Simulation of flooding of riparian wetlands using SWAT+

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Wetlands in catchments have an important role….

Important ecosystem services:

- Water retention
- Flood prevention
- Nutrient regulations
- Drough prevention
- Bio-diversity
- …

… but how do we model wetlands in catchment models?

Wetlands and catchments interact

Flooding

Evaporation and seepage processes
Water retention
Water pollution retention & removal

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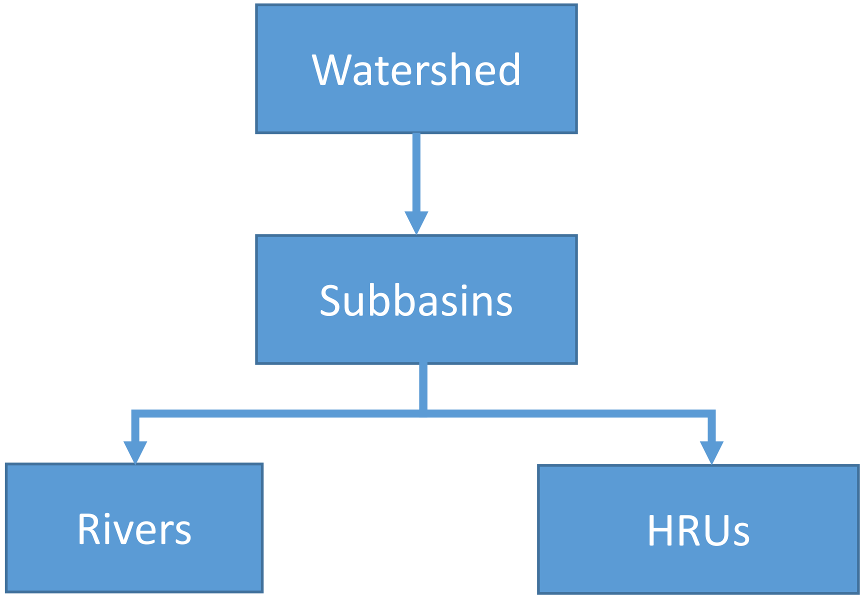
How to model wetlands in SWAT?

Soil & Water Assessment Tool | SWAT

(Arnold et al. 1998)

- Predict the impact of land management practices on water quantity and quality in large complex watersheds
- Subdivision of the watershed into subbasins and Hydrologic Response Units (HRUs)

SWAT | Soil & Water Assessment Tool



Wetlands as reservoirs

Wetlands as ponds

Incomplete wetland – catchment interactions in SWAT

Flooding

Wetlands as reservoirs

Evaporation [illegible] seepage processes

Water rete[illegible]o[illegible]

Water pollution retention & removal

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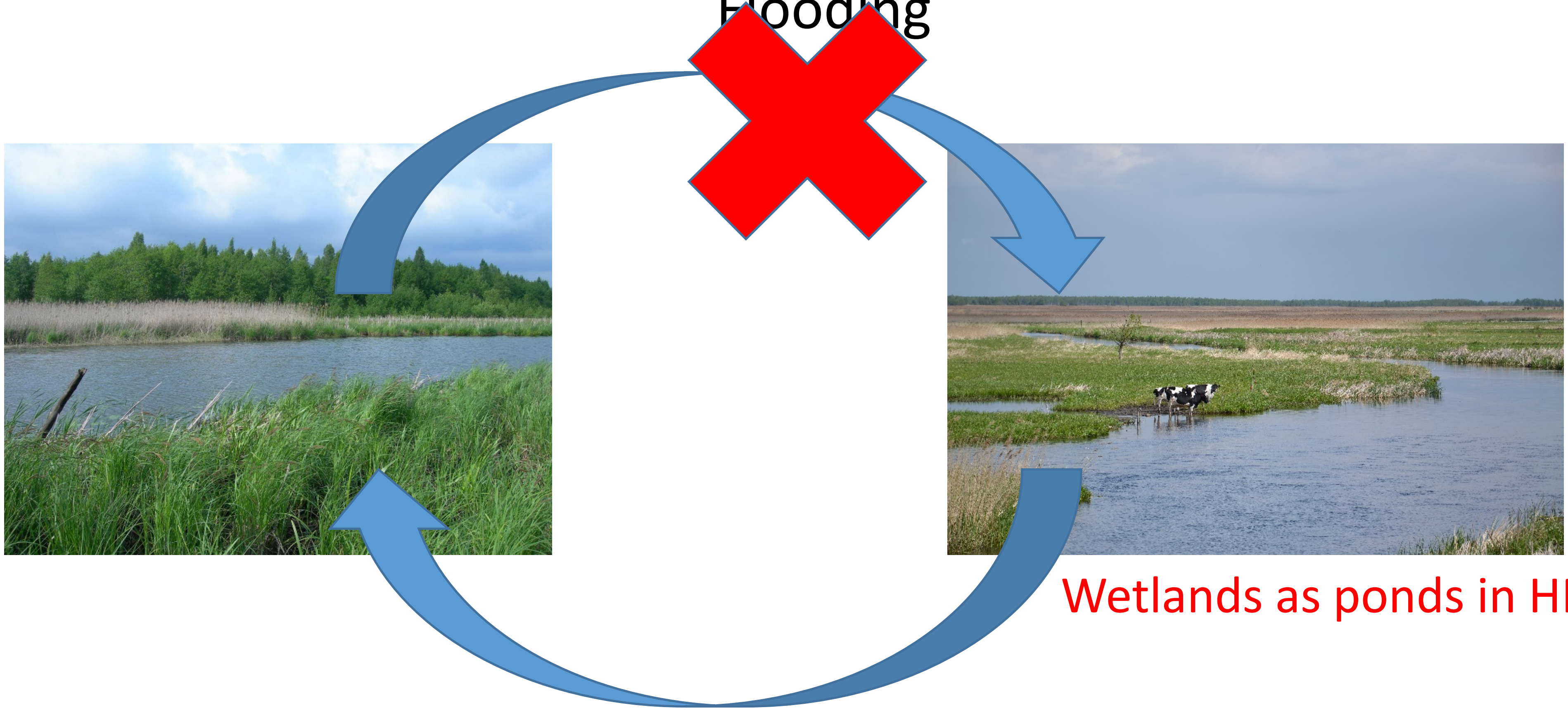
Incomplete wetland – catchment interactions in SWAT



