



A comparison between SWAT and WETSPA hydrological models for riparian fen modelling at the catchment scale

Joanna Suliga¹ (joanna.suliga@vub.ac.be)

Wojciech Ciężkowski² (w.ciezkowski@levis.sggw.pl)

Co-authors: Jarosław Chormański², Małgorzata Kleniewska², Ann Van Griensven^{1,3}, Boud Verbeiren²

1) VUB - Vrije Universiteit Brussels

2) WULS-SGGW – Warsaw University of Life Sciences

3) UNESCO - IHE

SWAT 2017

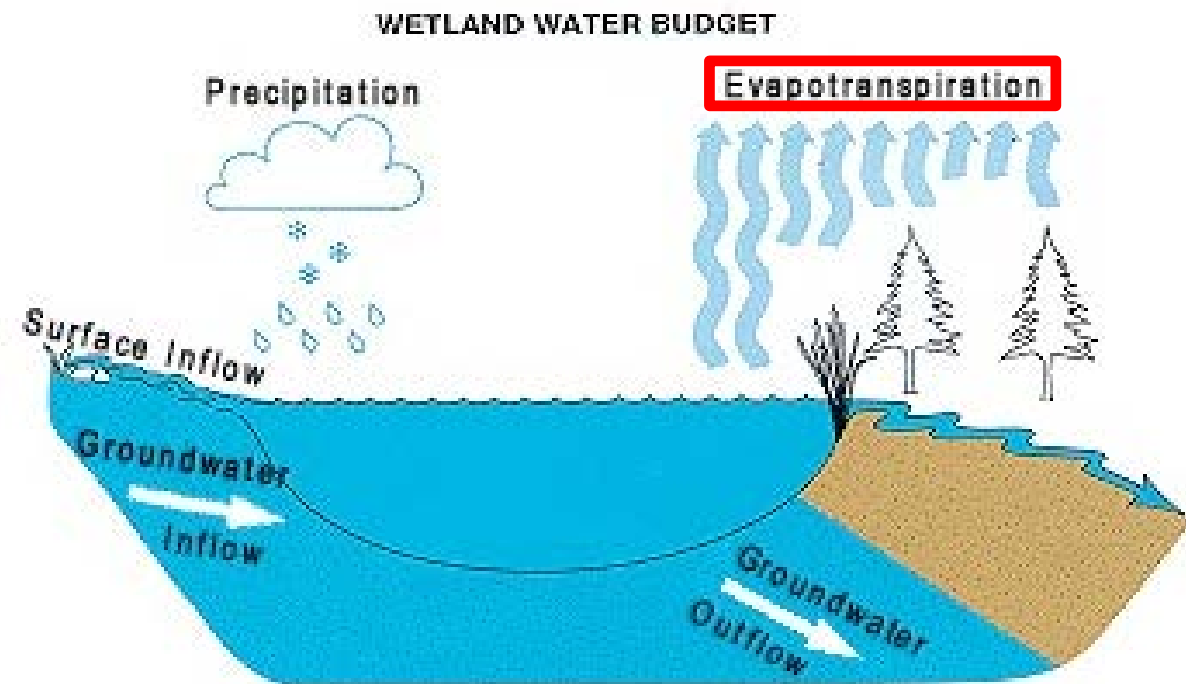
The main objective:

to make a **comparison** of **ET** simulations
in **wetlands** using two models:

SWAT and **WETSPA**

Why ET in Wetlands?

- Huge variability
- ET is a dominant process

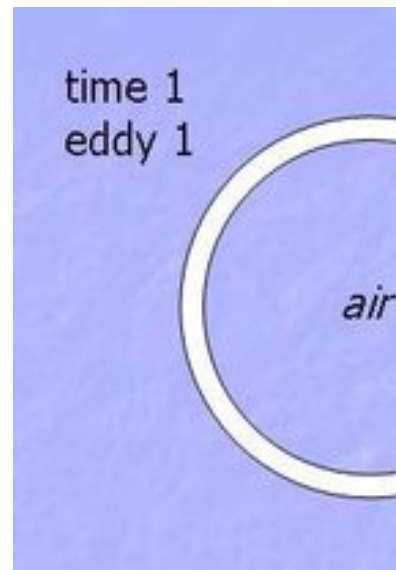


Eddy Covariance method

Based on high frequent (minimum 10 Hz) measurements of vertical wind velocity (w) and gas concentration flux. Gas flux (F_s) is equal to the mean covariance of the measurements.

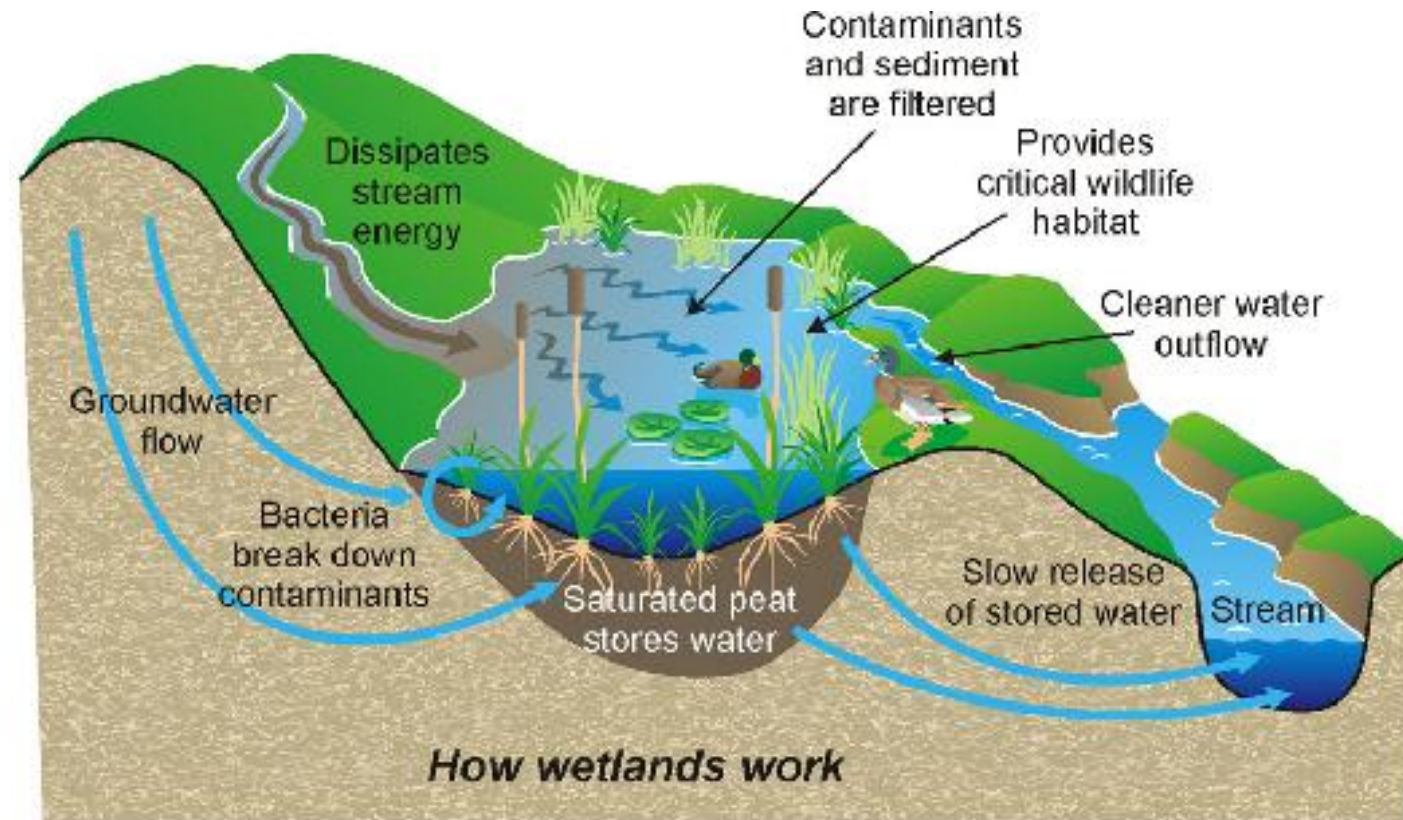
$$F_s = \overline{w \cdot c}$$

Eddy covariance method is allowed to measure evapotranspiration over the whole footprint



Why Wetlands?

