HOW INNOVATIVE HYDROLOGICAL MONITORING AND MODELLING ARE NEEDED TO UNDERSTAND WETLAND FUNCTIONING AND FUNCTIONS:

RECENT EXPERIENCES IN DIFFERENT TYPES OF WETLANDS

Aljosja Hooijer

WL | Delft Hydraulics

BETTER TITLE:
THE VALUE OF WATER LEVEL INFORMATION IN QUANTIFYING WETLAND HYDROLOGY FOR WATER RESOURCES MANAGEMENT

Topics:

2 … type of data needed needed in order to address the problems in wetlands

4 … advances in robust/accurate measurement techniques

5 problems of data acquisition ...

Why is wetland hydrology important?

- Conservation aim: it determines the 'internal' functioning of the ecosystem, and
- Water Resources Management aim: it determines the 'external' functions that wetlands can have within the river basin (flood peak reduction, storage of pollutants and sediments, baseflow maintenance).

In many cases, conservation aims are not considered important by decision makers, but WRM aims are…

➔ Claims on hydrological functions of wetlands only valid in WRM if well-proven == quantified!

Some relevant studies

Presented:

- Sarawak peatswamps (Indonesia, 1995-1997)
- Sumatra peatswamps (Indonesia, 2003-2004)
- Danube Delta (Romania, 1997-2002)

Similar:

- Shannon floodplains (Ireland, 1990-1995)
- Madagascar coastal wetlands (1997-1998)
- Doňana National Park (Spain, 2003-2004)

(partly with WL | Delft Hydraulics)

What do these wetlands have in common?

'Disadvantages'

- Flat: (sub-)basins can not be delineated from topography.
- Wet, water tables near soil surface, often flooded: diffuse flow.
- Tidal/backwatered: no rating curves, discharges very hard to measure.
- Inaccessible: only periodic visits possible, automatic monitoring required.

➔ basin area and discharge can not be determined 'as usually'; (as in dryland).

➔ $\Delta S = P - E - Q$

What do these wetlands have in common?

'Advantages'

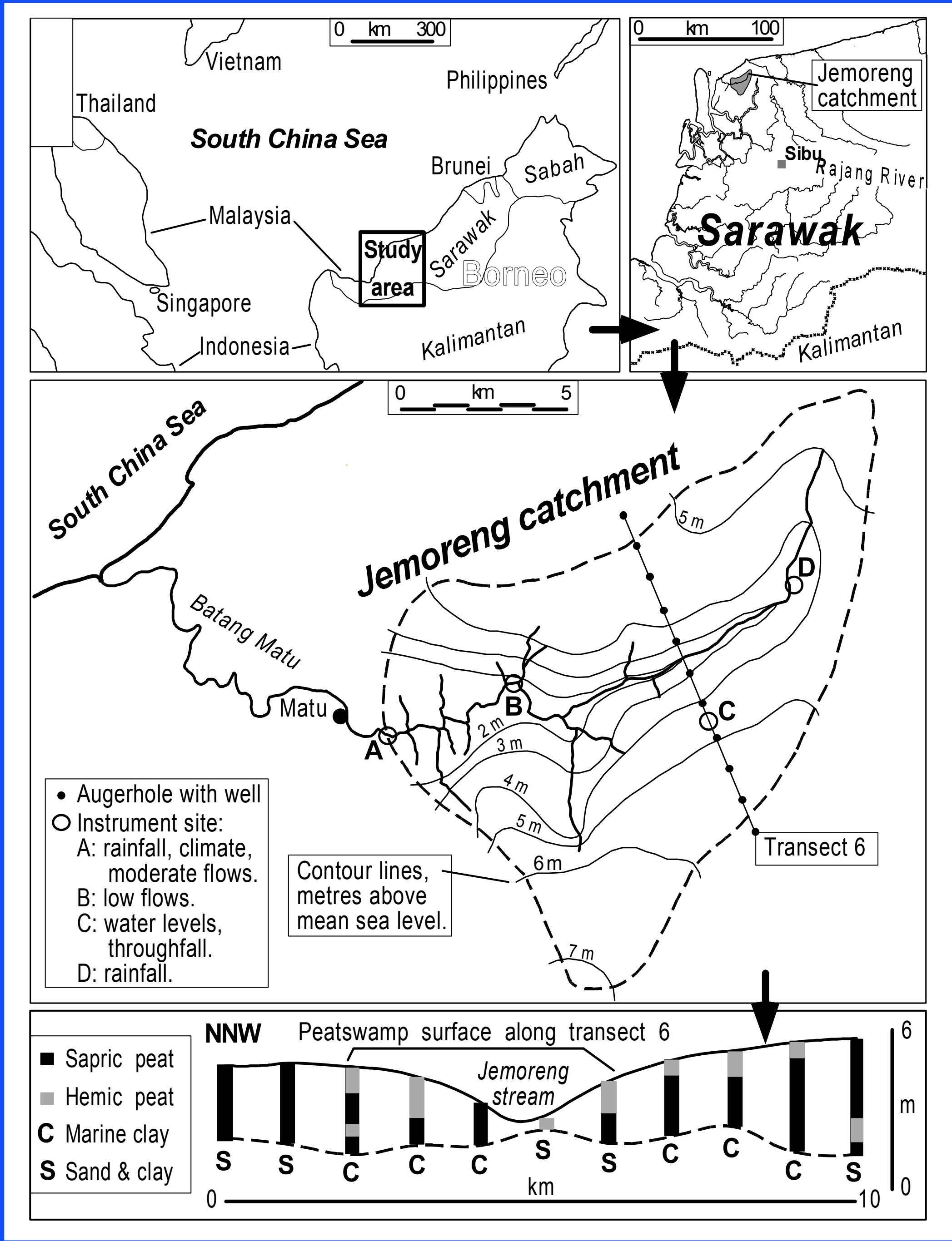
- High water tables (<40 cm) and soil types (organic, silt) keep unsaturated zone at field capacity; any change in storage is directly expressed in water level change.
- Water levels can be recorded permanently and cheaply, at many points: with 'diver' dataloggers or by local inhabitants.
- Soils and topography highly uniform: point measurements of water level representative for large areas.
- Little underground leakage across watershed boundary.
- Relatively low rainfall variability in these flat lands.

