Water management for climate smart agriculture on peatlands using submerged drains

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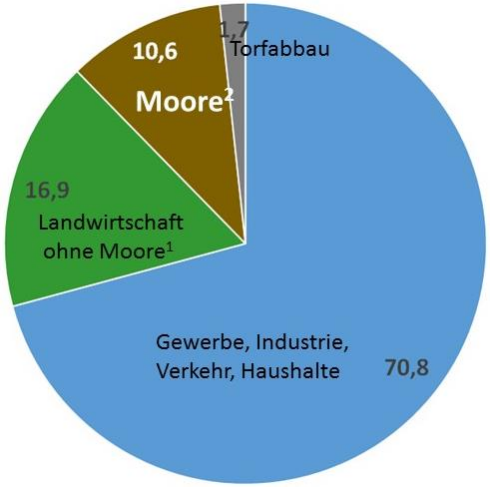
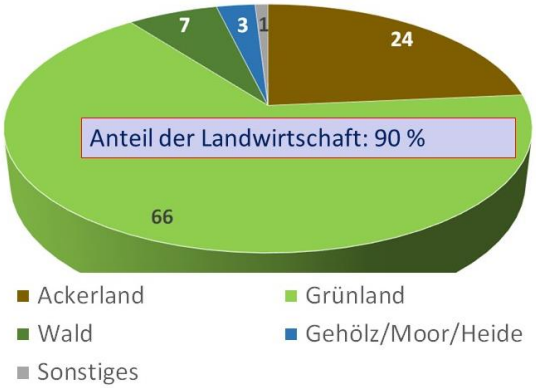
Greenhouse gas emissions from peatlands in Lower Saxony



- 10,6 Mio. t CO_2-eq./year
- 11% of total state GHG
- ≈ GHG-emission of 5,5 Mio. cars/year (Lower Saxony: 4,5 Mio. cars)



- 90 % of GHG of peatlands are due to agricultural use, mostly grassland

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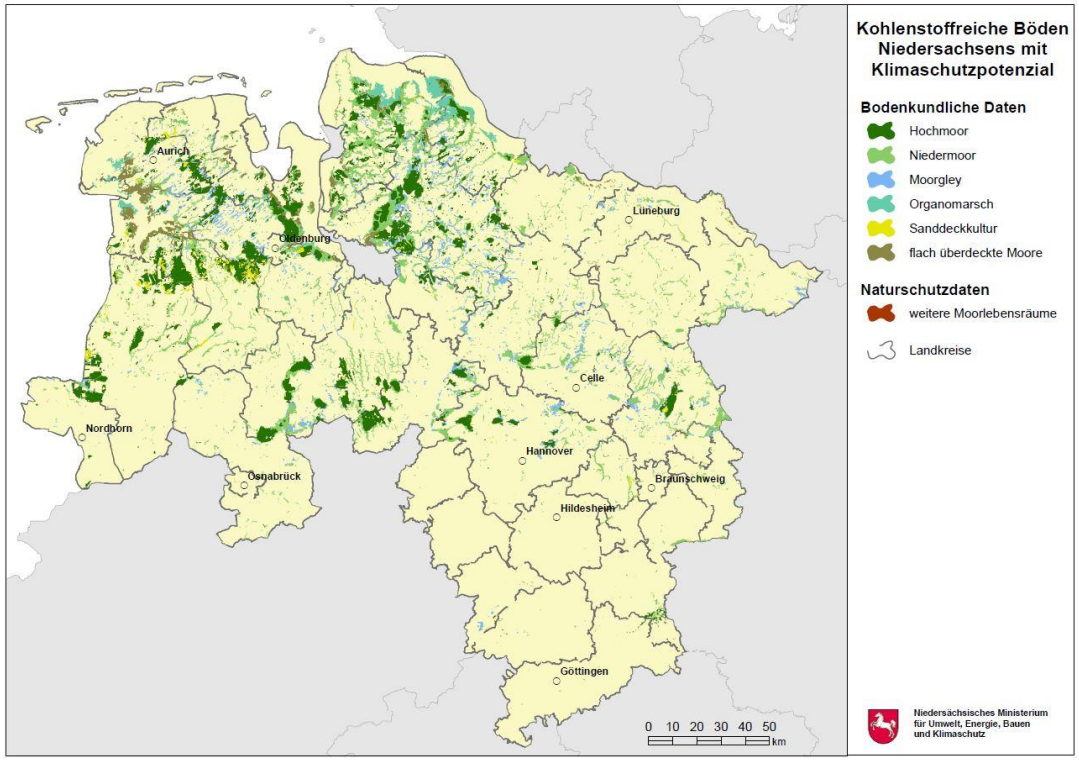
Peatlands and other organic soils in Lower Saxony



- 396.000 ha bogs and fens
- 64 % under agriculture
- Mostly grassland (82 %)
- Dairy farming
- Animal grassing on pasture land
- Regional high land pressure (high land prices)

