



BISCAYNE BAY:  
TURN THE TIDE



AN INTEGRATED LANDSCAPE APPROACH FOR COASTAL  
RESTORATION IN BISCAYNE BAY THROUGH SPATIAL AND  
ECOLOGICAL INTERVENTIONS



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## ABSTRACT

The coastline of South Florida has undergone a drastic change in the last century and that has had a major impact on flood safety and natural resources of its inhabitants. Natural coastlines supporting mangrove and wetland transformed into seawalls with buildings. It is estimated that in the last 100 years, 40 percent of the mangrove coast has disappeared, but also significant parts of wetland, pine forest and sea grass. ("Florida's Mangroves | Florida Department of Environmental Protection", 2019).

Mangroves forest stand out to be a future-oriented way of natural coastal defence for South Florida. Although they mainly appear in calm tropical waters, they are resilient to withstand and recover from tropical storms. Their unique growth with a characteristic root system and branching forms a robust forest, that functions as a natural coastal defence. Also, marine life is depended on the nursery grounds provided in the root system of the trees and maintain a healthy fish stock (Sheppard, 2018).

We can learn from the past that this forest provides the land with a natural levee and protect against flooding. Besides, this natural system has potential to adapt to the consequences of climate change

that highly urbanized areas like Miami are already facing and will increase rapidly in the future.

This research identifies and explores design strategies and principles for the mangrove landscape of Biscayne Bay in order to reduce the flood risk of Miami Metropolitan Area, as well as provides aesthetic, ecological and functional qualities that contributes to the identity and resilience of this coastal region. This is done through design-related-research, that divides the research in two domains. Design research, which consist of a system analysis and examination of best practices and research by design, which involves design experiments.

The result is a layered landscape strategy, that contributes to the harmony of the natural coastal landscape of Biscayne Bay and thereby restore its functions. The systematic strategy is converted into a spatial design, applying principles gathered from best practices. This landscape architectural design adds an extra dimension to the mangrove landscape that will invite the residents of the Miami Metropolitan Area to experience through exposure to changes and value its aesthetic and ecological qualities and protective functions.

KEYWORDS: mangrove landscape, South Florida, Biscayne Bay, landscape architecture, spatial design, flood protection, ecological restoration, social reconnection, research by design, design with natural processes, user experience,

# DISCUSSION AND CONCLUSION

## RESEARCH FINDINGS

The disappearance of the mangrove landscape makes the Miami Metropolitan Area vulnerable to tropical storms and the consequences of climate change. The remaining fragments of the landscape are being caught between a rising sea and a densely built city, which cannot offer retreat zones. This research has searched for an landscape architectural approach to this complex challenge. The predetermined goal was identify and explore design strategies and principles for the mangrove landscape of Biscayne Bay in order to reduce the flood risk of Miami Metropolitan Area, as well as provides aesthetic, ecological and functional qualities that contributes to the identity and resilience of this coastal region. Several research questions have been answered to investigate how this goal can be achieved and these are answered below.

### UNDERSTANDING

The mangrove landscape of South Florida originally existed out of three layers: wetland, intertidal forest and submerged meadow. These layers depend on each other and interrelated by their processes and actors. It functions most optimally when all layers are vital and present. The lack of layers obstruct processes and therefore the function of the landscape. In Biscayne Bay, the mangrove landscape changed drastically by obstructing factors like, an altered water system that increased water related problems as flooding, salinization and erosion. The reversion of the water system however, has increased the mangrove distribution zone and allows new growth opportunities.

### TOOLS

From the best practices we learned that restoration through rehabilitation is the only way to restore the landscape in a way that it can grow independently like natural succession. To create the right conditions for rehabilitation, the three layers of the mangrove landscape are needed, without any obstruction of the processes and natural actors. When there is not enough space for the restoration of one or more of the layers, typologies can shift. The same applies to barriers in the landscape that cause blockages. Levees that block natural water flows and thereby the sedimentation process can be moved to a place outside the mangrove landscape. This makes the flood reducing and protective function of the landscape stronger and could actually

replace the levee. In order to reconnect people to the mangrove landscape and raise their awareness for its protective function, they need to experience it by seeing the changes of the landscape, such as the tidal difference, sedimentations processes and mangrove movement because of changing sea levels.