➔ changes in basin storage, actual evapotranspiration and rainfall can be monitored well

➔ $\Delta S = P - E_{act} - Q$

Sarawak Peatswamp Study

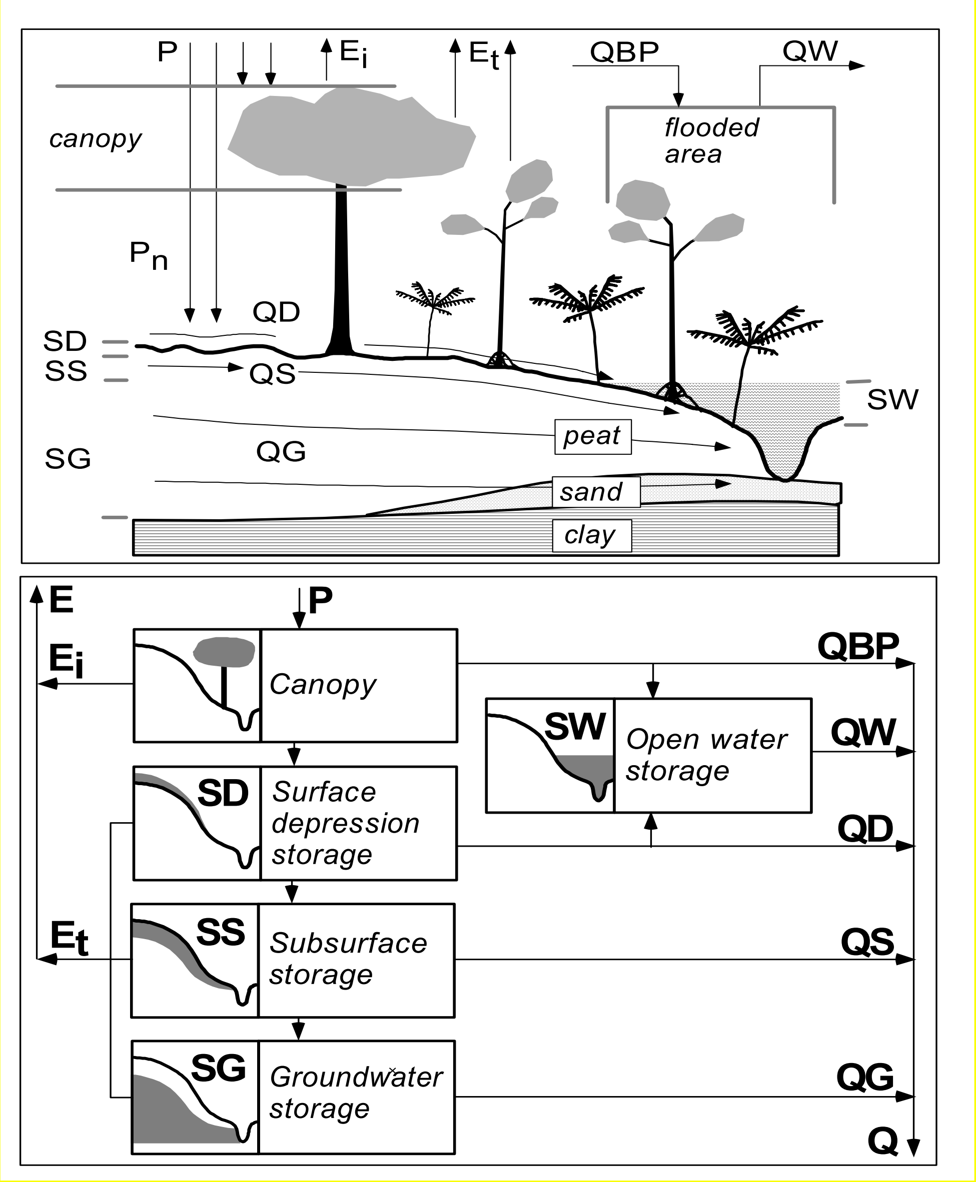
- Goal: Water Supply Study (for Malaysian Government)
- Question: how much discharge during 1:25y droughts? Worth conservation?
- Approach: discharge, water level, monitoring studies in 10 catchments.



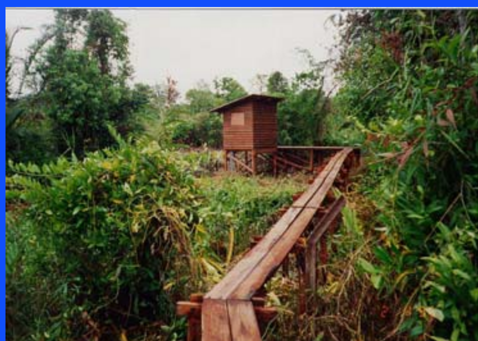
SE Asian Peatswamps (>25 Mha)

What do we want to study?

The ‘natural’ peatswamp hydrology, undisturbed by drainage



Sarawak peatswamp studies
- it started with Q …

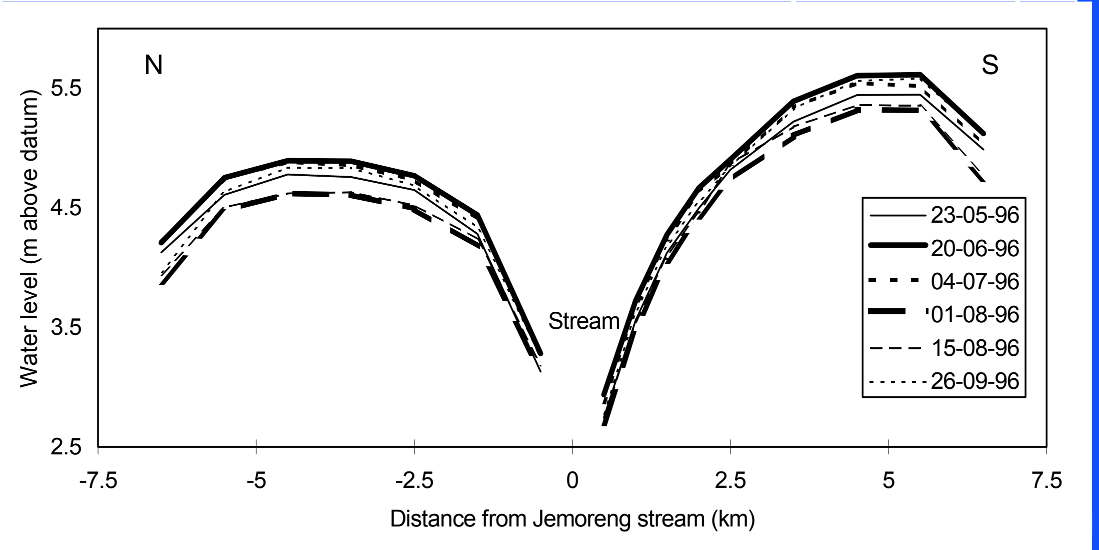


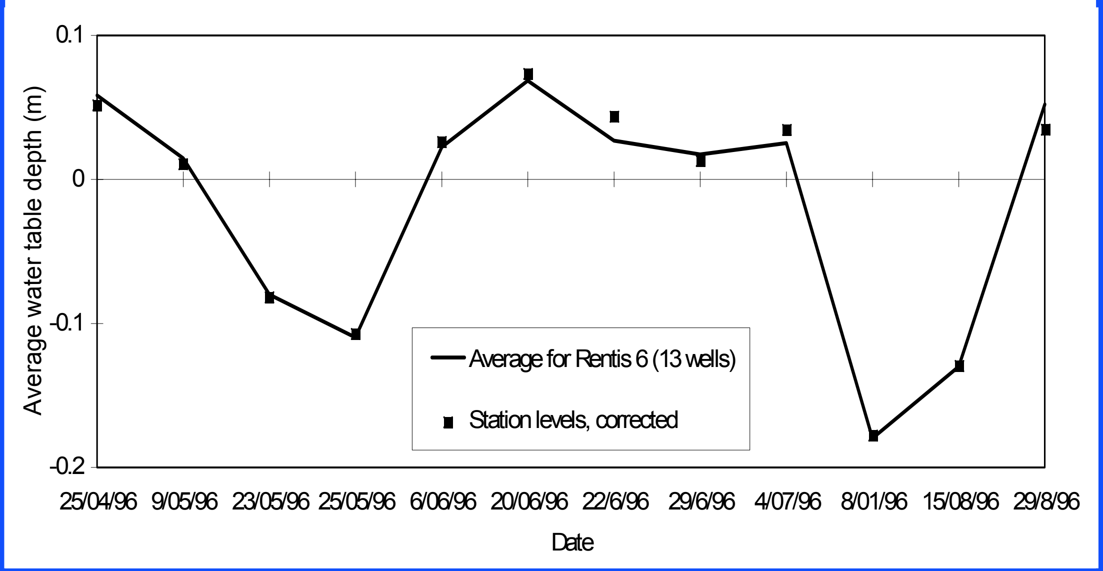
Sarawak peatswamp studies
- and ended with P, L …