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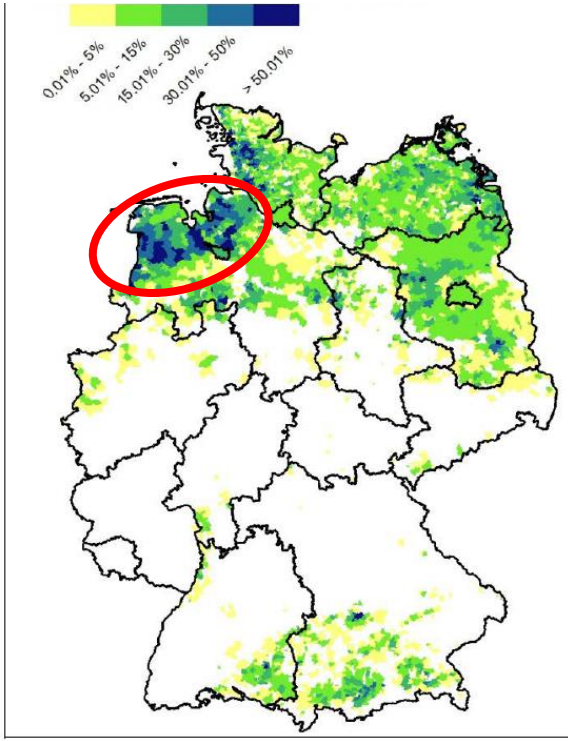
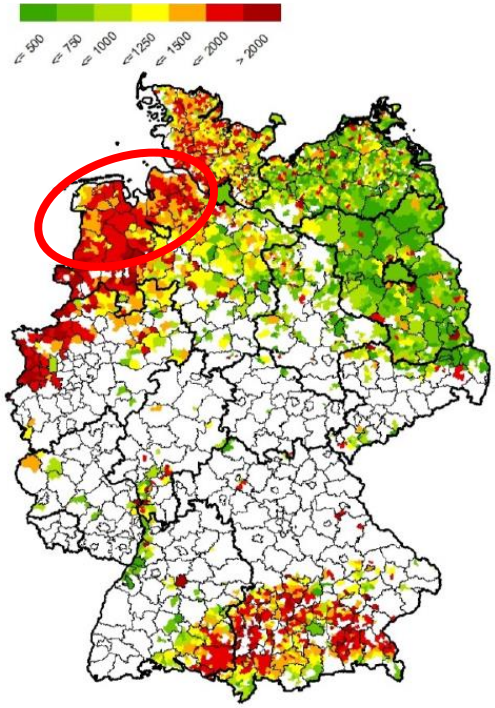
Land use intensity of grassland on peat in North-West Germany

Peatland as a proportion of farmland at the community level (%)



Contribution margin of farmland at the community level (EUR/ha)



Peatland as a proportion of farmland and standard contribution margin at the community level in Germany in 2007

Wissenschaftlicher Beirat Agrarpolitik, Ernährung und gesundheitlicher Verbraucherschutz und Wissenschaftlicher Beirat Waldpolitik beim BMEL, 2016

In peat areas in Lower Saxony high contribution margins are observed, mostly due to milk production

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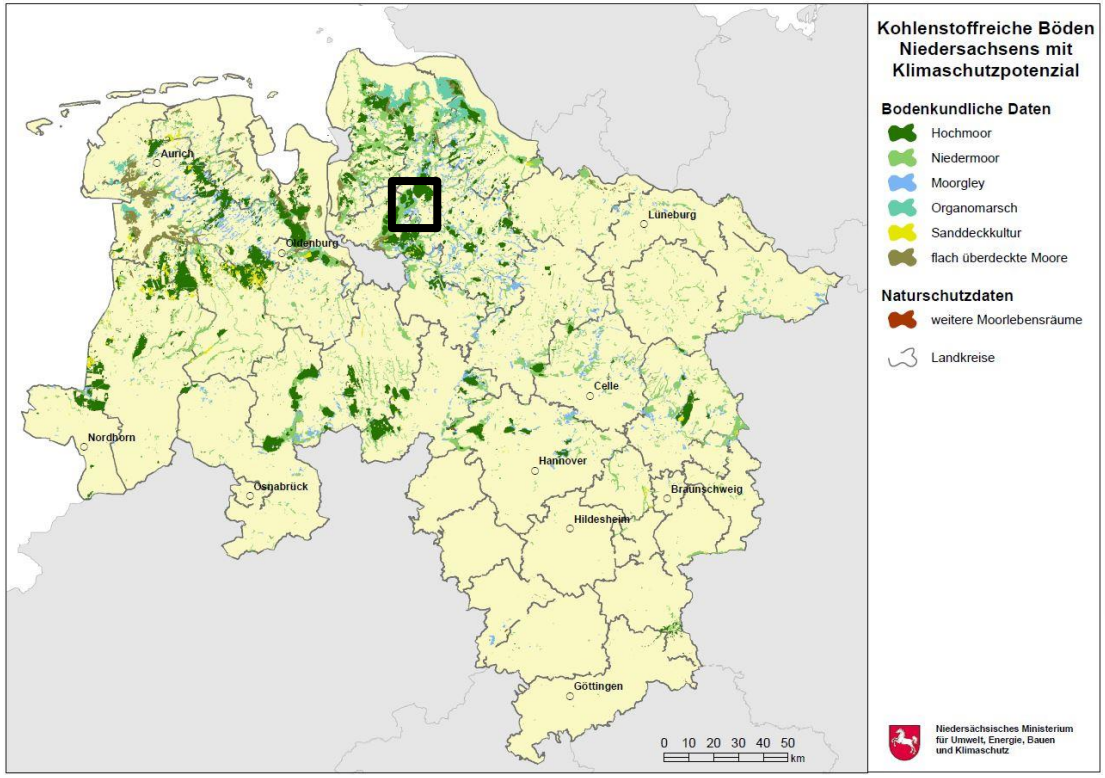
Pilot project „Gnarrenburger Moor“



Gnarrenburger Moor

- Bog area
- 7.100 ha
- 4.100 ha under agriculture
- German raised bog cultivation
- Large areas with peat depth > 2 m

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General Objectives

- To reduce GHG-emissions and peat degradation on peatlands under agriculture (grassland)
- To preserve and improve farming conditions on peatlands

- To study basics for water management
- To develop adaptation measures for farmers on grassland with raised water table
- To improve acceptance and efficiency of climate protection measures by cooperating with farmers
- To develop ways in order to implemente measures of water management

