Use of river discharge data and inverse hydrological modelling for the calibration of a Z/R-relationship

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INTRODUCTION

The quality of hydrological modeling is limited due to the availability of high resolution temporal and spatial input data. Rain gauge measurements give accurate information at a single point while radar measurements provide good spatial information. On the other hand, it is difficult to estimate areal precipitation from rain gauge measurements and absolute rainfall intensities from radar data. In this study, a method to calibrate a Z/R-relationship using observed river discharge data is presented. River gauge measurements from subcatchment sizes around 100 km² are used to estimate areal precipitation and finally Z/R-relationships using the calibrated hydrological model WASIM-ETH.

CALIBRATION OF THE HYDROLOGICAL MODEL

This study was performed in the Ammer catchment (Fig. 1) in southern Bavaria, Germany. The simulated catchment size is 601 km². Due to the complex orography (Fig. 2), it faces very short reaction times of the river gauges to rainfall events.

Tab. 2: Simplified split-three-part Z/R relationship after RADOLAN (2004) which is used as input data for optimization process. Crossovers between parts depend on reflectivity values.

<table>
<thead>
<tr>
<th>dBZ</th>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;36.5</td>
<td>125</td>
<td>1.4</td>
<td>1.6</td>
</tr>
<tr>
<td>36.5...44</td>
<td>200</td>
<td>1.6</td>
<td>1.3</td>
</tr>
<tr>
<td>&gt;44</td>
<td>77</td>
<td></td>
<td></td>
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</tbody>
</table>

Tab. 3: Results from the hydrological simulations using interpolated rain gauge measurements for the calibration period in Summer 2001 (June-August).

Fig. 5: Crossover 1

Aim of the optimization process is to find a robust Q-Z/R-relationship for hydrological modeling in the Ammer catchment. It is applied in a way that the Nash-Sutcliffe-criterion is minimized over a three-month period (over five subcatchments):

\[
\text{Nash-Sutcliffe-criterion} = 1 - \left( \frac{\sum_{i=1}^{n} (Q_{\text{obs}} - Q_{\text{sim}})^2}{\sum_{i=1}^{n} (Q_{\text{obs}})^2} \right)^\frac{1}{2}
\]

where:

- \(Q_{\text{obs}}\) is the observed river discharge data
- \(Q_{\text{sim}}\) is the simulated discharge data
- \(n\) is the number of time periods

The optimization process was done iteratively calibrating always two parameters at the same time.

RESULTS

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