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Water Consumption by Wetland Vegetation in Northeastern Germany

Ralf DANNOWSKI, Ottfried DIETRICH, Ralph TAUSCHKE

Centre for Agricultural Landscape and
Land Use Research (ZALF), Muencheberg
Institute of Hydrology
Eberswalder Strasse 84
D-15374 Muencheberg
GERMANY

E-mail: *rdannowski@zalf.de*

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Two years ago, at the Duluth Peatland Symposium, a poster has been presented dealing with results on water consumption by wetland vegetation in NE Germany. The research had been performed in the so-called Biesenbrow Pilot Area for a first year of investigation. Now, as the experiment is in its 4th vegetation period, there is reason enough for an oral presentation up-dating the water budget data obtained from evaluating the measuring results, as well as re-suming the state-of-the-art and our experience gained.

The Biesenbrow Pilot Area is located in NE Germany in the state of Brandenburg. The site con-sisting of degraded fen is at an 8 ha area in the Sernitz-Welse-Randow Fen Region as a part of the western Odra River Basin – the Odra River forming the frontier between Germany and Po-land.

The area is belonging to a valley mainly supplied by groundwater from a watershed of about 35 km². Under the semi-continental climatic conditions with negative water balance values in the annual sum, the existence of a fen wetland in the glacially formed landscape of NE Germany depends on the proximity of recharging upland areas which provide sufficient discharge for ei-ther the ground or surface water supply. The type of the fen is a polytrophic percolation mire which was used for decades for intensive grassland production.

Detailed hydrologic investigations into the demand for water are required, if rewetting of such a fen site is being planned. For re-inducing peat growing, reed and sedge vegetation has been planted. Knowledge of evapotranspiration of such a wetland vegetation is available for NE Ger-man conditions practically exclusively from lysimeter investigations. To avoid scale problems such as oasis effects, a long-term field-scale investigation based on water budget calculations was intended to be undertaken.

A triennial surface irrigation (border irrigation, ponding) experiment has been evaluated with re-gard to the area water budget, comprising hydrometeorologic components, surface and sub-surface recharge and discharge components, and the changing water volume stored at the area. Due to the geohydraulic site conditions, considerable infiltration water losses occur, even after an existing pipe drainage system had been locked up. Separating infiltration and storage fluctuation by means of a drawdown/irrigation field experiment in late autumn/early winter, the actual evapotranspiration by the reed and sedge vegetation could be determined from the area water budget for time intervals of 10 days at least. Comparing the specified actual evapotranspi-ration with FAO grass reference values as a standard for potential evapotranspiration, wetland vegetation consumes much more water – about 180 % as an average. In the third vegetation period, the actual evapotranspiration exceeded 1,100 mm, but did not reach such outstanding values as known from lysimeter investigations.

