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Learning from the 2020 floods in Tabasco
Moving beyond grey infrastructure

Retaining walls in the Oxolotán community, Tabasco. © Paulo Cerino, Community Technician in Tabasco, Mexican Red Cross.

This report is based on the Zurich Flood Resilience Alliance's Post-Event Review Capability (PERC) methodology, which analyzes flooding in Tabasco, Mexico, in 2020. This brief, based on key informant interviews and desk research, presents lessons learned surrounding flood resilience. More information on PERC can be found at: www.floodresilience.net/perc; more information on flood resilience can be found at: www.floodresilience.net

In the fall of 2020, Tabasco, Mexico experienced a series of cold fronts and cyclones that caused heavy rains and widespread flooding throughout the region. Because the state is located on a wide coastal plain and exposed to the impacts of climate change, it is likely to experience similar or more severe flooding in the future. In response to past floods, the federal and state governments have developed protective infrastructure, such as dams, levees, and retaining walls, which have helped mitigate damage. However, as the floods demonstrated, this infrastructure is not infallible: it requires constant and thorough maintenance, can create a false sense of security in communities living near protective infrastructure, and has design thresholds that, when exceeded, can have devastating consequences.

Adaptation to future flooding requires a change in thinking and approach to protective infrastructure; the use of nature-based solutions as a complement to grey infrastructure presents itself as a comprehensive approach to the problem.

Nature-based solutions are actions to protect, sustainably manage, and restore natural or modified ecosystems that effectively and adaptively address societal challenges while providing benefits to human well-being and biodiversity; they encompass natural, green, and integrated infrastructure, which combine elements of all three types (Watkins et al. 2019).

Green infrastructure is a type of nature-based solution that "encompasses a variety of water management practices, such as vegetated rooftops, roadside plantings, absorbent gardens, and other measures that capture, filter, and reduce stormwater" (Denchak, 2019).

Grey infrastructure refers to "structures such as dams, seawalls, roads, pipes, or water treatment plants" often constructed of concrete and thus literally grey (Green-Gray Community of Practice, 2020).

Training on "Maintenance of retaining walls" provided by the National Water Commission for community brigadistas in the municipality of Teapa, Tabasco. © Guadalupe Pérez, Community Technician in Tabasco, Mexican Red Cross

The integration of grey and green infrastructure

In the last twenty years, the federal and state governments in Mexico have made an immense effort to install grey infrastructure to mitigate flood risk in Tabasco such as the upper Grijalva dam system, the El Macayo control structure, the Tintillo cut-offs on the Grijalva River and the Censo (a diversion channel) on the Sierra River, and retaining walls on the Samaria River, among others. While such infrastructure played a role in reducing the impact of flooding in 2020, PERC research highlighted its limitations, such as the lack of maintenance plans, hard limits beyond which structures do not provide protection and often result in catastrophic impacts, and difficulty in adapting to changing conditions.

Integrating green infrastructure, such as bioswales, into flood risk management can minimize some of the challenges of grey infrastructure and help broaden the approach to flood risk mitigation in Tabasco (see Table 1). Also, green infrastructure projects have the potential to have a high return on investment, providing potential co-benefits for the social and economic well-being of the local community (Kopsieker et al. 2021). Implementing nature-based solutions can also create an opportunity to collaborate with communities in their flood protection, building their capacity and giving them control over interventions in their community.

Table 1
Benefits of integrating green infrastructure with Tabasco's existing grey infrastructure

Type of flood	Existing grey solution	Benefit		Green solution to be integrated	Benefit
Urban	Storm water drainage systems	Flood risk management	+	Green roofs Green spaces Restoration of riparian vegetation	Green roofs and green spaces help capture and infiltrate or temporarily retain and slow stormwater runoff, thereby reducing or delaying flows into drainage systems.
Riverine	Retaining walls	Flood risk management	+	Bank restoration Reforestation Riparian vegetation	Vegetation management and restoration can allow tree roots and other vegetation to stabilize and regenerate soils, reducing landslides, erosion, including streambank erosion, and flood risk.
Riverine	Dams and dikes: Limiting river flows within the river bed.	Flood risk management	+	Leaving space for water	Aligning rivers with parks, playing fields and/or agricultural fields provides space for water to safely overflow from riverbanks, temporarily flood bordering land, and then recede back into the river.
Coastal	Breakwaters	Storm protection	+	Protective mangroves Protective reefs	Restoring and conserving mangrove belts and reefs provides a natural break in the sea that reduces wave energy, thereby reducing the energy with which waves hit the coast. This reduces storm damage and erosion.
Coastal	Breakwaters	Storm protection	+	Wetlands and coastal marshes Natural dunes	Wetlands, coastal marshes and natural dunes provide land space to absorb wave and water energy; this is the oceanic equivalent of making room for water.

