IGC INTERNATIONAL GEODESIGN COLLABORATION
Changing Geography by Design

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ALTERNATIVE FUTURES FOR ZARIA CULTURAL LANDSCAPE

Presenter
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Chair Professional Practice and Policy (IFLA Africa)
The existing significant physical features of Zaria cultural landscapes are:

1. Ganiuwa – the city wall
2. Kofa – the eight city gates
3. Gidan Bakwa – the royal place of Zaria (fada)
4. Zaria Juma’a Mosque
5. Kasuwan Zaria – the Zaria Market
6. Anguwanni - (Wards)

Traditional space at household level

1. Kofar Gida – outdoor entrance
2. Zaure – entrance porch
3. Tsakar Gida – the court yard
4. Bayan Gida – the backyard
Objectives

• Identify challenges of the present cultural landscape configuration

• Propose alternative future interventions for Zaria city

• Indicate and address the SDGs captured in the future scenarios
Ahmadu Bello University

Zaria is within the North Central Guinea Savannah ecological zone of Nigeria. As a seat of tradition and culture established in 1536, its population is 955,522 with 95% in the 17.3km2 walled city. The main features of the historic landscape are six. One of which are the wards (Anguwanni). The greatest challenge lies in increasing built up areas in the wards, over the decades. The present land configuration affects the overall quality of life, livelihood and environment.
Ahmadu Bello University  Alternative Futures for Zaria Cultural Landscape

Requirement

• Governance
• Quality of environment and sanitation
• Facilities, utilities and services
• Agricultural and industrial revitalization
• Energy

Innovations

• RES 1 Good hygiene and storm water management
• RES 6 Policy on environmental sanitation
• RES 4 Residential layout (all basic infrastructure)
• TRANS 6 Lanes for tricycle, motorcycle and pedestrian
• TRANS 5 Provision of monorail for efficient transport
• GI 5 Riparian line restoration
• GI 6 Carbon trade off
• COMIND 6 Skills acquisition center
• COMIND 2 Industrial development
• ENE 1 Renewable energy sources
• CULTH 2 Reclaiming Cultural Sites
## Addressing the SDGs on the cultural landscape

<table>
<thead>
<tr>
<th>HUB No.</th>
<th>INFRASTRUCTURES</th>
<th>POLICY/PROJECT</th>
<th>NOTES</th>
<th>SDGs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>RESIDENTIAL</td>
<td>POLICY</td>
<td>Provision of residential Layout will help in decongesting Zaria city.</td>
<td>1, 2, 7, and 11</td>
</tr>
<tr>
<td>1</td>
<td>TRANSPORTATION</td>
<td>PROJECT</td>
<td>Roads are being constructed within the city. There is also need to expand road construction to provide access and to support economic development and human well-being in Zaria.</td>
<td>1, 2, and 9</td>
</tr>
<tr>
<td>1</td>
<td>WATER INFRASTRUCTURE</td>
<td>PROJECT</td>
<td>Additional reservoir water tanks and provision of boreholes to complement Zaria water works.</td>
<td>3, 4, and 6</td>
</tr>
<tr>
<td>3</td>
<td>INSTITUTION</td>
<td>PROJECT</td>
<td>Provision of institutional buildings in areas that with growing population.</td>
<td>3, 4</td>
</tr>
<tr>
<td>4</td>
<td>ENERGY INFRASTRUCTURE</td>
<td>PROJECT</td>
<td>Provision of the solar lights around the city wall in order to complement the business activities that take place, especially at the city gates.</td>
<td>7, 9, and 11</td>
</tr>
<tr>
<td>1</td>
<td>CULTURE</td>
<td>PROJECT</td>
<td>Completing the abandoned construction of city gates (Kofar Kona and Kofar Ban-Zazzau), and also rebuilding the Kafar Galadima that was not captured for the renovation.</td>
<td>11, 17</td>
</tr>
<tr>
<td>2</td>
<td>CULTURE</td>
<td>POLICY</td>
<td>Adopting policies regarding the protection of cultural heritage in all dimension, both tangible and intangible. Adopt measures to promote the role of culture in the renovation of historic centres and in neighbourhood, district and regional development plan.</td>
<td>11.16 AND 17</td>
</tr>
<tr>
<td>4</td>
<td>CULTURE</td>
<td>POLICY/PROJECT</td>
<td>This is one of the biggest house that can be protected as landscape because it still maintain the cultural architectural pattern of Zaria. The house is said to be of Emir of Zazzau Dalhatu, it is famously known as Gidan Madaki Shehu.</td>
<td>9, 11</td>
</tr>
</tbody>
</table>
Thank you
Virginia Beach facing a sea-level rise with frequent storm surges, does not have a comprehensive resilient plan against sea-level rise. As such, Geodesign was used as a framework to generate and evaluate scenarios to produce such a plan. This study work toward creating a resilient and sustainable community without grossly displacing its inhabitants and redeveloping the **Lynnhaven Bay area**.
Requirements:

- The current population is 53,777. The total Population in 2050 will not change.
- Additionally, 5,000 people will be displaced by 3-ft SLR requiring new housing.
- Higher density residential housing in less risky areas for SLR.
- 15-20% set aside as conservation areas.
- Natural sand dune must be conserved.
- Population over the age of 65 or older will be 25% of population.

