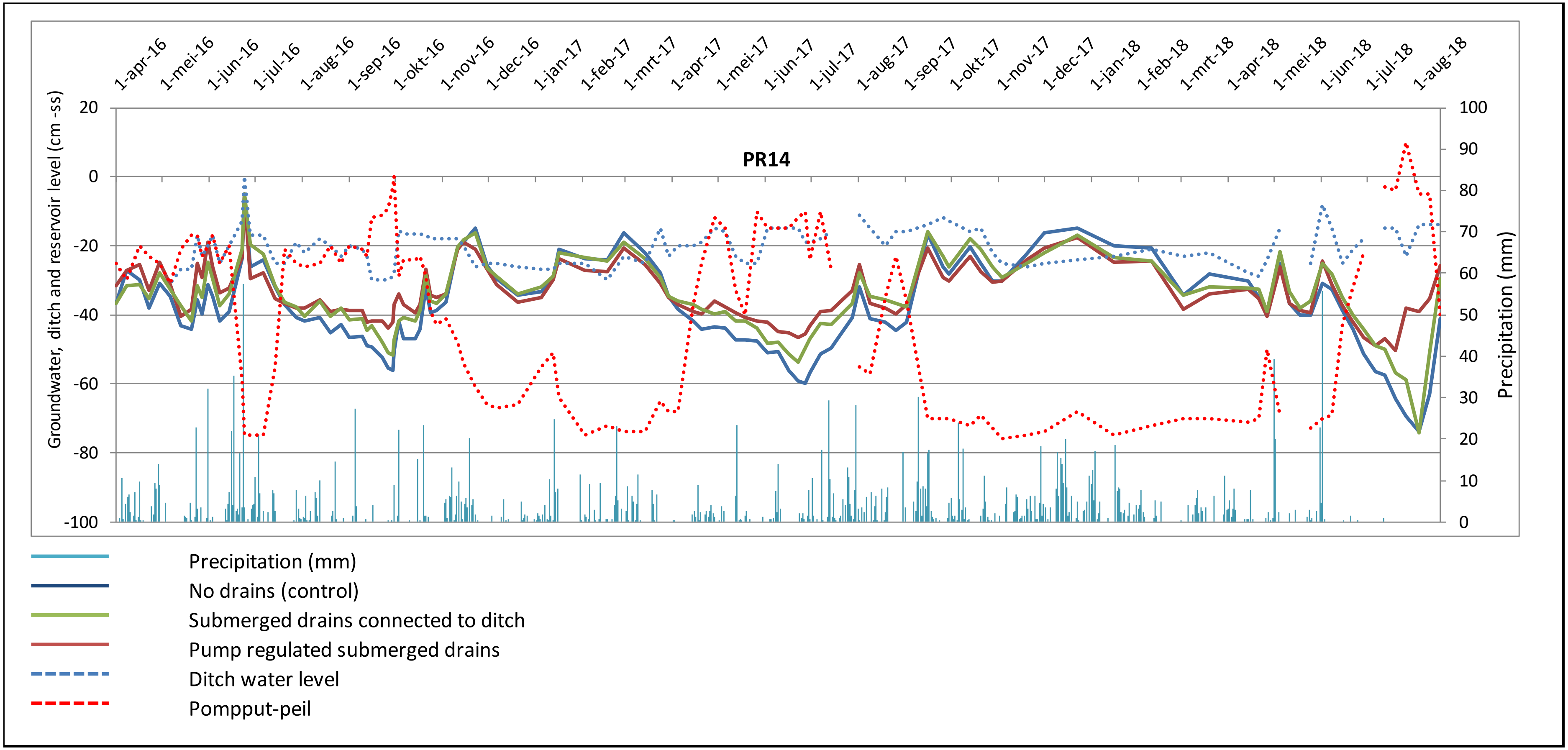
- Reference monitoring well per object with pressure sensor;
- Additional manual measurements monitoring wells;
- Mean groundwater level high and low ditch water level;
- Target groundwater level was 35 à 40 cm –soil surface;
- Manual execution of the water level management based on weather forecast and current groundwater level

