HOUSTON, we've got a problem

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Brand, Nikki; Kothuis, B.L.M.

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PROGRAM CASE: HOUSTON GALVESTON BAY REGION, TEXAS, USA

Nikki Brand, Baukje Kothuis

HOUSTON, WE'VE GOT A PROBLEM

INTRODUCTION PROGRAM CASE HOUSTON GALVESTON BAY REGION, TEXAS (USA)

Dr. Nikki Brand was a Postdoc in the STW-MFFD program at the Faculty of Architecture & the Built Environment, TU Delft in the project 'Urban design challenges and opportunities of MFFD's up to 2015. She initiated the Texas Program Case in 2012 and has been involved ever since. Brand currently works as a researcher in the program 'Spatial Planning & strategy' and as an independent consultant in the NSF-PIRE Research and Education Exchange Program for Texas-based universities and TU Delft.

Dr. Baukje Kothuis was a Postdoc in the STW-MFFD program at the Faculty of Technology, Policy & Management, TU Delft in the project 'Integrated design'. Currently she works at the Faculty of Civil Engineering & Geosciences as a researcher in the NWO Program 'Integral & sustainable design of ports in Africa' and for TU Delft and Texas-based universities as an independent consultant and co-PI in the NSF-PIRE research and education exchange program 'Coastal Flood Risk Reduction' to develop partnerships for international research and education.

In 2012, the University of Houston's (UoH) Architecture Faculty organized the Three Continents Exchange, an educational project where master's students from Houston, Buenos Aires and New Orleans compared architecture strategies for flood-prone cities. UoH's professor Tom Colbert invited TU Delft's Architecture Faculty to participate. The invitation reached the MFFD program and sparked off a quest to include as much academic capacity as possible to address the region's urgent flood risk issues.

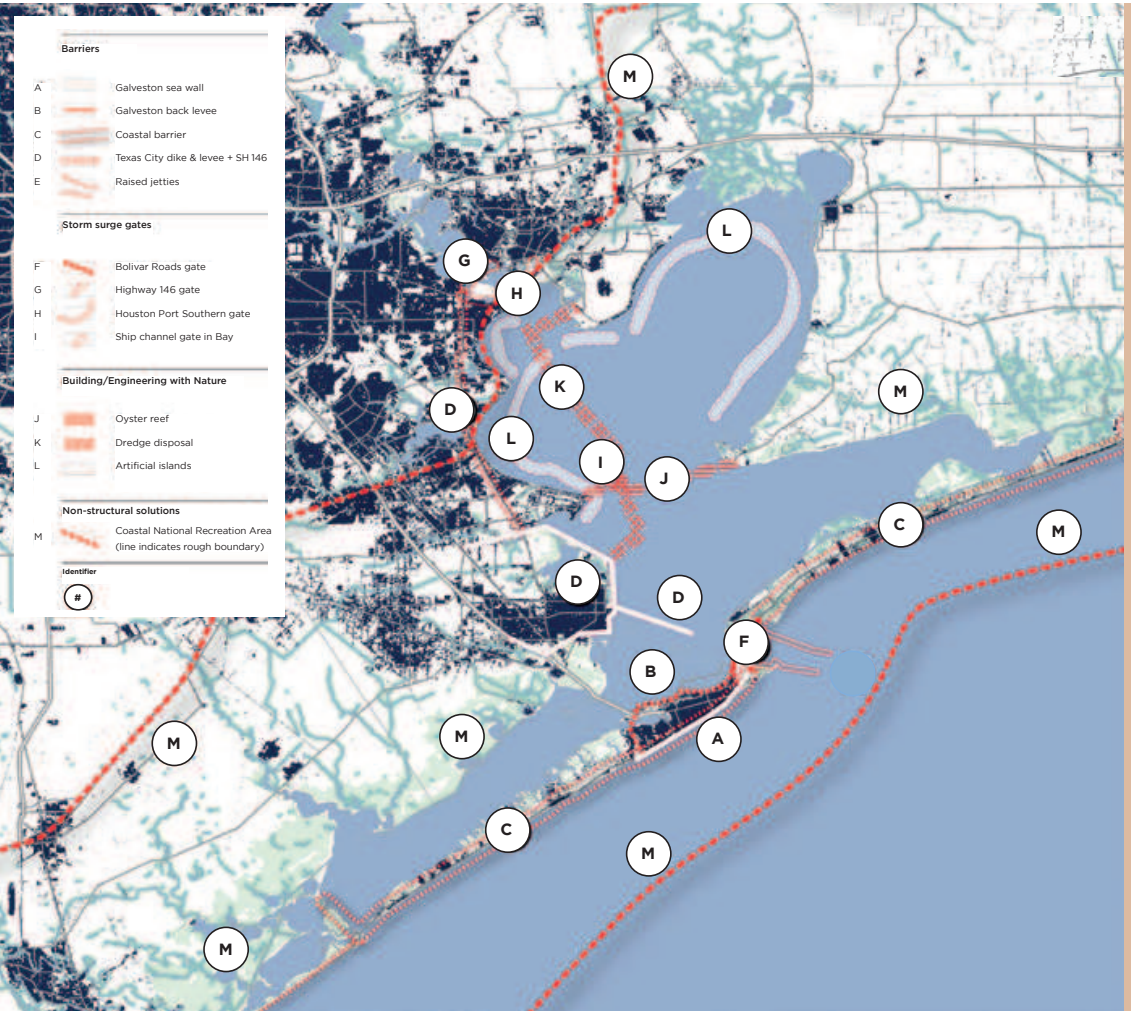
The Houston Galveston Bay Region in Texas is the fourth largest metropolis in the US, housing the largest petrochemical harbor in North America. Houston is located inland on Galveston Bay, and as a city, is notorious for not having land use controls. The city has expanded rapidly by incremental building activities, exacerbating run off, destroying natural habitats of bayous and wetlands, and reducing water buffer capacity. Houston is especially prone to flooding by severe rainfall events: at least three times in 2016 and early 2017. By contrast, the historical city of Galveston, located on a barrier island that shields Galveston Bay from the Gulf of Mexico, is prone to flooding by devastating storm surges. In 2008, Hurricane Ike produced a storm surge of 22 feet (6.8 meters), wiping the Bolivar Peninsula clean of houses. While flood events claim lives and damage livelihoods on a yearly basis, the region lacks a comprehensive flood safety system. With the exception of Galveston's historical sea wall and the Texas City Levee, the region has no structural flood defenses. Flood risk is mitigated primarily by evacuation programs, using an infrastructure network unable to cope with the demand, thus making evacuation potentially lethal too. In 2005, the exodus of 2.5 million people from the region to avoid Hurricane Rita, claimed a shocking 107 lives. The region's flood risk issues remain urgent, and the possibilities to reduce these risks via the traditional approach of emergency management and recovery has reached its limits.