Evaporation and seepage processes
Water retention
Water pollution retention & removal

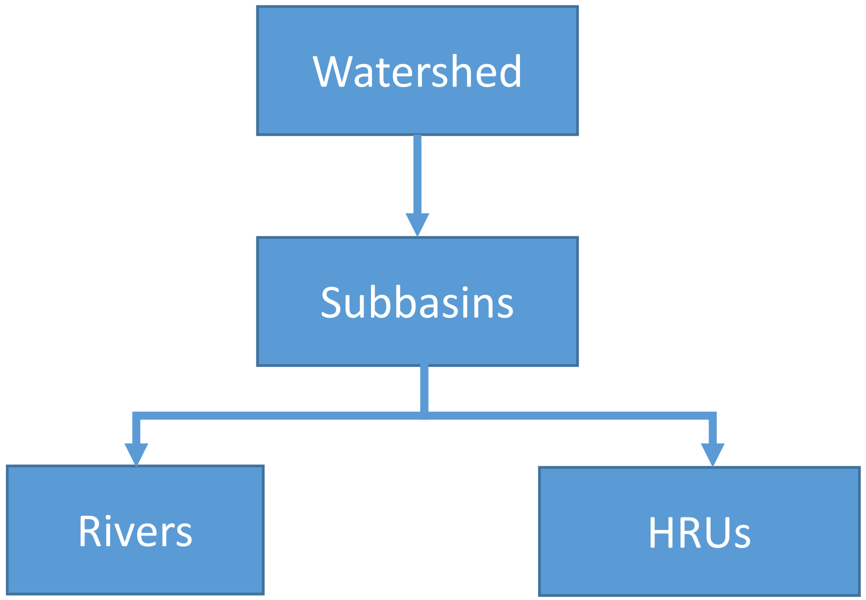
Solution comes from SWAT+, a revised version of SWAT

- SWAT+ SOIL & WATER ASSESSMENT TOOL is expected to facilitate
  - maintenance of code and input files
  - linkage of SWAT and other models
  - addition of new process subroutines

- HRUs, aquifers, channels, reservoirs, etc. are separate spatial objects
- → flexible spatial representation of interactions and processes within a watershed using “connect” files