Basin-wide water table studies

- Peat dome and water table 'in balance'
- Water level fluctuations uniform

➔ 2-weekly water table monitoring for changes in basin storage (40 wells per basin)

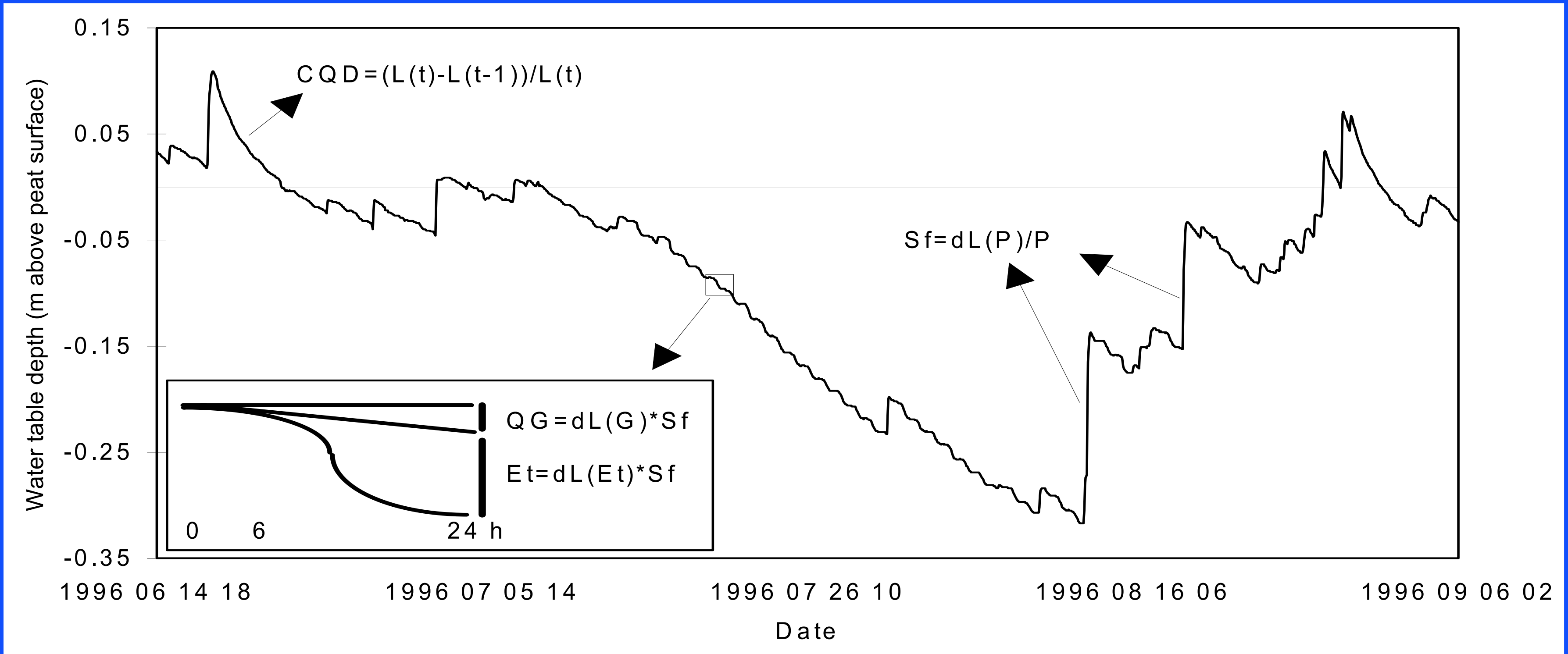




Diurnal water table studies

For:

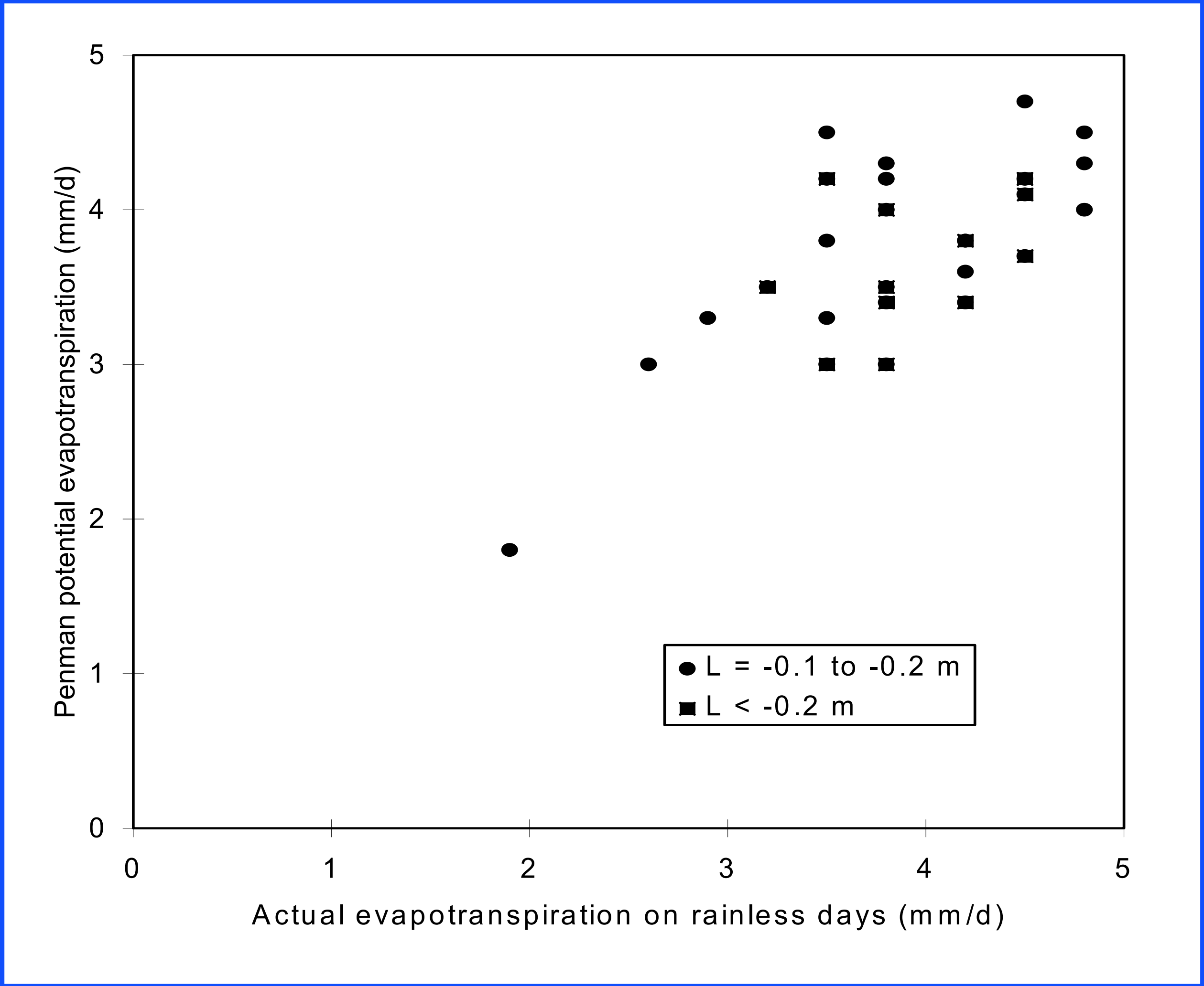
- actual evapotranspiration rates
- recharge rates,
- (peat characteristics, for above)