In response to Ike - the hurricane that devastated Galveston but just missed Houston's petrochemical complex - two university-based groups in the region studied and promoted flood risk reduction strategies. The first, based at Texas A&M Galveston, supported the concept of the so-called Ike Dike: a land barrier on Galveston and Bolivar Islands combined with flood gates, inspired by the Dutch Delta Works. The second, based at Rice University and known as the SSPEED-center, focused on a series of projects based on urgency and environmental concerns. While a floodgate across the Ship Channel would protect the petrochemical port from surge, a large national park known as the Lone Star National Recreational Area (LSNRA) would stop building activities in the flood zone and provide economic opportunities for leisure. The ecology of Galveston Bay would then remain untouched. As architecture professor Tom Colbert was a participant in SSPEED from the very beginning, adding spatial quality via architectural design was part of SSPEED's approach too. While the SSPEED center built its first contacts with Dutch knowledge via the architecture, ecology and governance routes, Texas A&M engaged with TU Delft's hydraulic engineers. The two were able to meet thanks to the MFFD research program.

The complex and multidimensional nature of the flood risk challenge of the Houston Galveston Bay Region provided a unique opportunity for the MFFD researchers to study flood risk reduction in all its facets, employing multiple disciplines. The lack of flood safety efforts in the past also meant that a variety of comprehensive flood risk reduction strategies might still be feasible.

However, the region's flood risk challenge turned out to be so large, and the demand for knowledge and support so great, it could not be served by the MFFD program alone. MFFD researchers became part of a larger research consortium

Figure 1 (below). Gathering debris on Galveston Seawall one week after hurricane Ike in September 2008 (Photo courtesy: Jocelyn Augustino, FEMA).



that combined Texas A&M, SSPEED, TU Delft, WUR and a variety of consultancy and engineering firms. In order to assess the true contribution of the MFFD program, the results of this program case have to be read together with other publications like *Delft Delta Design: The Houston Galveston Bay Region* (Kothuis et al., 2015) and the *Land Barrier preliminary design* (Van Berchum et al., 2016). Milestones in the Dutch-Texas collaboration were winning the multi-million dollar NSF PIRE research grant for the Coastal Flood Risk Reduction program and the introduction of the 'multiple lines of defense'-approach in 2015. This concept, based on the consideration of residual surge in Galveston Bay even after the completion of the Ike Dike, combined and balanced proposals that had been presented earlier. It also introduced new flood defense strategies and structures like the Coastal Spine and the Midbay Barrier.

Meanwhile, local initiatives pushing for comprehensive flood risk reduction in the region have grown, with new groups like the Bay Area Coastal Protection Alliance (BACPA) influencing policy-making of formal decision makers like the Gulf Coast Community Protection and Recovery District (GCCPRD) and the Texas General Land Office (TGLO).

New approaches, incorporating concepts like Building/Engineering with Nature and Natural-and-Nature-Based Solutions to address flood risk in the Houston Galveston Bay Area, are seriously being considered and explored by governmental agencies as well as academics.

The research collaboration that the MFFD program inspired, continues to thrive and yield new results, even though changes have occurred in the group. In 2015 professor Tom Colbert passed away. But his legacy of including spatial co-benefits in the design of a flood risk reduction strategy lives on (just as in the MFFD program's philosophy). This is demonstrated by the role of landscape integration (Van Berchum et al., 2016) and Noordwijk-style suggestions for artificial dunes (see for example "Ike Dike could be hidden by dunes" in the Houston Chronicle, October 25, 2016). The NSF PIRE, a US Federal research grant, has made it possible for the existing consortium to expand their research and educational portfolio, and every year dozens of new students join place-based case studies. These efforts continue and stimulate ongoing multidisciplinary and transatlantic knowledge transfer in flood risk reduction.

Figure 2 (left). Map of Houston Galveston Bay Region showing various proposed interventions for local and regional flood risk reduction.

Figure 3 (right). Residences at the Bay side of Galveston Island; built on stilts to mitigate flood risk and comply to food risk insurance requirements (Photo courtesy Baukje Kothuis).