Innovations:

- WAT 2035/2050 3: Agricultural Water Conservation
- AGR 2050 11: Urban Farming – Urban Agriculture
- AGR 2050 18: Controlled-environment Agriculture (CEA)
- GRN 2035/2050 1: Resilient Landscape Infrastructure
- ENE 2050 1: Renewable Energy Sources
- TRA 2035/2050 15: Integrated Transportation and Energy Infrastructure
- RES 2035/2050 11: Adaptable Modular Housing
- MIX 2035/2050 10: Managing High Density Locally
- MIX 2035/2050 1: Mixed Use Development
- INS 2050 11: Diversification in Entertainment Venues
Coastal community located with the Chesapeake Bay

**Characteristics:**
Residential neighborhoods including elder housing line the center spine of the subject area – Shore Drive.
The area in green is the Shore Drive Overlay District.

**Challenges:**
Stormwater, Bay Island redevelopment – FEMA grant program to elevate residential structures, redevelopment of commercial real estate along Shore Drive corridor, loss of marsh island at mouth of inlet.
Living in the Urban to Natural Transect  City Scale & District Scale Design

**Concept**
- Create a design that embodies the urban to rural transect within the context of a tidal city.
- Create a sustainable community that is resilient to storm surge and SLR and that engages with the tidal ecosystem of Virginia Beach.
- Create appealing high density and medium density living - including a plaza with shops, a park with trails and playgrounds, and a bayside boardwalk with a small beach area.

**Goals and Objectives:**
1. Providing quality housing for 2,000 of the 5,000 people displaced by the 3 ft sea-level rise.
   - a. Creating a mixed-use community with high-density residential housing that is at low risk of flooding.
   - b. Providing appropriate amenities for all ages.
   - c. Creating opportunities for urban agriculture.
   - d. Improving public transit connectivity and accessibility.
2. Creating a green infrastructure network that improves quality of life and ecological viability.
   - a. Implementing green infrastructure that connects residents to businesses.
   - b. Utilizing conservation areas for public education and non-invasive recreation such as walking and biking trails.
3. Using nature-based solutions to address SLR and flooding.
   - A. Dedicating 15% of the site to conservation areas in critical flood zones.
   - b. Preserving existing tidal ecosystems.
   - c. Restoring lost or damaged coastal ecosystems such as oyster reefs and tidal marshes.
Designing the Future of Virginia Beach

Current Sea Level

3 Feet SLR (2050)

6 Feet SLR (2100)

Design Program:
1. Connection to existing shore drive and bike trails
2. Assisted living apartments
3. Parking Garage
4. Apartments with ground floor businesses
5. Community plaza
6. Bus stop
7. Townhouses with driveway parking
8. Townhouses- alley parking
9. Community park with trails
10. Playground for preschool aged children
11. Playground for school aged children
12. Pavilions
13. Boardwalk access to marsh preservation
14. Living shoreline beach
15. Fishing pier
16. Oyster reefs
THANK YOU
The Green New Deal (GND) is a resolution in the U.S. House of Representatives (H. Res. 109, February 7, 2019) that calls for a 10-year national mobilization to achieve the following goals:

A. Net zero greenhouse gas emissions with a fair and just transition for displaced workers;
B. Millions of new green-economy jobs creating economic security for all Americans;
C. Infrastructure investments to meet 21st century challenges;
D. Clean air and water, climate and community resiliency, healthy food, access to nature, and a sustainable environment for all Americans;
E. Justice and equity for frontline and vulnerable communities.

This project looks at the impact of the GND on neighborhoods immediately adjacent to downtown Minneapolis, which contain some of the wealthiest and poorest districts in Minnesota. The project also seeks to align the GND goals with the UN’s Sustainable Development Goals (SDGs), while utilizing the International Geodesign Collaboration’s (IGC) categories.
University of Minnesota

Requirements:

- Reduce inequality and expand economic opportunities
- Transition to a green economy, helping displaced workers
- Achieve full employment with community-defined projects
- Adapt to climate change with re-purposed infrastructure
- Switch to 100% renewable energy and water recycling

Innovations:

- WAT 2 Water Retention
- AGR 11 Urban Agriculture
- GRN 9 Connected Green Infrastructure
- GRN 15 Climate Change Adaptation
- ENE 1 Renewable Energy Sources
- TRAN 1 Autonomous Vehicle Revolution
- IND 16 Re-Invented Small Business
- RES 3 Citizen-Responsive Smart Cities
- RES 4 Emerging Public/Private Spaces
MINNEAPOLIS, MINNESOTA
The City of Minneapolis, the largest city in the state of Minnesota, has 425,000 people, at the center of a metropolitan area of 3.46 million. The city has a median household income of $59,000 and a population density of 3,041 people per km². Although the city is the state’s leading job center, two neighborhoods in the project area, immediately adjacent to each other, are among the wealthiest and the poorest. The Mississippi River runs through the center of the project area, with downtown Minneapolis to the south, the lower income neighborhoods of North Minneapolis west of the river, and the working class neighborhoods of Northeast Minneapolis to the east of the river.

