FLOODS IN BRNO: HISTORY, CAUSES AND IMPACTS

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**Brno** (390,000 inhabitants) – the second largest town in the Czech Republic – industrial, administrative, university and cultural centre of the South Moravian region.
Inundation area of the Svitava River endangers heavy inhabited parts of Brno (example for Husovice, Zábrdovice, Židenice)
The Svratka River (left) - 167 km; 7119 km² (1707 km² to the confluence with the Svitava river)
The Svitava River (right) - 97.3 km; 1147 km²

The confluence
Natural and anthropogenic factors of floods

They influence origin, course and impacts of floods:

- **meteorological and climatological factors** (temperature, precipitation, snow cover)
- **land-use**
- **anthropogenic factors** (e.g. water reservoirs, regulation of river beds, bridges, building in the inundation area)
Climatic patterns

Mean annual temperature, 1961-2000
Mean annual precipitation totals, 1961-2000
Absolute daily precipitation maxima in selected rain-gauge stations, 1961-2000
Mean annual number of days with snow cover, 1961-2000
Mean seasonal maximum values of water equivalent of snow cover, 1961-2000
### Land-use changes

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<tr>
<td></td>
<td>km²</td>
<td>%</td>
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<tr>
<td>Arable land</td>
<td>1264.17</td>
<td>43.90</td>
<td>1387.71</td>
<td>48.19</td>
<td>1076.84</td>
<td>37.40</td>
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<td>Permanent grassland</td>
<td>536.20</td>
<td>18.63</td>
<td>242.21</td>
<td>8.41</td>
<td>333.19</td>
<td>11.57</td>
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<tr>
<td>Orchard</td>
<td>0.09</td>
<td>0.00</td>
<td>10.57</td>
<td>0.37</td>
<td>20.49</td>
<td>0.71</td>
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<tr>
<td>Vineyard, hop-field</td>
<td>4.20</td>
<td>0.15</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Forest</td>
<td>996.32</td>
<td>34.60</td>
<td>1080.68</td>
<td>37.54</td>
<td>1171.76</td>
<td>40.69</td>
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<tr>
<td>Water area</td>
<td>8.75</td>
<td>0.30</td>
<td>8.42</td>
<td>0.29</td>
<td>13.78</td>
<td>0.48</td>
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<td>Built-up area</td>
<td>69.50</td>
<td>2.41</td>
<td>147.48</td>
<td>5.12</td>
<td>238.06</td>
<td>8.27</td>
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<td>Recreation area</td>
<td>0.00</td>
<td>0.00</td>
<td>1.46</td>
<td>0.05</td>
<td>21.79</td>
<td>0.76</td>
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<td>Other area</td>
<td>0.26</td>
<td>0.01</td>
<td>0.89</td>
<td>0.03</td>
<td>3.53</td>
<td>0.12</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>2879.44</strong></td>
<td><strong>100.00</strong></td>
<td><strong>2879.44</strong></td>
<td><strong>100.00</strong></td>
<td><strong>2879.44</strong></td>
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Land use categories in the Svratka and Svitava catchments in different periods (decrease of arable land, increase of forest and built-up area)
Vír I (1958) - area 224 ha, total capacity 56.2 million m³

Brno (1940) - area 259 ha, total capacity 21 million m³

Water reservoirs and regulations of rivers
Channel changes of the Svratka river in the north-western part of Brno from 1838 (left) to 1991 (right)
Length (1) and sinuosity (2) changes of the Svratka (up to the confluence with the Svitava) (a) and the Svitava (b) rivers in different periods
Hydrological measurements

- **water stages** (cm)
- discharges (m³.s⁻¹)

Annual peak water stages on selected stations of the Svratka and Svitava rivers in the period 1888-1924
Annual peak discharges at the Veverská Bítýška station (1925-2007, missing year 1926), Brno-Pisárky/Poříčí station (1918-2007), Bílovíce nad Svitavou (1918-2007) station and Židlochovice station (1921-2007); $Q_2 - Q_{100}$ - peak discharge limits

**Floods analysed:** $Q_k \geq Q_2$
Decadal frequency of winter (December–April, blue) and summer (May–November, red) floods exceeding the two-year maximum peak discharge ($Q_2$) according to their N-year return period at Veverská Bítýška (missing years 1921–1924, 1926), Brno-Pisárky/Poříčí, Bílovice nad Svitavou and Židlochovice stations in the period 1921–2007.
Decadal frequency of floods exceeding the two-year maximum peak discharge ($Q_2$) according to their N-year return period at Veverská Bítýška (missing years 1921–1924, 1926), Brno-Pisárky/Poříčí, Bílovice nad Svitavou and Židlochovice stations in the period 1921–2007
Summer flood of the 20th century – Aug/Sep 1938

Daily precipitation totals: a – 24 August, b – 25 August, c – 1 September

Saturation expressed by antecedent precipitation index $\text{API}_{30}$ to 25 August (d), 26 August (e) and 2 September (f)
Variation of the flood wave on the Svratka and Svitava rivers during the period from 24th August to 7th September 1938

**Flood severity:**

26 August: $Q_{50}$ – Veverská Bítýška, Brno-Pisárky

2 September: $Q_{100}$ – Bílovice nad Svitavou

Besides casualties, this flood damaged the dam of Brno reservoir which was not finished yet
Air temperature, precipitation totals and depth of snow cover during the period from 30th January to 13th March 1941 on the selected meteorological stations.
Variation of the flood wave on the Svratka and Svitava rivers during the period from 3rd to 15th March 1941

**Flood severity:** 11 March: $Q_{100}$ – Brno-Pisárky, Židlochovice; $Q_{50}$ – Bílovice nad Svitavou
Historical floods from documentary evidence

Long Bridge across the Svratka river in Brno - accumulated ice floes during the flood of March 1830 after the extremely severe winter 1829/30
Decadal frequency of floods on the Svratka and Svitava rivers in Brno in comparison with whole catchment area of the Svratka river (Brázdil, Kirchner et al. 2007) according to documentary sources in the period 1651–1900 (Z - winter type, L - summer type, N - unclear)
Decadal frequency of floods on the Svratka and Svitava rivers in Brno during the period 1761–2000 according to documentary sources (1761–1887), water stages measurements (1888–1919) and discharges (1920–2000) on the selected hydrological stations in Brno and surroundings.
Climate and floods

(a) Decadal frequencies of the occurrence of floods (a), delimited according to documentary evidence and hydrological measurements on the Svratka and the Svitava Rivers in the Brno region.

(b) In comparison with decadal anomalies (the reference period 1961–1990) of mean air temperatures and precipitation totals of compiled Brno series in the period 1801–2000: 1 – winter floods, 2 – summer floods, 3 – air temperature, 4 – precipitation.
Conclusions

• floods – permanent danger for the inhabited part of Brno around the rivers

• high vulnerability of the town to the flood risk

• the most severe floods in the Brno region occurred in Aug/Sept 1938 and March 1941

• water reservoirs as protection against flood are effective for lower N-year waters

• what will be frequency and severity of floods in the Brno region in the future global warming?