POTENTIALS AND APPLICABILITY OF THE SWAT MODEL IN CHECK DAM MANAGEMENT IN SMALL WATERSHED

by

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Watershed Interaction Processes

- Climate
- Soil Properties
- Topography
- Land Use & Land Cover
- Semi arid/Sub-humid Climatic Watershed

- Quantitative Water Problems
  e.g. Flood, Low Storage, Low Groundwater Storage,

- High Sediment Transport

- Qualitative Water Problem
  e.g. Agro Chemicals, Bacterial Water Problem,
Runoff and Sediment Control Measures for Watersheds

Field Level Control
1. Terracing
2. Bunding
3. Crop Rotation and Land Preparation measures

Watershed Level Control
1. Checkdam/Reservoir
2. Detension Tank
3. Storm Water Pond

Farm Level Control
1. Farm Ponds
2. Water Harvesting Measures
# SWAT potential in runoff and sediment management from Watershed

<table>
<thead>
<tr>
<th>Relevant Process/Approach</th>
<th>Management Option</th>
<th>Potential/usefulness of SWAT</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>High sediment yield from subbasin</td>
<td>Changing from the conventional to <strong>conservation tillage practice</strong>,</td>
<td>Option to decide better tillage practice to control the sediment</td>
<td>Field Level Approach</td>
</tr>
<tr>
<td>Soil and water conservation in sloppy fields</td>
<td><strong>Bunding</strong> (graded as well as contour) and <strong>terracing</strong> of the area to conserve moisture</td>
<td><strong>Control Practice factor</strong> „P” can be managed to control the Runoff and Sediment</td>
<td>Farm Level Approach</td>
</tr>
<tr>
<td>More sediment transport by runoff from area</td>
<td>Better land cover and maintaining a <strong>crop cover</strong> to reduce direct runoff and increased infiltration,</td>
<td>Modified <strong>SCS curve number</strong> and a better <strong>Overland Flow</strong> „n“ value</td>
<td>Field/Farm Level Approach</td>
</tr>
<tr>
<td>More sediment yield due to high rains</td>
<td>Increase <strong>initial crop residue</strong> on soil surface, more erosion control practices,</td>
<td>Identification of suitable crop type</td>
<td>Farm Level Approach</td>
</tr>
<tr>
<td>To control sediment from high slopes (mountainous areas)</td>
<td>Instaling small <strong>check dams</strong>, water control <strong>structures</strong> and bunds against high slope and channels to control the slope length for subbasin,</td>
<td>Identification of optimal slope length (LS) for the area by SWAT</td>
<td>Watershed Level Approach</td>
</tr>
<tr>
<td>To control channel erosion with runoff</td>
<td>Reduced/safer water flow velocity in channels</td>
<td>Channel roughness, Cover and erodibility factor</td>
<td>Watershed Level Approach</td>
</tr>
<tr>
<td>To reduce sediment discharge from watershed</td>
<td>Increasing the <strong>storage capacity</strong> in the watershed to settle the suspended sediment from the runoff water</td>
<td><strong>Reservoir/Pond</strong> options of the SWAt model can be used in quantitative studies</td>
<td>Watershed Level Approach</td>
</tr>
<tr>
<td>Less groundwater storage recharge</td>
<td>Increase opportunity time in subbasin,</td>
<td>Identification of technical and management options for prolonging runoff and retention in ponds</td>
<td>Watershed Level Approach</td>
</tr>
</tbody>
</table>
Objective of the study

• Applicability of SWAT Model in sediment quantification in the on stream constructed checkdams in a small watershed

• The possible management for their sustainable, long time use
Study area

BANHA Watershed of DVC command at Hazaribagh, Jharkhand, India

Latitude : 24° 13’ 30” N to 24° 17’ N
Longitude : 85° 13’ 50” E to 85° 16’ E
MSL Height : 550 m
Area : 16.95 Km²
Slope : 1.9 % (average)
Rainfall : 1200 mm (annual average)
Crops : Paddy, Maize & Black Gram
Soil texture : Loam to loamy sand
Bulk density : varies around 1.5 g/cc
Saturated hydraulic conductivity : 9.7 ~ 16.8 cm/day
Check Dam's location in BANHA Watershed
<table>
<thead>
<tr>
<th>Check Dam No.</th>
<th>Year of Construction</th>
<th>Catchment Area (ha)</th>
<th>Height of the Dam (m)</th>
<th>Storage Capacity (Mm$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1995-96</td>
<td>567</td>
<td>6.405</td>
<td>0.18</td>
</tr>
<tr>
<td>2</td>
<td>1997-98</td>
<td>911.25</td>
<td>5.978</td>
<td>0.25</td>
</tr>
<tr>
<td>3</td>
<td>1996-97</td>
<td>1103.625</td>
<td>6.71</td>
<td>0.27</td>
</tr>
</tbody>
</table>
Measured rainfall, runoff and sediment from the watershed during monsoon period (June to October)
Schematic presentation of watershed in the SWAT Model
Results

• Model has been calibrated against the observed water and sediment yield at the watershed outlet for the monsoon season (June to October) of year 1996.

• The model then again ran for 1996 to 2001 to quantify the sediment generated from the watershed and accounting the controlled sediments by the checkdams.

• The outcomes then utilized to discuss the possible management options for the checkdams for their long time use.
Water Yield Calibration for 1996

$R^2 = 0.9995$
Sediment Yield Calibration for 1996

\[ R^2 = 0.9962 \]
Sediment Yield Comparison during 1996-2001 in real situation

$R^2 = 0.9704$
No check dam situation, Sediment Transport Comparison
<table>
<thead>
<tr>
<th>Year</th>
<th>Sediment out from Watershed (tons)</th>
<th>Sediment generated from watershed (tons)</th>
<th>Sediment controlled by checkdams (tons)</th>
<th>% Reduction in sediment out from watershed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>17780.55</td>
<td>22035.00</td>
<td>4254.45</td>
<td>19.33</td>
</tr>
<tr>
<td>1997</td>
<td>14797.35</td>
<td>18356.85</td>
<td>3562.89</td>
<td>19.41</td>
</tr>
<tr>
<td>1998</td>
<td>8898.75</td>
<td>11966.70</td>
<td>3067.95</td>
<td>25.57</td>
</tr>
<tr>
<td>1999</td>
<td>5288.40</td>
<td>17712.75</td>
<td>12475.20</td>
<td>70.13</td>
</tr>
<tr>
<td>2000</td>
<td>4729.05</td>
<td>7390.20</td>
<td>2678.10</td>
<td>36.18</td>
</tr>
<tr>
<td>2001</td>
<td>4644.30</td>
<td>7271.55</td>
<td>2627.25</td>
<td>36.16</td>
</tr>
</tbody>
</table>
## Conclusions

- Check dams contribute to enormous reduction of sediment transport from the watershed,

- The simulated and observed sediment transport from the watershed compares closely and thus shows a strong applicability of the SWAT model in accounting the same from small watersheds,

- SWAT comprises the individual sub basin and reach sediment loading to account for the whole watershed and this can be utilized in site selection for the check dam construction,

- SWAT makes an accurate estimation of the deposited sediments in check dams and thus their capacity estimation for effective use by removal of depositions, can be made over time,

Other usages as e.g. cooperative fish farming by the local societies or soil reuse will benefit from a frequent sand/sediment removal from checkdams and this will be benefited from a more comprehensive, model supported check dam management.
THANKs