Because of the region’s plentiful freshwater, with many lakes and rivers and the Great Lakes to the north, and its location far from coasts and north of hotter regions of the U.S., this project assumes that the city will be a destination for populations fleeing drought, heat, and coastal flooding from other parts of North America and the world. Minneapolis has a long history of welcoming international immigrants, who have contributed greatly to its prosperity and diversity. At the same time, it has some of the greatest income and achievement gaps between white and communities of color. This project explores the tension between that openness and inequality in an era of climate change while utilizing the International Geodesign Collaboration’s (IGC) categories.
EARLY ADOPTER SCENARIO
The early adopter scenario responds to increased flooding along the Mississippi River, replacing an existing industrial area with open space able to accommodate flood water. The rise of autonomous vehicles by 2035 leads to the repurposing of highways by 2050 into connected green space, with adjacent mixed-use affordable housing and community based businesses. Urban agriculture occupies most lawns and boulevards, as water retention and recycling strategies recharge the aquifer. Micro-grid renewable energy production also occurs in neighborhoods, using distributed networks of building-mounted solar arrays. A major emphasis is on community-based economic development, with accessible retraining opportunities and full employment of everyone capable of working. Green infrastructure connects neighborhoods currently separated from the river and offers linked habitat corridors as well as multi-model transportation corridors. Because of the intensive investment in the Green New Deal, Minneapolis becomes more socially equitable, economically prosperous, and environmentally resilient, and is better prepared to become a destination city for environmental refugees fleeing climate change and searching for a place that has ample freshwater, economic opportunities, a progressive social ethic, and a history of accepting immigrants.
LATE ADOPTER SCENARIO
The late adopter scenario has the same goals as the early adopter one, but because of its late start after 2035, the city is not as well prepared for the disruptions that climate change and environmental refugees will bring. The infrastructure is not as ready to handle the increased flooding that becomes the norm, causing a lot of flood damage to buildings. And, while autonomous vehicles have become common by 2035, resistance to changing the infrastructure in response to them leads to a lot of wasted investment in outmoded highways and parking structures. Opposition to a Green New Deal until 2035 also results in a lot of wasted human potential as unemployment and a lack of retraining opportunities prevent too many people from contributing to the economy and their communities. At the same time, investments in outdated fossil fuel and storm water infrastructure end up getting wasted as the city is forced, after 2035, to adapt more quickly to climatic and technological disruptions. As environmental refugees start arriving, accommodating their housing, sustenance, and employment needs is more costly and difficult because of a lack of preparation, resulting in greater resistance to immigrants, despite the city’s history as a welcoming place. The late adopter scenario goes in the right direction, but in a more expensive and tumultuous way.
The non-adopter scenario shows how resistance to change can lead a prosperous and progressive city to become impoverished, provincial and partisan. This scenario brings the political polarization that has gripped the U.S. to Minneapolis. This results in growing inequality, leading rich and poor neighborhoods, physically very close to each other in the city, to become embattled, with gated communities and local security forces protecting the wealthy neighborhoods near the downtown and on the high ground to the south from the poorer neighborhoods of North Minneapolis and the working class neighborhoods of Northeast Minneapolis. This scenario also sees growing climate change denial, and a refusal to plan for it. That, in turn, leads to ever-more expensive and catastrophic weather-related events, as people abandon low-lying parts of the city and infrastructure and building repair cannot keep up. As environmental refugees arrive, they squat on all available open space, occupying public golf courses and the city’s extensive park system. The lack of planning for this also leads to a deteriorating natural environment, declining public health, and overwhelmed water, food, and transportation systems, pushing the city toward bankruptcy. Non-adoption is an option that no one, knowing its consequences, would choose in 2020.
SUSTAINABLE DEVELOPMENT GOALS

The Early Adopter Scenario fully embraces both the UN SDG’s and the US GND goals, both of which focus on job creation - SDG 8 - in a green economy - SDG 9 - with an emphasis on clean energy - SDG 7 - and resilient communities - SDG 11. The GND goals also align with SDG 1, 2, 3, 4, and 5, in which the entire population would be gainfully employed, well nourished, in good health, with equal educational opportunities for all.

The Late Adopter Scenario has these same goals, but because of their adoption 15 years later, it has more obstacles to overcome, such as the loss of nearly an entire generation to unequal opportunities, inadequate education, and poorer health outcomes. The late adopter scenario achieves some of what the early adopter one does, but later and to a lesser extent.

