Disturbance of fluvial processes in the lower run of Yablunka river

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Plan:
- localization of the Yablunka River
- known problems
- goal and methods
- input data
- results
- discussion

maps.google.com
Localization of the Yablunka River

Yablunka flows in Carpathians
some facts:
- curvy river with rough bed material
- in some sections - braided
- multiple bars
- islands and forested islands
Yablunka River photos

420 meters upstream
Yablunka River photos

river outlet
known problems
bed material exploitation

Staryi Sambir
Voloshynovo

Legend
Rivers
Road
Forest
Settlements

Vertical and horizontal river beds deformations

Yablunka

Bilychi
Sririlbychi

Dniester River

officially:
Dniester – 7109 tons/year
Yablunka – 153 tons/year
known problems
unofficial gravel exploitation

river outlet
known problems

absence of fine material in the whole river channel

only thin layer of sediment in riverbed

rough material on bed
known problems

cross-sections
change
incision
goal and methods

The aim of this study was to determine the extent of boundary stress exceedance in the Yablunka bottom and the effects of this exceedance on the shape of cross-section profiles at the mouth section of the river.

Special attention was paid to the analysis of bankfull discharge within $Q_{10\%}$ and $Q_{25\%}$ flows indicated by Pickup and Warner. The cover stability was determined based on diameter $d_{90\%}$, as suggested by Bray.

Cumulative curves were calculated in all cross-sections.
goal and methods

The simulation outcomes were verified against an on-site inspection that took place in 2016, an analysis of changes in the catchment management and data on sediment harvesting from the Yablunka and the Dniester beds.

The study aim was approached by taking a series of 21 specific photographs of the river substrate cover depicting its bottom at a mean area of $0.16 \text{ m}^2$.

The photographs were then used to develop granulometric curves of the cover. Direct measurements covered dimensions “a” and “b”.

Dimension “c” was worked out after determining the predominant grain shape based on a grain sphericity index.
Punzet formula for Carpathians

goal and methods
average rainfalls

\[ P \text{ [mm]} \]

\begin{axis}[
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\addplot[red,mark=diamond] table {data2.csv};
\addlegendentry{Самбір}
\end{axis}
goal and methods
hydrological data

<table>
<thead>
<tr>
<th>p [%]</th>
<th>Q [m³/s]</th>
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<tbody>
<tr>
<td>0.01</td>
<td>275.12</td>
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<tr>
<td>0.1</td>
<td>211.33</td>
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<tr>
<td>0.2</td>
<td>191.55</td>
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<tr>
<td>0.5</td>
<td>164.83</td>
</tr>
<tr>
<td>1</td>
<td>144.27</td>
</tr>
<tr>
<td>2</td>
<td>123.29</td>
</tr>
<tr>
<td>3</td>
<td>110.69</td>
</tr>
<tr>
<td>4</td>
<td>101.71</td>
</tr>
<tr>
<td>5</td>
<td>94.73</td>
</tr>
<tr>
<td>10</td>
<td>72.57</td>
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<tr>
<td>20</td>
<td>50.08</td>
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<tr>
<td>25</td>
<td>42.90</td>
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<tr>
<td>30</td>
<td>37.23</td>
</tr>
<tr>
<td>40</td>
<td>29.05</td>
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<tr>
<td>50</td>
<td>24.90</td>
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Punzet formula
for Carpathians

<table>
<thead>
<tr>
<th>P</th>
<th>mm</th>
<th>800</th>
<th>annual rainfall</th>
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<tbody>
<tr>
<td>A</td>
<td>km²</td>
<td>84.7</td>
<td>area of basin</td>
</tr>
<tr>
<td>L</td>
<td>km</td>
<td>21</td>
<td>river length</td>
</tr>
<tr>
<td>W₁ m  a.s.l.</td>
<td>712</td>
<td>max elevation</td>
<td></td>
</tr>
<tr>
<td>W₂ m  a.s.l.</td>
<td>330</td>
<td>cross-section elevation (min)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>-</td>
<td>55</td>
<td>solis impermeability</td>
</tr>
</tbody>
</table>
goal and methods
hydraulic calculations
semi-floods estimation

