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

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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 ($\omega$) and gas concentration fluctuation ($\rho_s$). Gas flux ($F_s$) is expressed as mean covariance between these measurements.

$$F_s = \omega \rho_s$$

Eddy covariance method allowed to measure actual evapotranspiration over the whole footprint area.
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
A comparison of hydrological models in 3 steps

Data → Hydrological model → ET estimation

- Input: DEM, SOIL, LANDUSE, METEO
- Output: 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
Landuse

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
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

DEM setup

Stream Definition

Outlet Definition

Calculation of sub basin parameter

Watershed Delineator

HRU

Input tables

SWAT run

Results Output

data input

DEM

Land use

Soil type

Slope

Weather data
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

Evapotranspiration → Precipitation

- Interception
- Through fall

- Depression
- Infiltration

SOIL SURFACE → Surface runoff

- Interflow

SOIL → Interflow

GROUNDWATER → Drainage

DISCHARGE

Net Rainfall → Interception → Depression → Runoff

Unsaturated soil → Infiltration → Deep percolation

Saturated soil → Interflow

Groundwater flow and discharge → River Flow
STEP 3 - Results

Jan – Oct 2015

Monthly ET (mm)

Model:
- EC
- SWAT
- WETSPA
Jan – Oct 2015

Daily ET (mm)

Day of year

model
- EC
- SWAT
- WETSPA
ET variability in Wetlands (WetSpa)

MONTHLY EVAPOTRANSPIRATION (mm) MAPS

2012

2013
Daily products of NDVI at 100 m resolution

(Su, 2000) \[ \text{LAI} = \sqrt{\left( \frac{1 + \text{NDVI}}{1 - \text{NDVI}} \right)} \]
How to better represent wetlands in hydrological modelling?

<table>
<thead>
<tr>
<th>#</th>
<th>Land use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Built-up</td>
</tr>
<tr>
<td>2</td>
<td>Water</td>
</tr>
<tr>
<td>3</td>
<td>Agriculture</td>
</tr>
<tr>
<td>4</td>
<td>Bare soil</td>
</tr>
<tr>
<td>5.1</td>
<td>Coniferous forest</td>
</tr>
<tr>
<td>5.2</td>
<td>Deciduous forest</td>
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<tr>
<td>6</td>
<td>Bog</td>
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<tr>
<td>7</td>
<td>Bush</td>
</tr>
<tr>
<td>8</td>
<td>Reeds</td>
</tr>
<tr>
<td>9</td>
<td>Sedges</td>
</tr>
<tr>
<td>10</td>
<td>Pristine fen</td>
</tr>
<tr>
<td>11</td>
<td>Meadow</td>
</tr>
<tr>
<td>12</td>
<td>Fen meadow</td>
</tr>
</tbody>
</table>
Acknowledgments

- HiWET (www.hydr.vub.ac.be/projecthiwet)
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