The Non-Adopter Scenario shows what happens when the forces resisting change prevail, with ever greater inequality among communities and genders, increasingly expensive environmental damage that causes disruptions to the lives of growing numbers of people, and the growing socio-economic segregation of the city. It is a scenario that no one would want for their children.
Project context: The City, The Pinheiros River, and the nested watersheds

São Paulo is the biggest Metropolis of the Southern Hemisphere, with more than 21 million people dwelling a sedimentary basin once occupied by floodplains and rain forests. This metamorphosis from humid vegetated areas to paved dry ones occurred mostly in the last century, compromising the hydrological functioning of the landscapes and resilience of the City facing the challenge of climate change, how can we reverse such trends?
Requirements:

- Ensure greater sustainability of water quality through the use of green infrastructure elements to assist the water treatment and procedures adopted by the official project.
- Favor greater urban resilience in the face of extreme weather events by adaptation and mitigation using landscape-based solutions.
- Facilitate urban mobility, outdoors activities, ecosystems and public health.

Innovations:

- WAT 1 Water Crisis: Address Access to Clean Water
- WAT 8 Bioretention
- GRN 1 Resilient Landscape Infrastructure
- GRN 3 Integrated Vegetated Stormwater Infrastructure
- GRN 4 Linear Vegetated Corridors as Linear Parks
- GRN 10 Green Urban Streets
- GRN 12 Green Roofs
- TRAN 20 Permeable Pavement for UHI And Stormwater Management
Pilot Project for a Sub-Watershed: Antonico Creek
detailing solutions in the landscape

LID distribution by geomorphology
- Floodplain and valley bottom - potential for water storage
- Tabular areas - infiltration predominance good percolation
- Steep slopes - between 10 and 20% infiltration predominates but in heavy rainfall runoff increases
- Steep slopes more 20% - predominance of runoff
- Permanent Protection Areas and Spring Amphitheaters

Flood plain: rain planter no infiltration, built wetland, recovered stream, greenway, and urban afforestation.
Tabular areas: rain gardens, rain planters with infiltration, bioswales, porous pavement.
Steep slopes btw 10 and 20%: rain planters with or without infiltration, bioswale, porous pavement, tree canopy.
Steep slopes more than 20%: rain planters without infiltration, bioswale, tree canopy.
Springs: ponds, built wetlands, stream recovering, riparian forest, tree canopy.

(BONZI, 2014; SCHUTZER, 2012)
## Green Infrastructure for a New Pinheiros River

### ANTONIO'S CREEK BASIN

<table>
<thead>
<tr>
<th>TOTAL 1st FLUSH VOLUM (m²)</th>
<th>BIORETENTION LID REQUIRED (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>58.888,8</td>
<td>125.293,0</td>
</tr>
</tbody>
</table>

### Stormwater Runoff

![Stormwater Runoff Map]

The map illustrates the distribution of stormwater runoff across different areas within the basin. The runoff is color-coded, with darker blue areas indicating higher runoff volumes and lighter blue areas indicating lower volumes. The runoff pathways are clearly marked, showing how water flows through the landscape.

The runoff data is crucial for designing effective green infrastructure solutions, such as the bioretention systems shown in the diagram. These systems help in managing stormwater by infiltrating or collecting runoff, reducing its volume and pollutants before it enters the natural water bodies.
The Grid of BioRetention
High performance landscape based solutions (Moura, N.C.B et al., 2015)

Retrofit local streets | connected to remodelled public open spaces (EARLY 35 scenario)

<table>
<thead>
<tr>
<th>THE GRID OF BIORETENTION</th>
<th>BIORETENTION LID RESULT EARLY 35 (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public open spaces and local streets</td>
<td>240.021.8</td>
</tr>
</tbody>
</table>

Convencional wastewater treatment plant | Oficial State Program
University of São Paulo  Green Infrastructure for a New Pinheiros River  🌿IGC

- **runoff volume possibly retained**: approximately 58% of the 30cm layer formed on the bioretention elements.
- **vegetation suitable to high humidity and concentrations of organic matter**: mulch
- **planting soil**
- **geotextile fabric**
- **gravel**
- **bedrock**

**Bioretention LID**

- **0.47m³ POLLUTED 1st flush**
- **1sqm**
- **BETTER RIVER**

**Retention volume/m²**

<table>
<thead>
<tr>
<th>Bioretention</th>
<th>Gravel layer (h)</th>
<th>Bedrock layer (h)</th>
<th>$n_m$</th>
<th>Retention volume/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>15cm</td>
<td>60cm</td>
<td>0.396</td>
<td></td>
<td>0.296 + 0.174 = 0.47m³</td>
</tr>
</tbody>
</table>
Green infrastructure: such as a network of porous pavement, solar and wind energy, green roofs and vertical gardens, cisterns and water harvesting, rain gardens and bioswales and other LiDs for sustainable drainage, urban afforestation; new generation of stormwater reservoirs, riparian forests and restored and built wetlands, restoring rivers and streams, community gardens and new productive parks among other types of Landscape Based Solutions, will help meet, with GeoDesign support, the UN sustainability goals:

