High-Resolution Global Mean-Annual Surface Runoff And River Flow Datasets For Use In Risk Assessments

Raghu Vamshi\textsuperscript{1}, Kathleen McDonough\textsuperscript{2}, Kathy Stanton\textsuperscript{3}, Amy Ritter\textsuperscript{1}

\textsuperscript{1}Waterborne Environmental
\textsuperscript{2}Procter & Gamble
\textsuperscript{3}American Cleaning Institute

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Outline

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- Methodology
- Processing
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- Flow comparison
- Summary
- Applications
Global River Flow – Introduction

- Outside the United States, no high-resolution river flow data publicly available for use
- Detailed river flow data needed for expansion of iSTREEM® beyond the United States and parts of Canada
- iSTREEM® is a down-the-drain environmental exposure model to estimate chemical concentrations at wastewater facilities and effluent impacted rivers (www.istreem.org)
Global River Flow – Methodology

- River flow estimation is based on two steps:

  - **Step 1:** Estimating surface runoff, i.e., the amount of water that runs off a given area
    - Surface runoff from a single catchment

  - **Step 2:** Estimating river flow, i.e., capture the runoff water from a catchment, aggregate and route it downstream
    - Aggregating runoff from several catchments which becomes flow for a stream or eventually a river
Surface Runoff – Methodology

- **Step 1:** Surface runoff based on the Curve Number (CN) approach developed by the USDA (TR-55, 1986)

\[
S = \frac{1000}{CN} - 10
\]  \hspace{1cm} \text{Eq. 1}

- **CN** = value between 0 to 100 based on land cover and hydrologic soil groups

\[
S = \text{potential maximum retention after runoff}
\]

\[
Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}
\]  \hspace{1cm} \text{Eq. 2}

- **P** = rainfall

- **Q** = surface runoff
## Surface Runoff – Processing

- Global input datasets and spatial data processing

### Land Cover
(GlobCover, 2010)

### Hydrologic Soil Group
(Ross et al., 2018. 10.1038/sdata.2018.91)

### Spatial processing at 50m resolution

<table>
<thead>
<tr>
<th>Land Cover/ Hydrologic Soil Group</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated Land</td>
<td>67</td>
<td>76</td>
<td>83</td>
<td>87</td>
</tr>
<tr>
<td>Wood/Forest land</td>
<td>38</td>
<td>61</td>
<td>74</td>
<td>80</td>
</tr>
<tr>
<td>Meadow</td>
<td>30</td>
<td>58</td>
<td>71</td>
<td>78</td>
</tr>
<tr>
<td>Open Water</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urban Areas</td>
<td>74</td>
<td>83</td>
<td>88</td>
<td>91</td>
</tr>
<tr>
<td>Desert/Bare</td>
<td>63</td>
<td>77</td>
<td>85</td>
<td>88</td>
</tr>
</tbody>
</table>

### Precipitation
(Fick et al., 2017. 10.1002/joc.5086)

Unique curve number values

Annual average
Surface Runoff – Global gridded data

- Mean annual surface runoff for the globe
- Gridded data at 50m – highest resolution currently available
Global Surface Runoff to River Flow

- **Step 2**: Compute river flow from runoff data
- Hydrologic routing at HydroSheds/HydroBASINS level-12 catchment scale

**Global coverage: 8 regions**

Source: HydroSHEDS and HydroBASINS (https://hydrosheds.org/)

Hydraulic Routing
Global River Flow – Results

- Mean annual river flow by region
Global River Flow – Results

- Global mean annual river flow
- Based on HydroSheds level-12 catchments

1 million level-12 catchments
Global River Flow – China

- Comparison against measured river flow gage data from the Global Runoff Data Center (GRDC)

Source: Global Runoff Data Center (www.bafg.de/GRDC)
Global River Flow – Japan

- Comparison against GRDC gage data

Source: Global Runoff Data Center (www.bafg.de/GRDC)

\[ n = 142 \]
Global River Flow – India

- Comparison against GRDC gage data

Source: Global Runoff Data Center (www.bafg.de/GRDC)
Global River Flow – Ohio River, US

- Comparison of river flows against the NHDPlus V2

n = 170,000

Global River Flow – Summary

- Global surface runoff gridded data based on CN
  - Highest resolution currently available (50m)
- Global mean annual river flows
  - Estimated based on HydroSHEDS and HydroBASINS
- Comparison of flow data with
  - Existing river gage data in a few countries across diverse landscapes provided positive correlations
  - NHDPlus data for the Ohio River was positive too
- Next steps
  - Publication is in the works
  - Global runoff and river flow data will be made available for public use
Global River Flow – Application

- The mean annual river flow data is currently being used for iSTREEM® expansion
  - China – Integrated ERA Framework (Ming et al., Platform 30)
  - Japan – Global exposure model (Csiszar et al., MP123)
  - Canada and Mexico – in development
Thank you!

Raghu Vamshi (vamshir@waterborne-env.com)