A multi-level, multi-scenario perspective on the interplay between urban planning and flood risk management

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A multi-level, multi-scenario perspective on the interplay between urban planning and flood risk

Urbanization increases vulnerability in the floodplains.

The layout of buildings also affects the flow conveyance.
A complete modelling chain was set up, involving hydraulic, urbanisation and damage modelling

- Fully dynamic shallow-water model
- Based on laser altimetry (decimetre-scale vertical accuracy)

- Applied to all main rivers in the southern part of Belgium (1,300+ km)
- Considered flood frequencies: 25-year, 50-year & 100-year floods
A complete modelling chain was set up, involving hydraulic, urbanisation and damage modelling.

- Hybrid urbanization model, coupling cellular automata and agent-based modelling (Mustafa et al. 2017)

- Considering various scenarios for demand and allocation

- High demand
- Medium demand
- Low demand
- Business-as-usual
- Urban densification
- Ban in flood-prone areas?
A complete modelling chain was set up, involving hydraulic, urbanisation and damage modelling.

- Depth-damage functions
- Specific value correlated with the urban density
“Sustainable spatial planning” policies tend to promote urban densification, as opposed to urban sprawl.

- Facilitates transport-efficiency
- Promotes walking and cycling
- Reduces pressure on land

Densification promotes urbanization around existing urban areas mainly located close to the rivers.

- (10-15 percentage points)

2100:
- High rate
- Densification and expansion

2100:
- High rate
- Densification only

Flood risk
A multi-level, multi-scenario perspective on the interplay between urban planning and flood risk

Urbanization increases vulnerability in the floodplains.

The layout of buildings also affects the flow conveyance.
Does the layout of buildings (urban form) have a substantial influence on flooding severity?
The analysis is based on two modelling tools, complemented by statistical analysis.

1. Procedural modelling
   - Parameters $x_1, x_2, \ldots, x_9$ (average road width, length, curvature ...)

2. Efficient inundation model
   - Computed water depths
   - Computed inundation depths

3. Correlation analysis
The urban pattern generator uses nine input parameters, the ranges of which were calibrated on real-world data.

<table>
<thead>
<tr>
<th>ID</th>
<th>Characteristic</th>
<th>Minimum value</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_1$</td>
<td>Street length</td>
<td>40 m</td>
<td>400 m</td>
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<tr>
<td>$x_2$</td>
<td>Street orientation</td>
<td>0</td>
<td>180°</td>
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<tr>
<td>$x_3$</td>
<td>Street curvature</td>
<td>0 km$^{-1}$</td>
<td>10 km$^{-1}$</td>
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<tr>
<td>$x_4$</td>
<td>Major street width</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_5$</td>
<td>Minor street width</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_6$</td>
<td>Mean parcel area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_7$</td>
<td>Building rear setback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_8$</td>
<td>Building side setback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_9$</td>
<td>Building coverage</td>
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<td></td>
</tr>
</tbody>
</table>

From land registry data (Belgium)

Bruwier et al. (2017, STOTEN)
“Fragmented” building blocks tend to perform better, and distances between adjacent buildings are important.
General good practices in sustainable urban planning must be modulated to accommodate flood-resilience.

Regional level
- High rate
- Densification and expansion

2100:
- High rate
- Densification only

District level
- Facilitates transport-efficiency
- Promotes walking and cycling
- Reduces pressure on land
- Enhances heating efficiency
- Improves efficiency of supply network (water, energy ...)

2100:
- High rate
- Densification only
Conclusion

At the **regional level**, we coupled an **agent-based urbanisation model** with inundation and risk modelling.

At the **district (or local) level**, a **procedural model** was coupled with inundation modelling.

Remaining questions: improve damage and risk modelling, influence of infiltration, green roofs ...