1 (no poverty), because flooding will decrease;

3 (healthy living and well-being), because the green areas and the requalification of the water bodies will improve the temperature, health and social life;

6 (sustainable water management and sanitation), because sanitation will result from water pollution;

7 (affordable and clean energy), because the use of photovoltaics panels and solar heating water;

8 (decent work and economic growth), because green infrastructure will create jobs and innovation in commerce and industry;

11 (resilient and sustainable human settlements), because the environment will be healthier;

13 (climate action) because the green infrastructure improves the micro climate;

15 (protecting terrestrial ecosystems) because good soil, water and flora conditions will encourage the return of fauna to the area.
Tampa, Florida is ranked in the top five in the most vulnerable U.S. cities to flooding due to hurricanes. This research uses the LTM to predict potential future urban growth according to three different scenarios: 1) business as usual – predicted urban growth based on current growth patterns; 2) planned growth – predicted urban growth based on the current land use plan; and 3) resilient growth – predicted urban growth based on all future development occurring outside of the 100 year flood plain.
Requirements:
- Population will continue to grow
- Population will be concentrated in urban area
- The global economy will double, fastest in emerging markets
- Global temperature will rise, climate variability will increase
- Sea level will rise
- Freshwater scarcity will become more prevalent
- Pollution concern intensify

Innovations:

**Water (WAT)**
- Water retention
- Stormwater trading
- Bioretention
- Double dune system

**Agriculture (AGR)**
- Organic agriculture
- Clean energy farming
- Urban farming/AGR
- Rooftop gardening

**Green Infrastructure (GRN)**
- Resilient infrastructure
- Vegetated stormwater GRN
- Linear vegetated corridors

**Mixed Housing/Com. (MIX)**
- Mixed use development
- Population distribution
- Managing high density
- Compact neighborhoods
- Smart connected mobility
- Sustainable infrastructure

**Requirements:**
- Connectivity ecosystem service
- Connected GRN
- Green urban street
- Green roofs
- Riparian restoration
- Climate change adaptation
- Coastal urban resilience

**Innovations:**

**Water (WAT)**
- Water retention
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- Bioretention
- Double dune system

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- Organic agriculture
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TEXAS A&M UNIVERSITY- UNITED STATES

Land Transformation Model

STEP 1 DATA PROCESSING
STEP 2 SPATIAL TRANSITION
STEP 3 NEURAL NETWORK PROCESSING
STEP 4 FUTURE PREDICTION

Analytical Framework

SCENARIO MAKING
-- 3 Urban Growth Scenarios

SCENARIO 1: Business as Usual
Exclude existing urban, river & sensitive zones

SCENARIO 2: Growth as Plan
Exclude S1 and environmental sensitive zones

SCENARIO 3 : Resilient Growth
Exclude S2 and 2040 sea level rise high & floodplain

CLIMATE CHANGE
-- Floodplain Scenarios

Current Floodplain
SLR 2040 High (+0.54m) +Floodplain
SLR 2040 Extreme (+0.62m) +Floodplain

Floodplain Prediction

8.40% BUILDING IN CURRENT FLOODPLAIN
ABOUT 1025323 SQ.FT

10.65% BUILDING IN HIGH FLOODPLAIN
ABOUT 1300086 SQ.FT

32.14% BUILDING IN EXTREME FLOODPLAIN
ABOUT 3922410 SQ.FT

2291 (8.02%) PEOPLE AT RISK
$144.94 MILLION FLOOD RISK DEVIATION

2660 (9.31%) PEOPLE AT RISK
$175.93 MILLION FLOOD RISK DEVIATION

6114 (21.41%) PEOPLE AT RISK
$476.38 MILLION FLOOD RISK DEVIATION

Legends
- Current Floodplain
- High Floodplain
- Extreme Floodplain
- Hillsborough River

IMPACT ANALYSIS
Urban Analytics
Flood Risk
Avg. Annual Runoff Volume
Avg. Annual Runoff Depth
Pollutant Loads
Others...
**Design Strategies**

**Ecological Remediation:**
- Clean air while reducing the urban heat islands, and increase ecological services.
  - Urban forest
  - Urban tree canopy
  - Environmental corridors
  - Green belts
  - Conservancy park
  - Natural park
  - Wetland
  - Natural riparian forest
  - Waterfront recreation
  - Riverside jogging trail
  - Habitat conservation

**Active and Healthy Living:**
- Redevelop communities to reduce risk and improve ecological/human health.
  - Neighborhood playground
  - Neighborhood park
  - Community park
  - Community garden
  - Mini-park / Pocket park
  - Linear Park / Linkages
  - Sports fields
  - Amphitheater
  - Community facilities
  - Plaza and gathering space
  - Shared courtyard