Watershed configuration and wetland respresentation in SWAT and SWAT+

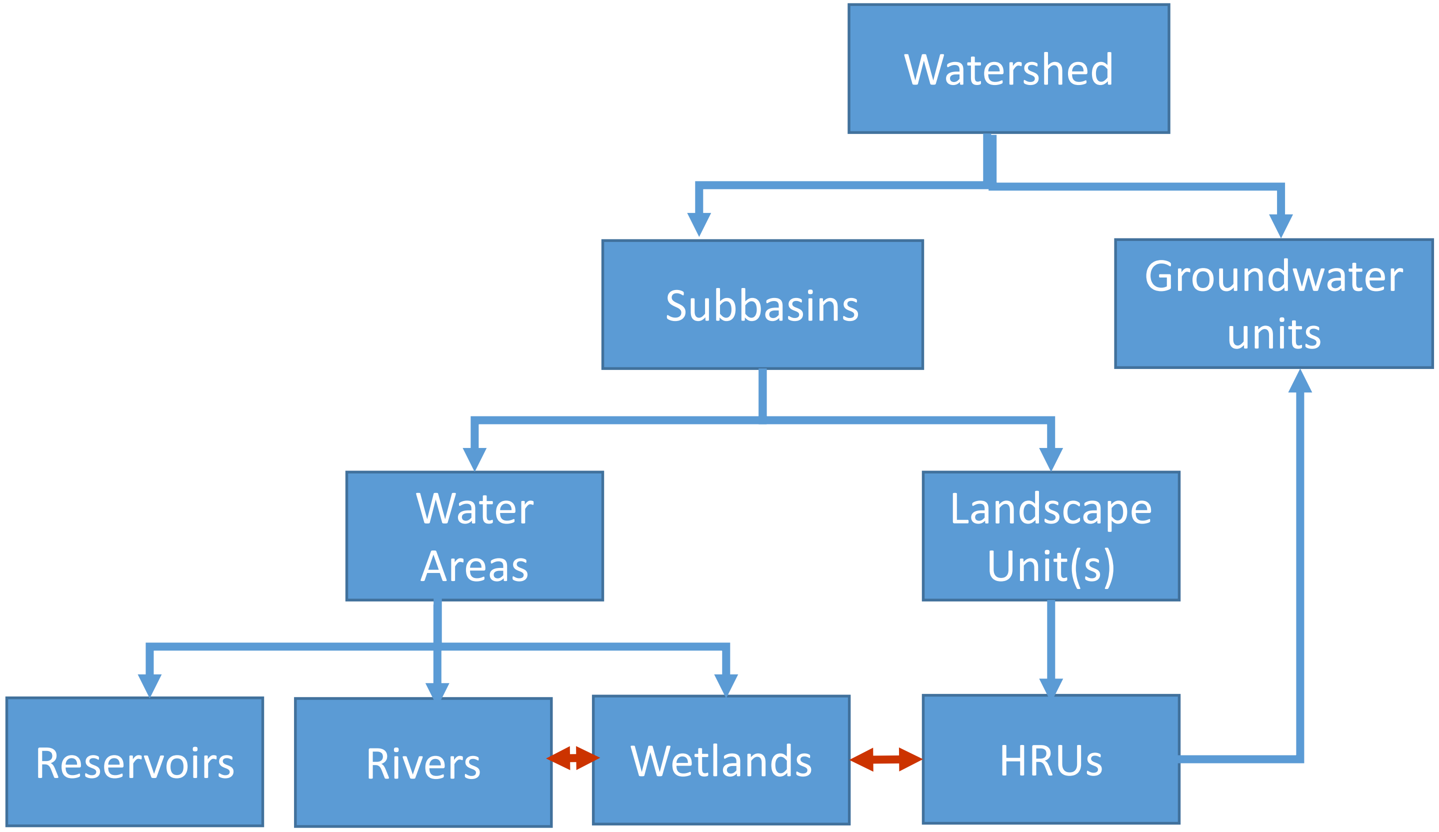
SWAT Soil & Water Assessment Tool



Wetlands as reservoirs

Wetlands as ponds

SWAT+ SOIL & WATER ASSESSMENT TOOL

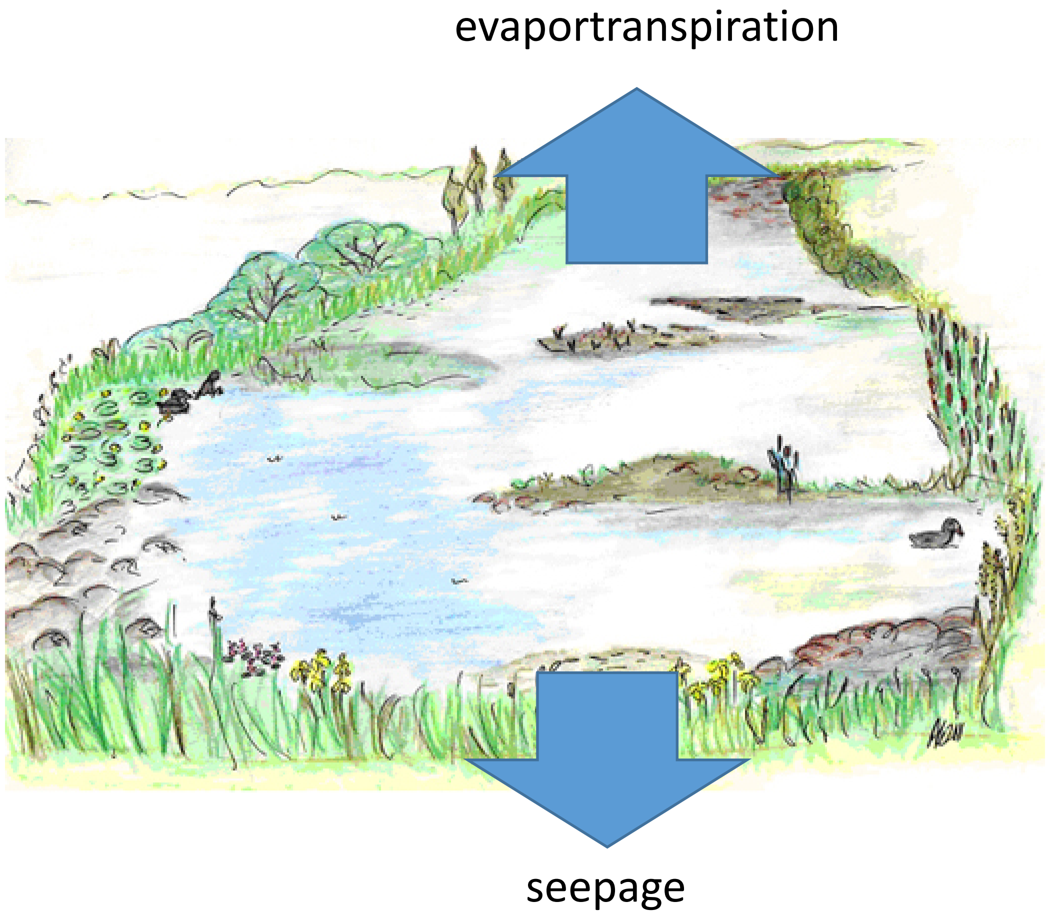


Flooding

- Flooding happens when bank-full flow is reached

- Flooded water is filling the wetlands till **maximum depth**

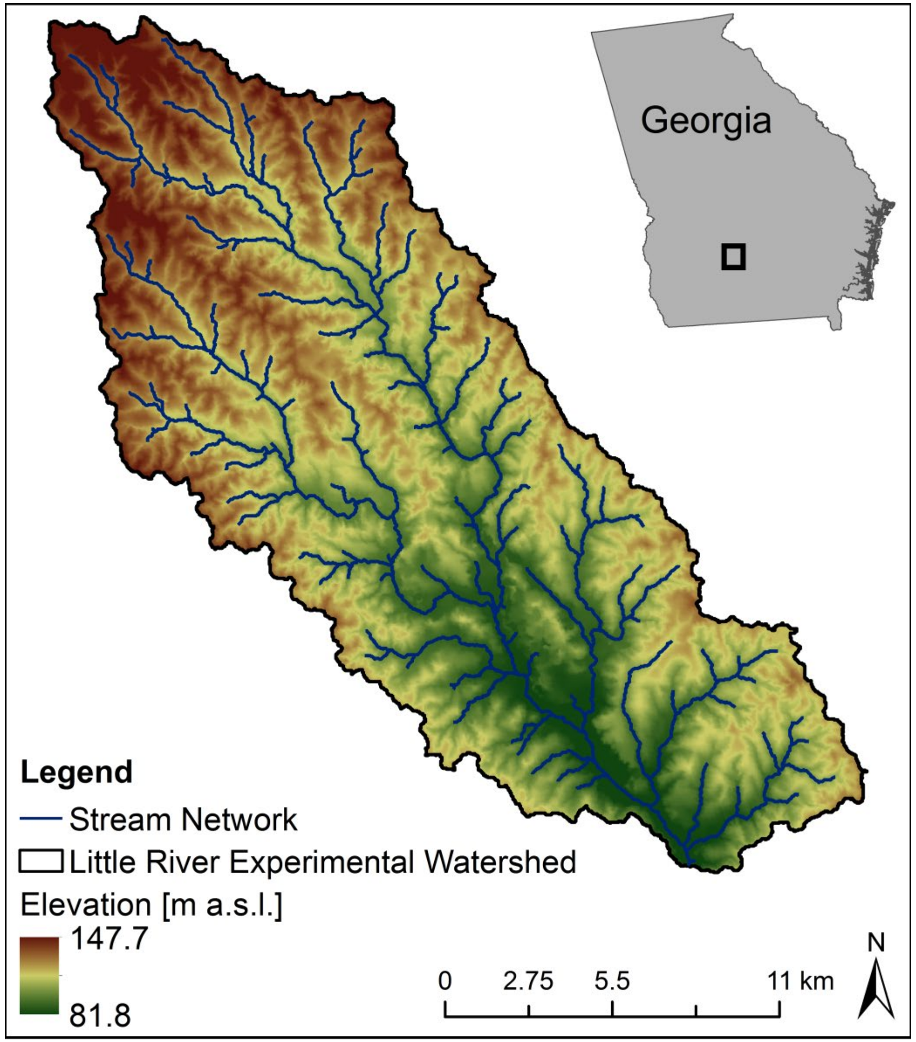
Wetland process



How to implement wetlands in SWAT+

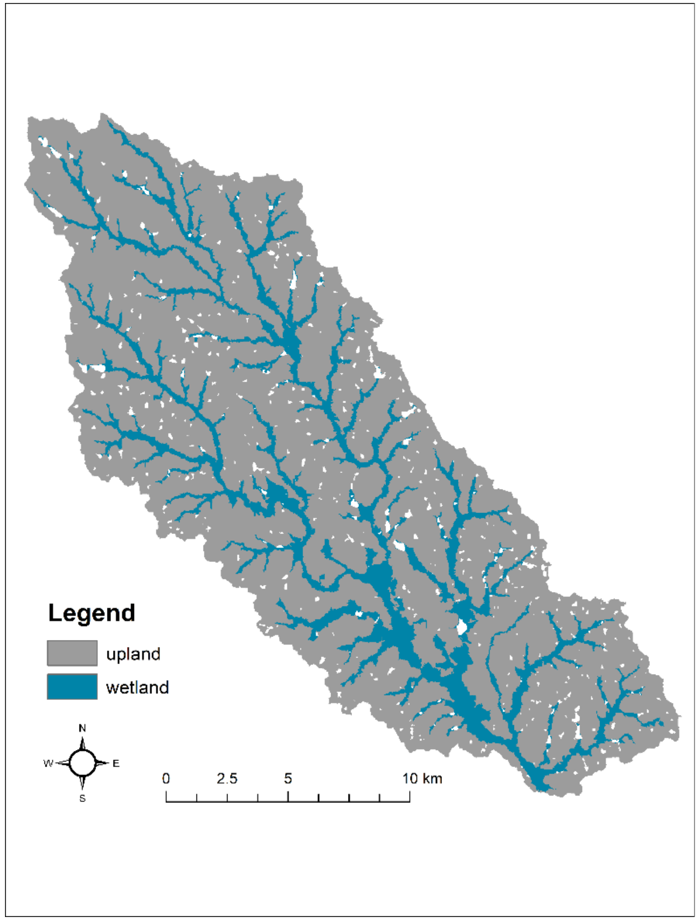
- Define landscape units
- Identify landscape units that are wetlands (= riparian HRU’s within a sub-basin) Link the wetlands to rivers
- Parameterisation of wetlands

Little River Experimental Watershed (LREW)



- Area: 334 km^2
- Average annual precip: 1208 mm
- Average temperature: 19.1°C
- Average streamflow: 2.95 m^3/s
- Topography: Broad floodplains, gently sloping uplands
- Land use: 50% forest, 41% ag land
- Soils: loamy sands and sandy loams

Characterisation of riparian wetlands



262 wetlands for 262 river reaches, covering 5199 riparian HRU’s

```
psa = 0.5      fraction of hru area at principal
pdep = 500.    average depth of water at principal spillway (mm)
esa = 0.9      fraction of hru area at emergency
edep = 1000.   average depth of water at emergency spillway (mm)
k = .01        hydraulic conductivity of the res bottom
evrsv = .6     lake evap coeff
acoef = 0      vol-surface area coefficient for hru impoundment
bcoef = 0      vol-depth coefficient for hru impoundment
ccoef = 1      vol-depth coefficient for hru impoundment
frac = .5      fraction of hru that drains into impoundment
```