Northeastern Germany Including the Biesenbrow Pilot Area

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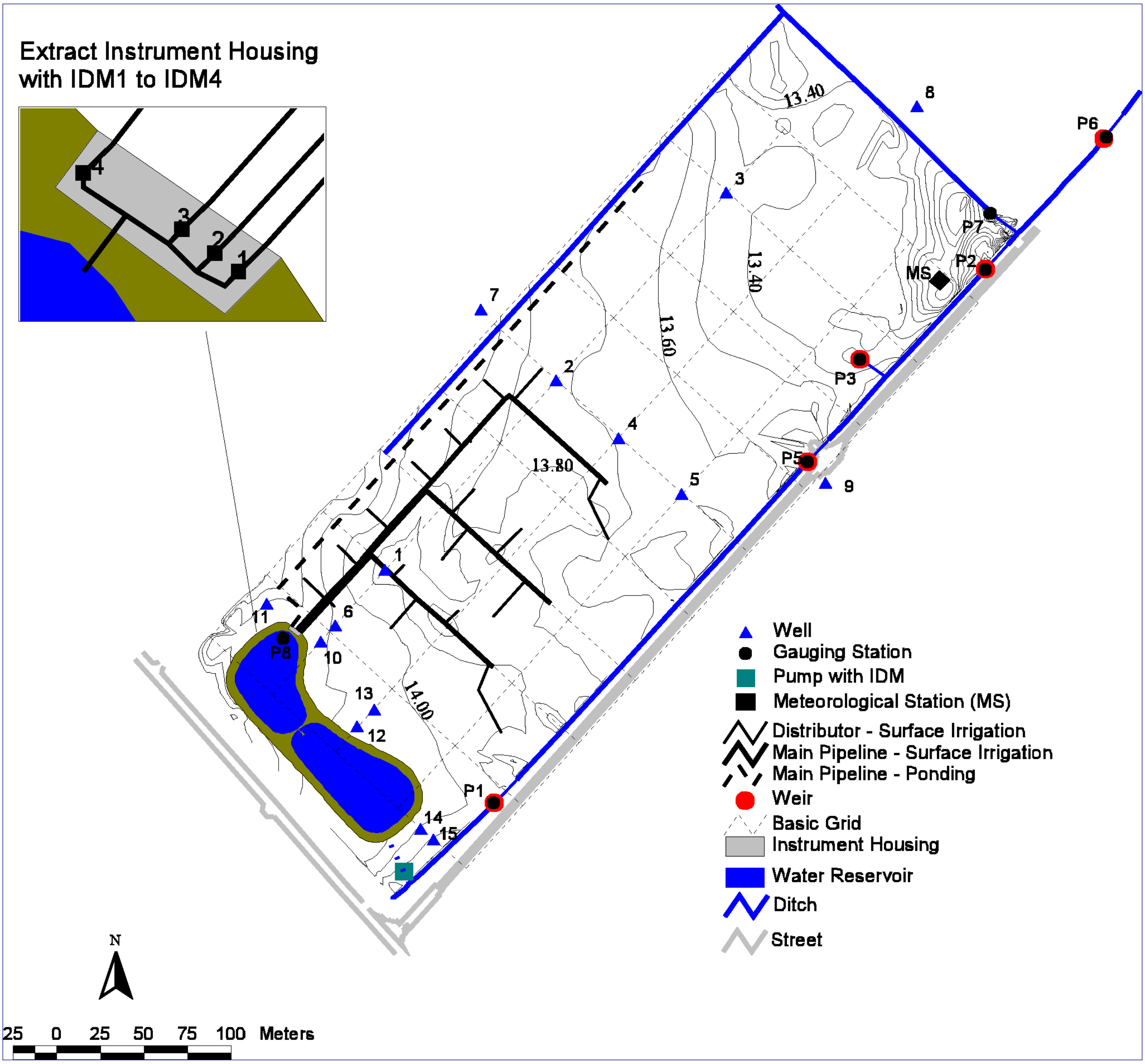
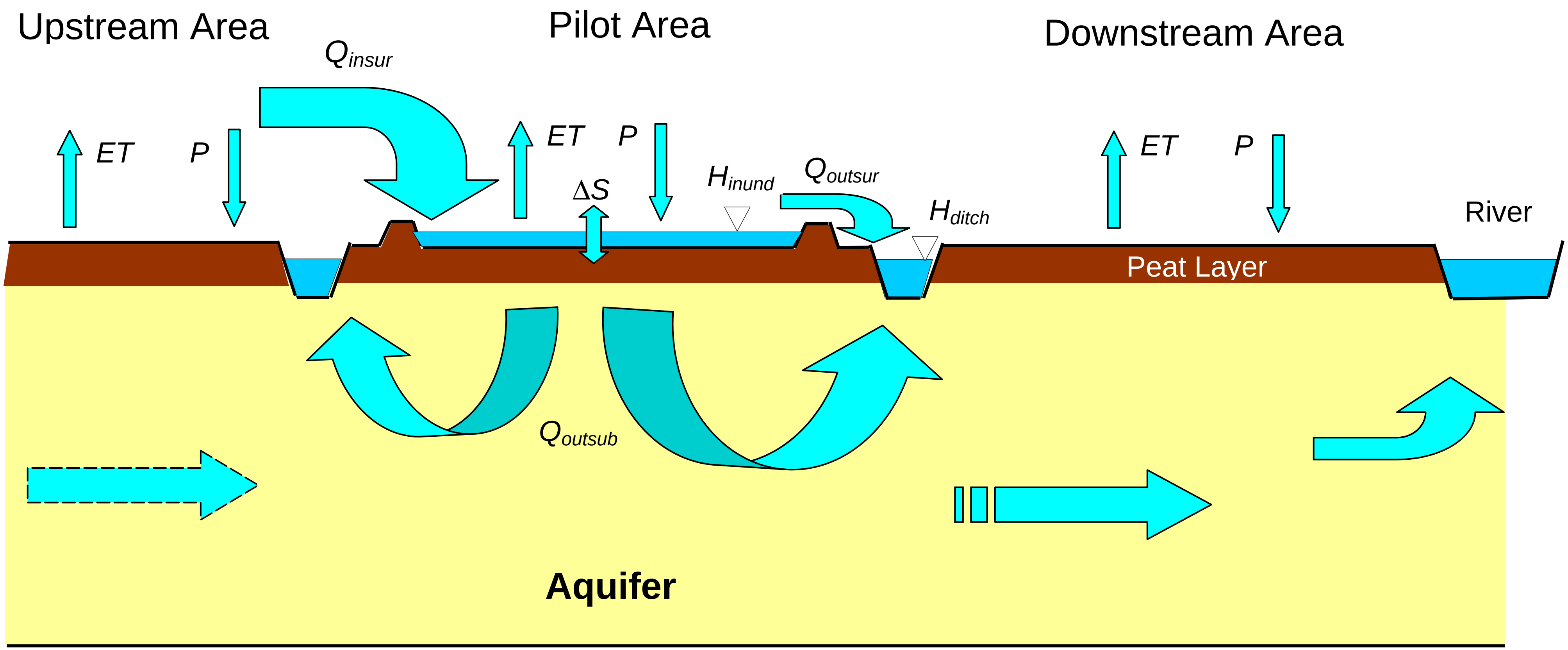
Site Map – Biesenbrow Pilot Area