Data collection methods

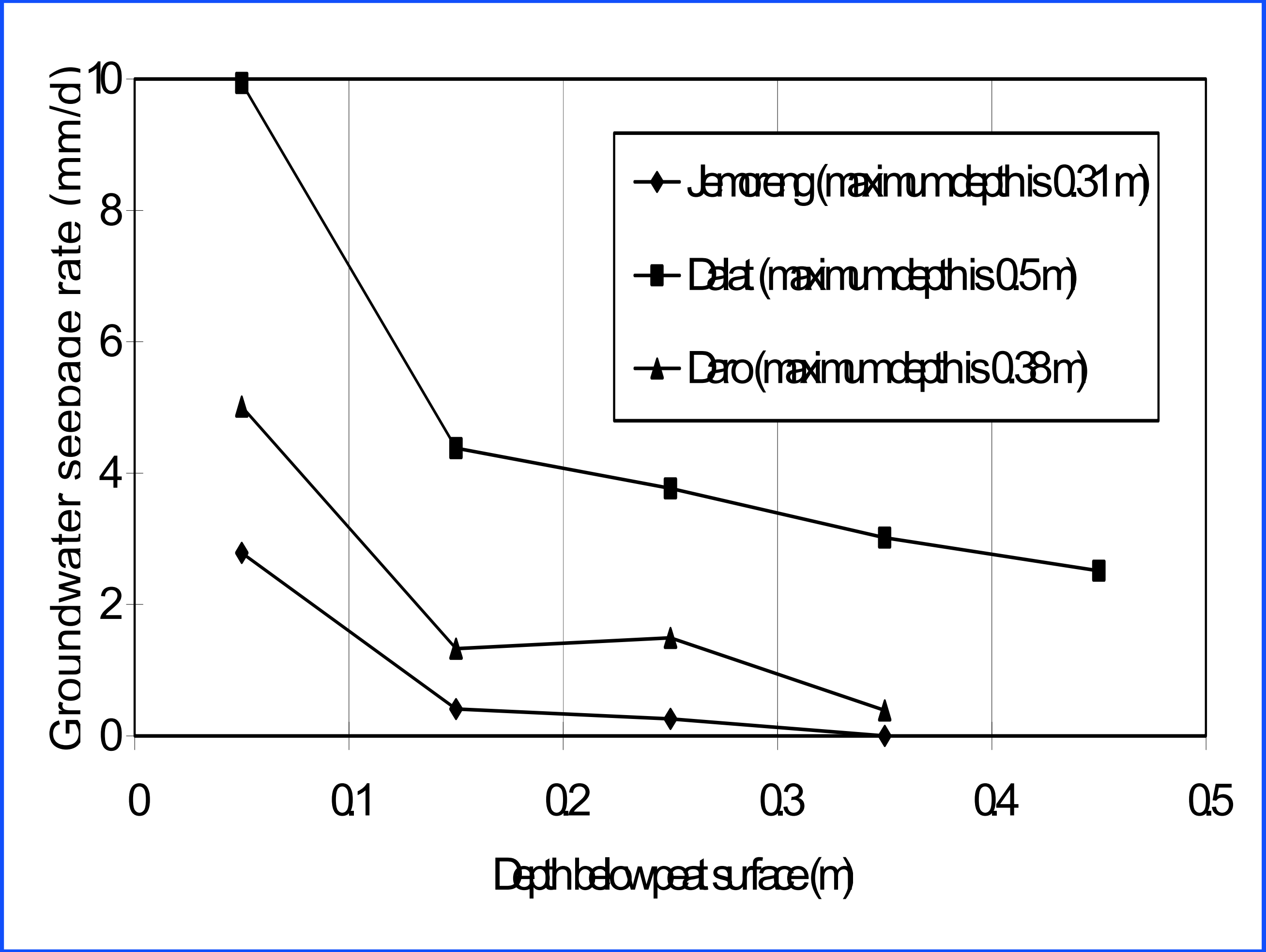
Water table studies

- Diurnal water table studies for actual evapotranspiration rates



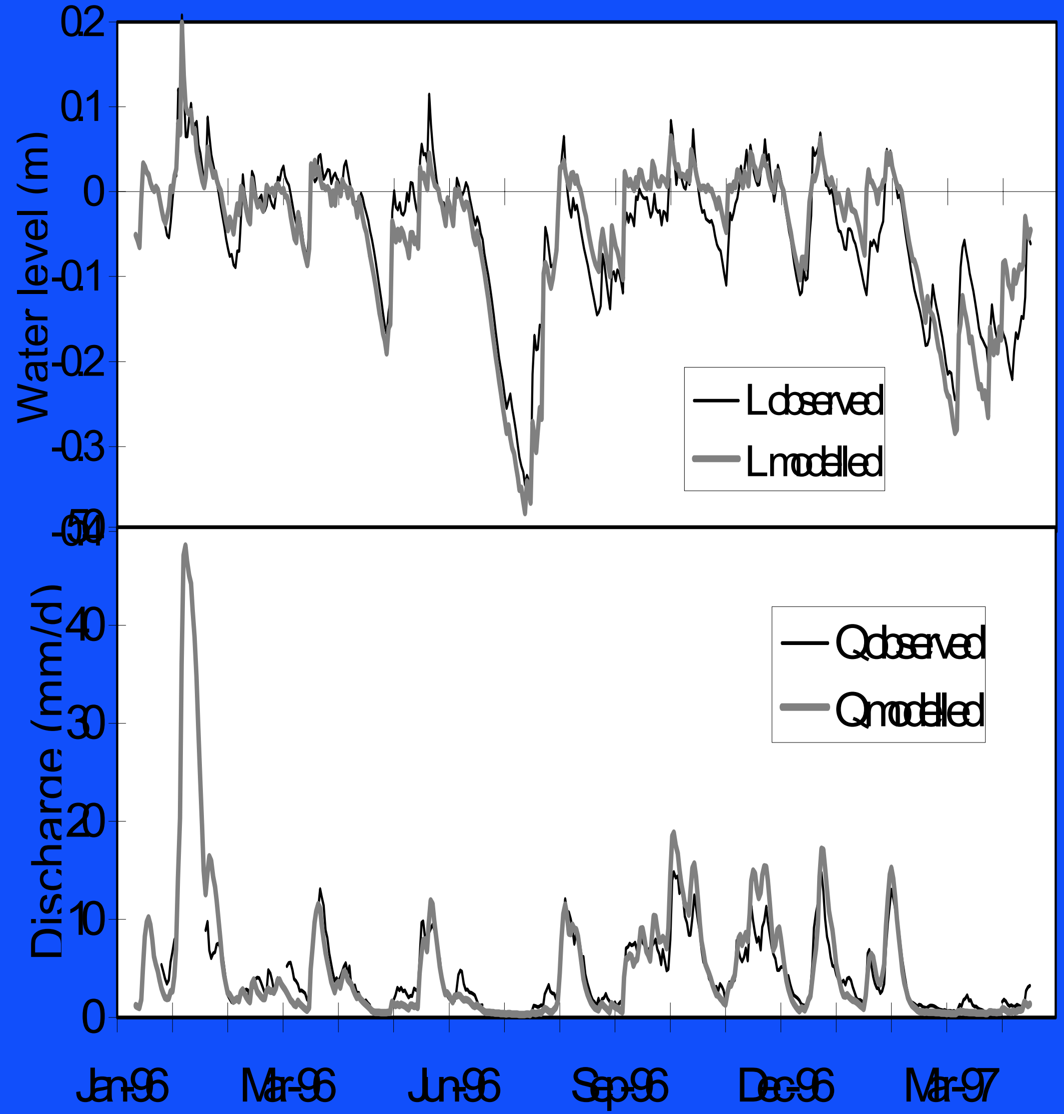
Data collection methods
Water table studies

