Basin characteristics

River Basin / River Basin (according EU-WFD)

Operation (from… to…)
2001, still in operation

Gauge coordinates / Gauge datum
54°01’N, 12°13’E / 34.5 m a.s.l.

Catchment area
15.5 km²

Elevation range
34.5 - 50.6 m a.s.l.

Batston type
(alpine, mountainous, lowland

Hydrogeology, lakes, reservoirs etc.

665 mm mean precipitation, 8.2°C mean temperature, 490 mm mean crop reference evapotranspiration (1979-2008)

Mainly agricultural (arable land, grassland), forest

Quaternary (ground moraine, Weichsel ice-age)

Quaternary deposits (Mergel)

Unconfined aquifer

Qmean = 0.01 s⁻¹, Qmax = 1094 l s⁻¹, Qmean = 64 l s⁻¹

Map of the research basin

Mean hydrograph / Pardé flow regime

Special basin characteristics

Hydrogeology, lakes, reservoirs etc.

Water, Vegetation, Geology

- To improve soil moisture and aration conditions, agricultural land in lowland areas is frequently artificiially drained.
- Tile drainage shortens the residence time of water in the soil and may therefore accelerate and increase the losses of nutrients and contaminants to surface water bodies.
- Especially the ubiquitous drainage of peatlands caused the loss of valuable ecosystems and environmental damage.
- Most of the tile drainage studies have concentrated on the plot scale.
- The Zarnow catchment is a typical artificially drained lowland catchment with tile drainage of arable land on mineral soils and ditch drainage of grassland on organic soils.

Instrumentation and data

<table>
<thead>
<tr>
<th>Measured hydrological parameters</th>
<th>Measuring period</th>
<th>Temporal resolution</th>
<th>Number of stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ditch and brook discharge</td>
<td>2001 - 2003</td>
<td>Daily</td>
<td>2</td>
</tr>
<tr>
<td>Ditch and brook discharge</td>
<td>2003 - cont.</td>
<td>15 minutes</td>
<td>1</td>
</tr>
<tr>
<td>Tile drain discharge</td>
<td>2003 - cont.</td>
<td>Hourly</td>
<td>3</td>
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<tr>
<td>Precipitation</td>
<td>2001 - 2003</td>
<td>Daily</td>
<td>1</td>
</tr>
<tr>
<td>Air temperature, humidity, wind speed</td>
<td>2001 - 2003</td>
<td>Daily</td>
<td>1</td>
</tr>
<tr>
<td>Groundwater level</td>
<td>2003 - 2005</td>
<td>Daily to weekly</td>
<td>17</td>
</tr>
<tr>
<td>Groundwater level</td>
<td>2005 - 2008</td>
<td>Daily to weekly</td>
<td>33</td>
</tr>
<tr>
<td>Surface water: Cl, NO³, SO4²⁻, Na⁺, K⁺, Ca²⁺, Mg²⁺</td>
<td>2001 - 2003</td>
<td>Daily to weekly</td>
<td>2</td>
</tr>
<tr>
<td>Surface water: P and PO₄-P</td>
<td>2003 - 2005</td>
<td>Daily - biweekly</td>
<td>4</td>
</tr>
<tr>
<td>Groundwater Cl, NO₃, SO₄, Na⁺, NH₄⁺, K⁺, Ca²⁺, Mg²⁺, P₀</td>
<td>2005 - 2008 (winter only)</td>
<td>Daily - weekly</td>
<td>2</td>
</tr>
<tr>
<td>Groundwater, TOC, Fe, Al, Mn, colour</td>
<td>2007/08 (winter only)</td>
<td>Daily - weekly</td>
<td>18</td>
</tr>
<tr>
<td>Stable isotopes of nitrate: 85³¹N and 86³¹O</td>
<td>2003/04 (winter only)</td>
<td>Event-based</td>
<td>2</td>
</tr>
</tbody>
</table>

Applied models

1. MHYDAS-DRAIN
2. SWAT (in preparation)

Main scientific results

- Artificially drained areas dominate the hydrological dynamics and the hydrochemistry of lowland catchments and must be thus be prioritized when addressing diffuse pollution.
- Discharge generation is dominated by tile drainage and groundwater flow, while overland flow only occurs when snowmelt, heavy rainfall and frozen soils concur. The main discharge period is the winter. Tile drainage amounts to 27% of the total rainfall on an annual basis, and to 54% in winter.
- Nitrate-nitrogen concentrations are very high, especially in the artificially drained subcatchments: 32% of all samples exceeded the drinking water limit of 11.3 mg l⁻¹ NO₃-N and 79% of all samples exceeded the limits of the water quality class (2.5 mg l⁻¹ NO₃-N, "good quality" according to the WFD).
- During nearly all discharge events, the highest NO₃-N concentrations went along with the peak discharge rate, even in the end of the winter.
- The annual NO₃-N losses of up to 55 kg ha⁻¹ are strongly depending on the annual rainfall (0.7034< R< 0.8876), while the fertiliser application shows no effect (yet) on the studied time-scale.
- Applying a mixing model for subcatchments IA, II and IV (in which the grassland is probably less degraded than in SC III) shows that ca. 25% of the total catchment area is responsible for 75% of the NO₃-N losses.
- With the exception of the peatland, phosphorus concentrations and losses are, in contrast, generally low.
- Solute concentrations in the groundwater of the subcatchment dominated by artificially drained peatlands showed a high temporal and spatial variability. Concentrations and losses of most solutes where highest in this subcatchment, and due to ongoing drainage and degradation, improvement is not in sight.
- The model MHYDAS-DRAIN can be used for modelling small catchments dominated by artificial drainage. However, snowmelt events aroused problems with model calibration and validation.
- Calibration parameters for MHYDAS-DRAIN could be identified with a multi-target sensitivity analysis. The spatial and temporal resolution of the modelling domain and the calibration criteria determine the calibration results.
- Therefore, they need to be urgently considered when addressing the reduction of diffuse pollution.

Key references for the basin


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