Funding

- European Fund for Regional Development „Climate protection by Peatland Management“
- 50 % EU, 50 % State of Lower Saxony
- Project term: April 2016 – June 2021

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Peat profile

Depth (cm)	Horizon	Peat type (Texture)	v. Post	Sat. conductivity (cm/day)
0 - 16	Hv	Sphagnum peat, earthified	(9-10)	
16 - 42	Hw	Sphagnum peat (Section Sph. cymbifolia Hhsy)	2-3 slightly decomposed	6
42 - 62	Hw	Sphagnum peat	6 moderatly decomposed	1 - 2
62 - 80	Hr	Sphagnum peat (Sec. Sph. cuspidatum Hhsu)	5 moderatly decomposed	1-2
80 -	Hr	Sphagnum peat	8 Very highly decomposed	
Ca. 190 -	Gr	Fine sand, medium sandy (msfS)		

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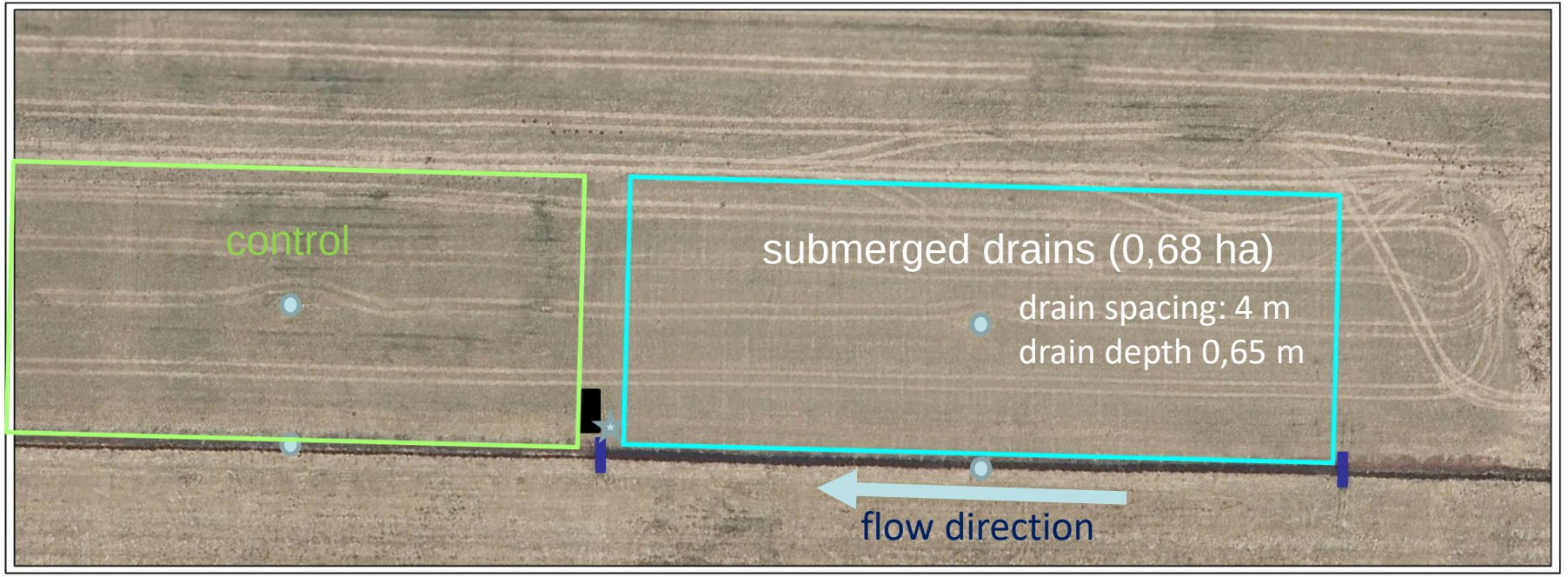
Experimental Setup



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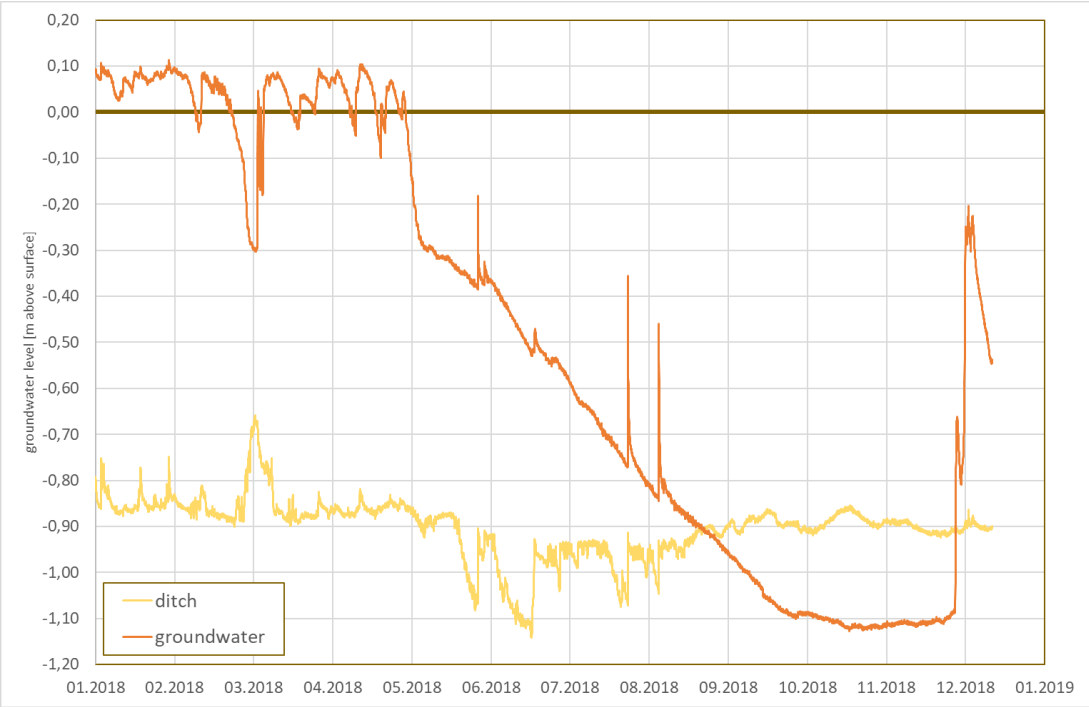
Control: ditch vs. ground water level



