Investigating the State of Practice of Resilience Among Water Infrastructure Agencies in the United States

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Abstract

This research focused on benchmarking the characteristics of resilience that are most commonly practiced among water infrastructure agencies. A survey generated using previously identified achievement indicators was distributed. The current status of 13 water agencies were assessed and results were used to find gaps in the adoption of practices. The inclusion of various agency locations was important as hazards differ, requiring slightly adapted resilience programs.

Introduction

Background: Infrastructure systems have been designed using analysis of past events, putting vital infrastructure at risk of failure as future conditions change(Figs 1 and 2).

Fig (1): Houston, Texas: Flooded water treatment plant

Fig (2): Miami, Florida: Sunny day flooding

Challenge: Utilizing resilient infrastructure to maintain functioning communities.

Needs: The ability of infrastructure to prepare for, withstand, and rapidly recover from disruptions as well as adapt to changing conditions.

Solution: Implementing characteristics of resilient lifeline systems.

Objective: Use developed resilient characteristics and achievement indicators to identify gaps (Fig 3) in practice among water infrastructure agencies in the United States.

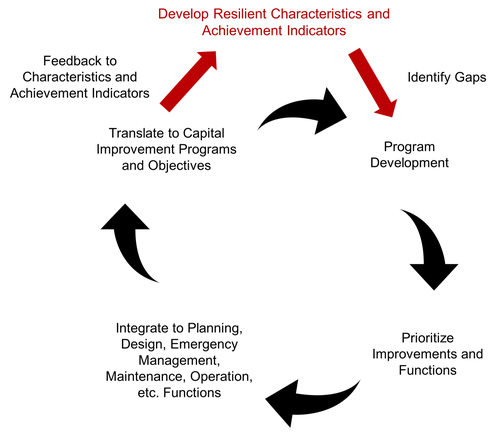


Fig (3): Resilience operationalizing process and checkpoints for evaluation of resilience characteristics and achievement indicators.

Research Questions:

- What characteristics of resilience are currently being operationalized in water systems across the United States?
- What gaps are present between the current state of practice and target resilience?

Methods

- Steps were created to identify resilient practices (Fig 4).

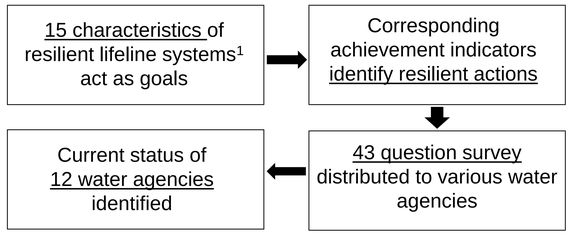


Fig (4): Procedure for identifying existing resilience

- Actions were scored based on implementation level (Table 1) and categorized into domains (Fig 5).

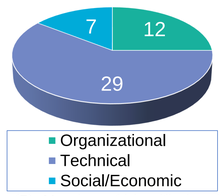


Fig (5): Number of identified actions in each domain.

Table (1): Corresponding response scores

Possible Response	Corresponding Score
Definitely Yes	3
To Some Extent	2
Never	1

- Resilience gaps were examined (Fig 6).

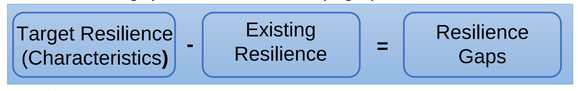


Fig (6): Relationship between target resilience, existing resilience, and resilience gaps

- *Five* follow up interviews allowed for elaboration and investigation into specific practices and actions with unknown implementation.
- Agency location varied to include geographic hazards/stressors (Fig 7).

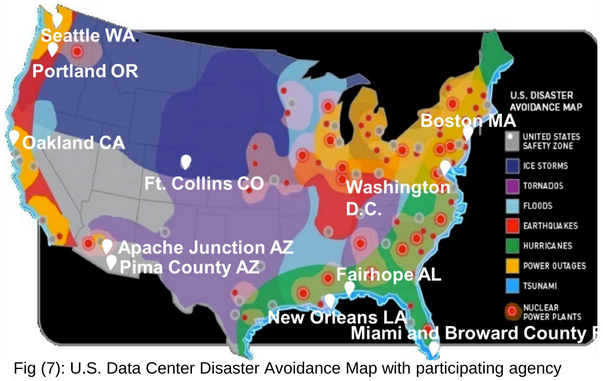


Fig (7): U.S. Data Center Disaster Avoidance Map with participating agency location

Results

1. Overall Resilience

- Resilience achievement scores were calculated by domain for each location (Fig 8).