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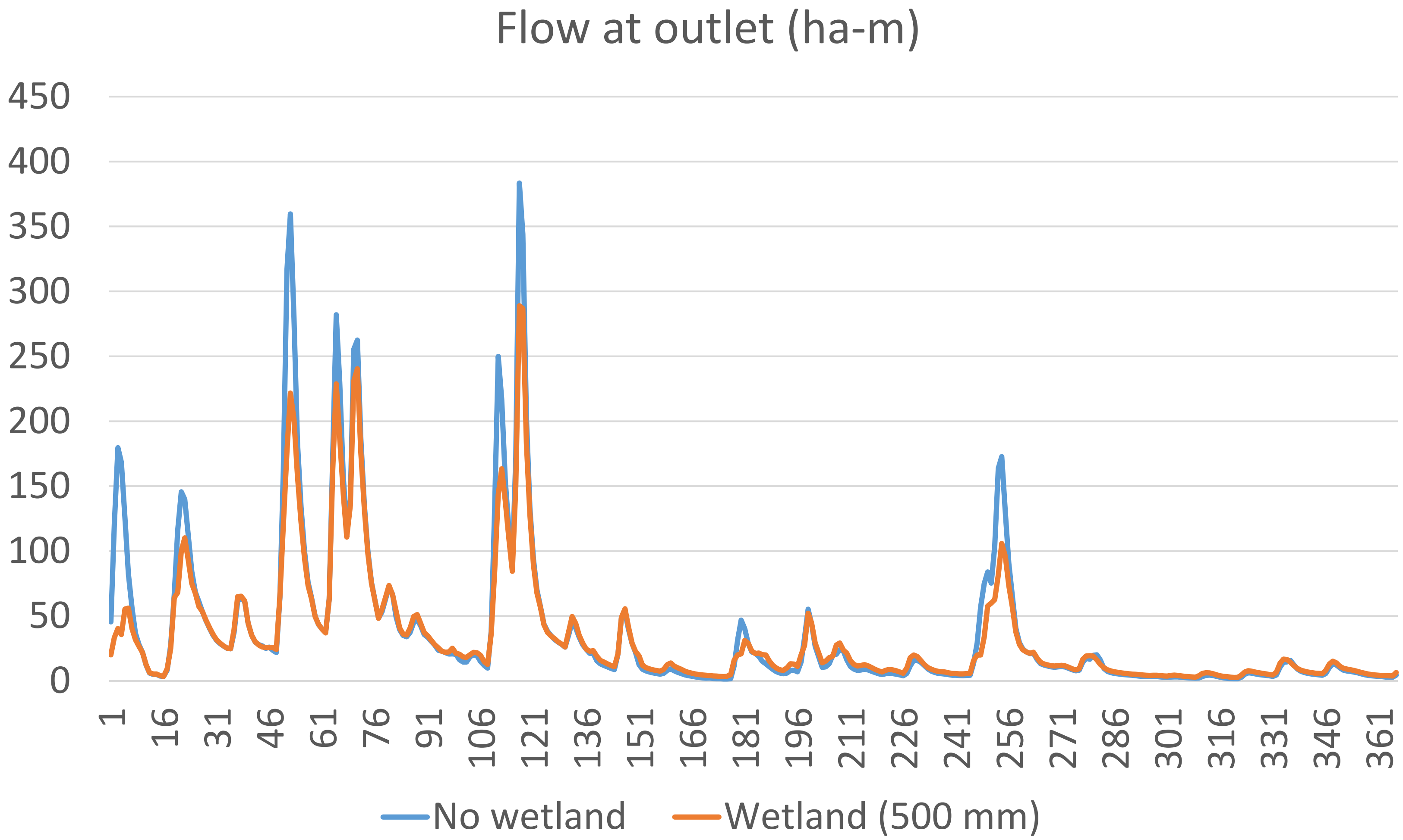
Results: Wetlands reduce peak flow



