Baseflow assessment

Jiri Sima
Baseflow definition

- Drought flow, groundwater recession flow, low flow, fair-weather flow, groundwater flow
- It is a part of total river flows which represent groundwater seepage into a stream channel from natural storage
- It is a streamflow which result from precipitation that infiltrates into soil and aquifers (recharge)
- Geomorphology controls on regional baseflow
Dynamic – static GWR
Baseflow assessment methods

• Kille method (monthly minima – long-term average – regional assessment)

• Separation of hydrograph (daily data – assessment of baseflow in various years – interval in which baseflow values varies)
Kille method

The application of the method can be summarized as follows:

- For each month in a year the minimum daily discharge rate
- Plot rates against the corresponding orders
- The linear zone of the distribution curve represents the baseflow.

- Average groundwater recharge rate $R = \text{baseflow}$
Kille

\[ \text{MoLR} = 0.00060 \times \frac{n}{2} + 0.02296 \]

linear zone of the distribution curve

interflow

baseflow

\( y_0 \)

\( n/2 \)

\( n \)
Hydrograph separation

Graphical approaches to partitioning baseflow vary in complexity and include:

• constant slope method (black line on the chart) connecting the start of the rising limb
• constant discharge method (green line)
• concave method (red line) attempting to represent the assumed initial decrease in baseflow and delay in aquifer recharge
Graphical methods

- **flow**
- **time**

- crest
- inflexion point

In the diagram, the flow over time is depicted with key points labeled as a, b, and c.
Comparing Kille and separation

<table>
<thead>
<tr>
<th>Map ID</th>
<th>River</th>
<th>Map ID</th>
<th>River</th>
<th>Area [km²]</th>
<th>Specific runoff [l/s.km²]</th>
<th>Specific runoff [l/s.km²]</th>
<th>Kille method [m³/s]</th>
<th>Hydrograph separation [m³/s]</th>
<th>Specific baseflow [l/s.km²]</th>
<th>Aquifer</th>
</tr>
</thead>
<tbody>
<tr>
<td>112001</td>
<td>Abbay / Kessie</td>
<td>112029</td>
<td>Robi Gummer / Lemi</td>
<td>65,784.0</td>
<td>7.97</td>
<td>117.790</td>
<td>196.84</td>
<td>1.79/2.99</td>
<td>76.8</td>
<td>Volcanic + sedimentary</td>
</tr>
<tr>
<td>112027</td>
<td>Aleltu / Muka Ture</td>
<td>112029</td>
<td>Robi Gummer / Lemi</td>
<td>447.0</td>
<td>9.82</td>
<td>0.990</td>
<td>1.32</td>
<td>2.21/2.95</td>
<td>70.6</td>
<td>Volcanic</td>
</tr>
<tr>
<td>112029</td>
<td>Robi Gummer / Lemi</td>
<td>112034</td>
<td>Jemma / Lemi</td>
<td>887.0</td>
<td>9.90</td>
<td>0.140</td>
<td>0.26</td>
<td>0.16/0.29</td>
<td>7.1</td>
<td>Volcanic</td>
</tr>
<tr>
<td>112034</td>
<td>Jemma / Lemi</td>
<td>112002</td>
<td>Mugher</td>
<td>5,412.0</td>
<td>14.78</td>
<td>37.370</td>
<td>39.74</td>
<td>6.91/7.43</td>
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<td>Volcanic + sedimentary</td>
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<tr>
<td>112002</td>
<td>Mugher</td>
<td>112044</td>
<td>Gorfo / Gorfo</td>
<td>489.0</td>
<td>15.87</td>
<td>0.240</td>
<td>1.52</td>
<td>0.49/3.11</td>
<td>64.5</td>
<td>Volcanic + sedimentary</td>
</tr>
<tr>
<td>112044</td>
<td>Gorfo / Gorfo</td>
<td>112012</td>
<td>Aleltu / Chancho</td>
<td>49.2</td>
<td>20.35</td>
<td>0.020</td>
<td>0.18</td>
<td>0.41/3.65</td>
<td>64.4</td>
<td>Volcanic</td>
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<tr>
<td>112012</td>
<td>Aleltu / Chancho</td>
<td>112012</td>
<td>Aleltu / Chancho</td>
<td>29.0</td>
<td>16.20</td>
<td>0.014</td>
<td>0.019</td>
<td>0.48/6.40</td>
<td>108.8</td>
<td>Volcanic</td>
</tr>
</tbody>
</table>
Abay – average discharge

Long-term average discharge: 531 m³/s
Maximum: 2001 – 1040 m³/s
Minimum: 1984 – 180 m³/s
Average: 1995 - 513 m³/s
Abay baseflow 117 m³/s
Abay - average

Abay ave. 1995 - 146 m³/s
Abay – minimum

Abay - min. 1984 - 60 m3/s
### Specific baseflow and recharge

<table>
<thead>
<tr>
<th></th>
<th>Dodola</th>
<th>Ginnir</th>
<th>Negele</th>
<th>Filtu</th>
<th>Addis Ababa</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volcanic rocks</strong></td>
<td>5.0</td>
<td>4.0</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Basement rocks</strong></td>
<td>1.0</td>
<td></td>
<td>1.0</td>
<td></td>
<td></td>
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<tr>
<td><strong>Sedimentary rocks</strong></td>
<td>0.14</td>
<td>1.0</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>Average specific baseflow [l/s/km²]</strong></td>
<td>2.8</td>
<td>1.0</td>
<td>0.6</td>
<td>0.14</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Recharge [mm/y]</strong></td>
<td>178.5</td>
<td>59.5</td>
<td>30.5</td>
<td>4.5</td>
<td>62.5</td>
</tr>
<tr>
<td><strong>Precipitation (%)</strong></td>
<td>21</td>
<td>7</td>
<td>4.5</td>
<td>1.1</td>
<td>5</td>
</tr>
</tbody>
</table>
BILAN model

- Precipitation (P)
- Evapotranspiration (E)
- Direct runoff (DR)
- Interflow (I)
- Baseflow (BF)

Soil (zone of aeration)
Groundwater storage (GS)
## Baseflow and Recharge

<table>
<thead>
<tr>
<th>River</th>
<th>Baseflow (l/s)</th>
<th>Specific baseflow</th>
<th>Recharge (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beressa</td>
<td>180</td>
<td>0.88</td>
<td>27/25</td>
</tr>
<tr>
<td>Aleltu</td>
<td>110</td>
<td>0.25</td>
<td>8</td>
</tr>
<tr>
<td>Chacha</td>
<td>140</td>
<td>0.33</td>
<td>11/23</td>
</tr>
<tr>
<td>Robi Gumero</td>
<td>140</td>
<td>0.16</td>
<td>5</td>
</tr>
<tr>
<td>Robi Jida</td>
<td>90</td>
<td>0.12</td>
<td>4</td>
</tr>
<tr>
<td>Jemma</td>
<td>1,700</td>
<td>0.31</td>
<td>10/30</td>
</tr>
<tr>
<td>Jemma (model)</td>
<td>2,300</td>
<td>0.15</td>
<td>5</td>
</tr>
</tbody>
</table>
Home made software

- Kille – (kille.exe) and (river kille.txt)
- Hydrogram – (hydrogram.exe) and river hydrogram.txt
Sources and Recommended Readings:

Groundwater Recharge.– IAH Contrib.8, Heise, Hannover.