- Wetlands have a significant impact on hydrological regime
- Transition zone between terrestrial and aquatic ecosystems
- Plenty of ecosystem services



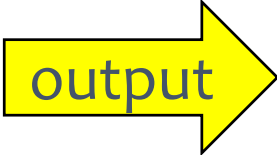
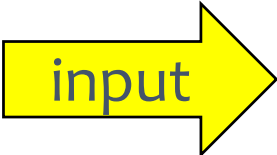
Study site: wetlands in the Biebrza Valley, Poland

Biebrza National Park

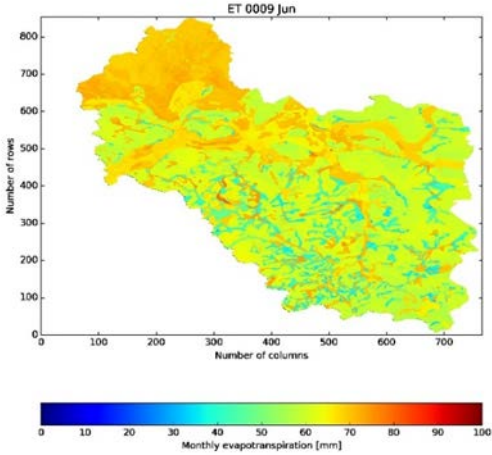
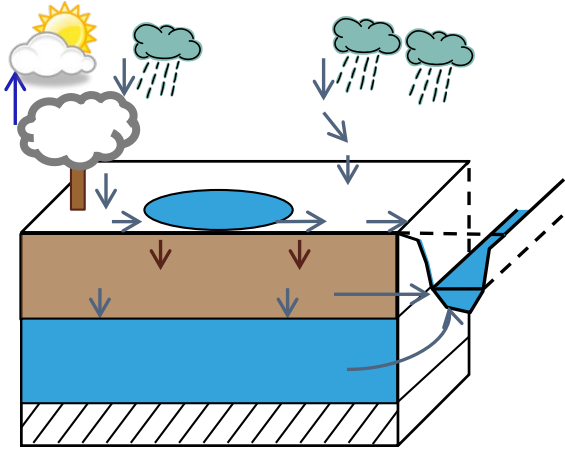
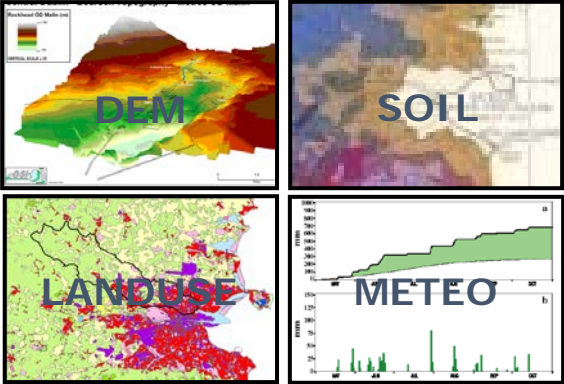


A comparison of hydrological models in 3 steps

Data



ET estimation



STEP 1 – data input

Meteorological data

- Temperature min/max
- Precipitation
- Discharge
- PET

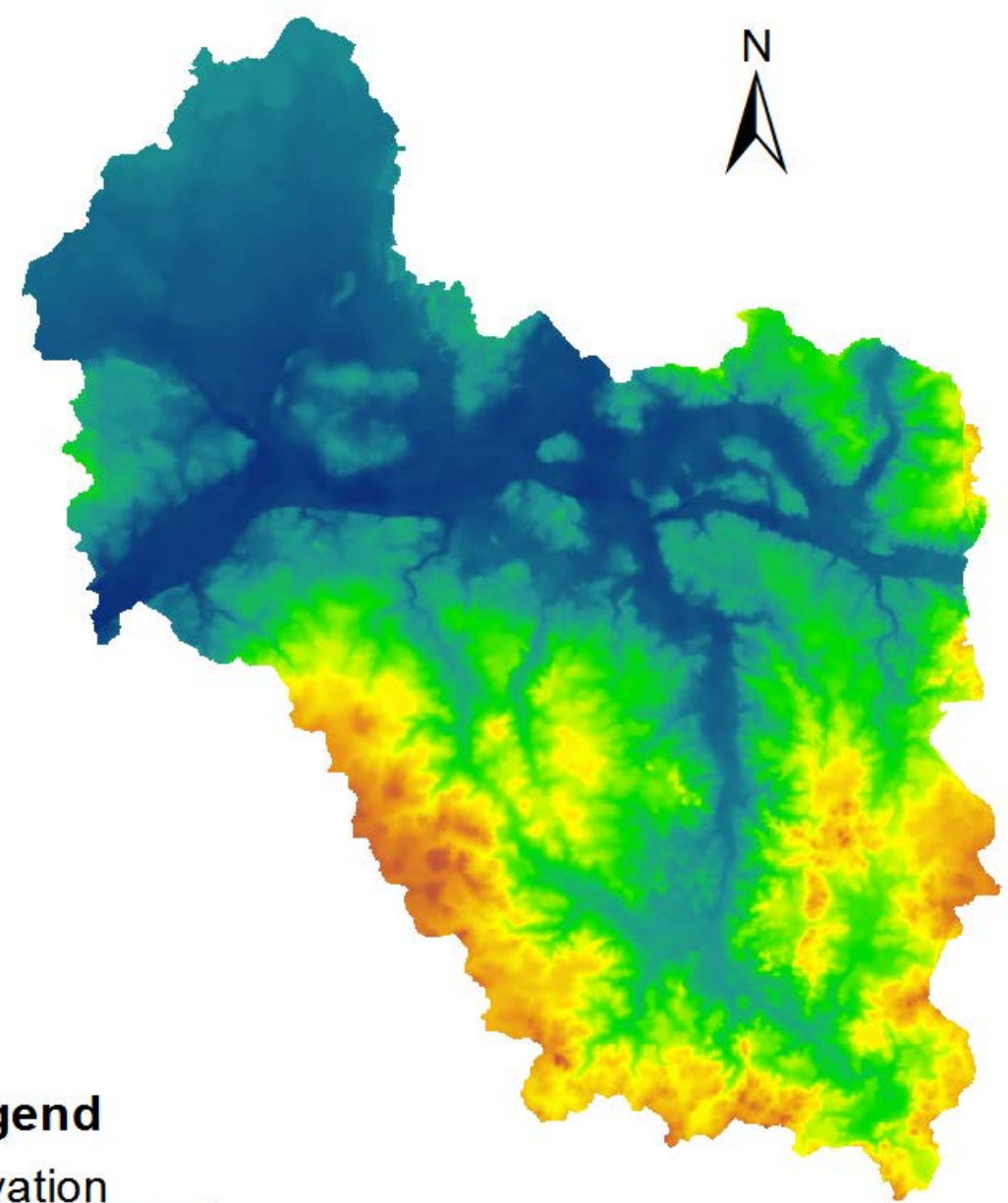
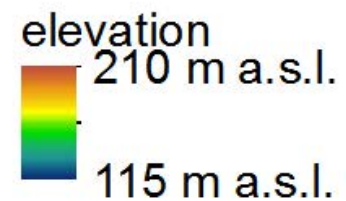
WETSPA requires PET as input data (Penman Monteith)

