The Landscape Green Infrastructure Design (L-GrID) Model

Metropolitan Planning Council
Calumet Stormwater Collaborative
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L-GrID Background
Motivations and questions

• IEPA 2009 – 2010

• Landscape design principles
  • How much?
  • Where?

• Publication:
Landscape Green Infrastructure Design (L-GrID)

- Sewer intakes
- Roads
- Permeable cover
- Impervious cover
- Green infrastructure
- Outlets (triangles over sewer intake icons)
L-GrID Processes

1. Rain
2. Infiltration
3. Sewers
4. Evaporation
5. Evapotranspiration
6. Surface Flow
7. Outflow (one cell only)

Impervious Green Infrastructure Permeable
How much?

5-year Storms and % GI Cover

100-year Storms and % GI Cover
Where?

- sorted random (baseline)
- adjacent to roads
- away from roads
- upstream
- downstream
- hybrid

- = road
- = impermeable block
- = permeable block
- = green infrastructure
Where? 5-year storms

% Green Infrastructure

5%

10%

15%

% of Precipitation

% of Total landscape flooded

Sorted random
Adjacent to roads
Away from roads
Upstream
Downstream
Hybrid

GI Blocks
GI Roads
Blocks
Rocks
Where? 100-year storms

% Green Infrastructure

15%  20%  25%  30%

% of Precipitation

GI infiltration  Sewers  Outflow

% of Total Landscape Flooded

Sorted random  Adjacent to roads  Away from roads  Upstream  Downstream  Hybrid

GI Blocks  GI Roads  Blocks  Roads
Design principles

• Thresholds
• Dispersed over clustered
• Advantage of curb cuts
  • Keep water in roads
  • Detention
  • Installation in public property and maintenance
• Hybrid in larger storms
  • Build on curb cut layout
• When all else fails, try random
• Other layouts?
UIC capital plan
UIC West Campus

[Map of UIC West Campus with street names labeled]
Baseline 1: (2-year, 6-hour storm)

Standing water levels during and immediately after the storm
Baseline 1: 2-year, 6-hour storm, 50% initial soil saturation, 70% initial sewer capacity, no CSOs
Baseline 1: (2-year, 6-hour storm)
Baseline 1: 2-year, 6-hour storm, 50% initial soil saturation, 70% initial sewer capacity, no CSOs
Scenario 1a: swales along Taylor Street
Scenario 1b: flow path
Scenario 1c: random
How well do scenarios perform?

<table>
<thead>
<tr>
<th>Ranking 1</th>
<th>Ranking 2</th>
<th>Metric</th>
<th>Value</th>
<th>Normalized Value</th>
<th>Ranking 1</th>
<th>Ranking 2</th>
<th>Metric</th>
<th>Value</th>
<th>Normalized Value</th>
<th>Ranking 1</th>
<th>Ranking 2</th>
<th>Metric</th>
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<th>Normalized Value</th>
<th>Ranking 1</th>
<th>Ranking 2</th>
<th>Metric</th>
<th>Value</th>
<th>Normalized Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>5</td>
<td>Present value cost: installation + maintenance (20 years)</td>
<td>NA</td>
<td>NA</td>
<td>$1,439,300</td>
<td>1.00</td>
<td>$1,439,300</td>
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<tr>
<td>2</td>
<td>2</td>
<td>$ per gallon runoff captured by GI</td>
<td>NA</td>
<td>NA</td>
<td>$1.65</td>
<td>1.00</td>
<td>$1.23</td>
<td>0.00</td>
<td>$1.63</td>
<td>0.95</td>
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<td></td>
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<td></td>
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<tr>
<td>1</td>
<td>1</td>
<td>GI capacity used</td>
<td>NA</td>
<td>NA</td>
<td>67.94%</td>
<td>1.00</td>
<td>90.82%</td>
<td>0.00</td>
<td>68.84%</td>
<td>0.96</td>
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<tr>
<td>5</td>
<td>6</td>
<td>Sewer capture (% of precipitation)</td>
<td>84.28%</td>
<td>NA</td>
<td>79.04%</td>
<td>0.47</td>
<td>77.81%</td>
<td>0.00</td>
<td>80.42%</td>
<td>1.00</td>
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</tr>
<tr>
<td>6</td>
<td>4</td>
<td>Outflow to downstream area (% of precipitation)</td>
<td>6.91%</td>
<td>NA</td>
<td>4.18%</td>
<td>1.00</td>
<td>2.56%</td>
<td>0.00</td>
<td>3.34%</td>
<td>0.48</td>
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</tr>
<tr>
<td>4</td>
<td>3</td>
<td>Area flooded (% of area ever flooded)</td>
<td>7.88%</td>
<td>NA</td>
<td>2.47%</td>
<td>0.99</td>
<td>0.86%</td>
<td>0.00</td>
<td>2.48%</td>
<td>1.00</td>
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**SCORES**