	Drainage				
	Infiltration-1	reservoir level 10 cm below soil surface			
	Infiltration-2	reservoir level equal to soil surface			
Current groundwater level (cm)	< 30	31-35	36-40	41-45	> 45
Rainfall forecast day 1-3 (mm)					
0	Drainage	0	Infiltration-1	Infiltration-2	Infiltration-2
0-10 mm	Drainage	Drainage	0	Infiltration-1	Infiltration-2
10-25 mm	Drainage	Drainage	Drainage	0	Infiltration-1
>25 mm	Drainage	Drainage	Drainage	Drainage	0

Results 'low' ditch water level plot 16



Results high ditch water level plot 14



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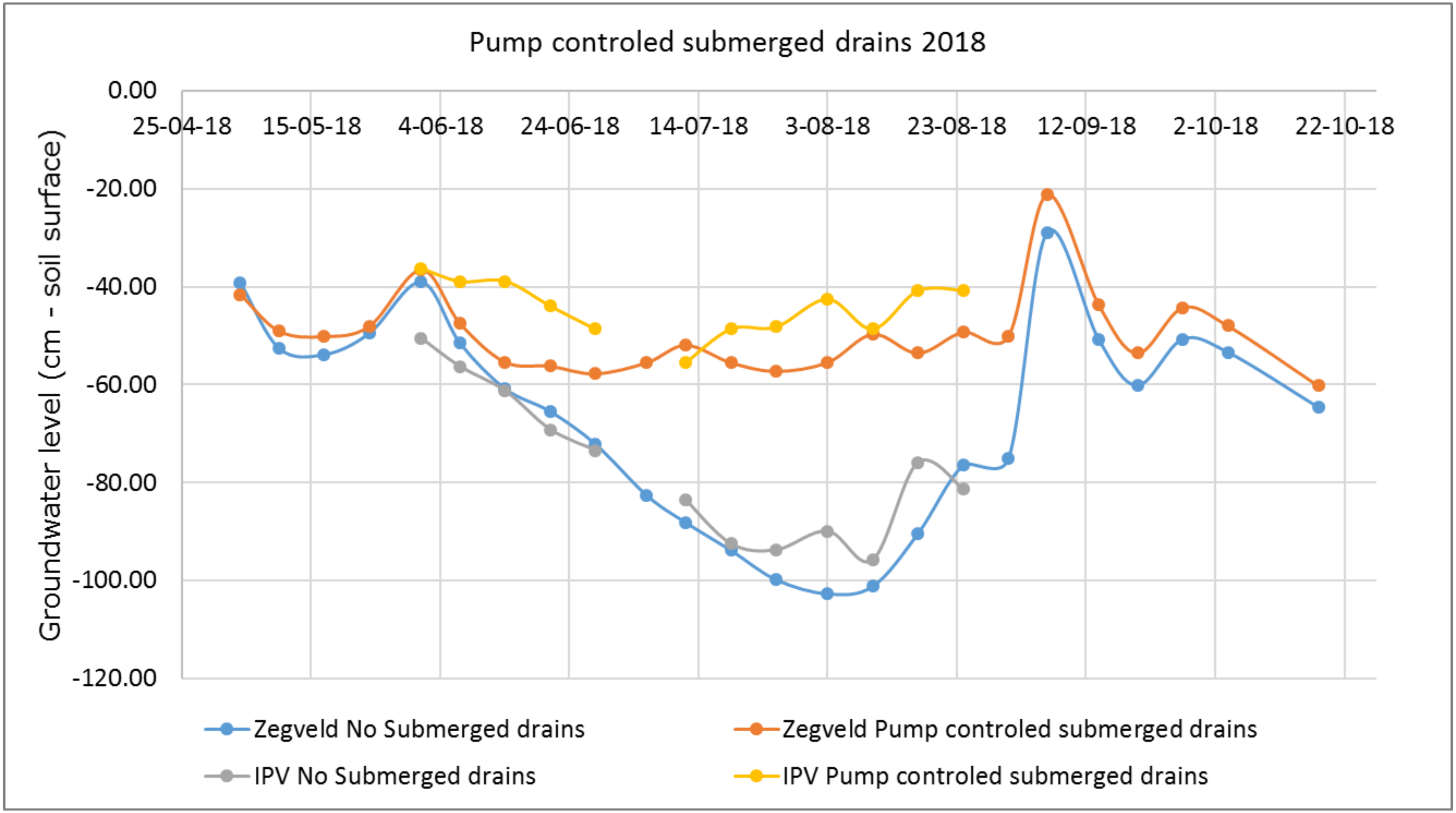
Comparison with application at other location