Study site

Biebrza Valley, Poland

- Upper Basin – 800 km²
- Riparian wetlands
- Peatlands: 4-6m depth

Legend



Landuse

Land Cover/Plant Growth Database Edit

Crop types

- Agricultural Land-Close-grown
- Agricultural Land-Generic
- Agricultural Land-Row Crops
- Alamo Switchgrass
- Alfalfa
- Almonds
- Alsike Clover
- Altai Wildrye
- Apple
- Asparagus
- Bananas**
- Barren
- Bell Pepper
- Bermudagrass
- Big Bluestem
- Broccoli
- Cabbage
- Cantaloupe
- Carrot
- Cashews
- Cassava
- Cauliflower
- Celery
- Cockle Bur
- Cocoa Tree
- Coconut
- Coffee
- Corn
- Corn Silage
- Cowpeas
- Crested Wheatgrass
- Cucumber
- Durum Wheat
- Eastern Gamagrass
- Eggplant
- Eragrostis Teff
- Eucalyptus
- Field Peas
- Flax
- Forest-Deciduous
- Forest-Evergreen
- Forest-Mixed
- Garden or Canning Peas
- Grain Sorghum
- Grarigue
- Green Beans
- Hay

Crop type Parameters

Crop Name: Bananas CPNM (4 character): BANA

IDC: Trees Crop is fertilized Op Schedule: AGRR

BIO_E [(kg/ha)/(MJ/m2)]: 30	HVST1 [(kg/ha)/(kg/ha)]: 0.44	BLAI (m2/m2): 4.5
FRGRW1 (fraction): 0.05	LAIMX1 (fraction): 0.05	CHTMX (m): 7.5
FRGRW2 (fraction): 0.4	LAIMX2 (fraction): 0.95	DLAI (heat units/heat units): 0.99
T_OPT (C): 30	T_BASE (C): 10	CNYLD(kg N/kg seed): 0.0064
BN1 (kg N/kg biomass): 0.06	BN2 (kg N/kg biomass): 0.032	BN3 (kg N/kg biomass): 0.016
BP1 (kg P/kg biomass): 0.003	BP2 (kg P/kg biomass): 0.002	BP3 (kg P/kg biomass): 0.001
WSYF [(kg/ha)/(kg/ha)]: 0.01	USLE_C: 0.001	GSI (m/s): 0.0036
FRGMAX (fraction): 0.75	WAVP (rate): 8	CO2HI (uL/L): 660
RSDCO_PL (fraction): 0.05	ALAI_MIN (m2/m2): 0.75	BIO_LEAF (fraction): 0.3
MAT_YRS (years): 10	BMX_TREES (tons/ha): 200	EXT_COEF: 0.45