Period: June - October	
ditch water level	0,9 m BGL
ground water level	0,4 / 1,1 m BGL

BGL: below ground level

Distance between monitoring well and ditch: 25 m

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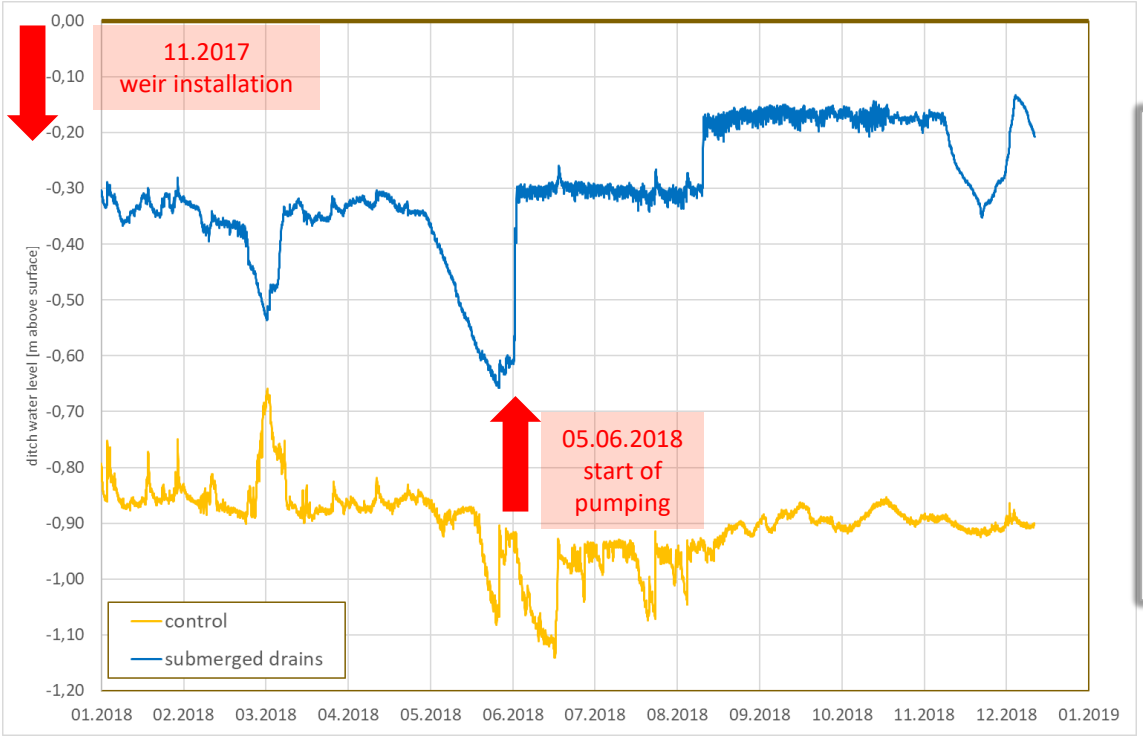
Ditch water levels: submerged drains vs. control



Winter 2017/2018 before pumping

Ditch water level in submerged drains about 0,6 m above control

Summer – autumn 2018 with pumping

Ditch water level in submerged drains about 0,6-0,7 m above control

BGL: below ground level

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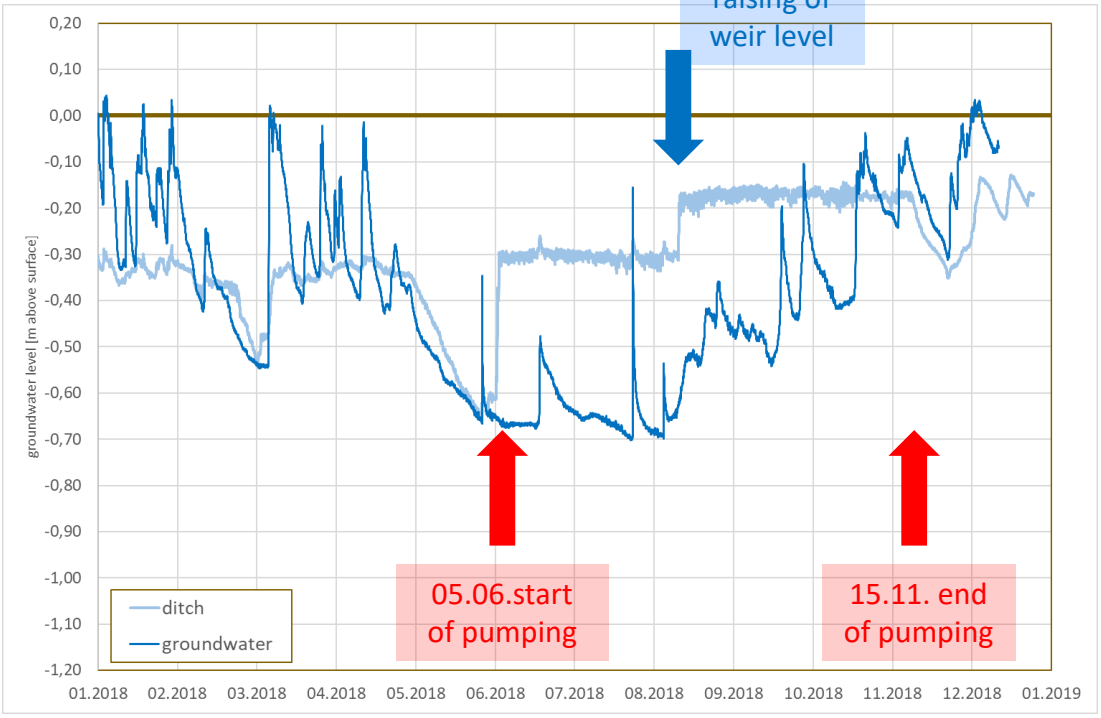
Submerged drains: ditch vs. ground water level



