Sediment Transport and Deposition under Different Subsurface Hydrologic Conditions

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Introduction

Sediment transport capacity ($T_c$) is a conceptual term used in soil erosion modeling to identify whether erosion or deposition process is occurring. Currently $T_c$ is estimated using flow related parameters.

Recent findings indicate that subsurface hydrology, through its control on soil erodibility, may play an important role in erosion and deposition processes. Changes in surface morphology, i.e., red for erosion and green for deposition, clearly showed that the deposition zone developed more extensively when the box was drained as compared to the seepage condition.

The objective of this study is to determine the effects of subsurface hydrology on soil erodibility, sediment deposition and total sediment transport.

Materials and Methods

The effect of subsurface hydrology condition on erosion and deposition
The $T_c$ under different subsurface hydrology

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Results and Discussion

The rill erodibility increased as increasing the seepage rate in the mini flume experiment. The vertical water gradient or the vertical water movement impacts the soil cohesion, resulting in an increased erodibility.

Without feeder input, the sediment discharge shows the same trend: Drainage < Saturation < Seepage 1 < Seepage 2.

For the same shift in subsurface hydrology from drainage to seepage, an increased soil erosion and a decreased sediment deposition was observed in the test flume (Fig. 4)

When $T_c$ was defined as the equivalent sediment discharge (sediment input = sediment output), $T_c$ values increased as the subsurface hydrology was changed from free drainage to saturation to low and then high seepage rates (Fig. 4 and Table 1).

Table 1. $T_c$ values under different subsurface hydrologic condition

<table>
<thead>
<tr>
<th></th>
<th>Drainage</th>
<th>Saturation</th>
<th>Seepage 1</th>
<th>Seepage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_c$ (g/min/m)</td>
<td>133.9</td>
<td>235.2</td>
<td>327.2</td>
<td>409.3</td>
</tr>
</tbody>
</table>

Conclusion

The subsurface hydrologic condition affects soil erosion and sediment deposition. Changing subsurface hydraulic gradient can change the soil erodibility, sediment deposition and total sediment transport.

The estimated transport capacity increased as the subsurface hydrology was varied from free drainage to saturation to low and then high seepage rates.

These results demonstrate how an extrinsic condition, such as the subsurface moisture gradient, can affect soil erosion and sediment deposition.