VPDFR (kPa): 4

BIOEHI (ratio): 31

BM_DIEOFF: 0.1

Hydrological Parameters

OV_N: 0.14 LU

SCS Runoff Curve Numbers

A: 45	B: 66	C: 77	D: 83
-------	-------	-------	-------

LU

Select land cover/ plant to edit the parameters

Add New

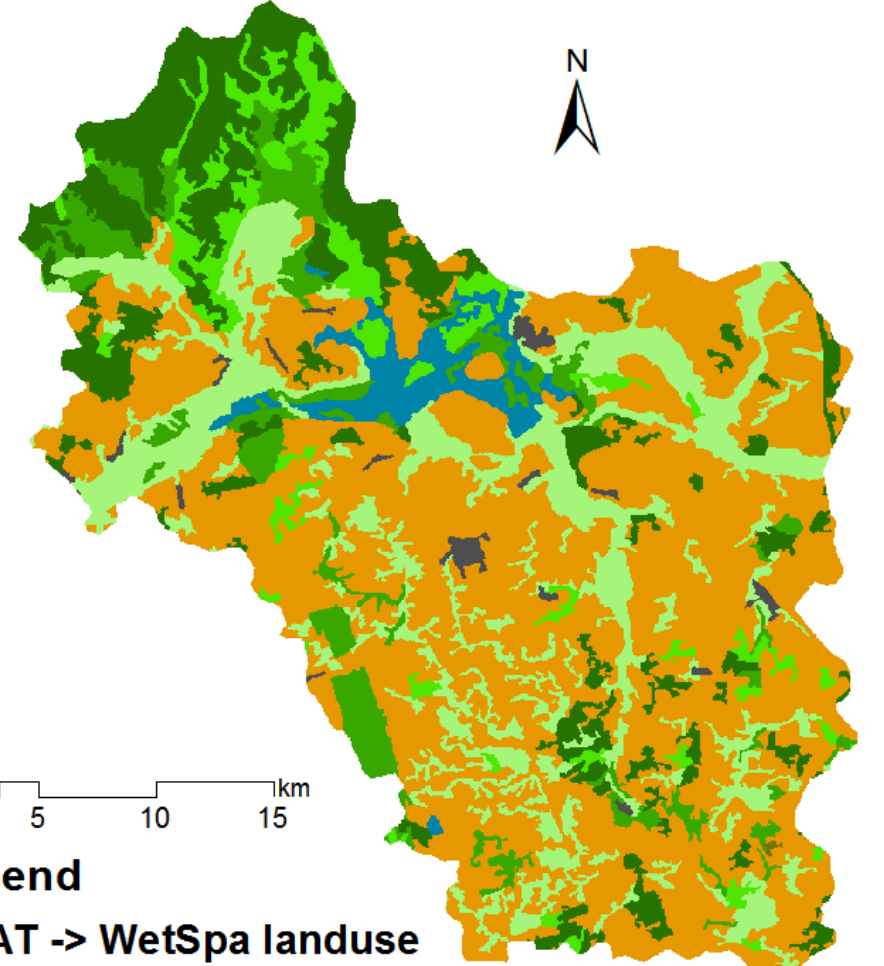
Save Edits

Cancel Edits

Delete

Default

Exit

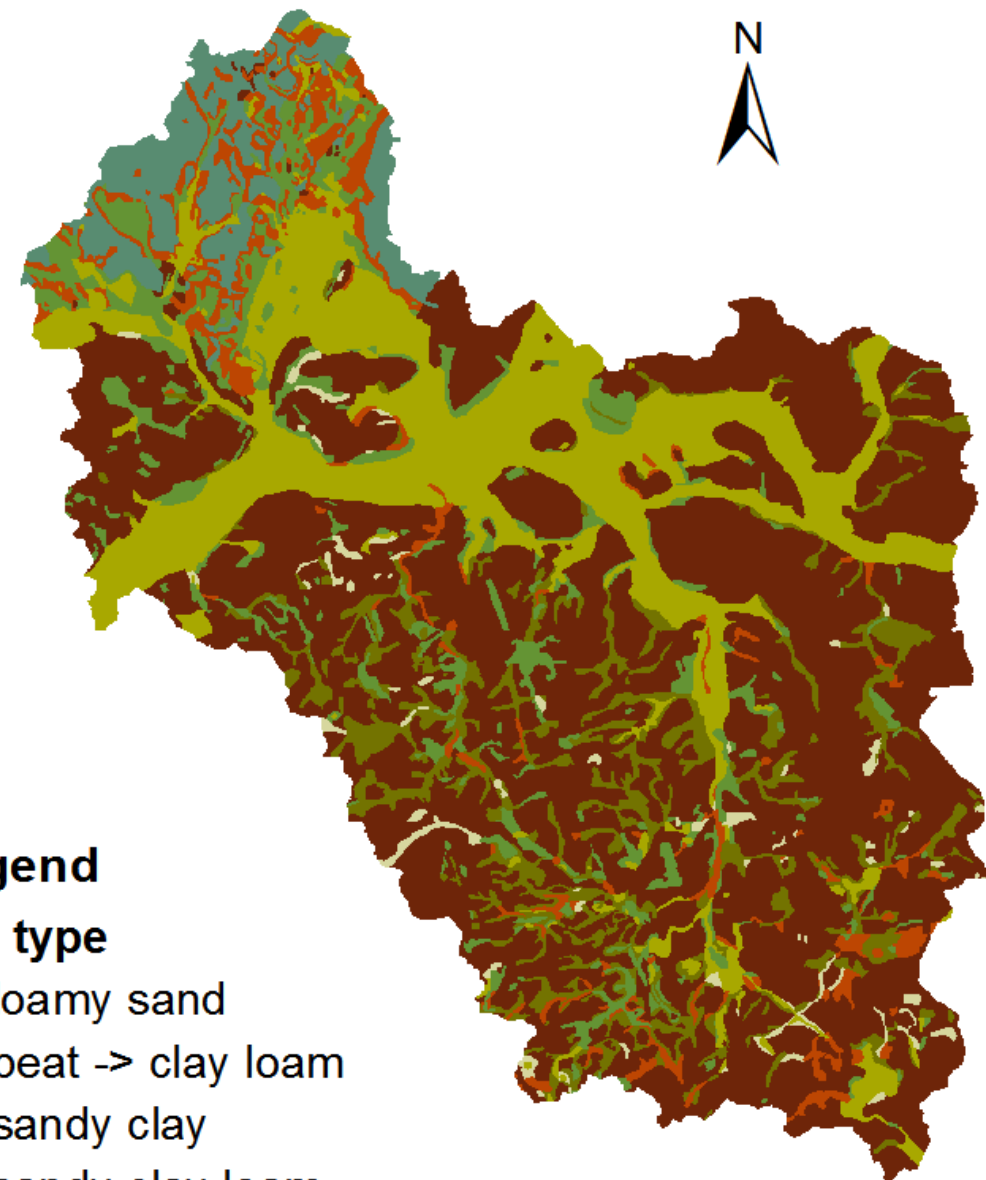


- Legend**
- SWAT -> WetSpa landuse**
- agricultural land generic -> croplands
 - deciduous forest -> deciduous broadleaf forest
 - evergreen forest -> evergreen needleleaf forest
 - mixed forest -> mixed forest
 - mixed wetlands -> permanent wetlands
 - pasture -> grasslands
 - range brush -> open shrublands
 - residential med/low density -> urban and built-up

SWAT soils parameters

Same type of soil in both model

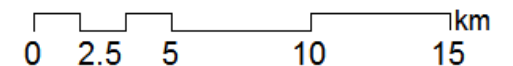
In SWAT division for layers with different parameters



Legend

soil type

- loamy sand
- peat -> clay loam
- sandy clay
- sandy clay loam
- sandy loam
- silt
- silt loam



User Soils Edit

ABRAM
ADAMS
ADRIAN
AGAWAM
AMENIA
AQUENTS
AU GRES
BEACHES
BECKET
BELGRADE
BENSON
BERKSHIRE
BERNARDSTON
BINGHAMVILLE
BIRDSALL
BLASDELL
BOMOSEEN
BRAYTON
BUCKLAND
BUCKSPORT
BUXTON
CABOT
CANAAN
CARDIGAN
CARLISLE
CASTILE
CHARLES
CHARLTON
CHOCORUA
CLAVERACK
COLONEL
COLONIE

Soil Component Parameters

SNAM	NLAYERS	HYDGRP
BIRDSALL	3	D

SOL_ZMX (mm)	ANION_EXCL (fraction)	SOL_CRK (m3/m3)
1524	0.5	0.5

TEXTURE

SIL-VFSL-VFSL

Soil Layer Parameters

Soil Layer: 1	SOL_Z (mm)	SOL_BD (g/ cm3)
	228.6	1.05

SOL_AWC (mm/mm)	SOL_CBN (% wt.)	SOL_K (mm/hr)
0.22	2.91	9.4

CLAY (% wt.)	SILT (% wt.)	SAND (% wt.)
9.5	69.16	21.34

ROCK (% wt.)	SOL_ALB (fraction)	USLE_K
0	0.01	0.49

SOL_EC (dS/m)	SOL_CAL (%)	SOL_PH
0	0	0

Add New
Cancel Edits
Save Edits
Delete
Exit

STEP 2 - Simulation

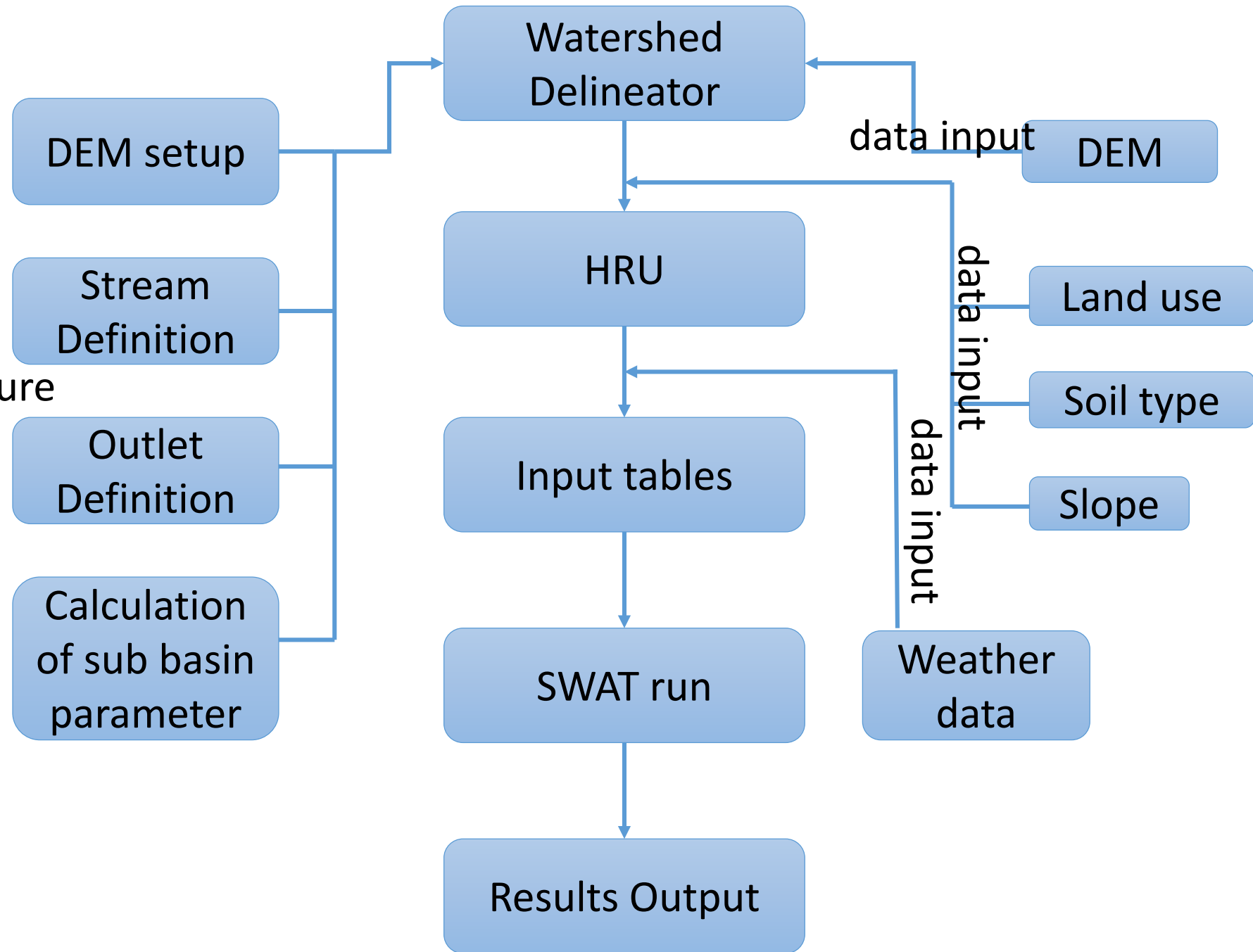
Both WETSPA and SWAT models:

- Daily timestep
- 50m resolution
- Same input data

SWAT model

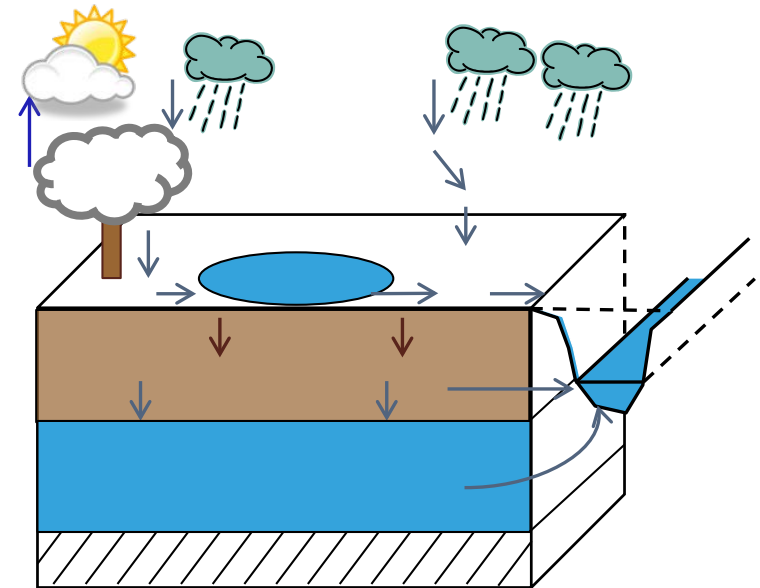
SETUP

- PET: Hargrave's method
- Runoff: SCS Curve Number Procedure

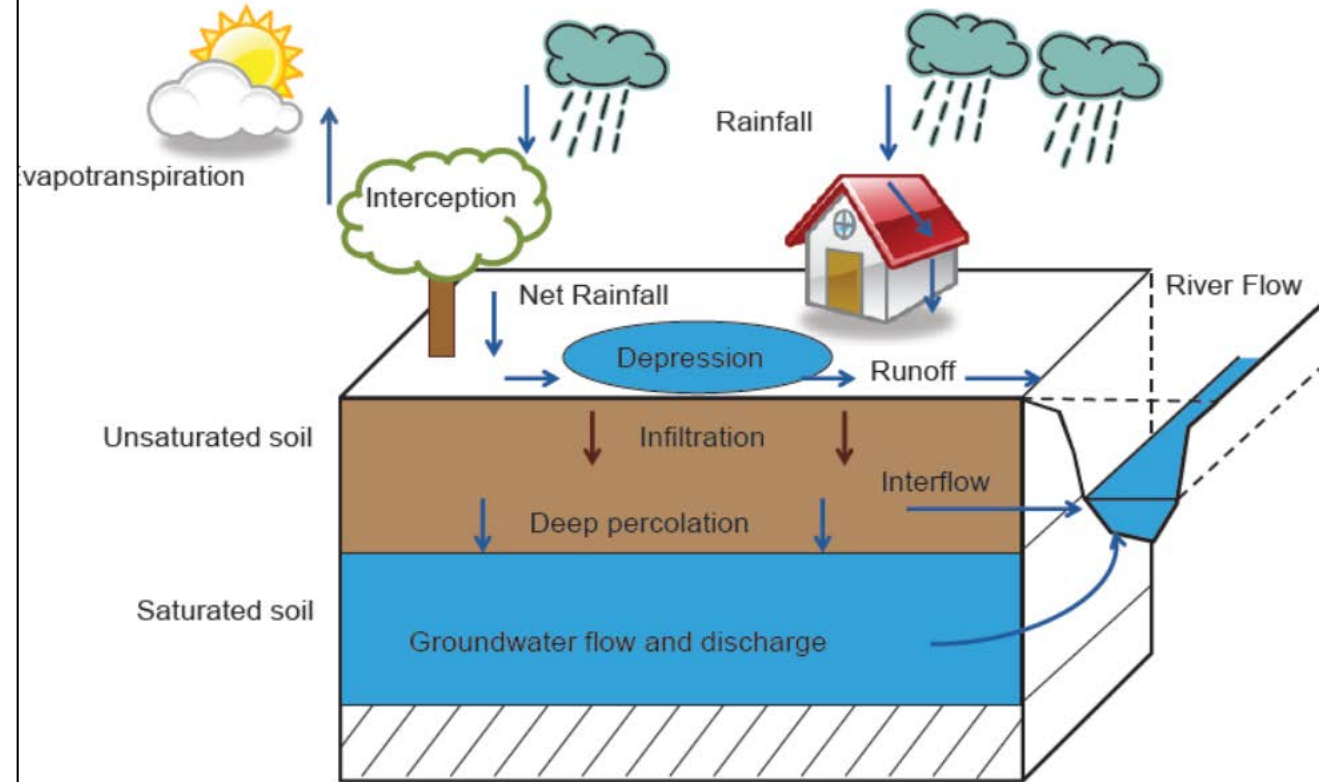
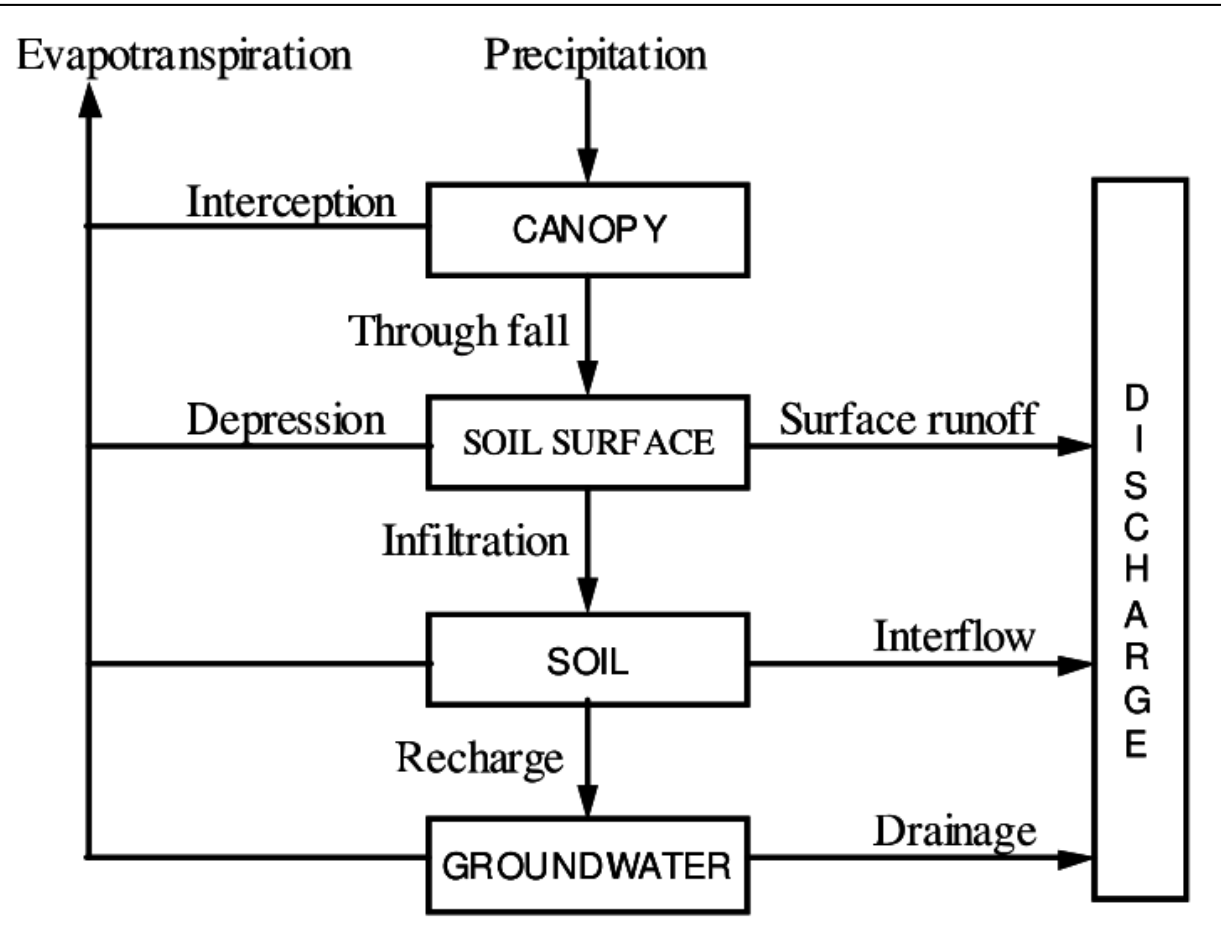


