Methods for assessing adaptation to climate change activities focused on urban green infrastructure

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Green approach to climate change adaptation

Ecosystems as infrastructure, which has a wide variety of benefits compared to single function grey infrastructure such as water, sewerage, electricity or transport networks.

Advantages of green infrastructure
- Multifunctionality (environmental, social, economic)
- Integration (cooperation with other sectors)
- Landscape connectivity
- Multi-scale solutions and diversification (multi-objectivity)

Project objectives:
- To identify methods for evaluating green infrastructure measures undertaken in an urban area
- To assess the relevance of their application in analysing the impact of the measure on climate change adaptation at local level

Green infrastructure is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation (European Commission)
## Urban green infrastructure components

<table>
<thead>
<tr>
<th>Parks</th>
<th>Rain gardens</th>
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<tbody>
<tr>
<td>Urban forest parks</td>
<td>Green roofs</td>
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<tr>
<td>Ecological areas and protected areas</td>
<td>Green facads</td>
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<tr>
<td>Street trees, verges and hedges</td>
<td>Green tracks</td>
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<td>Urban squares</td>
<td>Green stops</td>
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<td>Communal urban areas</td>
<td>Permeable surfaces for car parks</td>
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<td>Playgrounds</td>
<td>Retention ponds</td>
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<td>Pocket gardens</td>
<td>Bioretention basins and ditches</td>
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<td>Allotment gardens</td>
<td>Urban wetlands</td>
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<td>Community gardens</td>
<td>Continuous waterfronts</td>
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<td>Cemeteries and church gardens</td>
<td>Rivers and reservoirs</td>
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<td>Green school grounds</td>
<td>Floodplains</td>
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<td>Walking and cycling trails</td>
<td>Vacant and disused land</td>
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<td>Areas used for sports, leisure and recreation</td>
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<td>Lawns and flower meadows</td>
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</table>
# Green infrastructure – impact and monitoring

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Social and cultural impacts</th>
<th>Involvement of inhabitants</th>
<th>Possibility and transferability</th>
<th>Negative aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate, energy and emissions</td>
<td>Health and well-being</td>
<td>Involvement in the implementation of green projects</td>
<td>Integrated management</td>
<td>Inconvenience to residents associated with green infrastructure:</td>
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<tr>
<td>▪ Lowered local temperature,</td>
<td>▪ Improved physical health</td>
<td>▪ Share of residents involved in such projects</td>
<td>▪ number of decision-makers involved in the planning and implementation process from different</td>
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<td>▪ Increased protection against flooding (%)</td>
<td>▪ Reduced excess heatwave deaths</td>
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<td>disciplines/sectors</td>
<td>mosquitoes, ticks, mice, nesting birds,</td>
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<td>Biodiversity</td>
<td></td>
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<td>plants emitting allergic pollen</td>
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<tr>
<td>▪ Increased number of species present,</td>
<td>Access to public green and blue spaces</td>
<td>Ownership and responsibility</td>
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<td>▪ Reduced biodiversity loss</td>
<td>▪ Number of people using green areas</td>
<td>▪ Share or number of people owning or caring for green areas</td>
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<td>Revitalisation of abandoned and post-industrial areas</td>
<td>Quality of life, happiness</td>
<td>Sharing and adopting GI solutions in the community</td>
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<td>▪ Increased share of transformed post-industrial space</td>
<td>▪ Assessment of life satisfaction.</td>
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### Inconvenience to residents associated with green infrastructure:
- mosquitoes, ticks, mice, nesting birds, plants emitting allergic pollen
Impact of green infrastructure - climate

**Reduction of heat stress**

Cooling effect of different forms of GI (compared to a concrete surface): grass (2-4°C), trees (5-7°C). The effect also depends on the size and intensity of tree cover.

**Reduction of flood risk**

- Rainwater retention (a single tree can retain 6.7 cubic meters of water per year)

The volume of retained rainwater during heavy rainfall depends on:

- Structure of the greenery (number, density, size, species composition)
- Plant health status
- Spatial configuration
Evaluation of GI: Quality standards

- **Green roof standards**
  - Minimum substrate layer thickness (exceeds 12 cm for residential and office buildings, 8 cm on large industrial buildings) (Green Roof Strategy for Hamburg)
  - Standard for water retention capacity of a green roof (Urban strategies for the implementation of green roofs – Germany)

- **Standards for a small-scale urban surface retention system** (complex of buildings with different functions) - management of design rainfall volume in line with the assumptions of a given location (housing estate in Gdynia)

- **Biotope Area Factor (BAF)** – indicator defining the absorbent properties of a surface. Determines the relationship between the ecologically effective surface area and the total surface area (the Berlin Landscape Programme - concept for improving the microclimate in the city center)

- **Map of Tree Crowns for Warsaw** (tool for Urban Greens Management)
  - Number of trees planted - number and location of trees with a minimum height of 3 m (9 million)
  - Coverage of trees with a crown area of 7 sq m (32%); species of trees
Evaluation of GI: Green space availability indicators

AVAILABILITY of blue-green areas

- Area of installed green infrastructure (green roofs, green walls, rain gardens, community gardens, etc. [sq m] or
- Area of new green infrastructure solutions [sq.m./year]
- Area of green and blue infrastructure in the city [sq m]
- Share of parks, greens and residential green areas in the total area of the city [%]
- Relative change in the area of blue-green infrastructure in the city [%]
- Surface area of urban ventilation corridors [ha]
- Forest coverage [%]
Evaluation of GI: Green space accessibility indicators

AVAILABILITY of blue-green areas

- Number of squares and plazas transformed into so-called "climate squares and plazas" [units]
- Share of 'green stops' in the total number of public transport stops [%]
- Area of green space per inhabitant [m/person]

ACCESSIBILITY of blue-green areas

- Number of blue-green infrastructure facilities accessible to residents [units]
- Surface of green areas accessible for residents [sq km]
Evaluation of GI: Green space accessibility indicators

ACCESSIBILITY of blue-green areas (Close access)

- Share of residents living more than 300 m from recreational urban green space [%]
- Share of residents with access to green spaces of a given size within a given distance [%]
- Maximum distance to the closest green space from the residence
- Ratio of green areas to the number of residents with access to these areas (within a certain distance)
Conclusions

- The use of social and environmental performance indicators and green infrastructure quality standards seems to be an appropriate approach for assessing climate change adaptation related to the introduction and maintenance of green infrastructure in urban spaces.

- A unified approach to assessing the adaptation may be difficult due to the inter-city variation in urban climate risks and urban policy goals for adaptation to changing climate conditions.

- The scale of the measures to be introduced depends on the financial possibilities of the city.

- Local indicators defined by a range of different stakeholders will provide a better understanding, while the development of indicators at regional level may be an appropriate approach to assessing closely located areas.

- Classification and prioritization of the elements of GI of the city and the selection of appropriate measures for their evaluation in terms of adaptation effects will be carried out in case study.
Thank you for your attention!

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