Period: June - October	
ditch water level	0,3 / 0,2 m BGL
ground water level	0,6 / 0,2 m BGL

BGL: below ground level

Distance between monitoring well and ditch: 25 m
Distance between monitoring well drain tile: 1 m

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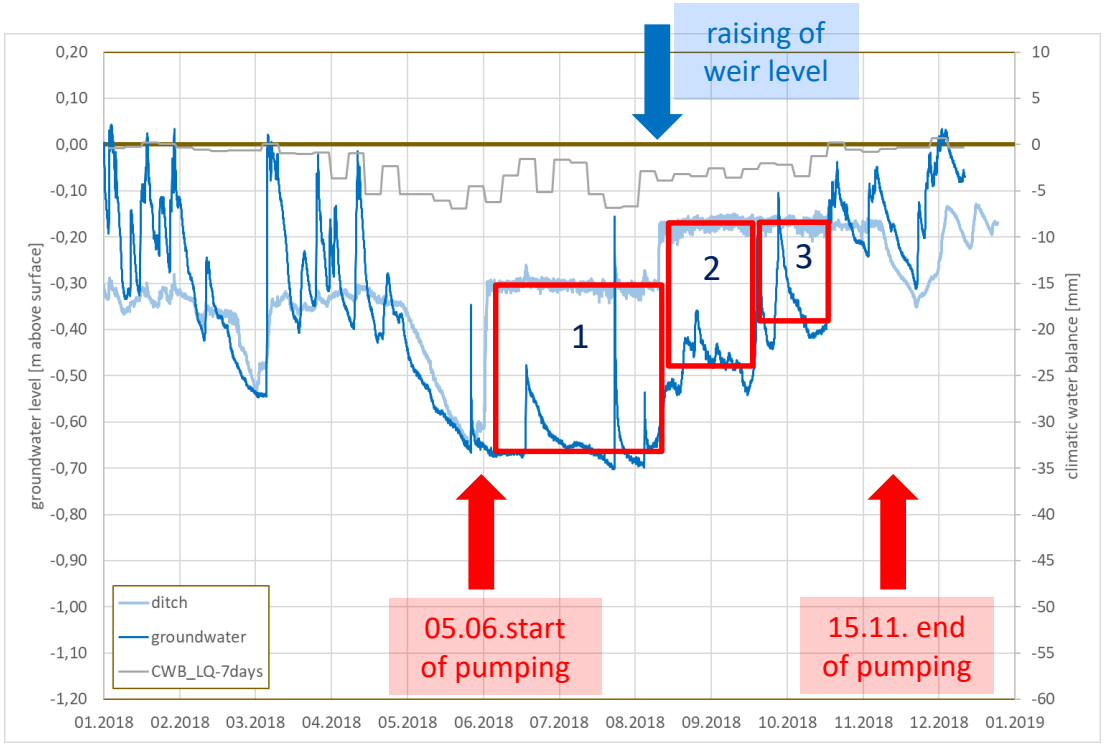
Submerged drains:

