Characterization of stormwater debris model parameters in southern California’s dense urbanized watersheds

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Catch Basin Insert for Trash Removal,
Courtesy of http://unitedstormwater.com/images/installed_drainpac.jpg

Ballona Creek Trash Boom
Courtesy of Richard Risemberg: https://www.flickr.com/photos/rickrise/
<table>
<thead>
<tr>
<th>Data Input for PCSWMM</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Elevation Models</td>
<td>USGS Earth Explorer</td>
</tr>
<tr>
<td>Hourly Rainfall Data</td>
<td>NOAA Climate Data Online</td>
</tr>
<tr>
<td>Hydrologic soil groups</td>
<td>Soil Survey Geographic Database</td>
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<tr>
<td>Evaporation Data</td>
<td>The California Irrigation Management Information System (CIMIS)</td>
</tr>
<tr>
<td>Land Use Data</td>
<td>San Diego Association of Governments (SANDAG) /County of Los Angeles Public Works Website</td>
</tr>
</tbody>
</table>

Legend

- ▲ Outfalls
- ● Junctions
- ▲ Conduits
- ▲ Subcatchments

Land Use for Lower San Diego River Watershed (LSDRW)
- **Total Area**: 834 sq. miles (533,760 acres)
- **Population**: ~9 million people
- **Percentage of Impervious Surfaces**: ~31%
- **Land Use**:
  - 37% Residential
  - 8% Commercial
  - 11% Industrial
  - 44% Open Space
- **Mean Annual Rainfall**: ~21 inches

**PCSWM Model For Los Angeles River Watershed**
- **Total Area:** 130 sq. miles (83,200 acres)
- **Population:** ~1.5 million people
- **Percentage of Impervious Surfaces:** ~65%
- **Land Use:**
  - 64% Residential
  - 8% Commercial
  - 4% Industrial
  - 17% Open Space
- **Mean Annual Rainfall:** ~16.4 inches
Various functions available in SWMM to simulate pollutant buildup and washoff

- Power buildup can follow a linear or nonlinear trend increasing with dry days
- With exponential washoff the washoff load is dependent on buildup mass available
- Buildup and washoff parameters developed using observed washoff load data

### Buildup and Washoff Governing Equations

#### Power Buildup

$$b = \text{Min}(B_{\text{max}}, K_B t^{N_B})$$

where,

- $b$ = buildup, (kg/ha)
- $t$ = buildup time interval, (days)
- $B_{\text{max}}$ = maximum buildup possible (kg/ha)
- $K_B$ = buildup rate constant, (kg/ha-days)
- $N_B$ = buildup time exponent, dimensionless

#### Exponential Washoff

$$w = K_w q^{N_w} B$$

where,

- $w$ = rate of washoff (mg/hr)
- $K_w$ = washoff coefficient (mm⁻¹)
- $N_w$ = washoff exponent (unitless)
- $q$ = runoff rate per unit area (mm/hr)
- $B$ = pollutant buildup (kg)

### Available Buildup Functions in SWMM

- **Linear Buildup**: $y = 0.0316x$
- **Power Buildup**: $y = 0.1291x^{0.5574}$
- **Exponential Buildup**: $y = 1.2(1 - \exp(-0.032x))$

![Graph showing available buildup functions](image-url)
TRASH FROM BALLONA CREEK YEAR 2002-2003

- Highest rainfall did not produce highest washoff load
- High rainfall accompanied with longest accumulation period produced greatest washoff load
- There is an upward trend of washoff load with respect to increasing dry days.
- With this watershed and land use there is poor correlation between socioeconomic data and washed off litter
Figure shows two years of rainfall-washoff (load) for the BCW with observed data.

Different storm events are plotted nonsequential on the top axis.

The storm events are plotted with total rainfall depth against dry days leading up to storm.

Storm events with similar buildup days but different washoff loads were used as the basis for developing washoff parameters.

The storm that occurred after 50 dry days (2002-2003) produced higher washoff loads than the storm after 60 dry days (2003-2004).

This suggests that the increased rainfall was able to mobilize more of the available litter load.

- First year rainfall **11.32 inches**, with a total load of **3714 lbs**.
- Second year rainfall **5.94 inches** with a total load of **1622 lbs**.
The horizontal axes show rainfall-runoff for two subcatchments in the LARW.

- S4 is further downstream than S1.
- Simulated washoff is plotted with observed washoff for each storm in 2002-2003.
- Washoff parameters were modified to test the sensitivity of washoff load with respect to washoff parameters.
## Results

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Simulation Year</th>
<th>Total Loading from PCSWMM (kg)</th>
<th>Total Loading per unit area (kg/ha)</th>
<th>Total Runoff Volume from PCSWMM (m³)</th>
<th>Total Rainfall for Simulation Year (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCW</td>
<td>2002-2003</td>
<td>155,145</td>
<td>4.61</td>
<td>28,588,000</td>
<td>417.1</td>
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<tr>
<td>BCW</td>
<td>2003-2004</td>
<td>103,205</td>
<td>3.07</td>
<td>18,334,400</td>
<td>223.5</td>
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<tr>
<td>LARW</td>
<td>2002-2003</td>
<td>2,486,808</td>
<td>11.51</td>
<td>237,182,300</td>
<td>404.5</td>
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<tr>
<td>LARW</td>
<td>2003-2004</td>
<td>1,584,020</td>
<td>7.33</td>
<td>124,718,100</td>
<td>226.8</td>
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<tr>
<td>LSDRW</td>
<td>2002-2003</td>
<td>275,958</td>
<td>6.58</td>
<td>27,907,600</td>
<td>301.5</td>
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<tr>
<td>LSDRW</td>
<td>2003-2004</td>
<td>141,086</td>
<td>3.36</td>
<td>11,488,400</td>
<td>138.4</td>
</tr>
</tbody>
</table>

### Future Work
- Validate LSDRW simulated results with field sampling
- Validate BCW with Ballona Creek Trash Interceptor

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Thank you!

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