Prioritization of Green Stormwater Infrastructure Research Needs in Miami, Florida, using a Fuzzy Multi-criteria Group Decision Analysis Method

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Introduction

- Miami metropolitan is the seventh most populous in the United States which is susceptible to climate change consequences.
- Miami is moving toward sustainability and resiliency.
- Green stormwater infrastructure (GSI) practices, such as rain gardens (bioretention and bioinfiltration), infiltration trenches, and bioswales, are nature-based (natural-engineered) practices that reduce, treat, or reuse stormwater at its source and improve sustainability and resilience through runoff volume reduction and nutrient removal/sequestration, ecosystem services (e.g., increased greenness, greenhouse gas emission mitigation, and reduced heat island effects), and social functions (e.g., improved livability and aesthetics) as well as adaptation to climate and land-use changes.
- Natural and nature-based features (NNBF) have gained popularity as an integrated approach that can address climate change and biodiversity loss, while supporting sustainable development. Most of the recent coastal resilience studies using NNBF have focused on natural coastlines rather than built coastal areas. However, "multiple lines of defense" in both coastlines and built upland areas (coastal cities) are needed to achieve coastal resilience.

Figure 1. Types of GSI

Objective

- Identify GSI research needs in the Miami area, Florida, and to prioritize them based on the opinions of multiple Decision Makers (DMs).

✓ Why do we need prioritization?

- Southeast Florida suffers from a lack of studies regarding stormwater control practices.
- Limited budget and resources for GSI research at the municipal level.
- Prioritization of GSI research needs will support funding organizations in an efficient allocation and use of research funds and researchers in directing their efforts to address the most important problems.
- The prioritized list of research needs can also serve as a roadmap for future directions of GSI research.

METHODOLOGY

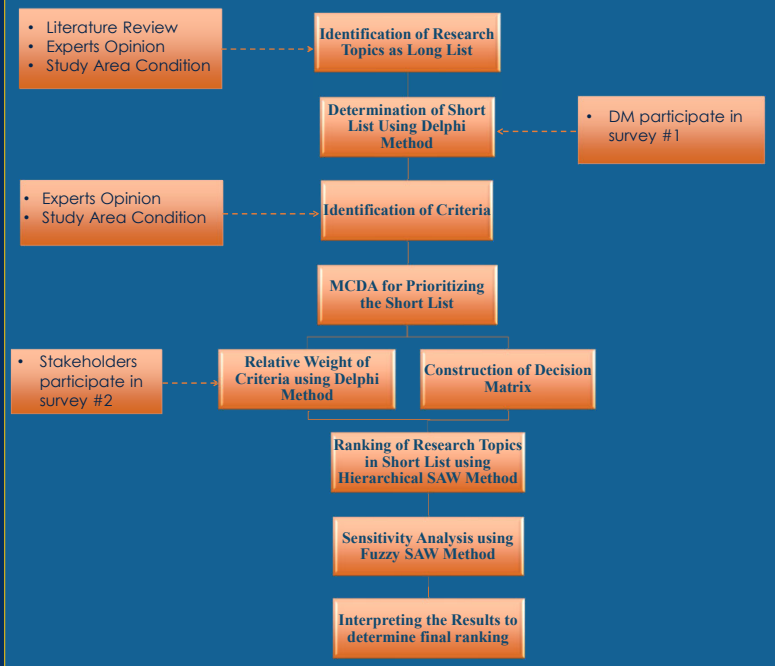

Figure 2. MCDA methodology flowchart

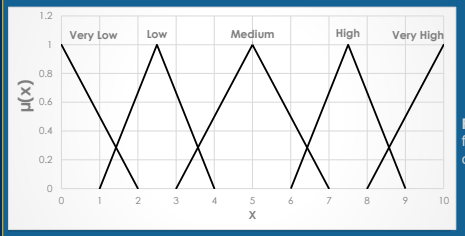

Figure 3. Triangular and half trapezoidal fuzzy numbers to represent the weights of criteria and alternatives evaluations

Participant Stakeholders

- Local government Organization
  - Miami-Dade County
  - The City of Miami
  - The City of Aventura
- Non-governmental Organization
  - The Biscayne Bay Marin Health Coalition (BBMHC)
  - Volunteer Clean up
  - Friend of the Everglades
- Consultants
  - The City of Miami's Comprehensive Stormwater Master Plan
  - GSI Pollution Reduction Guidance for Water Quality in Southeast Florida

Discussion

- 77 topics were developed as a long list under the themes of "Planning", "Technical", "Environmental and Ecological", "Social", and "Monitoring and O&M" .
- 10 topics were chosen as the short list by surveying panel
- 44 criteria were identified under an array of technical, economic, social, and environmental criteria (Fig. 4)
- Criteria evaluation and decision matrix construction were done based on a scale of 1 to 5 1=Very Low 2=Low 3=Medium 4=High 5=Very High.

Figure 4. Hierarchy of the criteria utilized in the MCDA process

RESULTS

Table 1. Short list research topics and ranking results

No.	Topic	SAW Ranking	FSAW Ranking
1	Understanding different functions and limitations for implementing each GSI type	10	10
2	Optimal combination of green and gray infrastructure in urban master plans and coastal resilience plans	7	6
3	Assessing long term performance of GSI	3	3
4	Monitoring water quantity/quality performance of existing GSI sites	2	2
5	Monitoring environmental/ecological performance of existing GSI sites	6	9
6	Ecosystem benefits of vegetation/plants/trees in GSI	5	5
7	Public (community) and Managers/policymakers awareness about the role and functions of GSI	9	8
8	Demonstration GSI sites for public and professional education	1	1
9	Real-time monitoring/control of GSI	4	4
10	Smart and data-driven approaches for GSI operation and maintenance	8	7

CONCLUSIONS

- The results indicated that "Demonstration GSI sites (including water quantity/quality and environmental/ecological monitoring) for public and professional education" and "Monitoring water quantity/quality performance of existing GSI sites" are the most required research needs in the Miami area and most likely for other similar urban coastal areas in the country.
- The presented tool is applicable after revising the decision criteria.
- The study paves the way for future GSI research in urban to other coastal cities coastal areas and the adoption of sustainable GSI systems in coastal resilience plans.

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