Source: Elaboration with information from Watkins et. al., 2019; Green-Gray Community of Practice, 2020.

BOX 1. BENEFITS OF GREEN INFRASTRUCTURE - AN EXAMPLE FROM NEPAL

Bangalipur in Nepal and Tabasco in Mexico are very different in their physical and socio-economic contexts, however, what they do share is that some of their communities located near rivers are at risk of flooding.

To mitigate the risk, the communities near the Aurahi River in Nepal built a 150-meter-long bio-dike. Some of the benefits of the bio-dike include:

- Erosion prevention
- Protection of land and houses during the 2017 floods
- The adoption of different agricultural practices

BOX 2. EXAMPLE OF NATURE-BASED SOLUTIONS IN TABASCO

In Tabasco, an example of a nature-based solution can be found in the Pantanos de Centla Biosphere Reserve. Wetland restoration in the Reserve helps to mitigate the impacts of floods by storing excess water.

Another example is mangrove rehabilitation. Together with a community in the area, key stakeholders rehabilitated 55 hectares of mangroves. This rehabilitation improved water quality and reduced the impact of storm surges. One of the benefits of mangrove rehabilitation has been community collaboration, capacity building and empowerment, which has contributed to a greater sense of ownership.

Where there is no infrastructure

In communities that lack or are in need of infrastructure to mitigate flood risk, an opportunity exists to implement bio-dikes. Bio-dikes are sustainable engineering solutions that are designed to divert water by using edges of flood walls or flood gates, as well as to reduce bank erosion. A typical bio-dike is constructed with sandbags and bamboo poles. The sandbags are covered with fertile soil to fill the voids between them, increase the strength and stability of the dike, as well as to provide a base for subsequent planting of vegetation. Trees and vegetation are planted in the gaps along the levee. It is recommended to use local materials and vegetation for greater effectiveness (Rözer et al, 2021; Practical Action, 2018).

For communities settled along rivers and which lack protection infrastructure, the implementation of bio-dikes—with the dual objective of reducing the impact of flooding and strengthening riverbanks with vegetation – is recommended.

Unlike grey infrastructure, bio-dikes need time to provide protection benefits, since they require the growth of vegetation to provide the strength and stability of the infrastructure.

Direct observation during the community diagnosis based on the Vulnerability and Capacity Assessment in Oxolotán, Tabasco. © Daniela Aguilar, Field Manager in Tabasco, Mexican Red Cross

Limitations of nature-based solutions

The very idea that nature-based solutions should mimic the local environment makes them difficult to implement. Solutions often have site-specific characteristics; what may work in one place may not work in another. There are therefore few examples that communities and stakeholders can draw from for direct replication. However, as in the case of the nature-based solution in Tabasco, stakeholders can evaluate existing examples, examine their local natural environment, analyze the possibility of applying them, and then experiment, learning from both successes and failures.

On the other hand, as with all types of infrastructure, communities need to be aware that nature-based solutions can also fail or be overwhelmed. Both grey and green flood protection must be accompanied by capacity building and awareness-raising so that communities know their risk, know when and how to act to minimize losses and damage, and have the necessary resources to act quickly in case of an emergency.

Conclusion

As recent floods in Tabasco and elsewhere in the world have shown, grey infrastructure can only mitigate flood risk within the limits of the design's capacity (when properly maintained). As climate change generates more intense rainfall, we can expect more and more intense floods that exceed the design thresholds of protective infrastructure. These constraints call for a change in the way we approach flood risk management and provide an opportunity to change practices. Nature-based solutions, both on their own and integrated with grey infrastructure, can help address the changing and increasing flood risk.

In addition, the critical role of local communities in the proposal and development of green infrastructure should be emphasized. By taking responsibility for nature-based community solutions in conjunction with local risk mitigation and management, they can reduce their risk to flooding and contribute to community development opportunities.

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