Urban riparian forests and their hydrological ecosystem services

Vilhar Urša, Kermavnar Janez, Erika Kozamernik

26 - 27 May 2021
EUROPEAN RIVER SYMPOSIUM
Urban riparian forests and their hydrological ecosystem services

Ecological processes
- Canopy interception
- Water flow
- Water quality
- Air pollution,…

Factors
- Precipitation
- Forest structure
- Soil properties
- Parent material,…

Indicators
- Canopy interception
- Topsoil water infiltration
- Soil water holding capacity,…
Urban riparian forests and their hydrological ecosystem services

- Linking Ecosystem Services & Human Well-being to indicators

- Measure by Ecologists
- Value by Economist
- Utilize by Decision-Makers

Source: Millennium Ecosystem Assessment (2005)
Urban riparian forests and their hydrological ecosystem services

**The City of Ljubljana**

Area: 275 km²  
Population: 276,091  
Population density: 1,004 indiv. km⁻²  
Forest cover: 41 %
Canopy precipitation interception of riparian forests

Transect:
Mixed forest ↔ Riparian pine forest ↔ Floodplain hardwood forest

Kermavnar & Vilhar, 2017
Urban forests and their hydrological ecosystem services

Transect:

- **Mixed forest in city center**
- **Riparian pine forest**
- **Floodplain hardwood forest**

**Dystric cambisols**

**Fluvisol (WRB 2007)**
Urban forests and their hydrological ecosystem services
Average throughfall, stemflow and canopy interception from 2008 to 2013

MIXED FOREST IN CITY CENTER

RIPARIAN PINE FOREST

FLOODPLAIN HARDWOOD FOREST

% of bulk precipitation

Leaved | Leafless | Year | Interception | Stemflow | Throughfall

18% | 4% | 7%

a) Mixed forest
b) Riparian pine forest
c) Floodplain hardwood forest

Relative frequency

Rainfall intensity (mm/h)

< 0.25 | 0.26 - 1.0 | 1.1 - 4.0 | 4.1 - 16.0 | 16.1 - 50.0

Winter | Summer
Urban forests and their hydrological ecosystem services

The City of Ljubljana

- Two important subsurface water-bodies:
  1. aquifer Ljubljansko polje and
  2. Ljubljansko Barje aquifer system.

- 102 potential water sources and springs:
  - 5 located outside the forest,
  - 36 in the forest,
  - 61 on the forest edge.
Assessment of hydrological ecosystem services of riparian vegetation for a potential drinking water source

**Different land use categories**

the Glinščica river study area (1665 ha) in the City of Ljubljana, Slovenia:

- **Forest:** 44.7 %
- **Built-up areas:** 31.4 %
- **Grassland and abandoned agricultural land:** 16.0 %
- **Agricultural land:** 7.5 %
- **Wetlands, marshes and flood plains:** 1.2 %
- **Lakes and rivers:** < 1 %
Assessment of hydrological ecosystem services of riparian vegetation for a potential drinking water source

Water protection zones of the potential drinking water source

water protection zone VVO I: Forest cover 76%
### Assessment of hydrological ecosystem services of riparian vegetation for a potential drinking water source

<table>
<thead>
<tr>
<th>Process</th>
<th>Indicator</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soil water holding capacity (g cm(^{-3}))</td>
<td></td>
</tr>
<tr>
<td>Water purification</td>
<td>Max. NO(_3) concentration in the groundwater of Ljubljana aquifer (mg l(^{-1}))</td>
<td>ICP Forests Database 2014, Life+ EMoNFUr Database, Ausec et al. 2005, Loose et al. 2010</td>
</tr>
<tr>
<td></td>
<td>Soil Bulk Density (g cm(^{-3}))</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C/N ratio of soil</td>
<td>Jamnik et al. 2003, Ivančič &amp; Vončina 2013, Koleša &amp; Planinšek 2013, Loose et al. 2010</td>
</tr>
<tr>
<td>Air pollution reduction</td>
<td>PM(_{10}) - Annual concentration (µg m(^{-3}))</td>
<td>Ivančič &amp; Vončina 2013, Koleša &amp; Planinšek 2013, Loose et al. 2010, Ogrin 2007a, Ogrin 2007b</td>
</tr>
<tr>
<td></td>
<td>PM(_{10}) - No. of days above daily threshold 50 µg m(^{-3})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NO(_2) - Annual concentration (µg m(^{-3}))</td>
<td></td>
</tr>
</tbody>
</table>

Relative values for indicators (Koschke et al. 2012):

- From 0 – no relevant contribution
- to 1 – maximum possible contribution
Assessment of hydrological ecosystem services of riparian vegetation for a potential drinking water source
Assessment of hydrological ecosystem services of riparian vegetation for a potential drinking water source
Urban riparian forests and their hydrological ecosystem services

Conclusions

- Every riparian ecosystem is unique (structural traits, soil features and microsite conditions) – difficult to draw general conclusions about their hydrological ecosystem services.

- Canopy precipitation partitioning in riparian forests is strongly influenced by tree species composition, canopy cover and growing stock (i.e., tree dimensions) as well as rainfall spatial distribution and intensity.

- Riparian forests act as a natural filter for pollutants in the air, soil and water with their dense tree crowns, litter and forest soils.

- Hydrologically oriented forest management measures to improve riparian ecosystem services in urbanized watersheds represent a nature-based solution.
Acknowledgments

• Postdoc applied research project, Target Research Project in the Target Research Program “Competitiveness of Slovenia 2006-2013”,
• Master thesis at Faculty of Civil engineering, University of Ljubljana,
• Public forestry service, financed by Ministry of Agriculture and the Environment, Republic of Slovenia,
• ICP Forests and Intensive Monitoring of Forest Ecosystems in Slovenia (Public Service)
• Life+ EMoNFUr Project „Establishing a monitoring network to assess lowland forest and urban plantation in Lombardy and urban forest in Slovenia” (LIFE10 ENV/IT/000399)
• The Slovenian Research Agency, Research Core Funding No. 0404-501; the Programme group “Forest biology, ecology and technology” and basic research project J2-1749
• FPS COST Action FP1204 Green Infrastructure approach: linking environmental with social aspects in studying and managing urban forests
• Interreg project PROLINE-CE, co-funded by ESRR.
Urban riparian forests and their hydrological ecosystem services

Vilhar Urša, Kermavnar Janez, Erika Kozamernik

26 - 27 May 2021
EUROPEAN RIVER SYMPOSIUM