WETSPA model

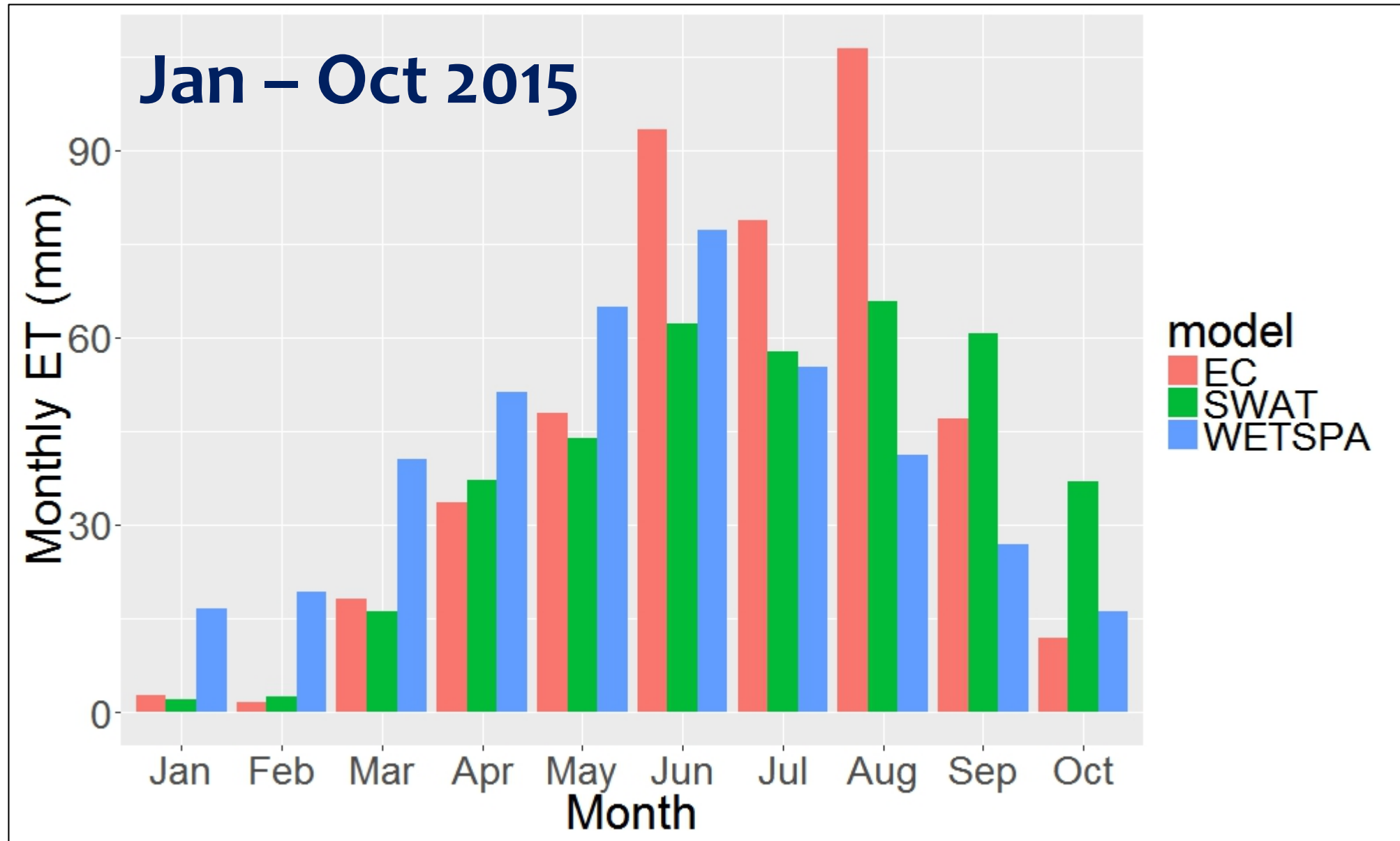
- Developed in VUB – Vrije Universiteit Brussels in 1997
- Written in Fortran and Python
- Non-commercial
- Daily time step
- Spatially distributed
- Parameter based
- PET as input data (Penman Monteith)



WETSPA model



STEP 3 - Results



Jan - Oct 2015

Daily ET (mm)

model
— EC
— SWAT
— WETSPA

0

100

200

300

Day of year

4

2

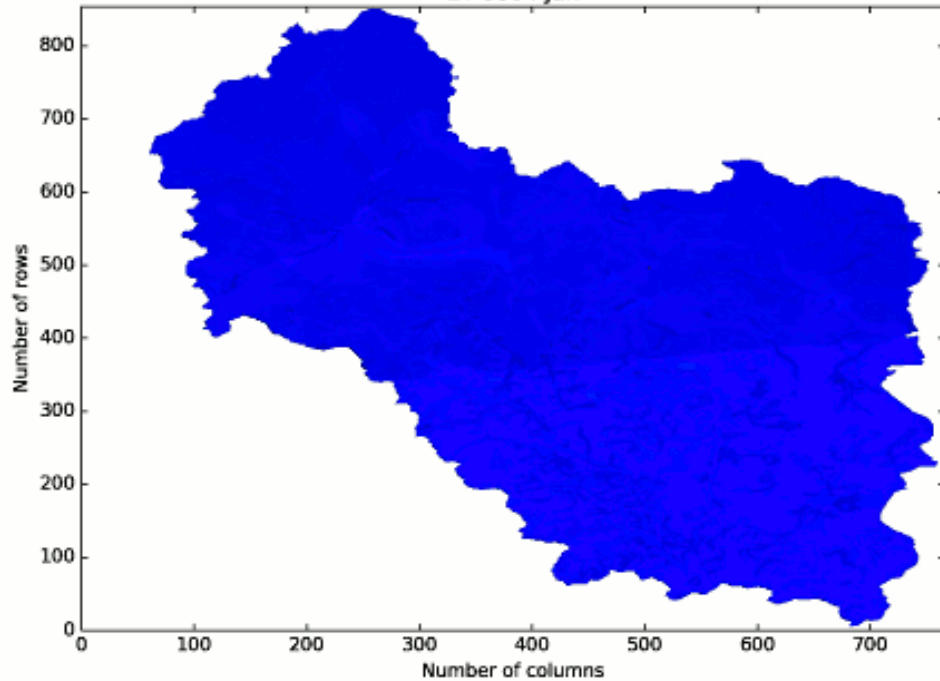
0

ET variability in Wetlands (WetSpa)

