Two case studies of cyanobacteria-related water quality problems and solutions in Serbia

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At the Embassy of Finland in Belgrade, 2014

Summer work at Vesijärvi, early 1980s

Flow of knowledge between Finland and Serbia for 35 years

Lahti, 2015

At the Embassy of Finland in Belgrade, 2014

Conference in Belgrade, 2014
Problems in Serbia

• Blooms of cyanobacteria in many lakes and reservoirs

• High levels of cyanotoxins measured and health problems observed

• Lack of legislation regarding cyanotoxins
Aleksandrovac lake

Area = 12 ha
Volume = 250,000 m³
Av. depth = 2 m
Max depth = 4 m
Prohibition of water use from Oct 2012 (Institute of Public Health)
Svirčev et al., 2017. Massive fish mortality and *Cylindrospermopsis raciborskii* bloom in Aleksandrovac Lake

Table 9 Comparison of analyses from November 15 and December 23, 2012

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>pH, in situ</td>
<td></td>
<td>9.05</td>
<td>7.3</td>
</tr>
<tr>
<td>Ammonium ion</td>
<td>mg N l⁻¹</td>
<td>0.08</td>
<td>0.9</td>
</tr>
<tr>
<td>Total organic carbon</td>
<td>mg l⁻¹</td>
<td>34.38</td>
<td>22.36</td>
</tr>
<tr>
<td>Phaeophytin</td>
<td>mg m⁻³</td>
<td>53.7</td>
<td>5.86</td>
</tr>
<tr>
<td>Chlorophyll <em>a</em></td>
<td>mg m⁻³</td>
<td>214.2</td>
<td>17.2</td>
</tr>
<tr>
<td>Number of filaments <em>C. raciborskii</em></td>
<td>Filaments ml⁻¹</td>
<td>2.06 × 10⁵</td>
<td>1.24 × 10³</td>
</tr>
</tbody>
</table>

*Artemia salina* test - **high intracellular toxicity** of *C. raciborskii*, **BUT:**

CYN, STX, MCs (dmMC-RR, MC-RR, dmMC-YR, MC-YR, dmMC-LR, MC-LR) **not detected**

**UNIDENTIFIED TOXIC COMPOUND??** (Vehovszky et al., 2015)
Drinking water source for > 70,000 people
Volume 54 million m³
Area 1.92 km²
Mean depth 20.8 m
Eutrophic, total P 23-45 ug/L in Dec. 2013
Reservoir (31 Dec 2013, Agency for Environmental Protection): 70,000-110,000 cells/ml

Supplying system (23 Dec 2013, Institute of Public Health):
10,000 cells/L in the treated water (conventional treatment)
1000 cells/L in the drinking water sample (MC-LR < 1 µg/L)

Prohibition of water use for drinking and cooking (26 Dec 2013-Sanitary Inspectorate of the Republic of Serbia)

Public unrest

Alternative water source since February 2014 - Sušičko vrelo
Svirčev et al., 2017. Lessons from the Užice case: how to complement analytical data

**Analytical data (LC-MS/MS)**

<table>
<thead>
<tr>
<th>Sample</th>
<th>dmMC-RR</th>
<th>MC-YR</th>
<th>dmMC-LR</th>
<th>MC-LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass (shoreline) January 2014</td>
<td>11700 µg L(^{-1})</td>
<td>20 µg L(^{-1})</td>
<td>3700 µg L(^{-1})</td>
<td>53 µg L(^{-1})</td>
</tr>
<tr>
<td>Tap water January 2014</td>
<td>5.7 µg L(^{-1})</td>
<td></td>
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<tr>
<td>(during the prohibition)</td>
<td></td>
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<tr>
<td>Reservoir water (shoreline) April 2014</td>
<td>2.1 µg L(^{-1})</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish muscle tissue October 2013</td>
<td>detected</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fish April 2014</td>
<td>detected</td>
<td></td>
<td>detected</td>
<td></td>
</tr>
</tbody>
</table>

*Table 31.1* Detected (LC-MS/MS) microcystins in cyanobacterial biomass, water, and fish samples from Lake Vrutci
Human health data = strong motivator for reservoir restoration

- **Questionnaire** indicated a number of health issues likely connected to the bloom in 2013: skin irritation, eye irritation, stomach problems, liver problems, dry cough, high blood pressure etc

- **Epidemiological investigation** – increased occurrence of digestive tract and skin diseases compared to earlier years (elevation in 2012 possibly caused by a sub-surface bloom)
January 2018 (photos by Tijana Jevtic)

April 2018 (https://uzickanedelja.rs/vrutci-se-crvene-od-stida/)
ECOSYSTEM – Targets for remedial measures
Current ECOMANIPULATION initiatives in Serbia

- Removal of macrophytes
- Mobile floating islands
- Zeolites
- Removal of microalgal biomass
- Extensive fishing
- Dredging
- Hydrogen peroxide
IN SUMMARY

Use of single method is usually not enough for successful restoration

We propose:

1. Simultaneous use of sustainable and environmentally friendly methods for reducing the total capacity* of aquatic ecosystems

2. Modification of restoration methods according to the specific characteristics of a given water ecosystem

3. Use of collected biomass

*defined as the abiotic and biotic potential to promote primary production
Thank you for your attention!