**Hydrological Infrastructure:**
- Insert structural and non-structural mechanisms to control, block, and slow floodwaters.
  - Green roof
  - Rain garden
  - Bioswale
  - Green parking
  - Carbon forest
  - Permeable Pavement
  - Rainwater harvesting
  - Small retention pond
  - Sustainable urban drainage

**Sustainable Transportation:**
- Conserve energy by offering walkable, transit-oriented options.
  - Rapid transit buses
  - Bike sharing scheme
  - Green cycle lanes
  - Good street connectivity
  - Well-maintained footpaths
  - Pedestrian crossings
  - Charging facilities
  - Signage
  - Public transportation
  - Water transportation

**Local Economic Incubators:**
- Create temporary and permanent functions for unused properties.
  - Entrepreneur spaces
  - Community-supported agriculture
  - Small businesses
  - Lofts + retail
  - Public art
  - Affordable housing
  - Neighborhood-serving retail space
  - Cultural event's festivals

**Adaptive Architecture:**
- Design and construct (or renovate) buildings to handle severe storms and flooding.
  - Construction on high elevations
  - Floodable surfaces
  - Earthen barriers and levees
  - Flood proofing infrastructure
  - Resilient edges
  - Flood damage-resistant materials
  - Proper placement of new development

**Data Sources**
7. https://tidesandcurrents.noaa.gov/sltrends/

**Team Credits**
- Haoting Li
- Yanzi Zhao
- Galen D. Newman
- Dongying Li
L-THIA Model Outputs

RUNOFF RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Annual Runoff Volume (acre-ft)</td>
<td>292.51</td>
<td>354.99</td>
<td>293.94</td>
<td>214.83</td>
</tr>
<tr>
<td>Avg. Annual Runoff Depth (in)</td>
<td>5.21</td>
<td>6.32</td>
<td>5.24</td>
<td>3.82</td>
</tr>
</tbody>
</table>

NONPOINT SOURCE POLLUTANT RESULTS

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (lbs)</td>
<td>1218</td>
<td>1466</td>
<td>1222</td>
<td>886</td>
</tr>
<tr>
<td>Phosphorous (lbs)</td>
<td>334</td>
<td>398</td>
<td>334</td>
<td>240</td>
</tr>
<tr>
<td>Suspended Solids (lbs)</td>
<td>39296</td>
<td>48185</td>
<td>39053</td>
<td>26463</td>
</tr>
<tr>
<td>Lead (lbs)</td>
<td>8.586</td>
<td>9.022</td>
<td>7.057</td>
<td>5.17</td>
</tr>
<tr>
<td>Copper (lbs)</td>
<td>8.613</td>
<td>10.045</td>
<td>8.115</td>
<td>6.367</td>
</tr>
<tr>
<td>Zinc (lbs)</td>
<td>109.032</td>
<td>136.027</td>
<td>107.069</td>
<td>70.235</td>
</tr>
<tr>
<td>Cadmium (lbs)</td>
<td>0.739</td>
<td>0.85</td>
<td>0.698</td>
<td>0.506</td>
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<tr>
<td>Chromium (lbs)</td>
<td>5.059</td>
<td>6.793</td>
<td>4.775</td>
<td>2.855</td>
</tr>
<tr>
<td>Nickel (lbs)</td>
<td>7.356</td>
<td>10</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>BOD (lbs)</td>
<td>18640</td>
<td>23046</td>
<td>18980</td>
<td>13245</td>
</tr>
<tr>
<td>COD (lbs)</td>
<td>66336</td>
<td>87606</td>
<td>69713</td>
<td>45547</td>
</tr>
<tr>
<td>Oil &amp; Grease (lbs)</td>
<td>4404</td>
<td>6021</td>
<td>4704</td>
<td>2960</td>
</tr>
<tr>
<td>Fecal Coliform (millions of coliform)</td>
<td>45378</td>
<td>51739</td>
<td>44328</td>
<td>33089</td>
</tr>
<tr>
<td>Fecal Strep (millions of coliform)</td>
<td>120272</td>
<td>141257</td>
<td>121329</td>
<td>90883</td>
</tr>
<tr>
<td>Total Pollutant</td>
<td>296017.39</td>
<td>359890.74</td>
<td>299758.71</td>
<td>213403.13</td>
</tr>
</tbody>
</table>

* L-THIA estimates changes in recharge, runoff, and nonpoint source pollution resulting from past or proposed development. In this basic model of L-THIA, users only need to input: their location (state and county); the type of soil in the area; and the type and size of land use change that will occur.
A University-led Community Conversation
Strategy to Build Public Trust

Lisa DuRussel, RLA, LEED AP
Assistant Teaching Professor
Practitioner in Residence
The Pennsylvania State University

Dan Meehan
Geodesign Program Manager
The Pennsylvania State University
President’s Vision

“... help protect the local water supply, plant and animal species, and to make it a place where people can enjoy nature, learn about the environment and be inspired.”