- **Diurnal water table studies for recharge rates**



Data collection methods
Water table studies

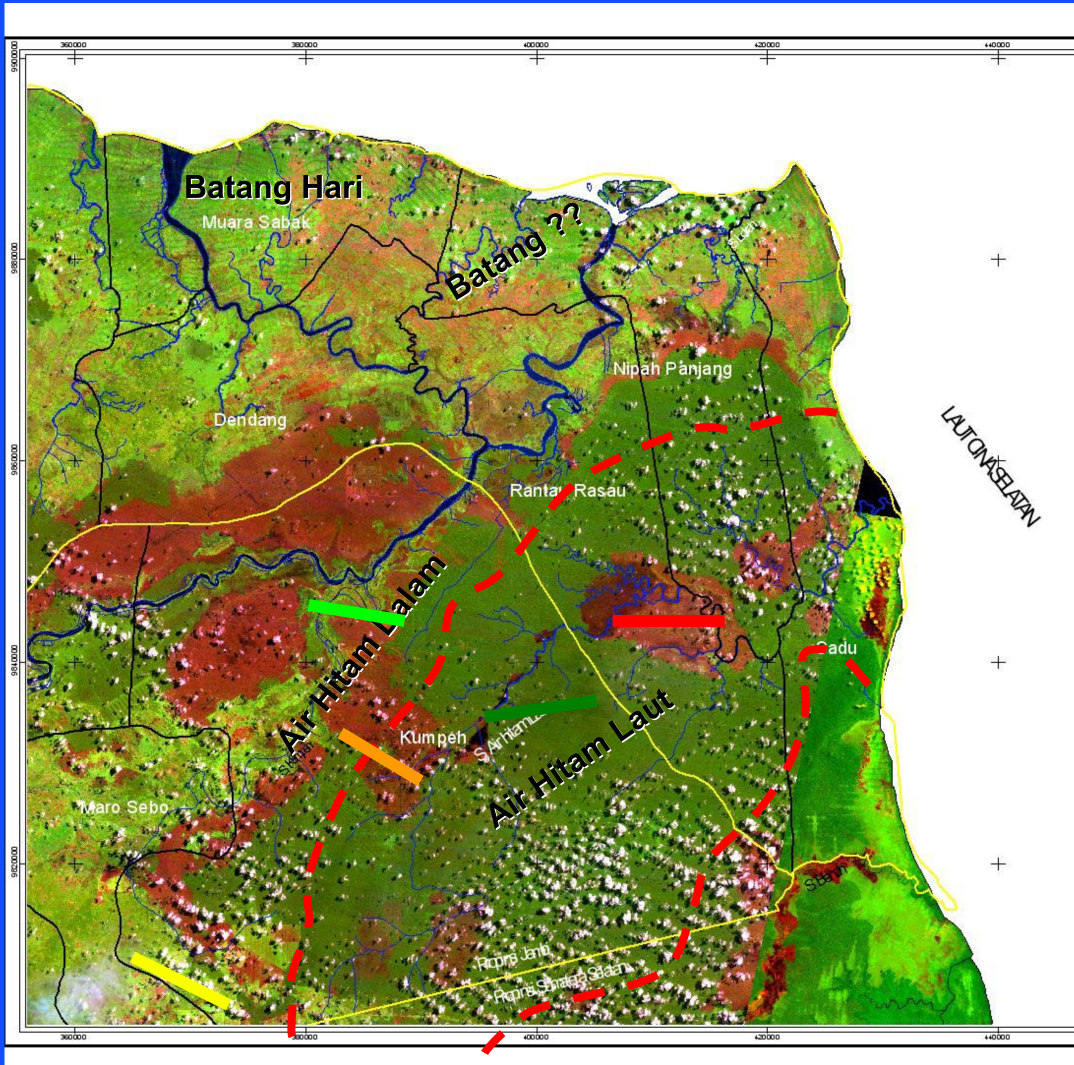
- Model schematisation with Sf, Qr and ET from diurnal WT record.
- Model calibration with storage changes from water table record (and with measured Q).
- Catchment area optimimisation through calibration.



Sumatra: next step
Intact and impacted peatswamps

- Goal: Management plan Air Hitam Laut river basin.
- Question: Entire peat dome needs protection?
- Approach: water table studies along 2*5 transects:

