GREEN INFRASTRUCTURE

A Strategy for Flood Risk Mitigation in Coastal Communities

TEXAS A&M AGRILIFE EXTENSION

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What is Green Infrastructure?

Green infrastructure (GI) is a nature-based approach to water management that uses engineered natural solutions in conjunction with gray infrastructure, such as culverts, pipes, and detention basins. Practices such as rain gardens, stormwater wetlands, and bioswales hold rainwater for a set period of time, allowing for infiltration and pollutant removal. This holding period also decreases the volume of water moving downstream during the storm. Water then slowly drains over time, so the system is emptied before the next rainfall.

Green infrastructure practices offer the same benefits as gray infrastructure, plus more. These include:

- Flood reduction
- Water quality improvement
- Improved aesthetics
- Improved air quality
- Public safety
- Habitat for wildlife
- Property loss prevention
- Recreational opportunities
- Carbon sequestration

How is GI Flood Hazard Mitigation?

Flood hazard mitigation aims to reduce or eliminate the long-term risk associated with flooding. Green infrastructure projects are localized, pre-disaster management practices that hold floodwater, lessening the severity of flooding for the contributing watershed.[1]

GI practices, like any infrastructure, are designed to hold a specific amount of rainfall. Each community determines what design storm they plan for and build their infrastructure to mitigate flooding. Once the design storm for infrastructure—gray or green—is surpassed, then flooding is likely.

Types of Green Infrastructure

Site-scale — rain gardens, bioswales, rainwater harvesting, pervious pavement, tree filter boxes, green roofs

Community-scale — constructed stormwater wetlands, conservation neighborhoods, green streets

Landscape-scale — open space preservation, habitat restoration, conservation easements

Why include GI in a Hazard Mitigation Plan?

Green infrastructure is a proven solution with multiple benefits. GI is based on natural practices; however, over the last century, advances in technology have moved communities to embrace gray infrastructure. But gray infrastructure is not working. Especially in rapidly developing areas, we see more and more localized flooding due to the increase in impervious surface cover.[2] Integrating GI practices like stormwater wetlands with existing gray infrastructure is an economically viable solution.

Exploration Green constructed stormwater wetland (Clear Lake, TX) on a typical day (left) and during Hurricane Harvey flooding in 2017 (right).

When assessing the cost-benefit ratio of a project, GI offers many more benefits than gray infrastructure, despite a similar cost of installation. The long-term benefits of GI exceed those of gray infrastructure projects. Hazard mitigation grants are available both pre- and post-disaster, which can fund actions identified through the planning process, including GI.

Additional local funds can be dedicated if GI is part of a community's Capital Improvement Plan. Also, if required for new development, then the cost of installing for on-the-ground practices falls on the developer, not the taxpayer.

How can GI fit into a Hazard Mitigation Action Plan?

The Hazard Mitigation Action Planning (HMAP) process is directed by guidance from the Federal Emergency Management Agency (FEMA) and the Texas Division of Emergency Management (TDEM). The planning process is intended to be stakeholder inclusive and to integrate recommendations from existing local and regional plans such as Comprehensive Plans, Capital Improvement Plans, Drainage Plans, and Economic Development Plans into the HMAP.

Potential hazards must be locally identified and ranked, then appropriate mitigation strategies determined. Upon approval, the HMAP competitive grants are available through FEMA's Hazard Mitigation Grant Program (HMGP). FEMA has identified four types of mitigation strategies:

1. Local plans and regulations
2. Structure and infrastructure projects
3. Natural systems protection
4. Education and awareness programs

An identified problem statement could lead to implementing the mitigation actions outlined in the table below. An example of a problem statement would be: *"Localized roadway flooding impacts multiple neighborhoods in the community, stopping traffic and preventing access by emergency vehicles several times a year. The flooding continues to worsen with increasing development pressure."*

Mitigation type[3]	Description[3]	GI example	Potential Actions
Local plans and regulations	Actions include government authority, policies, or codes	• Green Infrastructure Plan • Stormwater Management Plan • Make GI practices part of the development code	Adopt a stormwater ordinance that requires or encourages green infrastructures to manage stormwater volumes to reduce flooding and to mitigate risk to life and property.
Structure and infrastructure projects	Projects to construct manmade structures to reduce the impact of hazards	• Constructed stormwater wetlands • Bioswales • Rain gardens • Tree filter boxes	Reconstruct neighborhood storm drain systems and upgrade to include GI practices (rain gardens, constructed wetland, etc.) where feasible.
Natural systems protection	Actions that minimize damage and losses and also preserve or restore the function of natural systems	• Conservation easements • Wetland restoration • Forest management	Identify large tracts of land in and upstream from the hazard areas for acquisition and protection to preserve ecosystem services, including floodwater holding capability.
Education and awareness programs	Actions that inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them	• Websites with maps and information • Presentations to school groups and neighborhood organizations • Mailings to residents in hazard-prone areas	Develop materials and implement a program to educate property owners about green infrastructure options and allowable uses in the community based on existing or proposed codes and ordinances.

[1] EPA Storm Smart Cities: Integrating Green Infrastructure into Local Hazard Mitigation Plans
[2] Tyler, J. 2016. Sustainable Hazard Mitigation: Exploring the Importance of Green Infrastructure in Building Disaster Resilient Communities. The Journal of Sustainable Development Vol 15, Iss. 1, pp.134-145
[3] FEMA Local Mitigation Planning Handbook

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