Procedure:
1. characteristic discharges
2. water surface elevations
3. semi flood waves creation for bed stability analysis

water surface elevation
m a.s.l.

cross-section
21m
year
1987
goal and methods

bedload characteristics

a and b dimensions
goal and methods

Sphericity:

biggest grains; elongated ... ellipsoids, discs, prisms – 0.6

smallest grains; more rounded – 0.7, 0.8

\[ c = \frac{a^2 \Phi^3}{b} \]
goal and methods

sieve curves

y axes -
mass correction coefficient

x axes -
Shape Factor

sieve 8

\[ f(x) = -2.2x + 1.9 \]
\[ R^2 = 0.14 \]

sieve 6

\[ f(x) = -1.21x + 1.51 \]
\[ R^2 = 0.15 \]

sieve 4

\[ f(x) = -1.65x + 1.67 \]
\[ R^2 = 0.19 \]

sieve 2

\[ f(x) = -5.68x + 3.59 \]
\[ R^2 = 0.34 \]
goal and methods

sieve curves

\[ f(x) = -0.70005 \ln(x) + 0.10845 \]

\[ R^2 = 0.21982 \]

\[ M_i = abc \rho \left( -0.7 \ln(SF) + 0.10845 \right) \]
goal and methods

sieve curves
bed stability - analysis

In this example biggest grains are moved with bankfull discharge
results

sieve curves
bed stability analysis

Where: 21m, when:1987yr.

Where: 420m, when:1985yr.

armour coat is too strong
results

sieve curves
bed stability analysis

<table>
<thead>
<tr>
<th>cross-section</th>
<th>H [m a.s.l.]</th>
<th>h [m]</th>
<th>Q [m$^3$/s]</th>
<th>Q% range</th>
<th>h$_{25%}$ [m]</th>
<th>h$_{10%}$ [m]</th>
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</thead>
<tbody>
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<td>21m 1987</td>
<td>331.41</td>
<td>0.51</td>
<td>44.2</td>
<td>25</td>
<td>0.48</td>
<td>0.71</td>
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<tr>
<td>21m 1997</td>
<td>331.54</td>
<td>1.35</td>
<td>421.0</td>
<td>&gt;0.01</td>
<td>0.39</td>
<td>0.51</td>
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<tr>
<td>420m 1985</td>
<td>336.74</td>
<td>1.11</td>
<td>405.0</td>
<td>&gt;0.01</td>
<td>0.38</td>
<td>0.48</td>
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<tr>
<td>420m 1997</td>
<td>336.10</td>
<td>1.17</td>
<td>336.0</td>
<td>&gt;0.01</td>
<td>0.55</td>
<td>0.69</td>
</tr>
</tbody>
</table>

incised channels are described by big capacity

<table>
<thead>
<tr>
<th>cross-section</th>
<th>max armour Q [m$^3$/s]</th>
<th>max armour h [m]</th>
<th>max armour range Q%</th>
<th>bed elevation [m a.s.l.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>21m 1987</td>
<td>44.54</td>
<td>0.57</td>
<td>25-10</td>
<td>330.90</td>
</tr>
<tr>
<td>21m 1997</td>
<td>72.00</td>
<td>0.51</td>
<td>10</td>
<td>330.19</td>
</tr>
<tr>
<td>420m 1985</td>
<td>70.00</td>
<td>0.46</td>
<td>10</td>
<td>335.63</td>
</tr>
<tr>
<td>420m 1997</td>
<td>71.70</td>
<td>0.67</td>
<td>10</td>
<td>334.93</td>
</tr>
</tbody>
</table>

within 3 cases armour coat can exist even with during 10 year flood
The Yablunka experienced intensive erosion processes that caused the river incision. There are still some sources of eroded material, however, standard deviation $\delta g = 1.88$ is close to armored bed indicated with a value of 1.3. As reported by other researchers armoring indicates low rates of sediment supply.

The Yablunka used to be an active braided river. The current chaotic gravel exploitation should be stopped not only in the Yablunka but also in the Dniester due to the headward erosion entering to the Yablunka outlet section.

As long as there is no explicit information on the current river dynamics, the next measurement sessions are expected to provide a more precise description of the tendencies for fluvial processes in the Yablunka river.
the end

Thank You for Your attention