Schematic Flow Conditions and Water Budget Components of the Biesenbrow Pilot Area



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Step 1

Establishing the General Water Balance Equation:

$$\Delta S = P - ET + Q_{insur} + Q_{insub} - Q_{outsur} - Q_{outsub} \qquad \text{(in mm/}\Delta t\text{)}$$

with

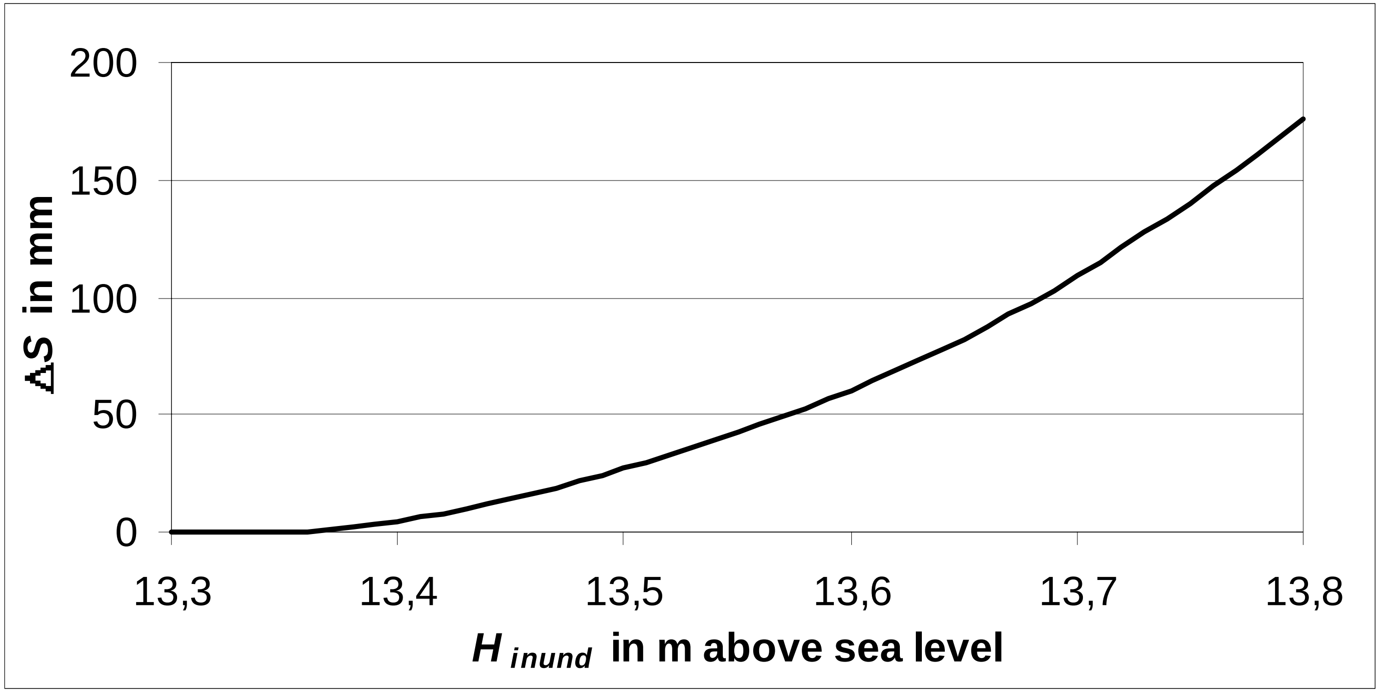
ΔS	–	change of the stored water volume
P	–	precipitation
ET	–	evapotranspiration
Q_{insur}	–	surface recharge (irrigation)
Q_{insub}	–	subsurface recharge
Q_{outsur}	–	surface discharge
Q_{outsub}	–	subsurface discharge (infiltration)
Δt	–	evaluated time interval