Climatic water balance (CWB) and difference of ditch to ground water level

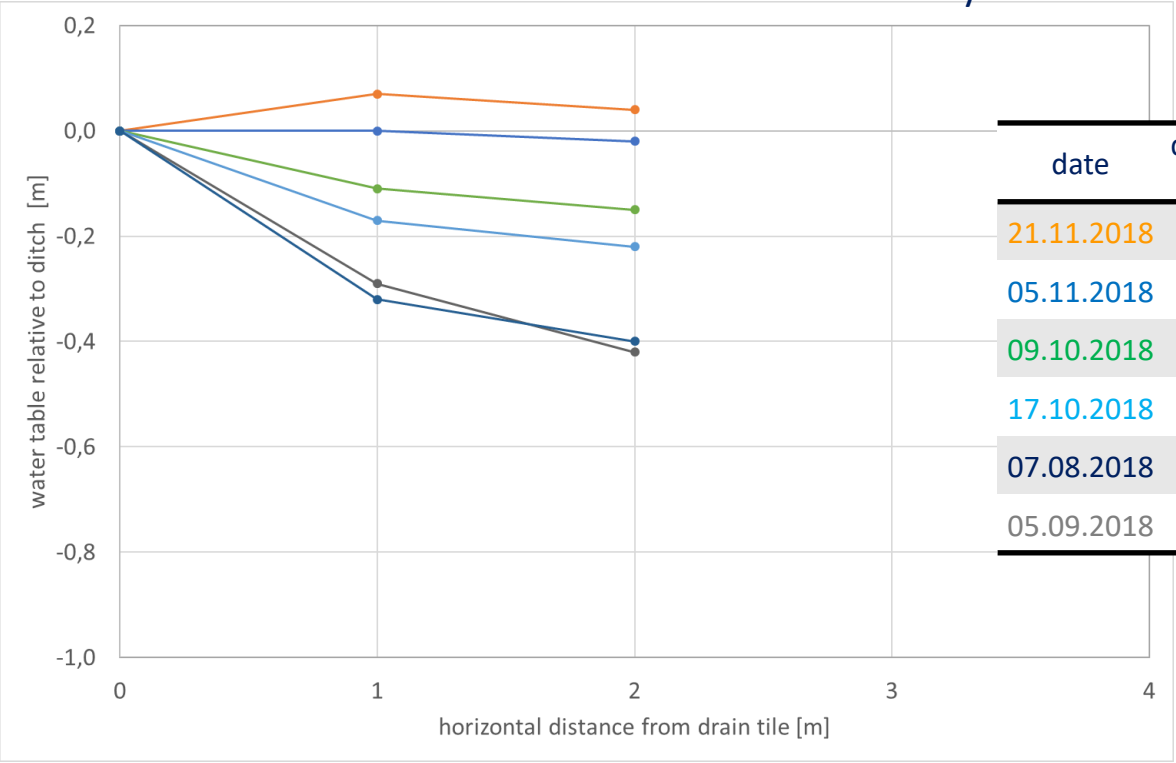


Period	climatic water balance (LQ-7days)	Difference ditch to ground water level (baseline)
1	- 3,9 mm	0,34 m
2	- 3,1 mm	0,26 m
3	- 2,2 mm	0,18 m

LQ-7days: lower quartile over 7 days

Submerged drains:

Gradient in water level between ditch and peat ground water in relation to the climatic water balance of the last 7 days



date	delta h (peat vs. ditch) [m/2 m distance]	CWB (7 days) [mm]
21.11.2018	0,04	-2,8
05.11.2018	-0,02	-0,8
09.10.2018	-0,15	-7,1
17.10.2018	-0,22	-20,9
07.08.2018	-0,40	-37,2
05.09.2018	-0,42	-9,2

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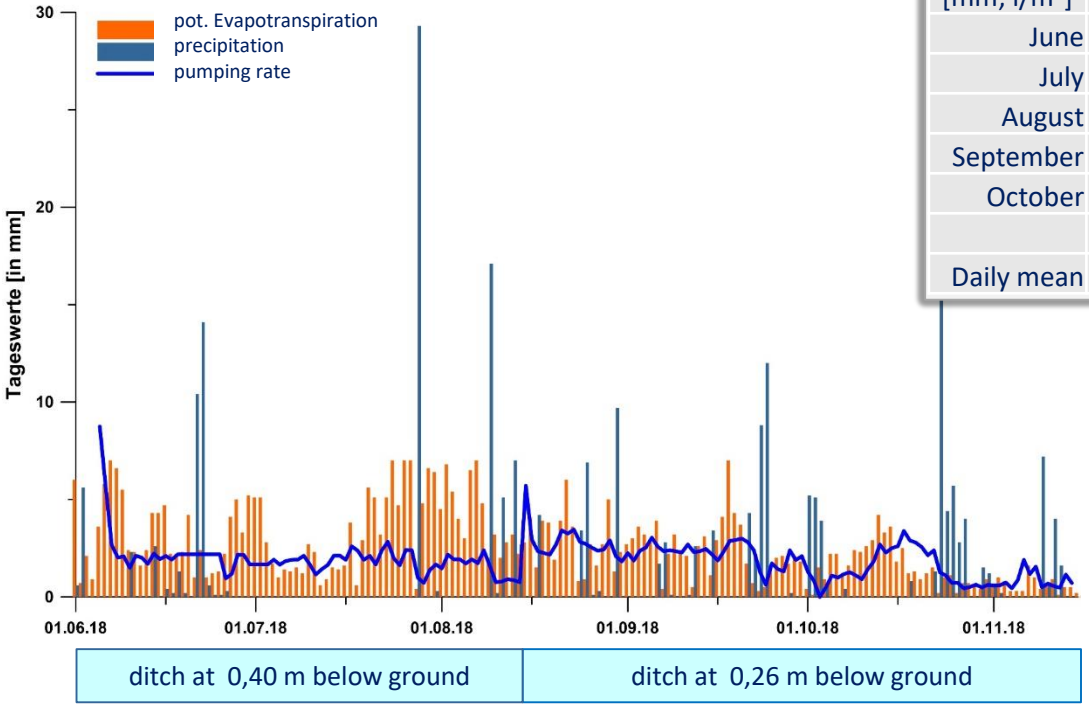
Elements of water balance



[mm; l/m²]	Precipitation	Pumping	Pot. ET	Balance	Storage
June	39	62	- 98	3	-5
July	30	57	- 102	-15	-11
August	57	69	- 106	19	75
September	38	67	- 73	32	-15
October	53	45	- 48	50	46
Daily mean	1,4	2,0	-2,8	0,6	0,6

June - October

Pumping rate:	2,0 mm/day
Precipitation:	1,4 mm/day
Evapotranspiration:	- 2,8 mm/day
Balance surplus/storage:	0,6 mm/day