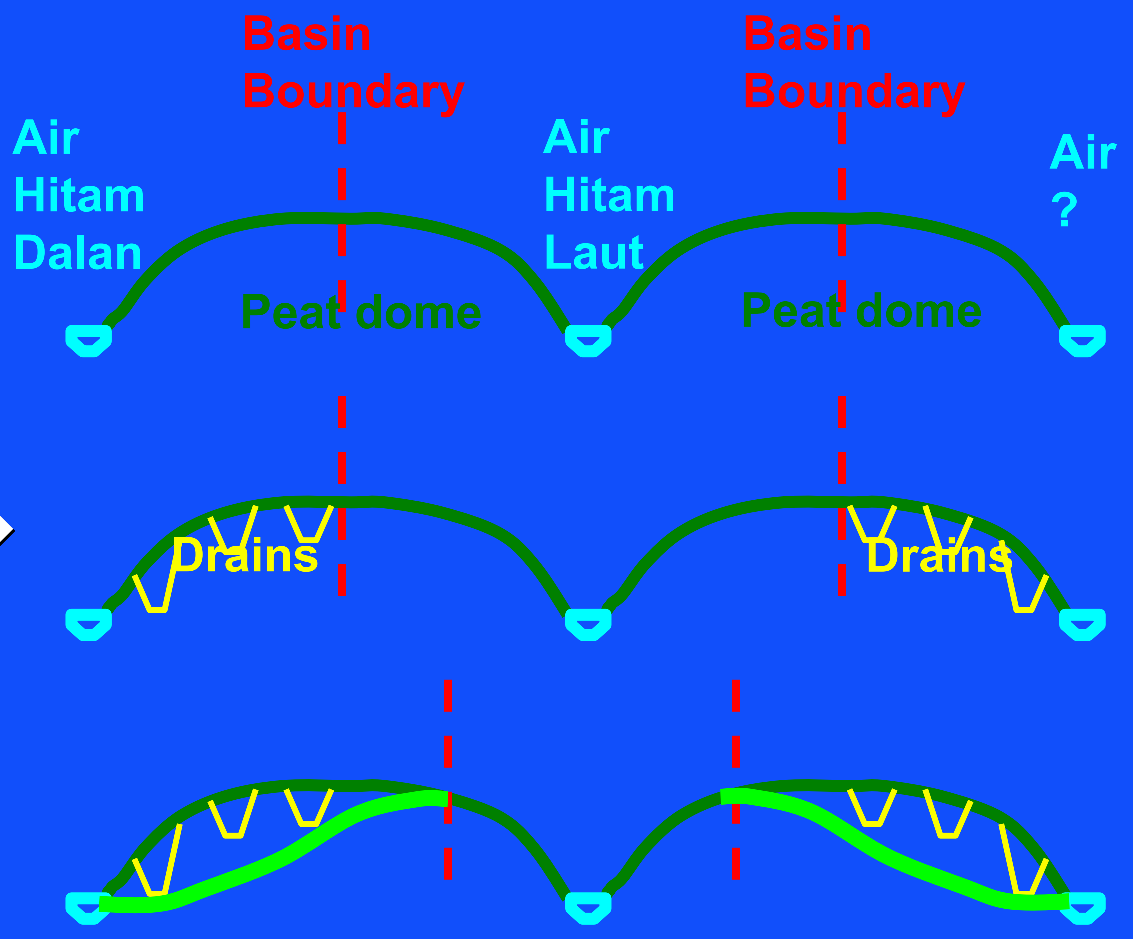
1 intact peatswamp
2 drained for agriculture
3 drained for plantation
4 logged
5 burnt



Sumatra
➔ *What do we want to study?*

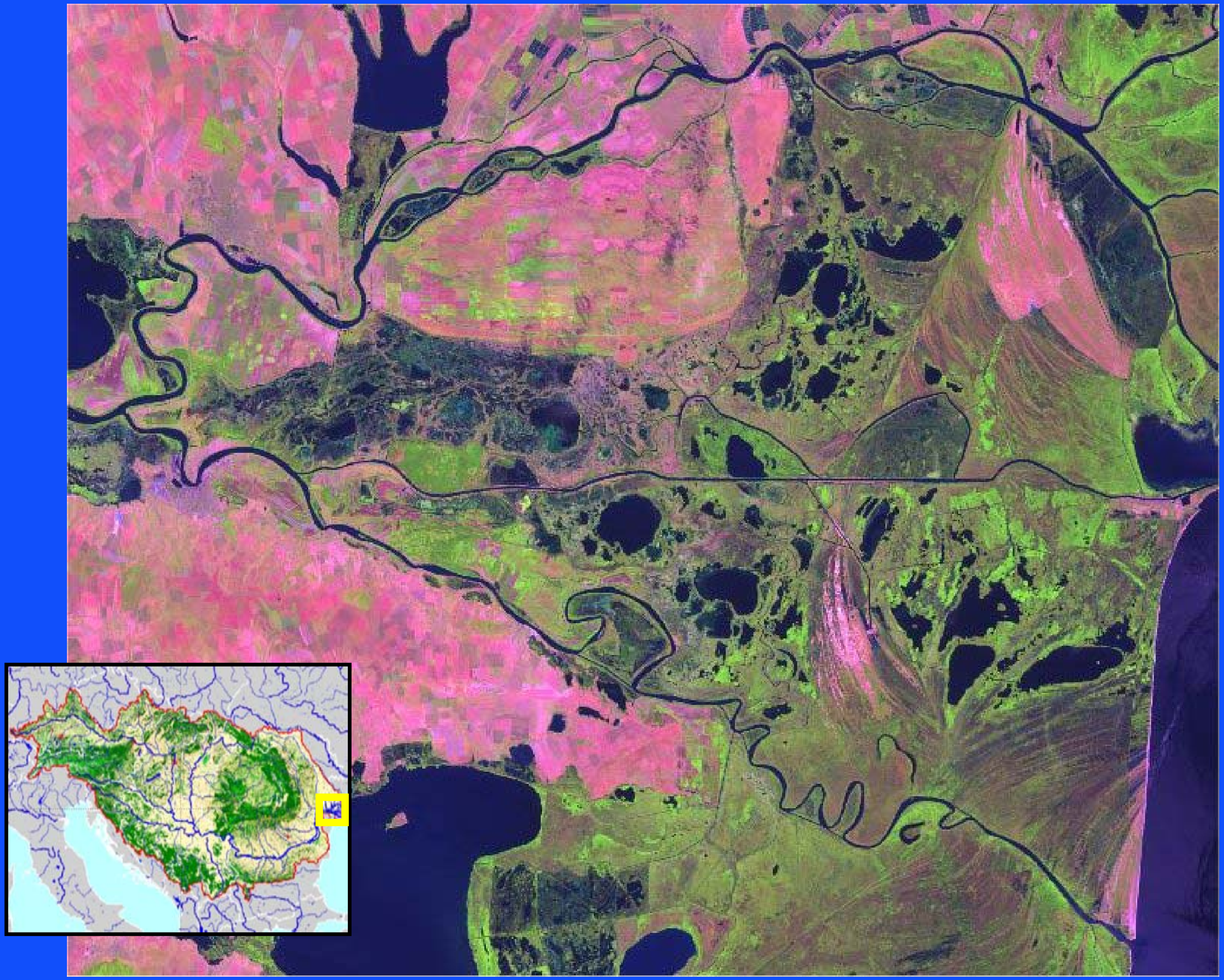
Effects of <u>changes</u> to the natural hydrology, on:

- Water levels
- Peat Subsidence
- Watershed area ➔
- Lowest flows
- Peak flows
- Water quality



Danube delta
lakes and reedlands

- **Highly complex system of lakes, streams, artificial channels, reedlands, floating reedlands**