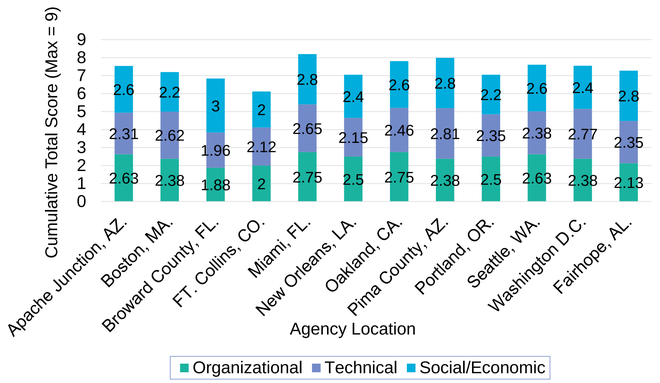


Fig (8): Locational resilience by domain

2. Characteristics

- Two agencies are working towards or meeting all goals set by the established resilient characteristics (Fig 9).

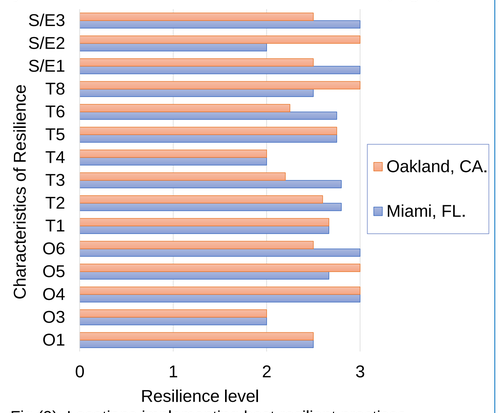
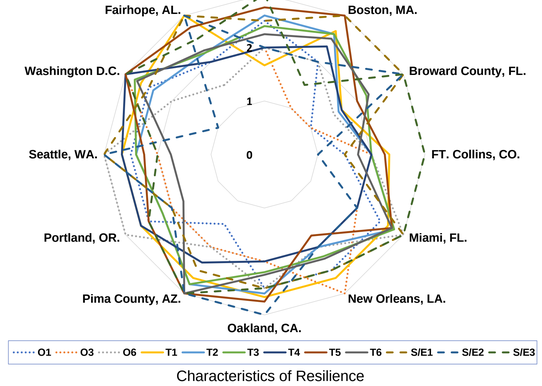


Fig (9): Locations implementing best resilient practices

3. Resilience Gaps

- Relationships between the adoption of certain resilient characteristics and locations were specified (Fig 10).



Characteristics of Resilience

Fig (10): Identified resilience gaps

- Gaps in the full implementation of three characteristics of resilience were recognized (Fig 11).
  - O1: Clearly defined resilience plan.
  - T2: Established procedures for potential hazards impacting the system.
  - T3: Identifies and minimizes vulnerabilities with established performance objectives.

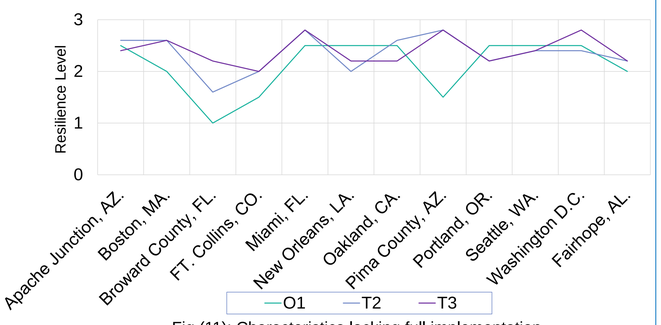


Fig (11): Characteristics lacking full implementation.

Conclusion

In order to improve the state of resilience it is important to first understand the current behaviors and actions common among water infrastructure agencies but contemporary research on resilient lifeline systems does not incorporate practices currently operationalized. The influencing factors of resilient behavior can be used in further research and as an aid in the implementation of resilience plans. Gaps in the adoption of resilient practices were found to be influenced by geographic stressors and correlations between the implementation of certain achievement indicators.

- This research belongs to Thrust B, Project B1-1: Urban Water Infrastructure Resilience focused on agency operations.

References

[1]Davis, C. A., A. Mostafavi, and H. Wang. 2018. Establishing Characteristics to Operationalize Resilience for Lifeline Systems. Natural Hazards Review 19:04018014.

Acknowledgements

- Thank you to the Texas A&M I-SoS Research Group, specifically Dr. Ali Mostafavi, Kambiz Rasoulkhani, and Dr. Chen Zhang
- The funding for this work was made possible by the NSF Sustainability Research Network (SRN) Cooperative Agreement #1444758 with the Urban Water Innovation Network.

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