NSE = 0.7

NSE = 0.83

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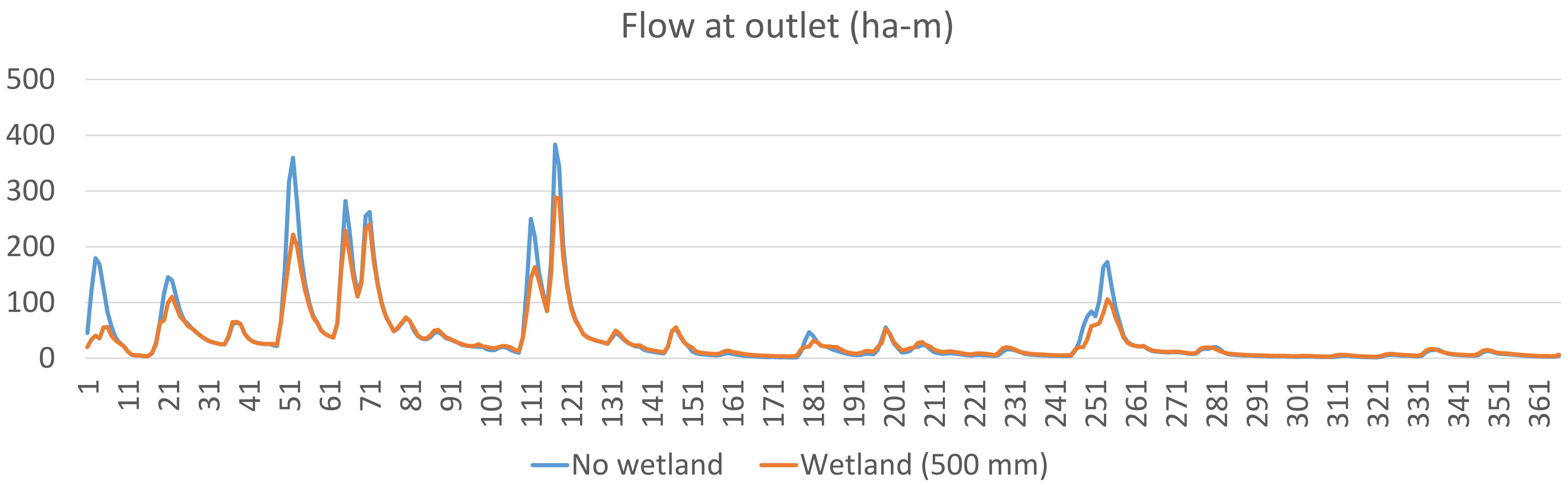
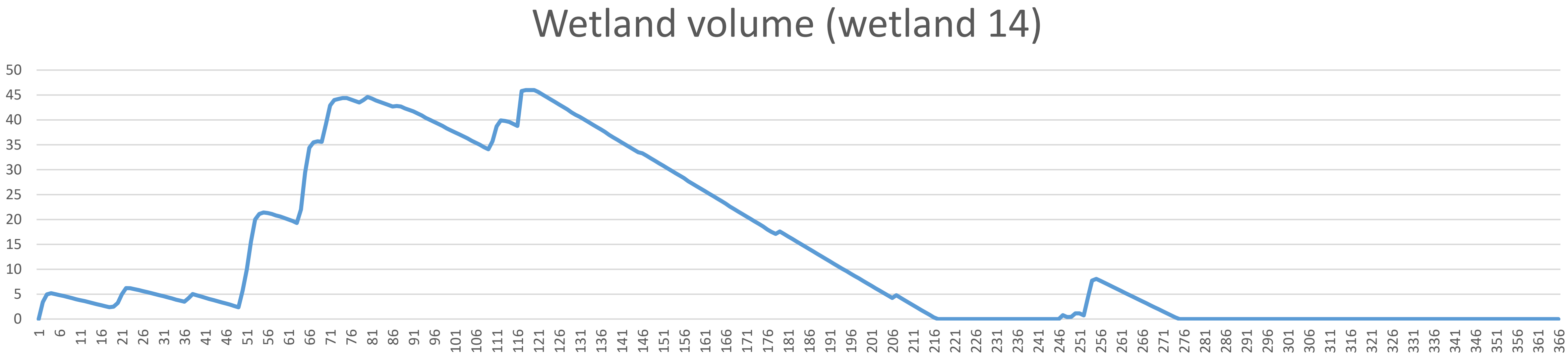

Flow at outlet (ha-m)
500
400
300
200
100
0
No wetland
Wetland (500 mm)


Wetland volume (wetland 14)
50
45
40
35
30
25
20
15
10
5
0

Results: wetlands affect landscape hydrology

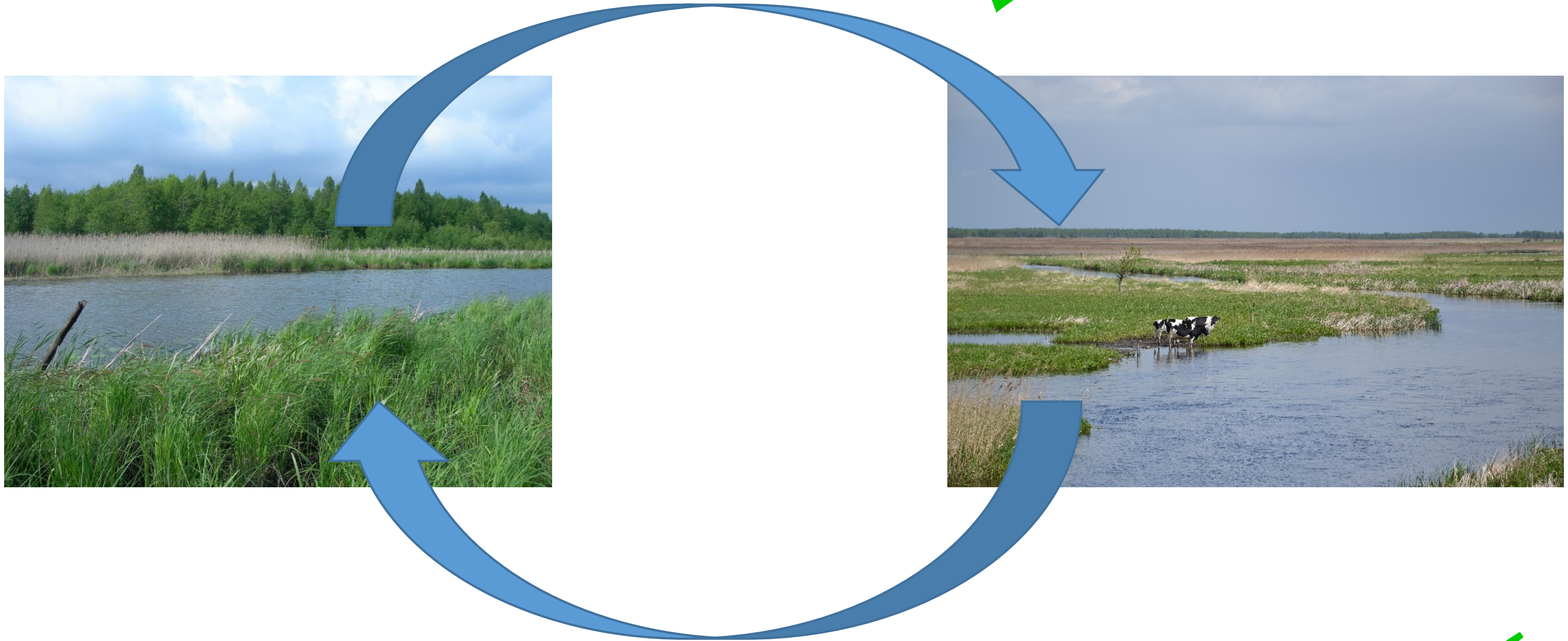
Increase evapotranspiration (+9% ~ 70 mm/yr)