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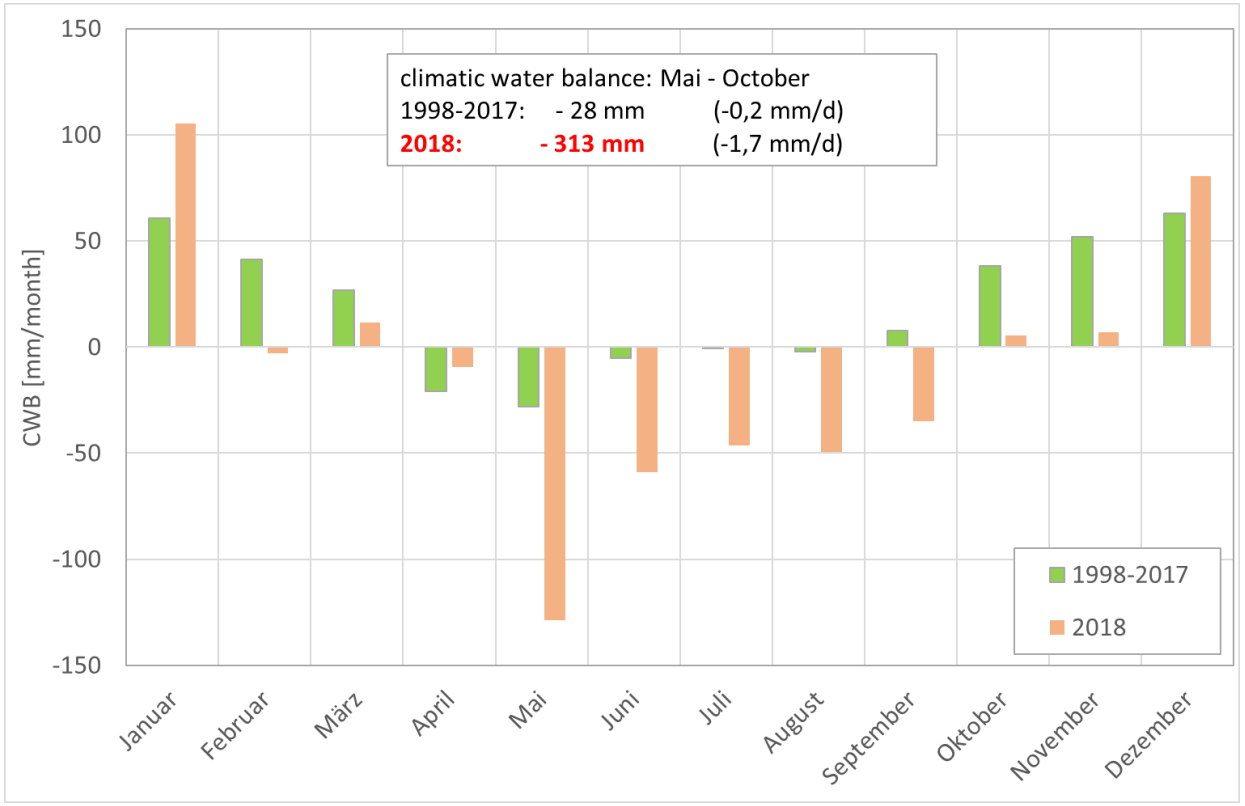
Climatic water balance: 2018 compared to 20-year mean value



2018 was a year with an extremely dry summer

Weather station Bremervörde, DWD 2018

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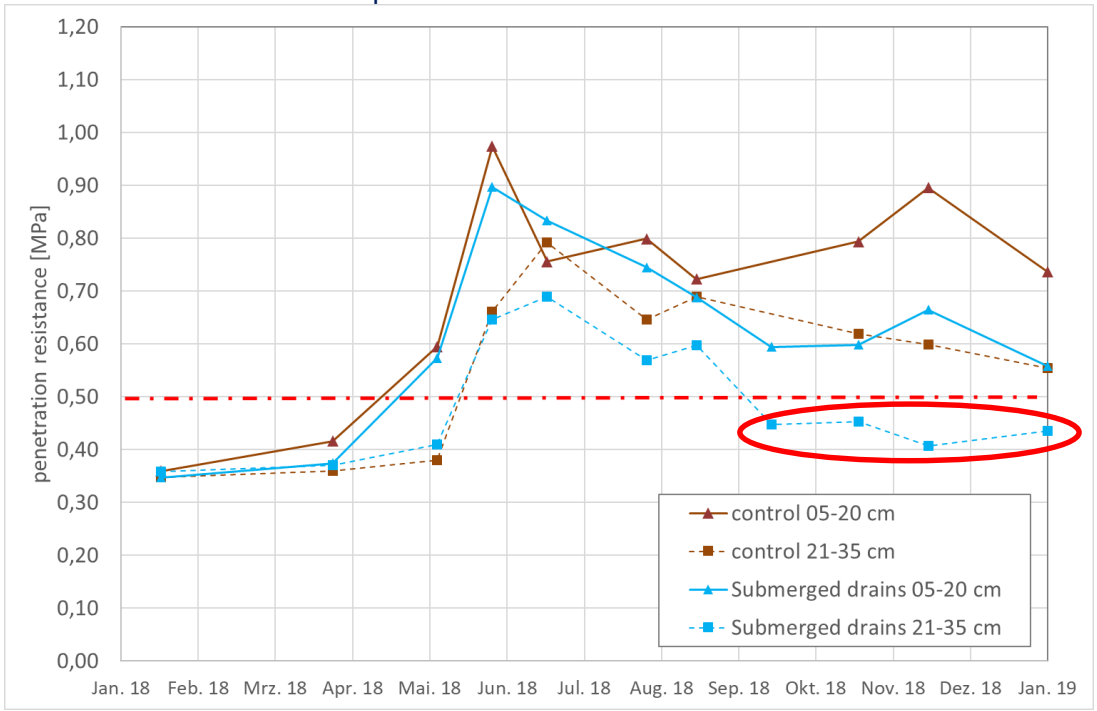
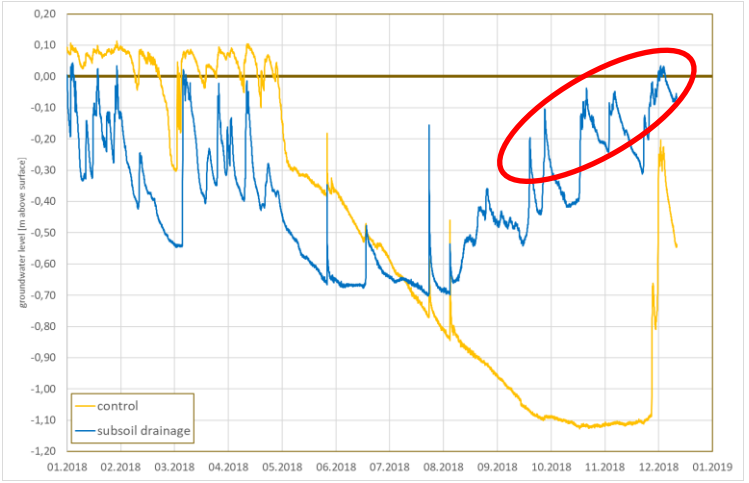
Penetration resistance: submerged drains vs. control

