GREEN TECHNOLOGY INNOVATION FOR ECOLOGICAL BALANCE IN SMART SUSTAINABLE CITIES

Seoul National University
Graduate School of Environmental Studies

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Self introduction

• Landscape and ecological planning lab. (landscape.snu.ac.kr)

• Professional field
  • Ecological Planning, Ecological Restoration, Urban Ecosystem, Urban Climate, Habitat, Landscape Ecology
  • Remote sensing, Environmental DNA, CFD... for ecological monitoring
  • Smart × Green City, Environmental Planning and Management
GREEN SPACE VISITS IN COVID-19 (KOREA CASE)

No. of Visits
In January vs
End of March
April 3, 2020 by
Google

What is the “Green”?
What is the “Green”?

KOREA NEW DEAL:
DIGITAL & GREEN “NEW DEAL” FOR THE POST COVID-19
KOREA NEW DEAL: DIGITAL & GREEN “NEW DEAL” FOR THE POST COVID-19

Green New Deal & Smart Green City Project of Korea (2020~)

What is the “Green”?
Green New Deal & Smart Green City Project of Korea (2020~)

1. Climate resilience (기후탄력)
2. Water cycle system (물순환)
3. Security and safety in water resource (물안전 안심)
4. Future mobility (미래차)
5. Waste resource cycle (자원순환)
6. Ecological restoration (생태복원)
7. Ecological recreation (생태휴식)
8. Clean atmosphere (청정대기)
9. Environmental education (환경교육)
10. Living environment (생활환경)
How can the green be “smart”? 

SMART x GREEN TECHNOLOGIES FOR CITY

- Technological Aspects

Smart x Green = Innovation to overcome the bottle neck at Green

**Green Environment**

- Technology for Improving Water Environment System
- Natural Environment Management Technology
- Green Mobility Technology
- Waste Reduction and Recycling Promotion Technology
- Air Quality and Emission Sources Management Technology
- Noise Vibration and Light Pollution Reduction Technique

**Smart Innovation**

- Big data
- GPS
- Mobile Communication
- Service Control Platform
- Internet Module
- Sensing
How can the green be “smart”?

SMART UNDERSTANDING, SMART USE
THE URBAN GREEN (EXAMPLE)

• 3D based monitoring urban ecological structure
• Using remote sensing with high spatio-temporal resolution
Microclimate as an Indicator for Managing and Planning Urban Green Infrastructures

**Improving Microclimate and Thermal Comfort by Optimizing the Vegetation Arrangement in an Urban Park**

- Study site: Daecheong park, located in the Gangnam district of Seoul
- The thermal environment condition was analysed by using the ENVI-met model.

- The objectives of the present study are to:
  1) assess the impact of vegetation modification on air temperature and thermal comfort;
  2) identify key processes and factors that most influence the spatial and temporal microclimates distribution.

*(Li Y. & Song Y., 2019)*
How can the green be “smart”?

Smart understanding, smart use the urban green (example)

Microclimate as an Indicator for Managing and Planning Urban Green Infrastructures

Improving Microclimate and Thermal Comfort by Optimizing the Vegetation Arrangement in an Urban Park

**Case A**: no vegetation, replaced all the existing vegetation with concrete, for presenting the most extreme non-green case;

**Case B**: removed bushes, for presenting single-layered vegetation structure;

**Case C**: doubling the LAD of the existing trees and remove the bushes, for presenting the single-layered vegetation structure with increased green canopy;

**Case D**: current situation, it presenting multi-layered vegetation structure;

**Case E**: doubling the LAD of the existing trees, for presenting the multi-layered vegetation structure with increased green canopy.

(Li Y. & Song Y., 2019)
How can the green be “smart”?

Smart understanding, smart use the urban green (example)

Microclimate zone mapping in the urban park based on Lidar-driven canopy structure

Impact of the Landscape Configuration on Seasonal Variation of Microclimate and Human Comfort in Yeouido Park, Seoul, Korea

(Li Y. et al., 2018)
How can the green be “smart”?

Smart understanding, smart use the urban green (example)

Microclimate zone mapping in the urban park based on Lidar-driven canopy structure

Impact of the Landscape Configuration on Seasonal Variation of Microclimate and Human Comfort in Yeouido Park, Seoul, Korea

Method and material

ENVI-met model

(Li Y. et al., 2018)
How can the green be “smart”?

Smart understanding, smart use the urban green (example)

Microclimate zone mapping in the urban park based on Lidar-driven canopy structure

Impact of the Landscape
Configuration on Seasonal Variation of Microclimate and Human Comfort in Yeouido Park, Seoul, Korea

**Mean radiant temperature**
- Morning (8:00-10:00)
- Noon (11:00-13:00)
- Afternoon (14:00-16:00)
- Late afternoon (17:00-19:00)

**Air temperature**
- Morning (8:00-10:00)
- Noon (11:00-13:00)
- Afternoon (14:00-16:00)
- Late afternoon (17:00-19:00)

**Relative humidity**
- Morning (8:00-10:00)
- Noon (11:00-13:00)
- Afternoon (14:00-16:00)
- Late afternoon (17:00-19:00)

**Wind speed**
- Morning (8:00-10:00)
- Noon (11:00-13:00)
- Afternoon (14:00-16:00)
- Late afternoon (17:00-19:00)

*Figure 5. Microclimate zone classified by ISO cluster Unsupervised Classification in GIS: a summer season; b winter season.*

(Li Y. et al., 2018)
Simulated Thermal Comfort during the Hottest Season in Low-rise Dense Urbanized Area by Applying Urban Greening Units

**Objective**

- Estimation of change in thermal comfort by applying a scenario consisting of differences in green area types in low-rise high-density urbanization areas
- Derivation of optimal scenarios within the study site
- Derivation of major factors affecting thermal comfort in addition to the type of urban greening

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**How can the green be “smart”?**

Smart understanding, smart use the urban green (example)
How can the green be “smart”? 

