Transforming a Low Income Neighborhood into a Climate Resilient Neighborhood in Zhenjiang, China

Dr. Nian She
Location of the Project Area

This is a high density neighborhood built in 1970s. Most residents are low income retirees. Due to the lack of maintenance, this neighborhood had endured annual flooding, deterioration of aging infrastructure, lack of appropriate sanitary conditions and no parking lot. Young people moved out.
Problem 1 - Flooding

Flooding Event in 2015 before the retrofit
For decades there was no maintenance. The pavements in the neighborhood were damaged. Many green spaces were destroyed.
Problem 3 – Landscape Sites Became Garbage Dumping Ground

The garbage were dumped into landscape sites
Problem 4 – Lack of Parking Space

Due to lack of parking space some green space became “illegal parking lots”
Problem 5 – Building Surface Deterioration and Lack of Appropriate Infrastructures
“Sponge City” Targets

- Control 1” rainfall
- Remove 40% TSS

However,
- Is this really what the residents want?
- Does this really make the residents happier?
- Can these problems identified be solved by following above targets?
- What should we do as a designer?
Our Approach

- **Landscape + N**
  - **Improve Livability**
    - Increase recreational spaces
    - Preserve big trees
    - Landscape reclamation
  - **Flood Mitigation**
    - Route impervious surface into rain gardens and green spaces
    - Change sidewalk into permeable pavement
  - **Better Property Management**
    - Re-organize property management
    - Setup maintenance guidance
  - **Retrofit Gaslines**
    - Switch from coal gas to natural gas
  - **Upgrade Water Supply Infrastructure**
    - Repair leaking pipes and meters
    - Replace eroded pipes
  - **Increase Parking Space**
    - Increase parking spaces
    - Install porous parking lots
  - **Energy Conservation**
    - Utilize thermal insulation materials
    - Install window shading
    - Upgrade electrical system and lighting
  - **Sewer Separation**
    - Disconnect illegal connections
    - Separate sewer from storm drains
Design minus principle is minimizing the landscape intervention because this neighborhood has about 40 years of history. Residents spent most of their life in the neighborhood. Keep their memory is so important in the design work. After the retrofit it is desirable to minimize the maintenance cost, and encourage the residents to maintain their vegetable gardens and fruit trees.
**LID design process:**
1. Site Investigation
2. Survey drainage network
3. Subcatchment delineation
4. Communication with residents
5. Soil infiltration testing
6. LID layout and modeling
7. Separation
8. Monitoring
Section Design

1. Bioretention
2. Recreation space
3. Porous pavement
4. Building
5. Yard
How Green Stormwater Infrastructure Works
Experiments before the construction

Growing Media Test

Plants Selections

Infiltration Test

Observation of Plant Growth
Site Delineation and Modeling:
Delineation: Rooftop, Road, Green Space and “Yard”
Model: SWMM

<table>
<thead>
<tr>
<th>Description</th>
<th>Volume</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial LID Storage</td>
<td>0.022</td>
<td>11.521</td>
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<tr>
<td>Total Precipitation</td>
<td>0.413</td>
<td>219.979</td>
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<tr>
<td>Evaporation Loss</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Infiltration Loss</td>
<td>0.052</td>
<td>27.927</td>
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<tr>
<td>Surface Runoff</td>
<td>0.189</td>
<td>100.574</td>
</tr>
<tr>
<td>Final Surface Storage</td>
<td>0.193</td>
<td>102.629</td>
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<tr>
<td>Continuity Error (%)</td>
<td>0.160</td>
<td>------</td>
</tr>
</tbody>
</table>
NO-LID (Before) 6.2mm rainfall detention

LID (After) 34.6mm rainfall detention

Concluding:
LID can delay 13 hours of discharge at the outfall. (Without LID it is just 1 hour)
Data Analysis: 113 events, 7 events exceed 34.6mm, 6.2%.
Annual rainfall 1032.6mm, Discharged runoff 173.5mm, 16.8%.

注：以上年总降雨量及实测降雨量均参考2005年南京实测数据。
### 1yr-2h:

<table>
<thead>
<tr>
<th></th>
<th>Rainfall (mm)</th>
<th>Peak rainfall (min)</th>
<th>Peak runoff (min)</th>
<th>Runoff Volume (m³)</th>
<th>Peak runoff (m³ / s)</th>
<th>Runoff Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>37.5</td>
<td>40</td>
<td>50</td>
<td>598</td>
<td>0.24</td>
<td>0.85</td>
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<tr>
<td>After</td>
<td>37.5</td>
<td>40</td>
<td>50</td>
<td>198</td>
<td>0.07</td>
<td>0.28</td>
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</table>

72% runoff volume reduction
10yr-24h:

<table>
<thead>
<tr>
<th></th>
<th>Rainfall (mm)</th>
<th>Rainfall peak (min)</th>
<th>Runoff peak (min)</th>
<th>Runoff Volume (m³)</th>
<th>Runoff peak (m³/s)</th>
<th>Runoff Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>175.0</td>
<td>1115</td>
<td>1120</td>
<td>2810</td>
<td>0.30</td>
<td>0.85</td>
</tr>
<tr>
<td>After</td>
<td>175.0</td>
<td>1115</td>
<td>1125</td>
<td>1290</td>
<td>0.17</td>
<td>0.40</td>
</tr>
</tbody>
</table>

Volume Reduction 54%, Peak Reduction 43%, Peak shifting
30yr-24h:

<table>
<thead>
<tr>
<th></th>
<th>Rainfall (mm)</th>
<th>Rainfall peak (min)</th>
<th>Runoff peak (min)</th>
<th>Runoff volume (m³)</th>
<th>Runoff peak (m³/s)</th>
<th>Runoff Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>220.0</td>
<td>1115</td>
<td>1120</td>
<td>3600</td>
<td>0.30</td>
<td>0.87</td>
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<tr>
<td>After</td>
<td>220.0</td>
<td>1115</td>
<td>1125</td>
<td>1890</td>
<td>0.29</td>
<td>0.46</td>
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</tbody>
</table>

Runoff volume reduction 47.5% , No significant reduction of peak
There are 24 hot spots before. Flood volume 512m$^3$, 14 spots exceed 15cm in depth. Only 7 hot spots left after. Flood volume 62m$^3$, only 1 spot exceeds 15cm in depth. Flood time 30min.
Design Process

Design Discussion

Outreach

Public Comments
During Heavy Storm

After completion of the project the neighborhood experience two heavy storm events. One is 138 mm rainfall in 2016 and another is 125mm rainfall in 2017.
Monitoring Results

95% Flow Reduction, and 98% TSS Removal
An Ideal Place for Social Interactions of the Residents
Beautiful Landscape – Reduced Symptoms of Depression and Anxiety
Rain Garden + Porous Access = Improved Personal Safety
Happiness – Yong People bring their Children back
Take the green home
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