Penetration resistance in topsoil and subsoil



Ground water table



Eijkelkamp Penetrologger: depth resolution 1 cm; Cone type 3,3 cm^2 60 deg,
mean of 12 insertions per depth layer

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Dry matter grassland yields 2018: submerged drains vs. control

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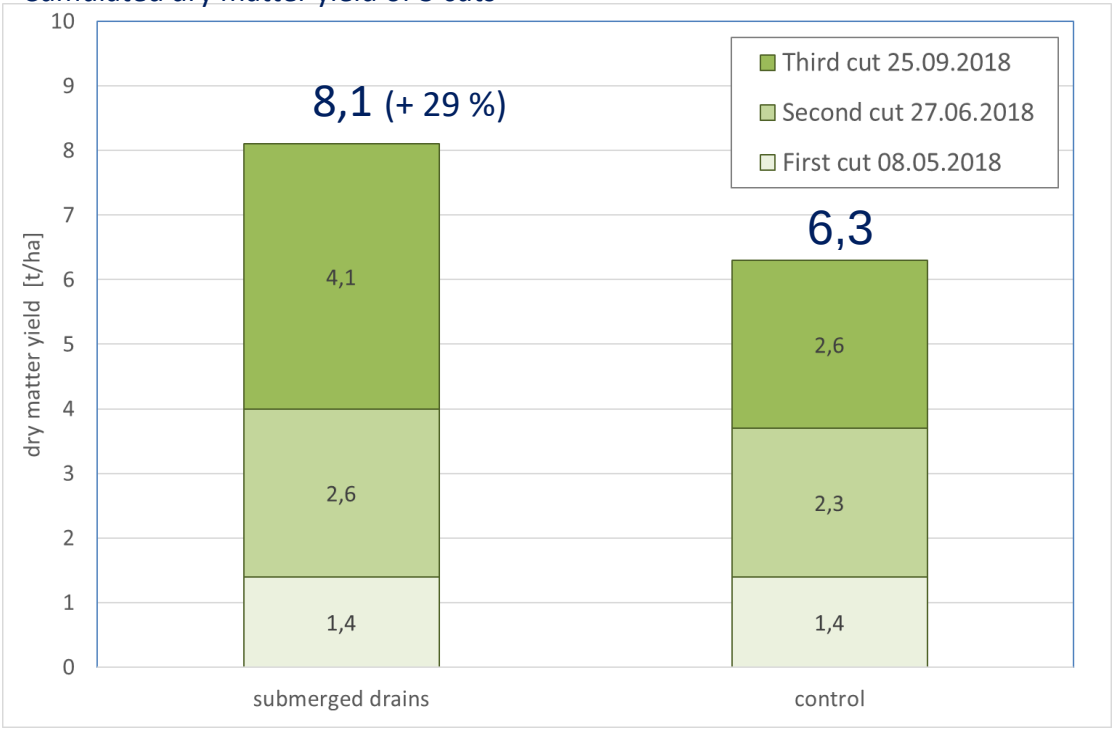
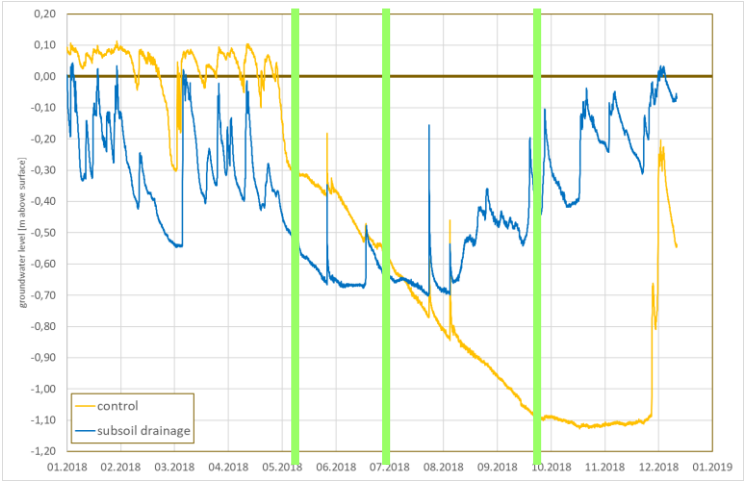
Cumulated dry matter yield of 3 cuts



Water table: submerged drains vs. control



cut: 1 2 3

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Conclusions

- A submerged drain system was established on a German raised bog cultivation, i.e. grassland on a drained bog peatland with a slightly decomposed peat layer in the upper 0,5 m.
- The system consists of a ditch weir, drains in a distance of 4 m and the supply of groundwater by solar pumping in the summer months.
- The installed system is working. The ground water table was strongly raised compared to the non rewetted control, even in the very dry summer 2018.
- Due to the low hydraulic conductivity and the exceptionnally low climatic water balance in summer 2018, a ditch water table of up to 35 cm above the target ground water table was necessary.
- The relationship between ditch and ground water level will be studied for further years with the objective to get highest ground water levels together with the necessary trafficability of the site.

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Thank you for your attention!

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