<table>
<thead>
<tr>
<th>Ranking 1</th>
<th>Ranking 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA</td>
<td>5%</td>
</tr>
<tr>
<td>NA</td>
<td>3%</td>
</tr>
</tbody>
</table>

For normalized values, 1 is worse, 0 is better.
Things to consider

- Simulations alone are not enough
  - Tradeoffs
  - Costs and distribution
  - Spatial constraints
  - Diverse stakeholder interests
- Solution-building AND compromise
- Awareness of preferences
  - Addressing diverse needs
  - metrics, evaluation, exploration
Participatory Modeling
Workshop structure

Participatory Modeling Protocol

1. Initial presentation
2. Group discussion
3. Interactive modeling
4. Data analysis
5. Final discussion
1: Concern profile

Sort the items based on how important they are to you

- Maximum Flooded Area
- Damage Reduction
- Efficiency of Intervention ($/Gallon)
- Capacity Used
- Water Flow Path
- Groundwater Infiltration
- Investment
- Impact on my Neighbors

Definitions

Investment: Cost to install and maintain new green infrastructure on both city and private property. Maintenance costs are in Present Value (PV) over 20 years, at 3% discount rate.

Damage Reduction: The amount of property damages reduced by the investment.

Efficiency of Intervention: ($/Gallon) The amount of money spent per gallon of rainwater stored or infiltrated by green infrastructure installations.

Capacity Used: The percentage of capacity used by interventions over their total available capacity.
2: Interactive placement of tokens
3: L-GrID Simulations

Landscape Green Infrastructure Design Model (L-GrID)
This model is designed to compare different green infrastructure layout scenarios at the subwatershed scale.

Sample Rainfall Totals (24-hour only listed)
1-year = 2.43 inches
3-year = 3.95 inches
5-year = 3.77 inches
10-year = 4.45 inches
100-year = 7.2 inches

Run only with no GI (Blank.txt).
Oversides neighbor option and has no inflows; records outflows.
Must be run after outflow calibration, again, with no GI (Blank.txt).

Setup of Landscape and Processes

- Go until Stop Conditions Met
  - Go

- Model Parameters
  - Rainfall-distribution
  - Photographic
  - Storm-type
  - 1-year
  - Storm-duration
    - 1-hour

- Initial-soil-saturation
  - 50%

- Initial-soil-capacity
  - 70%

- Initial-soil-capacity
  - 70%

- Run-after-rainfall
  - Rainfall-run

- Run-without-GI
  - Blank.txt

- Run-after-outflow
  - GI.outflow-run

- Run-with-calibration
  - GI-calibration-run

- Run-with-configuration
  - GI-configuration-run

- GI-Import-scenario
  - Blank.txt

- Type-to-place
  - GI

- GIS-to-place
  - GI

- Remove GI
  - GI

- Export GI
  - GI
4: Sorted simulation results

<table>
<thead>
<tr>
<th>Sort by</th>
<th>Trial Number</th>
</tr>
</thead>
<tbody>
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</table>

Simulation Results Sorted By Your Priorities
The Performance score is broken down into colors corresponding to the outcomes on the right

<table>
<thead>
<tr>
<th>Water Flow</th>
<th>Max Depth of Flooding</th>
<th>Damage Reduction</th>
<th>Impact on</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 hrs</td>
<td>48 hrs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storm Playback: 21 hours</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Trial 2</th>
<th>Performance:</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Broken down by source:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Best for me</td>
<td>Worst for me</td>
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</table>

<table>
<thead>
<tr>
<th>Trial 3</th>
<th>Performance:</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Broken down by source:</td>
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</table>
5: Social viewer

Simulation Results of Yours and Other Users Priorities, Sorted By Your Priorities
Each color in the score breakdown is linked to an outcome measure to the left of it

Legend
- Investment
- Intervention Capacity
- Efficiency of Intervention
- Groundwater Infiltration
- Impact on my Neighbors
- Damage Reduction
- Max Depth of Flooding
- Water Flow

Highest priority categories
- ped
- pol

You can revise your profile by returning to the "Your Survey" tab below
Condensed ○ Expanded
Iterative structure
Learning, innovation, compromise

• Transparency of assumptions and tradeoffs
  Jo: “Oh wow, that’s much better…for you.”
  Nina: “I guess it matters what your priorities are!”
  Kevin: “Damage was reduced by 87%…but we were over budget by 1.2 million.”

• Systematic exploration
  “Let’s start by going crazy, putting a lot of stuff on here, and then pare back from there.”
  “We can run multiple simulations, so let’s run this one and then try that”

• Gesturing and mental modeling
  Following the flow
  Imagining different performance

• Green infrastructure cannot locally solve the problem
  “Perhaps we need to think of moving the houses out of there”
  Green AND gray infrastructure
  Coordination with other communities
Takeaways

- Collaborative design
- Facilitation for synthesis
- Consensus or compromise?
- Participatory modeling as a point of entry
  - to the problem,
  - to other tools,
  - to diverse interests
  - to other problems

Thank you!

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