PSU President - Dr. Eric Barron

MG2V Site

“Together we can create a lasting community resource.”

- Dr. Barron
MG2V Phase I – Fall 2018

- Deep Dive
- Context and Land use
- Geology, Hydrology, Soils, Flora & Fauna
- Source Water Protection
- Zoning
- Historical Records

Musser Gap to Valleylands Project

MG2V Phase II – Spring 2019

- Data Organization
- Stakeholder Interviews
- Conducted Survey
- Community Conversations
- Geodesignhub Workshop
- Presentation of Ideas
PENN STATE UNIVERSITY

Musser Gap to Valleylands Project

Phase III – Summer & Fall 2019

- 2nd Iteration Through GDH
- Leadership Teams

- Agreement & Values
- Priorities & Decision

AGREEMENT

VALUES

AGREEMENT

VALUES

Priorities & Decision

Leadership Teams

Agreement & Values

Finance & Business

Local Government & Community Relations

Facilities & Planning

President

Finance & Business

Local Government & Community Relations

Facilities & Planning

President
Project location

PSU owns a parcel of land known as MG2V. Most of the land is used for conventional ag but it also includes forested land and a healthy stream. The land provides a connection between suburbs and forested area and is upslope of aquifers that provide drinking water to the community. The goal of this project is to provide an assessment of general design approaches for future management of the property, and prospective land use scenarios for the adjacent properties.
Requirements:

- (1) Population Will Continue to Grow
- (7) The Built Environment Will Be More Networked and Smarter
- (10) Freshwater Scarcity Will Become More Prevalent
- (11) Food Production Pressures will Increase.

Innovations:

- Water (WAT) - (3) Agricultural Water Conservation Best Practices
- Agriculture (AGR) - (1) Organic Agriculture, (3) Rewilding, (5) Agritourism
- Green Infrastructure (GRN) - (2) Resilient Rural Community Landscape Infrastructure, (5) Integration of Vegetation into Building Design, (8) Ecosystem Services of Green Infrastructure, and (13) Restoring the Riparian Ecosystem
- Energy Infrastructure (ENE) - (1) Renewable Energy Sources
- Low Density Residential (RES) - (1) Building Integrated Solar PV Home, (3) Direct Current (Dc) Microgrid
- Mixed Housing and Commercial (MIX) - (1) Mixed Use Development, (5) Technology for Multi-dimensional Use of Space, and (14) Compact Sustainable Neighborhoods
The site, called “The 78th,” is located at the southern downtown Chicago, neighboring Chinatown (Pin Tom Park), Chicago River, and the industrial zone. After conducting analyses at multiple scales, four major issues were found: 1) flooding risks, 2) environmental fragmentation, 3) social injustice, and 4) inaccessibility. Based on them, students set two main goals: “net-zero” and “diversity.”
Requirements and Assumptions

- Precipitation will increase from 5.1” (2020) to 5.9” (2050)
- Population in Chicago will grow from 2.6 M (2020) to 3.1 M (2050), and high density area will increase by 20%
- Public transportation ridership will increase from 2.3 M to 4M.
- Solar energy-related jobs will increase by 37% and accordingly cost of solar panel installation will decrease by 89$.
- Illinois bill targets 100% renewable electricity by 2050

Innovations

- **AGR:** [11]Urban farming
**Potential 1**: Creating blue corridor

- Flow Direction and Hydrology map calculated in GIS, using DEM, soil, and land cover data. The square is the location of our site. It appears when there is high rain precipitation the water will flow into the site.

**Potential 2**: Developmental gap

- Distribution of Event spaces
- Distribution of Yelp-rated restaurants

**Basic hydrological analysis (based on DEM)**

- Population Density
- Education Attainment (bachelor degree and higher)
Potential 3: New form of urban community

Potential 4: Higher walkability and accessibility

Network Analysis (walk-distance from the existing stations)

10 mins walking area
5 mins walking area

Inaccessible Area by public transit
Design Strategies

- Culture Diversity
- Max Income
- Accessibility
- Net Zero
- Energy
- Water

Design strategy: Region Scale

Design strategy: Neighborhood Scale

Design strategy: region-neighborhood-site
Impact Assessment

Typical Terraced House Plan
- Density
- Views
- Energy Efficiency
- ESV (ESV=0)
- Stormwater management

Max FAR: 13,000,000 + sq ft.

Typical Developer Plan
- Density
- Views
- Energy Efficiency
- ESV (ESV=25,868)
- Stormwater management

Max FAR: 13,000,000 + sq ft.