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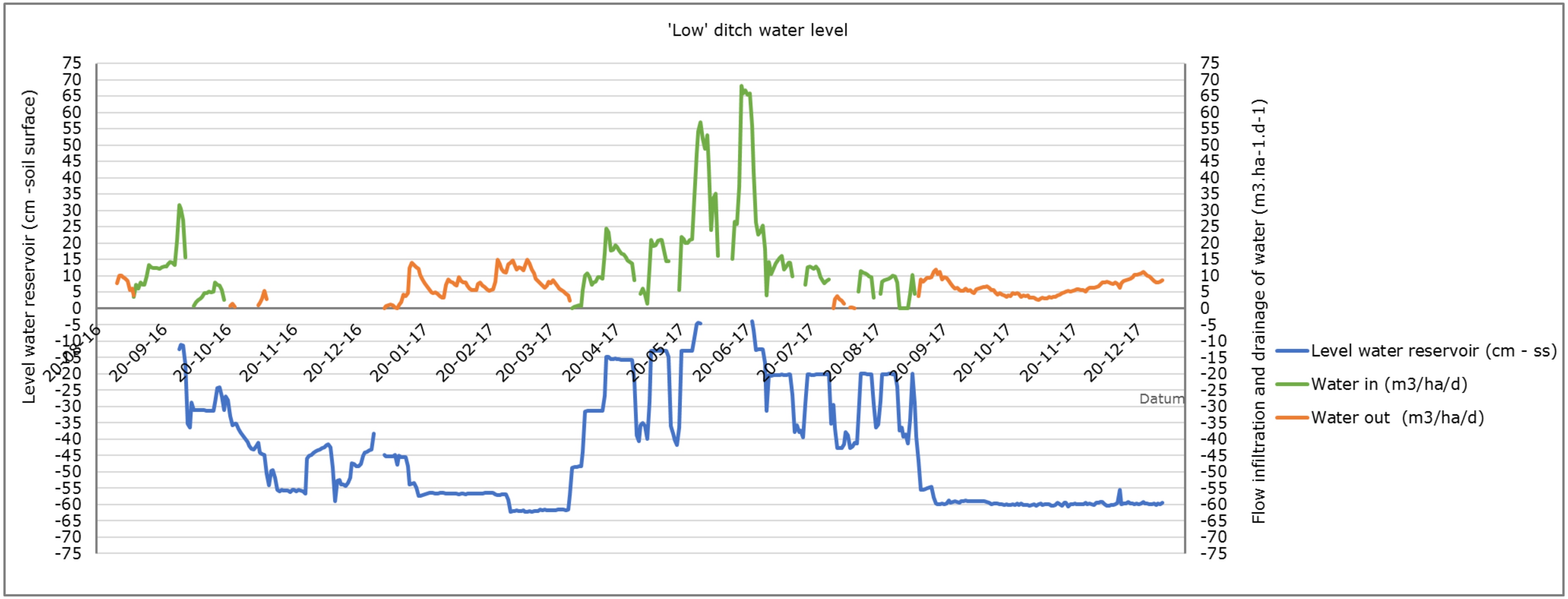
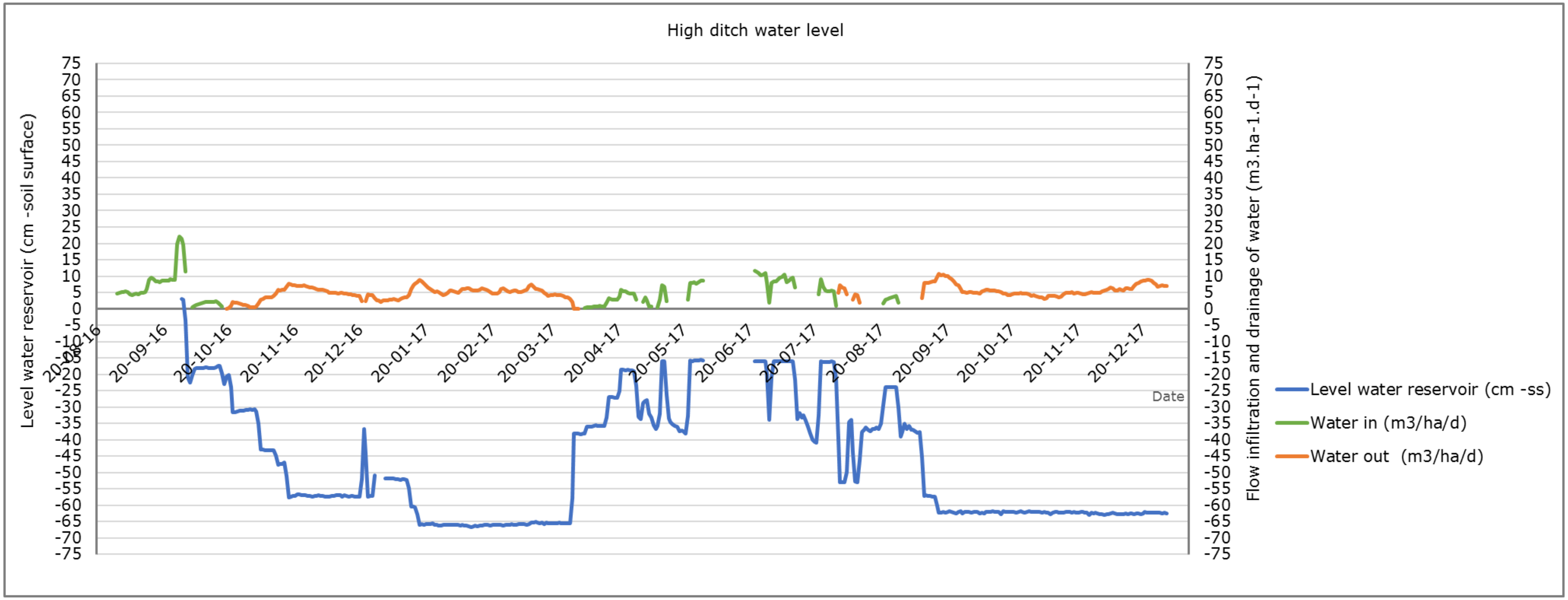
Quantity infiltration water