Step 2

Determining the Demand for Water:

$$ET + Q_{outsub} = P + Q_{insur} - \Delta S$$

Storage characteristics $\Delta S(H_{inund})$ of the Pilot Area, based on the DEM



Biesenbrow Pilot Area in Late Autumn

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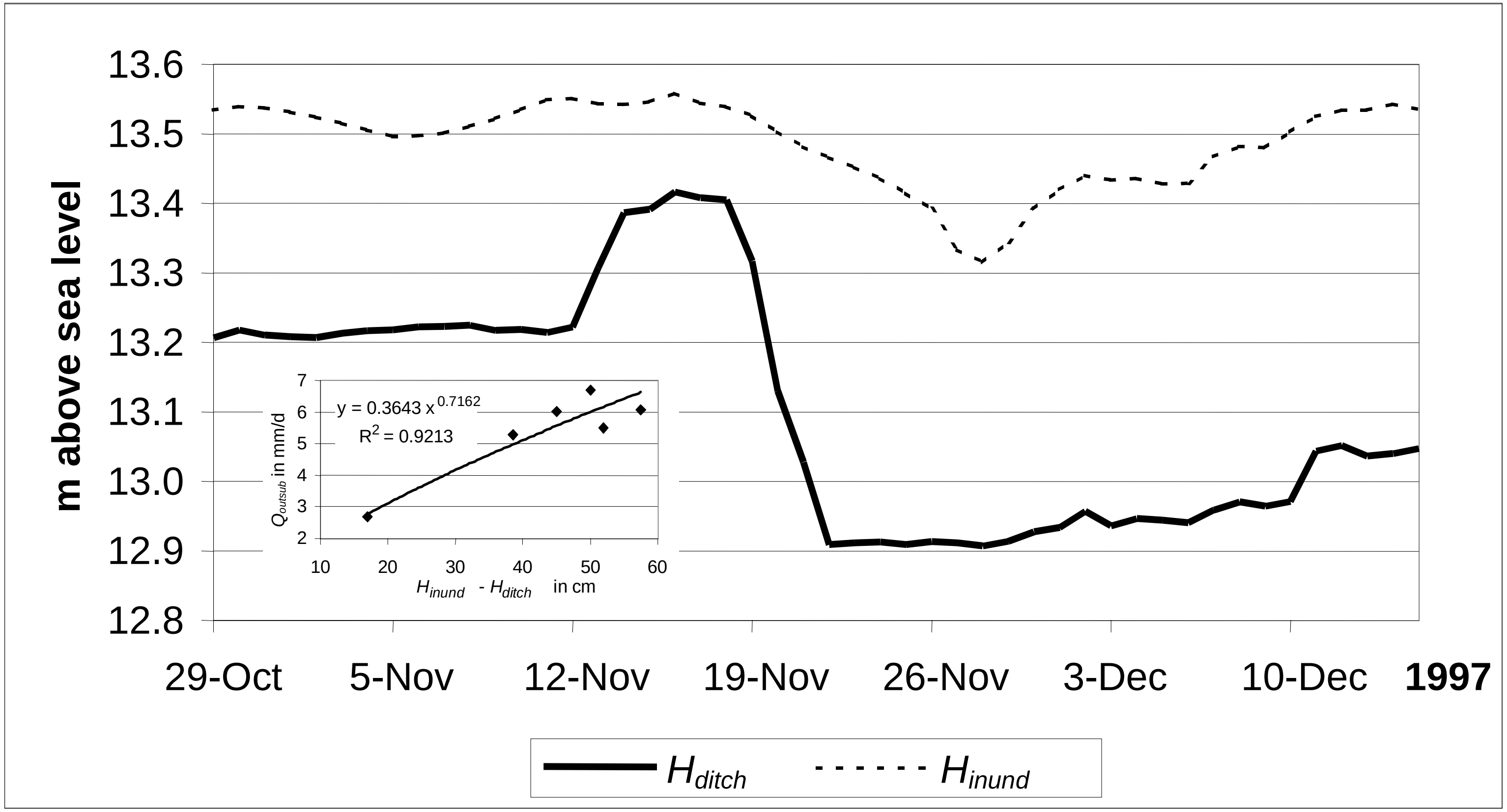
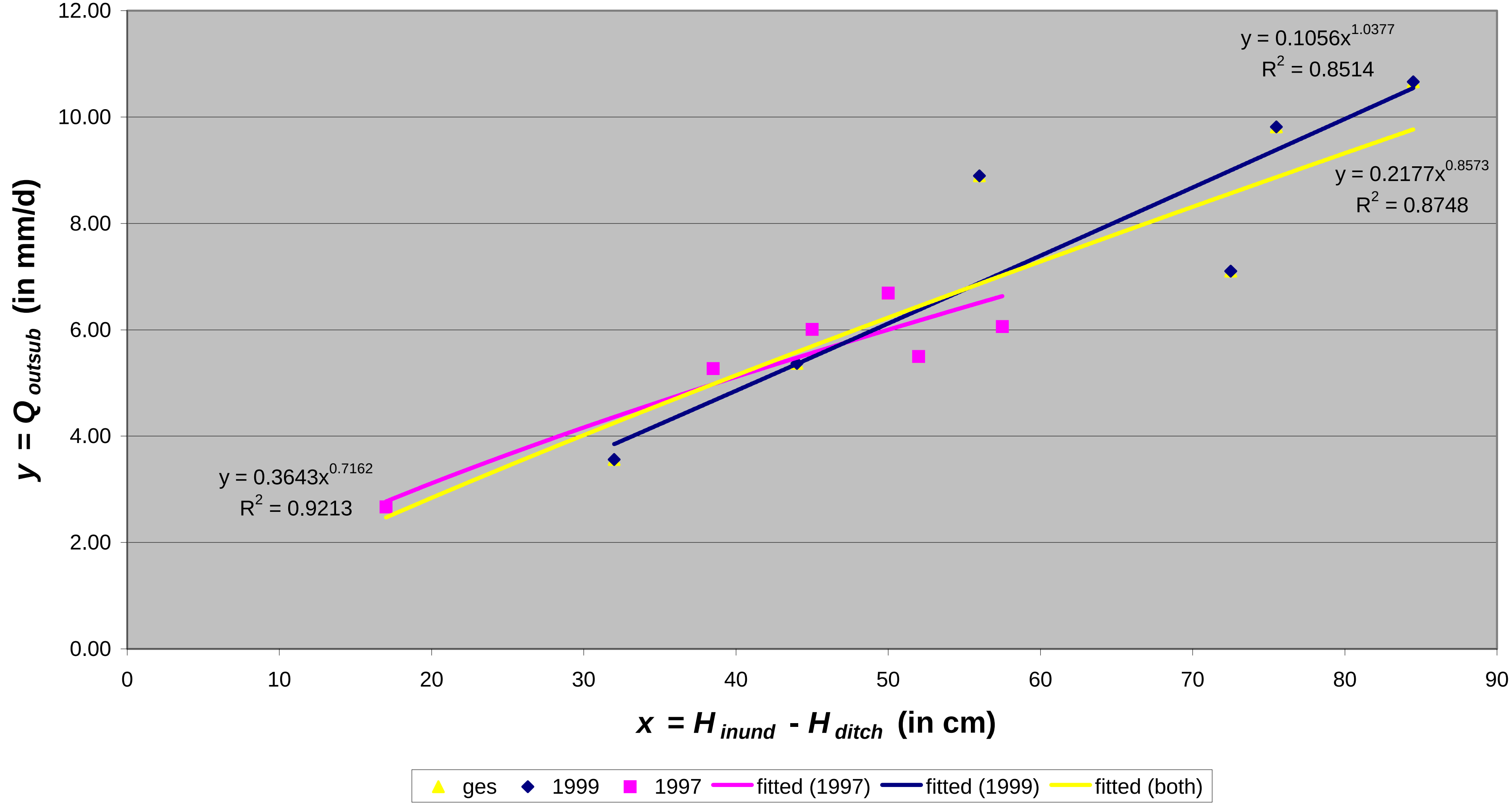
Step 3

