APPLICATION OF SWAT MODEL ON THREE WATERSHEDS WITHIN THE VENICE LAGOON WATERSHED (ITALY): SOURCE APPORTIONMENT AND SCENARIO ANALYSIS


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Aims of the study

APPLICATION OF SWAT MODEL TO THREE BASINS OF THE VENICE LAGOON WATERSHED TO

• Assess the apportionment of point and non point sources

• Quantify the non point sources in terms of rain-driven and not-rain-driven diffuse sources

• Simulate a scenario analysis to assess the effect of a reduction of agricultural loads
Study area

- **Naviglio Brenta**
  - Bondante Watershed
  - 307 km²
- **Dese Zero Watershed**
  - 290 km²
- **Vela Watershed**
  - 101 km²
- **Venice Lagoon Watershed**
  - 2038 km²

About 35% of the VLW area

- ~ 5,000 t N y⁻¹
- 3,000 t N y⁻¹
Groundwater recharge area is very complex with a network of drainage/irrigation channels. The watershed characteristics include:

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<tr>
<th></th>
<th>NBB</th>
<th>DZ</th>
<th>VL</th>
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</thead>
<tbody>
<tr>
<td>Urban Area</td>
<td>24%</td>
<td>26%</td>
<td>13%</td>
</tr>
<tr>
<td>Agricultural Area</td>
<td>69%</td>
<td>72%</td>
<td>86%</td>
</tr>
<tr>
<td>Dominant crops</td>
<td>Corn, soy, wheat, sugar beet</td>
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Contributions from external basins are also significant.
Measures available

- WWTP discharge
- Industrial discharge
Sources apportionment

**DRY WEATHER LOADS**

- Point loads
  - WWTPs discharge
  - Industrial discharge
  - Direct sewer discharge

- Diffuse loads
  - Groundwater recharge
  - Channel network

**WET WEATHER LOADS**

- Diffuse loads
  - Surface runoff loads

Direct discharge/instream measurements:
- BOD/nitrogen mass balance

BASINS-SWAT loads from WWTPs/Industries and from channel network
loads from direct sewer discharge and from groundwater recharge.
BASINS-SWAT input

10 stations - 13 years daily meteorological data
SWAT calibration

Groundwater flow (m³/s)

Groundwater estimates
Groundwater simulated

GW from external watersheds

Additional inlet contribution

Parameter calibration

- BLAI (corn, wheat)
- HVSTI (corn, wheat)

- CN
- OV_N

- USLE_P
- EORGN
- EORGP
- NPERCO
- FRT_LY1
SWAT model: hydrological calibration

DDE station

Nash Sutcliffe coefficient of efficiency

\[ E \approx 0.4 \]

Daily flowrate - DDE station

- Measured
- Predicted

Flowrate (m\(^3\) s\(^{-1}\))
SWAT model: RESULTS

kg N during rainstorm events

Error rainstorm event
± 15%

Flowrate (m³ s⁻¹)

Daily event
Rainstorm event
SWAT model: RESULTS – mean of 10 years simulation

**Total N annual load** = 2200 t N y⁻¹

**Total P annual load** = 140 t P y⁻¹

Present State - Ntot

- WWTP and industrial discharge: 34%
- Tributary channels or irrigation systems: 6%
- Atmospheric deposition runoff: 6%
- Urban runoff: 3%
- Direct sewer discharge: 8%
- Groundwater recharge: 5%
- Atmospheric deposition runoff: 3%
- Agricultural runoff: 13%

Present State - Ptot

- WWTP and industrial discharge: 35%
- Tributary channels or irrigation systems: 24%
- Atmospheric deposition runoff: 9%
- Urban runoff: 13%
- Direct sewer discharge: 19%
- Groundwater recharge: 15%
- Atmospheric deposition runoff: 5%
- Agricultural runoff: 65% dry weather diffuse loads

20% runoff loads
15% point loads
65% dry weather diffuse loads
**Implementation of an agricultural scenario**

<table>
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<tr>
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<th>kg N ha⁻¹ y⁻¹</th>
<th>kg P ha⁻¹ y⁻¹</th>
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<tbody>
<tr>
<td>Corn</td>
<td>-37%</td>
<td>-17%</td>
</tr>
<tr>
<td>Corn + manure</td>
<td>-53%</td>
<td>-27%</td>
</tr>
</tbody>
</table>

**Agricultural nitrogen runoff load**

- Present state: AN = 139 tN y⁻¹ (~50% agricultural nitrogen runoff load)
- Agricultural scenario: AN = 7 tP y⁻¹ (~15% phosphorus runoff load)
Loads at the basin closure

**Nitrogen load at the basin closure**

- **Present state**
- **Agricultural scenario**

\[ \Delta N = 139 \text{ tN y}^{-1} \] (-6%)

**Phosphorus load at the basin closure**

- **Present state**
- **Agricultural scenario**

\[ \Delta P = 7 \text{ tP y}^{-1} \] (-5%)
Conclusions

• The application of SWAT model allowed to quantify the total annual nutrient load and to assess the source apportionment

• The dry weather diffuse sources (i.e. groundwater/spring recharge and tributary/irrigation channels coming from bordering watersheds) constitute the most important source (65% N and 35% P);

• Runoff loads cover about 20% of the total N load and about 30% of the total P load. Agricultural runoff constitute about 2/3 of the runoff load;

• Better-business agricultural scenario: reduction in agricultural runoff loads of about 50% for N and of about 15% for P → decrease in the total annual load of about 5-6%.

• Most significant model outputs → implemented in a decision support system software (mDSS)