### APPLICATION

The regional plan shows how the Biscayne Bay coast can be restored and the layered mangrove landscape can be applied to it. Following the topography of the landscape, a zone is created for applying the principles. The elaboration of the three focus areas, shows in a landscape architectural how each zone with its own characteristics can function in the big picture. First, Restoring wetland and its connection with the mangrove landscape, through breaking barriers in the southern natural zone. Second, Reintroducing wetland in the middle residential zone, by the means of a bypass between the canal and the mangrove landscape. And third, Introducing the mangrove landscape in the northern urban zone, by creating offshore barrier islands with mangrove and sea grass meadow development.

### REFLECTING

A landscape architectural design can contribute to the restoration of the harmony of the natural coastal landscape of Biscayne Bay and thereby restore its function. The spatial aspect of design tells that in some areas of the bay there is simply not enough space for a complete mangrove landscape, but by studying best practices one learns that there are principles to find a solution for this. The systematic layer approach is then converted into a spatial design, transforming a scheme into a tangible landscape. The landscape architectural design is needed to add an extra dimension to the mangrove landscape that will invite the residents of the Miami Metropolitan Area to experience it. On the one hand, by seeing the special flora and fauna and the spatial quality of the three different landscape types, the user will give the landscape aesthetic value. And on the other hand, exposing the user to change, such as tides, sea level rise and mangrove retreat, will let them assign the ecological value, which will form the basis for awareness of the indispensable function of this landscape in the coastal protection of this area.

## LESSONS LEARNED

### BEYOND THE BAY

The result of this research is a regional plan for Biscayne Bay and three partial elaborations that represent a landscape architectural design for the entire bay. This is a specific result for that area, but this research is also relevant for other places where the risk of flooding has increased due to a lack of mangroves. The used 'landscape as system' method make the research findings also applicable to other regions. This is because the mangrove coasts have many similarities throughout its distribution area. Considering the mangroves as landscape with layers, instead of only a forest, is an generic approach that can be used as a tool for designing vulnerable (sub)tropical coastal regions.

### RESEARCH AND DESIGN

In this research, design is on the one hand a method for conducting research and on the other hand a way to arrive at the result of the research itself, by testing and demonstrating the design. The analysis of the mangrove landscape in South Florida and Biscayne bay, using the landscape as a system method, is a form of design research. The landscape mangrove is explored and understood by making and combining maps and sections. When searching for the right tools for dealing with the challenges of the bay, existing designs are examined to find design principles. Subsequently, design is used as a method to apply the principles and to display the result. This form of research by design shows in a theoretical way how the outcome would function in practice.

## IMPLICATIONS & RECOMMENDATIONS

### IMPLICATIONS

The application of the research results will largely surround the coastline of Biscayne Bay with a natural landscape. This has implications for both the natural and the urban environment. In the south of the bay, the restoration of the wetlands can shift the boundaries of the national park and thereby expand, to protect this landscape and its function as coastal defence. In the north of the bay, the spatial experience of the border area between neighborhood and mangrove, and the waterfront through the barrier islands, changes. This will affect the current and future residents of these places and how they use the landscape.

### RECOMMENDATIONS

Recommendations to improve this research and the design result are to conduct further multidisciplinary research into the undiscovered parts of the aspects (structure, process and actor) of the used method. Ecological research on the different types in the mangrove landscape and their interrelation and dependence, hydrological research into sedimentation processes and barrier island development offshore and a social study on the behavior of the user towards the landscape. This allows a more detailed design to be made for Biscayne Bay. Furthermore it is important to take into account that the projections of the effects of climate change, such as sea level rise and increasing storm surges, deviate in future studies and that has consequences for the functions of the mangrove landscape and its spatial design.