Danube delta
→ *What do we want to study?*

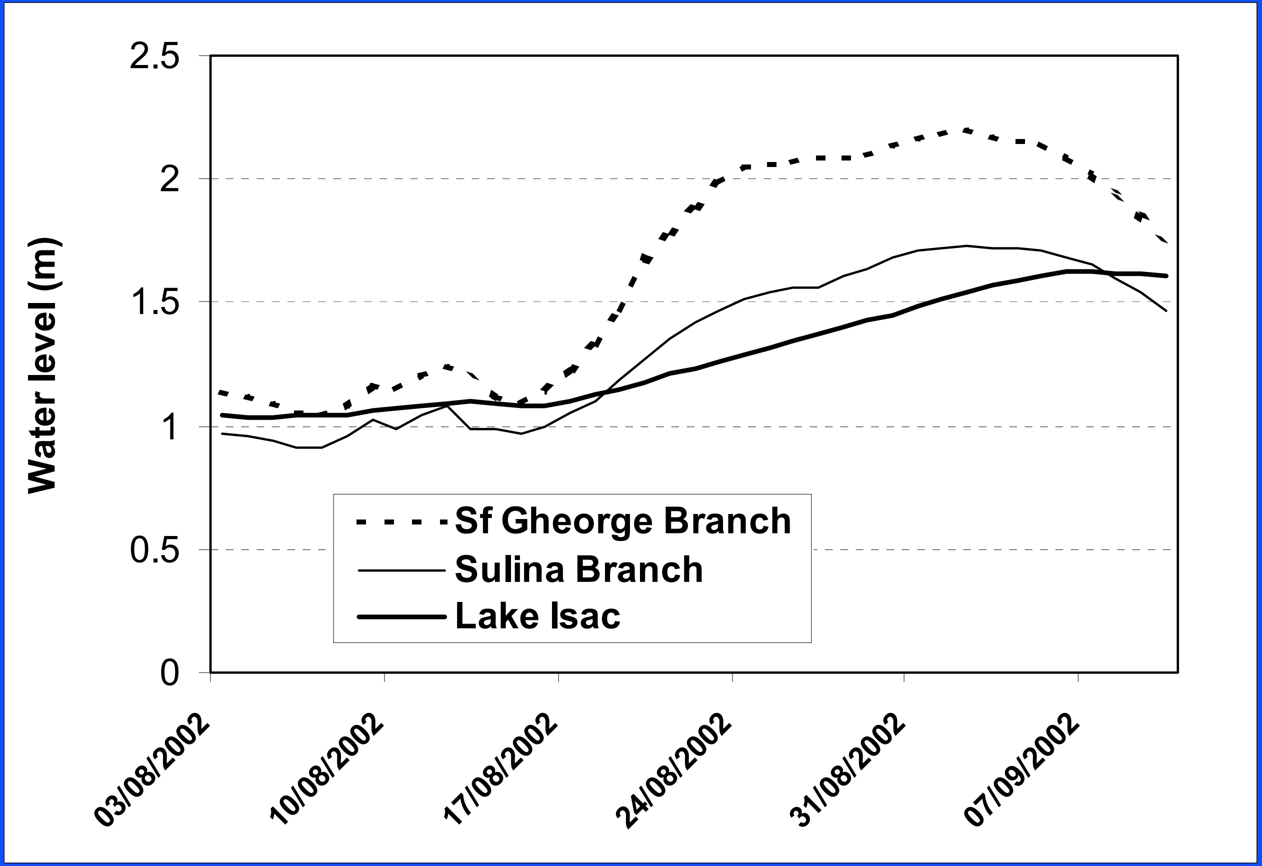
- Goal: accurate hydraulic/WQ model for WQ management (with DDNI)
- Question: connectivity between lakes? how much flow under floating reedbeds, and how much through channels?
- Approach: collect calibration data for existing model.

Danube delta
monitoring & measurements

- Flows in channels measured daily (shown: Lake Isac system).

Danube delta
monitoring & measurements

- Water levels monitored in lakes ('divers', gauges).
- Ideal 'Water balance' period: high water, no 'net' water level change in lakes.



Danube delta
closed w. balance per lake system

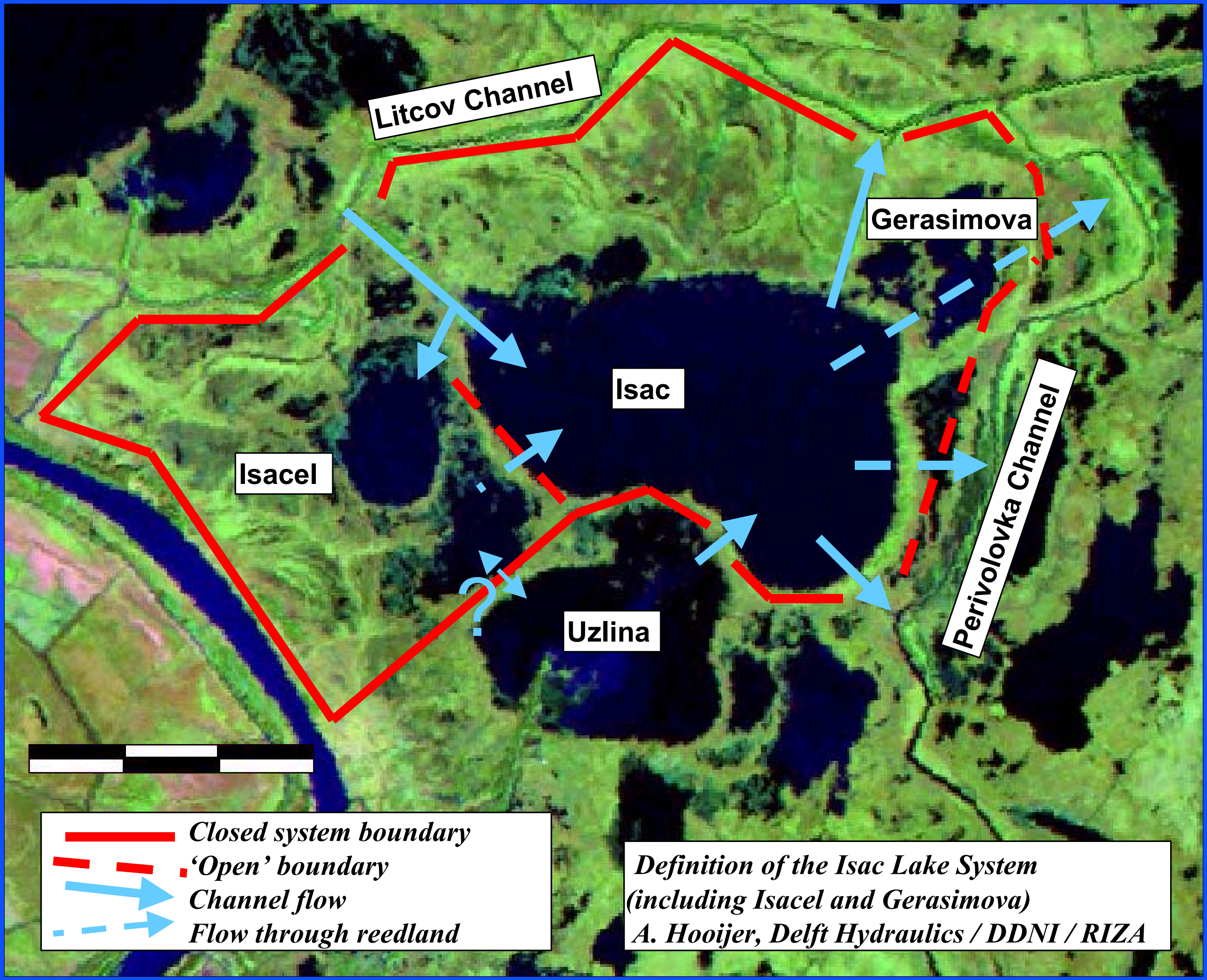
- **Using flow- and water level measure- ments**