Increased seepage (+9% ~ 15 mm/yr)

Reduced river flow (-12%)

Improved wetland – catchment interactions in SWAT+

Flooding ✓



Evaporation and seepage processes ✓
Water retention
Water pollution retention & removal

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Grassland Soil & Water Research Laboratory

Thanks !

Ann van Griensven

Floodplains in SWAT

Wetland.wet

wetland - Notepad

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wetland.wet

NUMB	NAME	INIT	HYD	RELEASE	SED	NUT	PST
1	wetland1	wetland001	pnd1	null	res001	res001	res001
2	wetland2	wetland001	pnd1	null	res001	res001	res001
3	wetland3	wetland001	pnd1	null	res001	res001	res001
4	wetland4	wetland001	pnd1	null	res001	res001	res001
5	wetland5	wetland001	pnd1	null	res001	res001	res001
6	wetland6	wetland001	pnd1	null	res001	res001	res001
7	wetland7	wetland001	pnd1	null	res001	res001	res001
8	wetland8	wetland001	pnd1	null	res001	res001	res001
9	wetland9	wetland001	pnd1	null	res001	res001	res001
10	wetland10	wetland001	pnd1	null	res001	res001	res001
11	wetland11	wetland001	pnd1	null	res001	res001	res001
12	wetland12	wetland001	pnd1	null	res001	res001	res001
13	wetland13	wetland001	pnd1	null	res001	res001	res001
14	wetland14	wetland001	pnd1	null	res001	res001	res001
15	wetland15	wetland001	pnd1	null	res001	res001	res001
16	wetland16	wetland001	pnd1	null	res001	res001	res001
17	wetland17	wetland001	pnd1	null	res001	res001	res001
18	wetland18	wetland001	pnd1	null	res001	res001	res001
19	wetland19	wetland001	pnd1	null	res001	res001	res001
20	wetland20	wetland001	pnd1	null	res001	res001	res001
21	wetland21	wetland001	pnd1	null	res001	res001	res001
22	wetland22	wetland001	pnd1	null	res001	res001	res001
23	wetland23	wetland001	pnd1	null	res001	res001	res001

Hru-data.hru

hru-data - Notepad

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hru-data.hru: HRU properties #NAME? split

HRU_NUMB	HRU_NAME	HRUTOPO	hydRO	soil	LU_MGT	soilNUT_IN	ISURF_STOR	SNOW	FIELD
1	hru1	top1	hyd1	soil003	lrew_ag01	soilnut001	null	snow001	null
2	hru2	top2	hyd2	soil004	lrew_ag01	soilnut001	null	snow001	null
3	hru3	top3	hyd3	soil006	lrew_ag02	soilnut001	null	snow001	null
4	hru4	top4	hyd4	soil009	lrew_ag04	soilnut001	null	snow001	null
5	hru5	top5	hyd5	soil010	lrew_ag01	soilnut001	null	snow001	null
6	hru6	top6	hyd6	soil003	landuse002	soilnut001	null	snow001	null
7	hru7	top7	hyd7	soil004	landuse002	soilnut001	null	snow001	null
8	hru8	top8	hyd8	soil006	landuse002	soilnut001	null	snow001	null
9	hru9	top9	hyd9	soil010	landuse002	soilnut001	null	snow001	null
10	hru10	top10	hyd10	soil003	landuse003	soilnut001	null	snow001	null
11	hru11	top11	hyd11	soil004	landuse003	soilnut001	null	snow001	null
12	hru12	top12	hyd12	soil006	landuse003	soilnut001	null	snow001	null
13	hru13	top13	hyd13	soil009	landuse003	soilnut001	null	snow001	null
14	hru14	top14	hyd14	soil010	landuse003	soilnut001	null	snow001	null
15	hru15	top15	hyd15	soil003	landuse004	soilnut001	null	snow001	null
16	hru16	top16	hyd16	soil006	landuse004	soilnut001	null	snow001	null
17	hru17	top17	hyd17	soil009	landuse004	soilnut001	null	snow001	null
18	hru18	top18	hyd18	soil010	landuse004	soilnut001	null	snow001	null
19	hru19	top19	hyd19	soil004	landuse005	soilnut001	null	snow001	null
20	hru20	top20	hyd20	soil006	landuse005	soilnut001	null	snow001	null
21	hru21	top21	hyd21	soil006	landuse007	soilnut001	null	snow001	null
22	hru22	top22	hyd22	soil004	landuse003	soilnut001	wetland1	snow001	null
23	hru23	top23	hyd23	soil009	landuse003	soilnut001	wetland1	snow001	null

