Mann-Kendall Non-parametric Trend Detection Test models were developed by using 30 or more days of continuous 15-minute rainfall-runoff time series from the pre and post development period, stream restoration construction and engineered SCMs installation.

In this study, the change of runoff hydrology in five developing SE Piedmont sub-watersheds (10% to 54% conversion of forest/field to suburban development) with a combination of engineered SCMs and stream restoration to meet the stormwater control requirements under climate water supply conditions assessed. Three different analytical approaches, the Mann-Kendall statistical trend test, the unit hydrograph comparison, and unit impulse response were applied to the detection of a true rainwater comparison across the ongoing land cover alterations, a short predescriptive period, stream restoration construction and engineered SCMs installation.

Table 1: Land use changes from 2003 to 2011 in the BDC sub-watersheds

<table>
<thead>
<tr>
<th>Land Use Change</th>
<th>BD1</th>
<th>BD2</th>
<th>BD3</th>
<th>BD4</th>
<th>BDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2010</td>
<td>12%</td>
<td>8%</td>
<td>12%</td>
<td>13%</td>
<td>50%</td>
</tr>
<tr>
<td>2003</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
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<td>2010</td>
<td>12%</td>
<td>8%</td>
<td>12%</td>
<td>13%</td>
<td>50%</td>
</tr>
</tbody>
</table>

Methodology: Research Approaches

Average Unit Hydrograph Approach

The unit hydrographs for the stable pre development period (July 2003 to March 2003/April 2004 for the BD4) and for the post development period (March 2008 to December 2010) were developed.

The increasing trend in average streamflow and peak streamflow for the BD4 sub-watershed was attributed to the groundwater supplemented with the increasing precipitation events were captured in engineered SCMs and subsequently evaporated without contributing to the stream runoff (Figure 5, Table 2).

The results of this study demonstrated that the unit hydrograph, unit impulse response, and Mann-Kendall trend test approaches all generally indicated similar changes in runoff response from a baseline to the developed land development period.

Acknowledgements

This study was conducted as a part of a PhD dissertation. The fund was provided by the City of Charlotte Stormwater Services through a long-term urbanizing SE Piedmont watershed monitoring project. The contribution from Dr. C.J. Allan as the PhD committee chair and the project coordinator is highly appreciated. Special thanks go to all UNC Charlotte students who worked extremely hard to carry on the intensive fieldwork required for this study.

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References