Our Site Plan
- Density
- Views
- Energy Efficiency
- ESV (ESV=102,372)
- Stormwater management

Our propose FAR: <10,000,000 sq ft. (reduce 25%)

Notes: ESV= Ecosystem Services Value, CN=(average) Curve Number

“Zero & Infinity” in Chicago

Service Diversity

Net Zero Water System

Net Zero Energy System

- Energy Generation and Offset
- Energy required
- Energy produced

- Geothermal energy
- Solar energy

- Intelligent Transportation system
- Share Biking Station
- Intelligent Lighting System
- Urban Agriculture
- Stormwater Recycle System
- Geothermal Energy
- Waste Recycle System
- Smart Parking System

- Geothermal energy
- Solar energy

- Building GHG
- 50% Recycled material
- 30% Recycled content
- 15% reused material
University of Illinois at Urbana-Champaign

“Zero & Infinity” in Chicago

DIVERSITY
- Cultural activities
- Providing 25% affordable housing
- 100% Walkability
- ESV up to 400% of typical development

NET ZERO
- Output: GHG Emission ↓ 62.5%
- Input: Geothermal Energy 48%
- Solar Energy >47%
- Landscape 5%
- Storage 8%
- Runoff Reuse 22.9%
- Infiltration 69.1%
Rates of sea level rise in Long Island Sound, Connecticut are more than 50% higher than the global average, projections estimate that sea level will be 20" higher than the national tidal datum by 2050. The City of New Haven is one of the 15 coastal towns/cities which are facing the increasing risk of flooding and SLR. The focused area is located in the industrial district along the shoreline in which most lands were filled up from the original open water.

From 1934 to 1970, 250.6 acres of open water were transferred into industrial/commercial land which are increasingly vulnerable to coastal flood.

According to FEMA 100-year flood hazard datum, the current flooding area is 774.1 acre which is projected to increase to 1038.8 acre in 2035 and 1213.1 acre in 2050.
Requirements:

- Global warming and sea level rise
- Increased extreme weather events and coastal flooding
- Population growth and urban development
- Zoning change (a transfer from industrial to mixed-use)
- Clean energy and net-zero carbon building/area
- The built environment will be more networked and smarter
- Brownfield remediation and Pollution concerns intensify

Innovations:

- WAT 2 Water Retention
- WAT 8 Bioretention
- GRN 3 Integrated Vegetated Stormwater Infrastructure
- GRN 12 Green Roofs
- GRN 15 Climate Change Adaptation
- GRN 17 Resilient Green Coastal Infrastructure
- ENE 1 Renewable Energy Sources
- TRA 20 Permeable Pavement and Stormwater Management
- IND/COM 1 The Future Office Workspace
- MIX 1 Mixed Use Development
- MIX 16 Sustainable Urban Infrastructure
- INS 12 Diversification in Entertainment Venues
The Framework of coastal flood hazard mitigation and resilience planning process:
The 5 analytic/thematic maps for flood resilience planning:
1 Topography/Elevation
2 Flooding Projections
3 Ecological Systems
4 Structures & Roadways
5 Land Uses & Social Characteristics

1 DEM topology
2 FEMA 100-year flood and CIRCA flood projection
3 Wetland, open space, natural diversity database & environmental sensitivity index
4 Key buildings & facilities, coastal structures
5 Historic zone, opportunity zone, social vulnerability index, coastal management area
Resilience Strategies:

Coastal Strategies:
- Living shoreline
- Vegetated berm system
- Flood wall
- Flood gate
- Elevated building

Inland Strategies:
- Stormwater retention
- Green infrastructure
- Pervious pavement
- Pump station & drainage system
- Green buffer

Regulation Strategies:
- Open space
- Green roof & green building
- Renewable energy

Examples:
- Stratford Point Living Shoreline, CT
- Berm along Mississippi River in Winona, MN
- Perez Art Museum Miami, FL
Planning Interventions:

To mitigate the hazard of coastal storm and flooding, double systems of living shoreline and berm/floodwall play an important role to reduce the energy of the wave and stop the floodwater.

First barrier:
- living shoreline and green buffer
- floodwall along with the industrial facilities on the shoreline

Second barrier:
- berm system along the highway I-95 and residential area
- three flood gates connect the berms and allow people to access the waterfront park

To cope with inland low-lying area flooding, the stormwater retention/drainage systems combined with new green infrastructure and open space are incorporated.

Inland resilient measures:
- new constructed wetlands and retention ponds
- bioswale
- drainage system and pump station
- pervious pavement
- green roof & green buildings
- stilt buildings
The goals of the planning:

- Mitigate coastal flood hazard and promote the resiliency of the harbor area
- Incorporate green infrastructure and open space into the traditional industrial/commercial area
- Promote the use of clean energy and green buildings and facilitate the transformation of mixed land use
- Stimulate social and economic vitality of the harbor area and create a healthier community
Interactive design phase:
Public involvement was key to the development of the design solutions, it sorted out the main concerns of the people and the city, helped to find the potential opportunities and resources, and creative interventions.

Participants included officials, property and business owners, public works and municipal planners, environmental scientists, urban planner and landscape designers, and experts in public engagement and outreach to moderate the discussions and ensure that all voices were heard during the public engagement.