➔ **Flow under reed very limited, even during <u>high</u> water**

	4-sep	5-sep	6-sep	7-sep	8-sep	9-sep	10-sep	11-sep	***Average 5-11 Sep***	***Average June***
Inputs										
Inflows through channels (not Isac 3)*										
Channel Isac 1 to Isac	3.64	*3.3*	2.93	3.3	3.7	4.01	4	4.02	3.61	4
Channel Isac 1 to Isacel	1.75	2	2.71	2.7	2.6	2.5	2.5	2.48	2.50	0.9****
Uzlina Channel	2.79	4.46	4.42	4	3.5	2.92	2.5	2.05	3.41	1.3
Total m3/s	8.18	9.76	10.06	10	9.8	9.43	9	8.55	**9.51**	6.2
Total m3/d	706752	843264	869184	864000	846720	814752	777600	738720	822034	535680
Rainfall (mm/d)	0	0	0	0	0	0	0	0	**0**	?*****
Outputs										
Outflows through channels										
Isac 2	3	3.75	4.12	5.25	5.5	5.87	5.02	6.18	5.10	2.5
Isac 3 (sometimes inflow)*	-2.21	0.37	-1.9	2.11	1.7	1.36	3	4.66	1.61	1.7
Total m3/s	0.79	4.12	2.22	7.36	7.2	7.23	8.02	10.84	**6.71**	4.2
Total m3/d	68256	355968	191808	635904	622080	624672	692928	936576	579991	362880
Loss to evapotranspiration										
mm/d	3	3	3	3	3	3	3	3	3	4
m3/d**	126000	126000	126000	126000	126000	126000	126000	126000	126000	168000
equivalent m3/s	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	**1.5**	1.9
Change in storage, inferred from water level change2										
Water level in Isac (m)	**1.84**	1.861	1.878	1.88	1.87	1.864	1.855	**1.84**		
W. l. change in Isac (m)	0.022	0.02	0.017	0.002	-0.01	-0.006	-0.009	-0.015		
Storage change, m3/d**	924000	840000	714000	84000	-4E+05	-3E+05	-4E+05	-6E+05	**-6000**	?*****
Storage change m3/s	**10.7**	**9.7**	**8.3**	**1.0**	**-4.9**	**-2.9**	**-4.4**	**-7.3**	**-0.07**	
<u>Result:</u> Outflow outside main channels (partly through reed) from Isac to Perivolovka channel to east										
.	-4.8	-5.5	-1.9	0.2	6.0	3.7	3.9	3.5	**<u>1.4</u>**	0.1
% of total outflow									**<u>17.4</u>**	**1.3**
flow velocity (m/s)***	-0.0019	-0.0022	-0.0008	0.0001	0.0024	0.0015	0.0016	0.0014	**<u>0.00057</u>**	0.00002

Danube delta
hydrological system definition

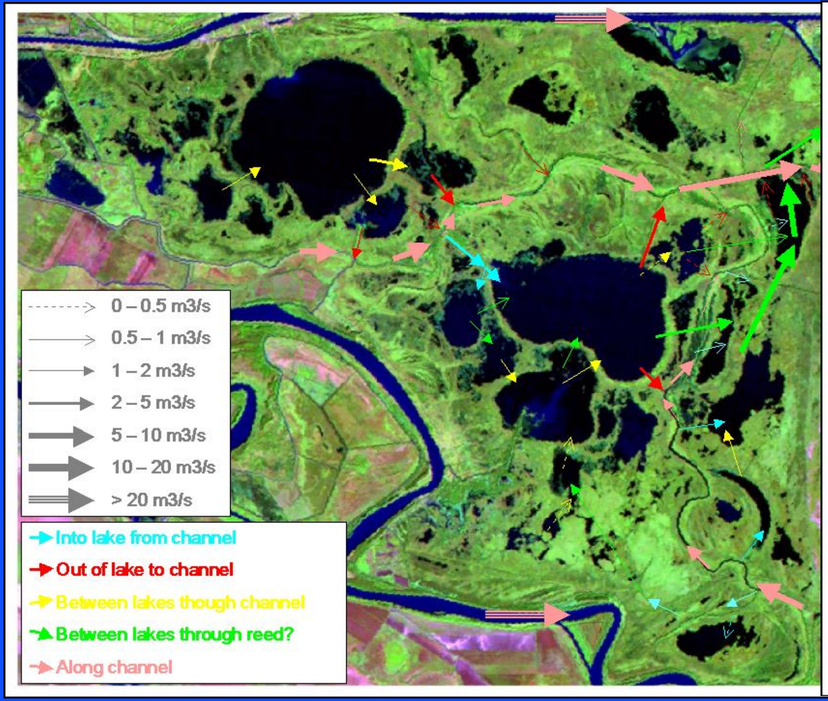
- ‘Discharge points’ outside of channels identified

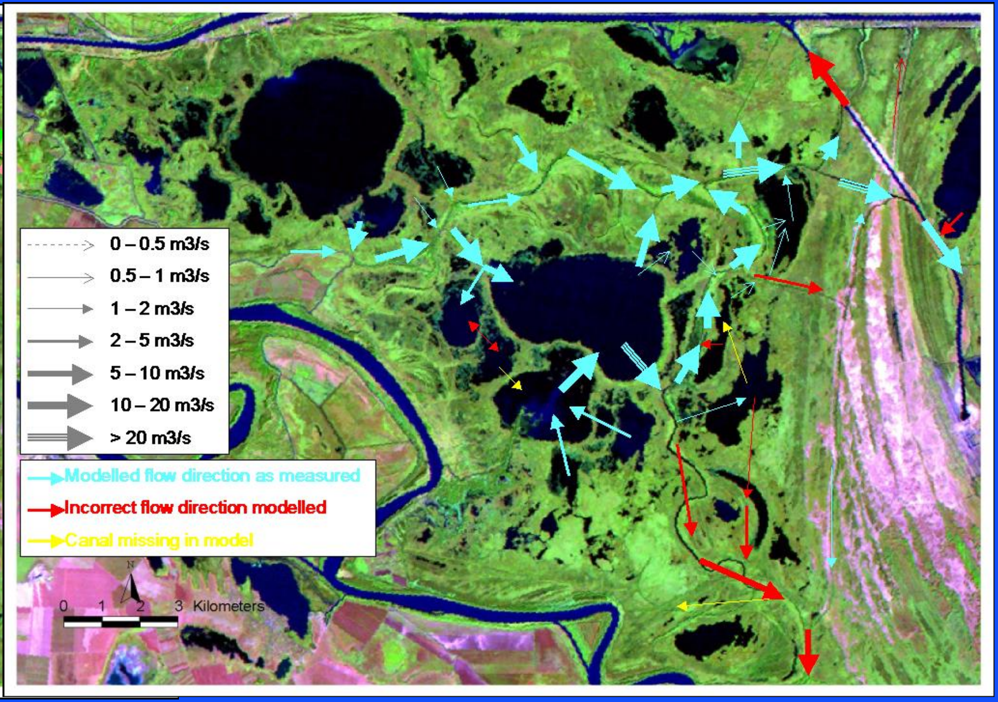


Danube delta

analysis → modelling → management

- Comparison of measured and modelled flows and water levels, as basis for further calibration.





Summary conclusion…

In all cases, water level data and specific ‘wetland’ water level record analyses methods help(ed) improve understanding and modelling of wetland hydrology:

- **Actual evapotranspiration determined**
- **Soil characteristics determined (storage coefficient)**
- **Water balance ‘closed’ with storage information**
- **Hydrological models calibrated with water levels**
- **Catchment areas refined/determined**

➔ *Water level monitoring & analysis will improve hydrological studies in wetlands*