Quantity drainage water



	High ditch water level (m3/ha/d)		Low ditch water level (m3/ha/d)	
	In	Out	In	Out
max	22	11	68	15
min	0	0	0	0
Median	5	5	13	6
Average	6	5	16	7

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Discussion

- Target level of 40 cm-mv was an empirically determined level, which applies to the relevant experimental plots
- For the optimization of the reduction of peat degradation and CO2 emission, the soil moisture condition should be the guiding principle
- Rainfall forecasts did not always come out, so that level changes sometimes were delayed
- During considerable precipitation peaks the groundwater level rose above the desired level, but the duration was much shorter than that of the underwater drains in the ditch.
- The permeability differed between and within plots. Is soil permeability determined properly? The drain distance for the ditch connected submerged drains should probably be smaller (4 m?).
- Inflow of contaminated water may also have been a problem.

Conclusions

- Pump controlled submerged drains have a clear effect
- Provides both extra infiltration and extra drainage
- Result is independent of the ditch water level
- Extra drainage seemed to give extra carrying capacity
- Potential reduction in soil surface fall is expected more than 50%
- The quantity of infiltration is 2.5 times higher at 'low' ditch levels than at a high ditch level. The quantity of drainage is almost equal
- Steering sharply on groundwater level is essential to reduce soil surface fall and CO_2 emissions significantly
- Higher investment costs and application costs lower economic returns

Perspectives

- Submerged drains in combination with reservoir and pump makes it possible to control groundwater level more directly
- Independent from ditch water level
- Groundwater level should be leading instead of ditch water level
- Main benefit concerns increase of number of grazing days
- Main cost concerns electricity (regardless construction costs)
- Improved operation should cover higher costs for construction



Recommendations

- Placement of monitoring wells preferably between drain tubes at one third to half the width of a plot.
- Use multiple automatic pressure sensors per plot, so that observations remain available in the event of a malfunction
- The use of automatic pressure transmitters requires a good organization of data. This concerns identification of the sensors linked to a location in the field and insight into the observations of the sensor.
- In order to prevent loss of water to adjacent ditches during infiltration, the ditch water level should be set to the target groundwater level.
- A protocol should be made to identify permeability and to determine drain distance properly

Thank you for your attention!

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