Smart understanding, smart use the urban green (example)

Three dimensional estimation of wind corridor & comfort in the city

<table>
<thead>
<tr>
<th>Activity</th>
<th>Places</th>
<th>Sensory Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Good</td>
</tr>
<tr>
<td>Walking fast</td>
<td>Sidewalks</td>
<td>5</td>
</tr>
<tr>
<td>Strolling/Skating</td>
<td>Skating rinks; Parks, Entrances</td>
<td>4</td>
</tr>
<tr>
<td>Short-term Sitting</td>
<td>Plaza areas, Parks</td>
<td>3</td>
</tr>
<tr>
<td>Prolonged sitting</td>
<td>Outdoor restaurants, Theatres, Band shells</td>
<td>2</td>
</tr>
<tr>
<td>Tolerance</td>
<td>&lt;1/week</td>
<td>&lt;1/month</td>
</tr>
</tbody>
</table>


How can the green be “smart”?

Smart understanding, smart use the urban green (example)

Terrestrial LiDAR-estimated canopy volume in different seasons

(Zelkova serrata)

Leaf-off canopy
Mar. 22, 2017

Leaf-off canopy
Aug. 30, 2017

Non-photosynthetic part

+ Photosynthetic part

Amount of leaves at the single tree module

(Han Z. master thesis)
How can the green be “smart”?

Smart understanding, smart use the urban green (example)

<table>
<thead>
<tr>
<th>Per-tree characteristics</th>
<th>Plot A</th>
<th>Plot B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leafy volume (m³)</td>
<td>0.22 ± 0.16</td>
<td>0.33 ± 0.14</td>
</tr>
<tr>
<td>Woody volume (m³)</td>
<td>0.1 ± 0.07</td>
<td>0.25 ± 0.10</td>
</tr>
</tbody>
</table>

(Han Z. master thesis)
How can the green be “smart”? 

Smart understanding, smart use the urban green (example)

Photosynthetic part ratio

Leafy volume

<table>
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<tr>
<th></th>
<th>Densely planted young trees</th>
<th>Sparsely planted mature trees</th>
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</thead>
<tbody>
<tr>
<td>Plot A</td>
<td>1.55</td>
<td>2.38</td>
</tr>
<tr>
<td>Plot B</td>
<td>1.55</td>
<td>2.38</td>
</tr>
</tbody>
</table>

Ratio of Leafy to total volume

<table>
<thead>
<tr>
<th></th>
<th>Densely planted young trees</th>
<th>Sparsely planted mature trees</th>
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</thead>
<tbody>
<tr>
<td>Plot A</td>
<td>0.68</td>
<td>0.48</td>
</tr>
<tr>
<td>Plot B</td>
<td>0.68</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Canopy structure → Ecological function

Ecological function e.g., mitigation of air pollutants

Single tree level

Large in sparsely planted mature trees

Plot level

Large in densely planted young trees

(Han Z. master thesis)
Digital Twin for Seoul Botanic Garden
Virtual Tour at “Scanned Real” Seoul Botanic Garden with VR
Suwon *Corvus frugilegus* vulnerability map

We have no idea where it came from and where it goes

Average 3000 to maximum 7700 rooks were cited
Droppings hygienically threatening Suwon city (especially cars parked outdoor)
Wireline contamination and short circuit power outage

Citizen science overcomes known barriers when it comes to ecological investigation
### Suwon *Corvus frugilegus* vulnerability map

**Cada (App)**
- Provides age/address of the providers moreover, appearance time/coordinates/field photos of rooks
- Collected 5242 points in total (including boundaries beyond Suwon)
  - 4523 points which are only collected within Suwon

**How can the green be “smart”?**

**Smart understanding, smart use the urban green** *(example)*

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<th>Provdr age</th>
<th>Provdr adress</th>
<th>Year</th>
<th>Month</th>
<th>Day</th>
<th>H</th>
<th>Min</th>
<th>Sec</th>
<th>Image name</th>
<th>Latitude</th>
<th>Longitude</th>
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How can the green be “smart”?

Smart understanding, smart use the urban green (example)

Visualized Heatmap of the location of Rooks collected via citizen science

• The results of the field investigation showed consistent results when compared Heatmap of the rooks in Suwon city in other words, data collected with citizen science was confirmed with its validity

Suwon Corvus frugilegus vulnerability map
What we expect to Smart x Green in the city

- Tackle the global to local environmental issues
- In more effectively and efficiently
- By Smart technologies
  - ET (remote sensing, spatial informatics, environmental modeling)
  - IT (e.g., VR/AR, IoT, GPS, web, app)
  - BT (e.g., Environmental DNA)
- With Citizens
Thank you for listening!

Youngkeun Song
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Seoul National University