Separating *ET* and Q_{outsub} from the Demand for Water:

Drawdown/irrigation field experiment in late autumn/early winter



Subsurface discharge Q_{outsub}



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Water Budget Components of the Biesenbrow Pilot Area

1997	Apr	May	Jun	Jul	Aug	Sep	Oct	Sum
P	37	53	86	161	28	26	32	423
Q_{insur}	98	154	264	127	278	169	186	1.276
Q_{outsub} 1)	**67**	**110**	**145**	**153**	**135**	**121**	**83**	**814**
Q_{outsur}	0	0	0	57	0	0	0	57
ΔS	12	15	82	-27	-9	-73	37	37
ET 2)	**56**	**82**	**123**	**105**	**180**	**147**	**98**	**791**
ETP 3)	79	102	114	109	111	71	40	626

1998	Apr	May	Jun	Jul	Aug	Sep	Oct	Sum
P	27	33	47	63	96	38	62	366
Q_{insur}	170	188	255	336	340	366	203	1858
Q_{outsub} 1)	**87**	**39**	**102**	**157**	**177**	**203**	**196**	**961**
Q_{outsur}	0	0	0	1	52	101	37	191
ΔS	27	12	17	59	46	-46	25	140
ET 2)	**83**	**170**	**183**	**182**	**161**	**146**	**7**	**932**
ETP 3)	65	105	101	101	84	53	35	543

1999	Apr	May	Jun	Jul	Aug	Sep	Oct	Sum
P	55	70	32	23	28	36	18	262
Q_{insur}	38	218	248	237	332	318	345	1736
Q_{outsub} 1)	**43**	**173**	**187**	**85**	**27**	**75**	**175**	**765**
Q_{outsur}	0	0	0	0	0	0	0	0
ΔS	0	30	-30	0	33	20	7	60
ET 2)	**50**	**86**	**122**	**175**	**300**	**259**	**181**	**1173**
ETP 3)	69	107	100	129	106	81	38	630

1) Calculated for daily values ($H_{inund} - H_{ditch}$)
2) Calculated from water balance
3) Grass reference evapotranspiration as calculated from the meteorological measuring results

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Conclusions

- The water balance method, if supplemented by geohydrologic knowledge, is suitable for determining reliable values of the water consumption (evapotranspiration) by wetland vegetation at the field scale.

- Measuring equipment installed at the Biesenbrow Pilot Area used in combination with suitable water management practices provides excellent conditions for performing water budget investigations comparable to those at lysimeter stations.

- Blocking an existing pipe drainage system did not show the effect expected for reducing subsurface discharge. Irrigation management should be carefully executed under the present geohydrologic conditions to avoid increased matter leaching and additional pumping costs.

- During the evaluated years after planting, the averaged water consumption increased year by year due to the developing wetland vegetation. In the 3rd year, for the first time it exceeded 1,000 mm as measured in lysimeter investigations.

- Further monitoring and evaluation of the Biesenbrow Pilot Area will be helpful in settling the long-standing dispute between lysimeter experts and hydrologists with respect to the share of oasis effects at lysimeter and field sites.