MONTHLY EVAPOTRANSPIRATION (mm) MAPS

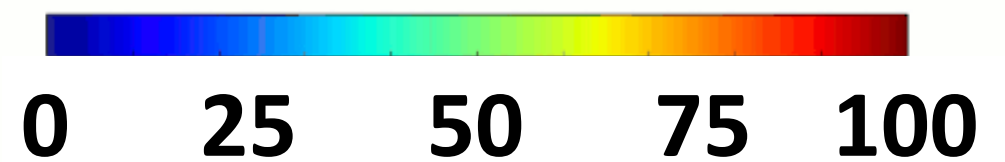
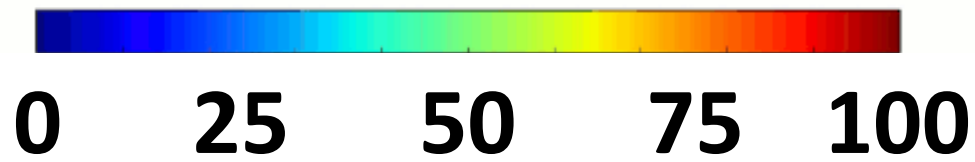
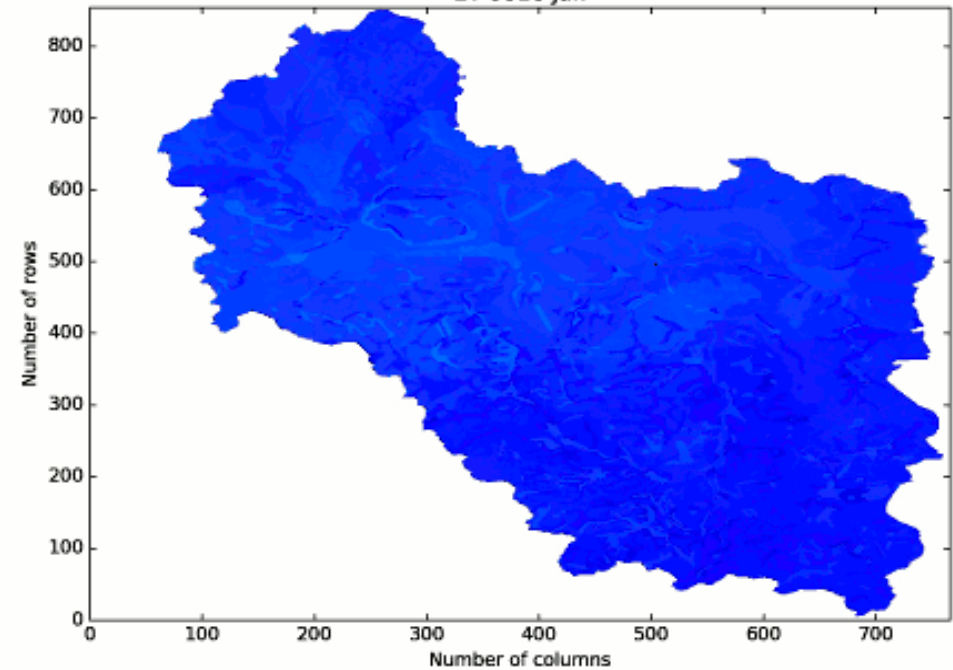
2012

ET 0004 Jan



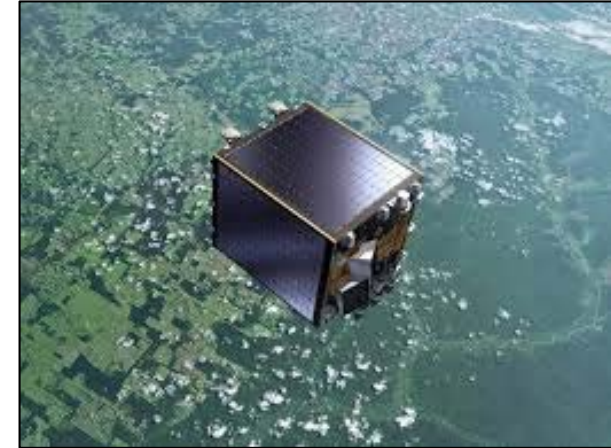
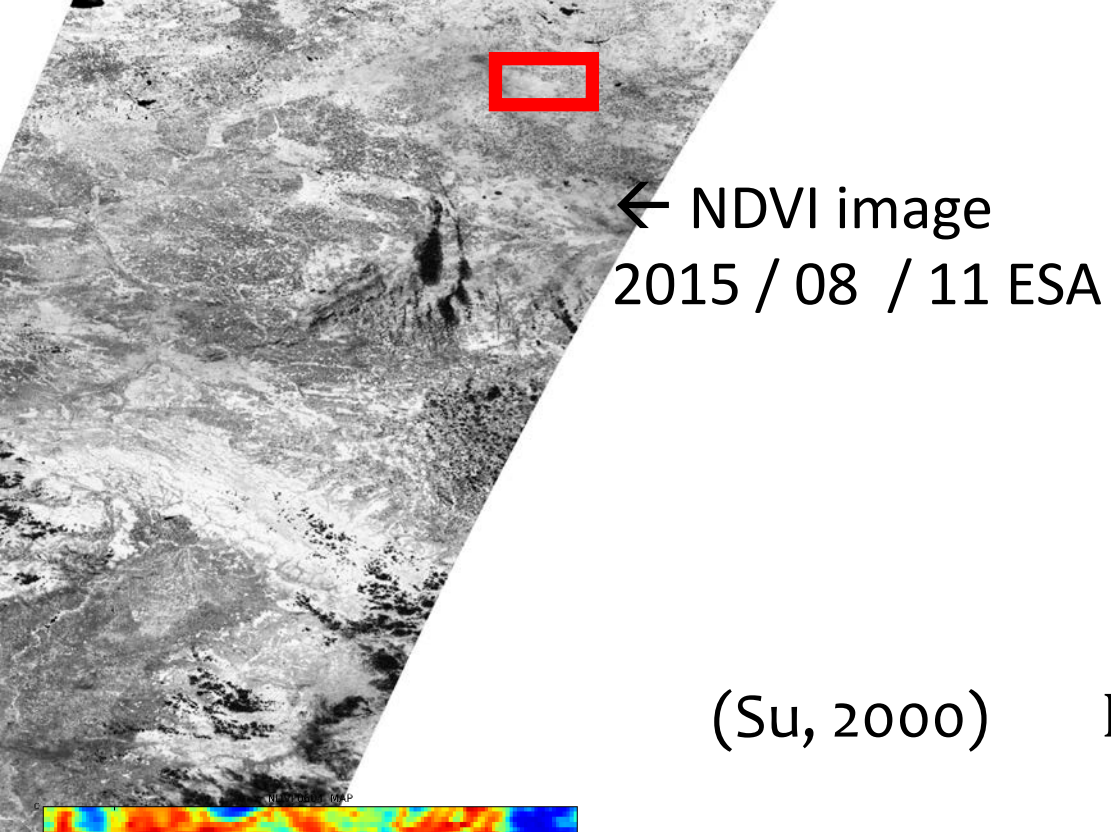
2013

ET 0016 Jan



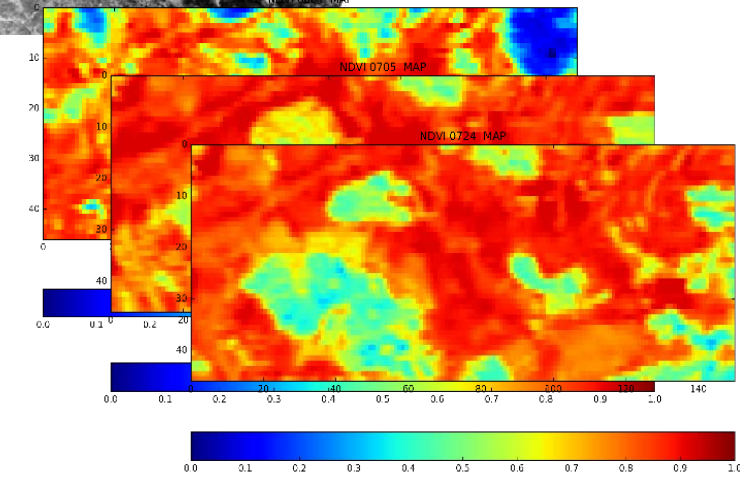
Proba V – satellite (ESA)