Hydrology.wet

hydrology - Notepad

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```
hydrology.wet
     NAME          PSA         PVOL       ESA            EVOL         K        EVRSV     ACOEF      BCOEF      CCOEF      FRAC
     pnd1         0.5       120.             0.9        140         0.02           0.6       0.           0.          1.    0.01
```

Chan-surf.lin

chan-surf - Notepad

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Chann el_land scape_li nkage

639

NUM	ICHAN	NAME	OBNUM	OBTYP	TYP_NO
1	1	surf_chan1	1	sub	2
2	2	surf_chan2	1	sub	4
3	3	surf_chan3	1	sub	6
4	4	surf_chan4	1	sub	8
5	5	surf_chan5	1	sub	10
6	6	surf_chan6	1	sub	12
7	7	surf_chan7	1	sub	14
8	8	surf_chan8	1	sub	16
9	1	surf_chan9	1	sub	18
10	1	surf_chan10	1	sub	20
11	2	surf_chan11	1	sub	22
12	2	surf_chan12	1	sub	24
13	3	surf_chan13	1	sub	26
14	3	surf_chan14	1	sub	28
15	4	surf_chan15	1	sub	30
16	4	surf_chan16	1	sub	32
17	5	surf_chan17	1	sub	34
18	5	surf_chan18	1	sub	36
19	6	surf_chan19	1	sub	38
20	6	surf_chan20	1	sub	40
21	7	surf_chan21	1	sub	42
22	7	surf_chan22	1	sub	44

Linkages

HRU i-> (ru_def) SUB j -> chan-link k (ch-sur%iobjnum) ->channel nr l (ch_sur%chnum)

HRU i-> HRU%dbs%surfstor -> wetland m

When flooding in chan k, it looks for HRU i and floods towards wetland m (HRU%dbs%surfstor)

Do ihr =1, tothru

iob = hru(ihr)%obj_no

ichan = ob(iob)%flood_ch_lnk

- if (ichan == k) then
- ires = hru(ihr)%dbs%surf_stor
- -> flooding processes

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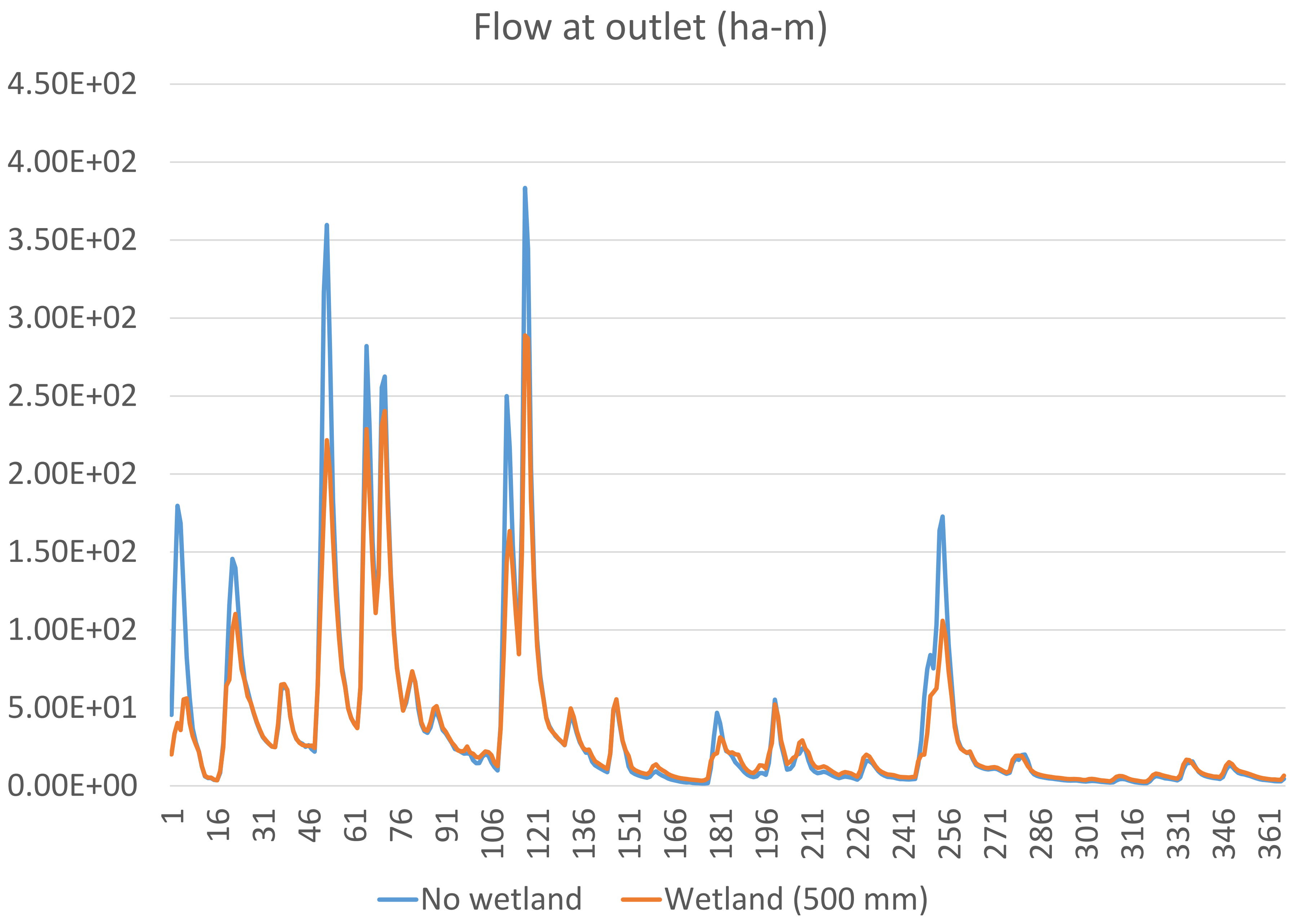

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