Daily products of **NDVI** at **100 m** resolution

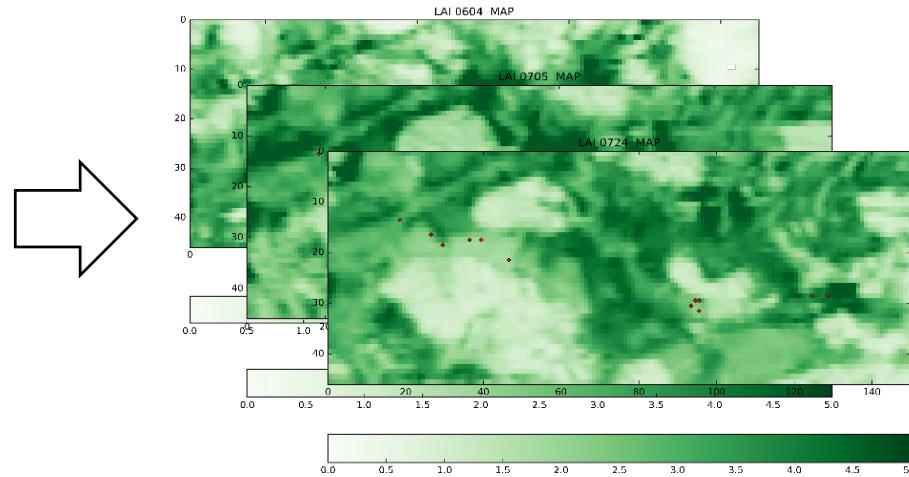


(Su, 2000)

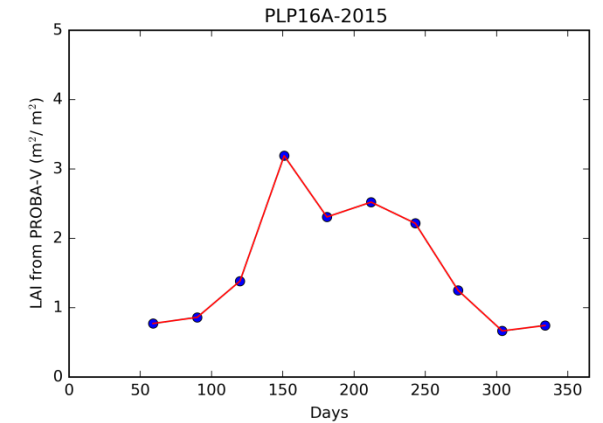
$$LAI = \sqrt{\left(NDVI \frac{1 + NDVI}{1 - NDVI}\right)}$$



NDVI maps



LAI maps

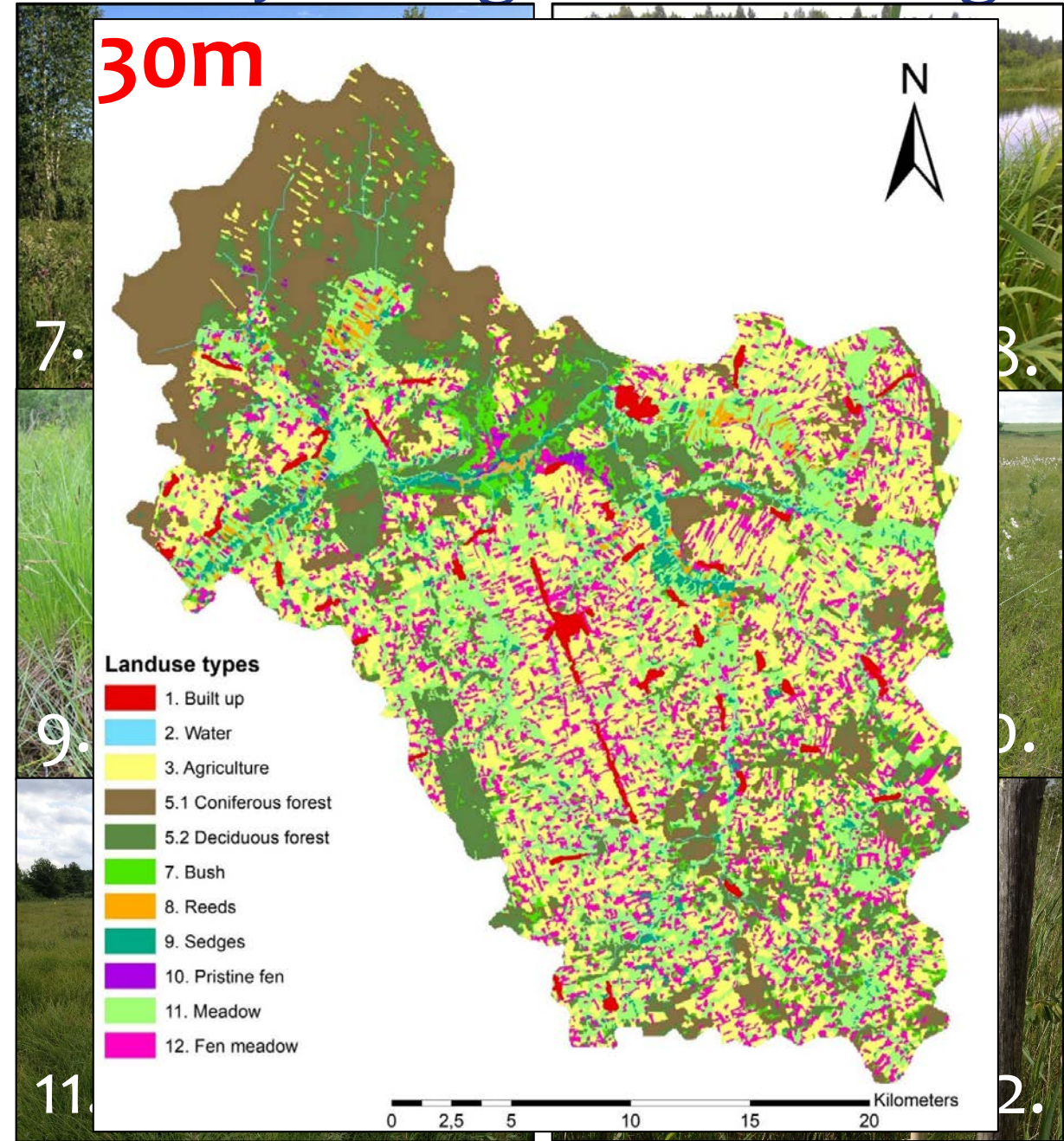


LAI dynamics per
vegetation type

How to better represent wetlands in hydrological modelling?

WETLANDS

#	Land use
1	Built-up
2	Water
3	Agriculture
4	Bare soil
5.1	Coniferous forest
5.2	Deciduous forest
6	Bog
7	Bush
8	Reeds
9	Sedges
10	Pristine fen
11	Meadow
12	Fen meadow



Acknowledgments

- **HiWET** (www.hydr.vub.ac.be/projecthiwet)
- **INTREV-WetEco**
- BELSPO – main funding source
- WETSPA developers at VUB – (www.hydr.vub.ac.be/models)
- IMGW – meteorological data



VRIJE
UNIVERSITEIT
BRUSSEL

